TENDER NUMBER: SK8/3/1-52/2024/25

TENDER DOCUMENT FOR:

MAMPURU BULK WATER SCHEME: PHASE 1A - RESERVOIRS

CIDB CLASS GRADING: 8CE or Higher

TENDER SUBMITTED BY:

NAME OF TENDERER	
AMOUNT OF TENDER (VAT INCLUSIVE)	
CIDB GRADE	
CSD NUMBER	
TEL (Office) No.	
Cell No.	
E-mail.	

ISSUED BY:

SEKHUKHUNE DISTRICT MUNICIPALITY
Private Bag X 8611
Groblersdal
0470
Tel: 013 262 7300
Fax: 013 262 3688

COMPILED BY:

ZUTARI (PTY) LTD
Baobab Corner, Clivicola Street
Cnr Munnik & De Wet Drive
Polokwane
0699
Tel: (015) 287 3800
Fax: (015) 287 3888

EXPANDED PUBLIC WORKS PROGRAMME

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TENDER NOTICE AND INVITATION TO TENDER

MAMPURU BULK WATER SCHEME: PHASE 1A - RESERVOIRS

TENDER NUMBER: SK8/3/1-52/2024/25

Description	Date of availability of documents	CIDB Grading	Briefing Venue and site inspection Date	Closing Date and Time	Contact Person for Technical Enquiries
Mampuru Bulk Water Scheme: Phase 1A - Reservoirs	28/05/2025	8CE or higher	Date: 03/06/2025 Time: 11h00 Venue: Mapodile Thusong Centre (Tukakgomo)	Date: 04/07/2025 Time: 14h00	Tender Enquiries to: Voster Masemola, Manager Supply Chain Management, masemolav@sekhukhune.gov.za Tel: 013 262 7656. Technical Enquiries to: Floyd Mashele Director Infrastructure mashelef@sekhukhune.gov.za Tel: 013 262 7535 during office hours

Tender documents are available from the Sekhukhune District Municipality Offices, Bareki Mall, corner Van Riebeek and Chris Wild Street, Groblersdal 0470.

Specifications and other conditions are detailed in the tender documents.

NO LATE/TELEPHONIC/FAXED OR EMAILED TENDERS WILL BE ACCEPTED

SEKHUKHUNE DISTRICT MUNICIPALITY

T1.2 Tender Data

The Conditions of Tender applicable to this contract are the Standard Conditions of Tender as contained in Annex C of the CIDB Standard for Uniformity in Engineering and Construction Works Contracts – August 2019.

The Standard Conditions of Tender makes several references to the Tender Data for details that apply specifically to this Tender. The Tender Data shall have preference in the interpretation of any ambiguity or inconsistency between it and the Standard Conditions of Tender.

Each item below is cross-referenced to the relevant clause in the Standard Conditions of Tender to which it applies.

Clause Number	**Tender Data**
C.1.1.1	The Employer is: Sekhukhune District Municipality (SDM)
	The Employer's domicilium citandi et executandi (permanent physical business address) is:
	Sekhukhune District Municipality Offices, Bareki Mall, Corner Van Riebeek & Chris Wild Street, Groblersdal 0470
	The Employer's address for communication relating to this project is:
	Private Bag X8611, GROBLERSDAL Telephone: (013) 262 7300 Fax: (013) 262 3688
C.1.2	The tender documents issued by the Employer comprise:

THE TENDER

Part T1	Tendering Procedures
T1.1	Tender Notice and Invitation to Tender
T1.2	Tender Data
T1.3	Standard Conditions of Tender
Part T2	Returnable Documents
T2.1	List of Returnable Documents
T2.2	Returnable Schedules

Clause Number	Tender Data

THE CONTRACT

Part C1	Agreement and Contract Data
C1.1	Form of Offer and Acceptance (Agreement)
C1.2	Contract Data
C1.3	Performance Guarantee (Pro Forma for Fixed)
C1.3	Performance Guarantee (Pro Forma for Variable)
C1.4	Retention Money Guarantee (Pro Forma)
C1.5	Adjudicator's Agreement
C1.6	Agreement in Terms of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993)
Part C2	Pricing Data
C2.1	Pricing Instructions
C2.2	Bill of Quantities
Part C3	Scope of Work
C3.1	Description of the Work
C3.2	Engineering
C3.3	Procurement
C3.4	Construction
C3.5	Management of the Works
C3.6	Health and Safety
C3.7	Specifications
Part C4	Site Information
C4.1	General
C4.2	Nature of ground and subsoil conditions
Part C5	Drawings
C5.1	List of drawings
Part C6	Annexures
C6.1	Occupational Health and Safety Specification
C6.2	Environmental Management Plan
C6.3	Geotechnical Report

C.1.4 The Employer's Agent is: ZUTARI (PTY) LTD

The Employer's Agent 's address for receipt of communications is:

Physical address:
Baobab Corner, Clivicola Street
Cnr Munnik & De Wet Drive
POLOKWANE
0699.

Postal address:
PO Box 3519.
Polokwane
0700.

Contact person: Niel Swarts
Tel: (015) 287 3800
Email: Polokwane@zutari.com

C.1.6.2 A competitive negotiation procedure will not be followed.

Clause Number	Tender Data
C.1.6.3	A two stage-system will not be followed.
C.2.1	Only those tenderers who can demonstrate that they will have in their employ management and supervisory staff satisfying the requirement of the scope of work for labour-intensive competencies for supervisory and management staff during the validity of the contract are eligible to submit tenders. Only those tenderers who are registered with the CIDB, or are capable of being so registered prior to the evaluation of submissions, in a contractor grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered, or a value determined in accordance with Regulation 25(1B) or 25(7A) of the Construction Industry Development Regulations, for a 8 CE or higher class of construction work, are eligible to have their tenders evaluated. Joint ventures are eligible to submit tenders provided that: 1. every member of the joint venture is registered with the CIDB; 2. the lead partner has a contractor grading designation in the CE class of construction work; and 3. the combined contractor grading designation calculated in accordance with the Construction Industry Development Regulations is equal to or higher than a contractor grading designation determined in accordance with the sum tendered for an 8 CE class of construction work or a value determined in accordance with Regulation 25(1B) or 25(7A) of the Construction Industry Development Regulations.
C.2.3	The tenderer is required to complete his/ her tender in full using a black ink. The tenderer is required to initial all pages of the tender document. Failure to complete the form of offer in full is an automatic disqualification. Other contraventions also constitute an incomplete tender and may result in the tender being disqualified.
C.2.6	Failure to apply instructions contained in addenda may render a tenderer’s offer non-responsive in terms of clause C.3.8.
C.2.7	The arrangements for a compulsory clarification meeting are as specified in the Tender Notice and Invitation to Tender. The onus rests with the tenderer to ensure that the person attending the clarification meeting on his behalf is appropriately qualified to understand all directives and clarifications given at that meeting. Tenderers shall sign the attendance list in the name of the tendering entity. Addenda will be issued to, and tenders will be received only from those tendering entities appearing on the attendance list. The tenderer shall bear all costs associated with his visit or visits to the site and his attendance at the compulsory clarification meeting.
C.2.8	Request clarifications at least 7 working days before the closing time.
C.2.11	Do not make any alterations or additions to the tender documents, except to comply with the instructions issued by employer, or necessary to correct errors made by the Tenderer. All signatories to the tender offer shall initial all alterations. Erasure and the use of masking fluid are prohibited.
C.2.12	If a tenderer wishes to submit an alternative tender offer, the tenderer shall in addition to the conforming Tender submit a separate complete set of Tender Documents clearly marked as an "Alternative Tender" in order to distinguish it from the unqualified Tender. The only criteria permitted for such alternative tender offer is that it demonstrably satisfies the Employer's standards and requirements, the details of which may be obtained from the Employer's Agent.

Clause Number	Tender Data

Calculations, drawings and all other pertinent technical information and characteristics as well as modified or proposed Pricing Data must be submitted with the alternative tender offer to enable the Employer to evaluate if the efficacy of the alternative complies with the Employer's standards and requirements and its principal elements, to take a view on the degree to which the alternative and to evaluate the acceptability of the pricing proposals. Calculations must be set out in a clear and logical sequence and must clearly reflect all design assumptions. Pricing Data must reflect all assumptions in the development of the pricing proposal.

Acceptance of an alternative tender offer will mean acceptance in principle of the offer. It will be an obligation of the Contract for the tenderer, in the event that the alternative is accepted, to accept full responsibility and liability that the alternative offer complies in all respects with the Employer's standards and requirements.

The modified Pricing Data must include an amount equal to 5% of the amount tendered for the alternative offer to cover the Employer's costs of confirming the acceptability of the detailed design before it is constructed.

C.2.13.1 Tenderers are not allowed to submit more than one offer, either as a single entity or as part of a joint venture.

C.2.13.4 Parts of each tender offer communicated on paper shall be submitted as an original, plus NIL copies.

C.2.13.5 Submit only the signed “Original” Tender offer.

C.2.13.6 A two-envelope procedure will **not** be followed.

C.2.13.7 Place and seal the printed and completed tender document in an envelope clearly marked "TENDER" and bearing the Employer’s name, the contract number and description, the tenderer’s authorised representative’s name, the tenderer’s postal address and contact telephone numbers.

C.2.13.9 Telephonic, facsimile or emailed tender offers will **not** be accepted.

C.2.15.1 The Employer’s address for the delivery of tender offers and identification details to be shown on each tender offer package are:

Location of tender box:	AB Skhosana Fire station (Groblersdal)
Physical address:	Sekhukhune District Municipality Offices, Bareki Mall, Corner Van Riebeek & Chris Wild Street, Groblersdal 0470
Identification details:	Place the signed original tender offer in a package marked TENDER: CONTRACT No. **SK8/3/1-52/2024/25**

Tenders must be submitted during office hours (08:00 to 16:00 hrs) Monday to Friday at the Employer’s address.

C.2.15.2 The closing time for submission of tender offers is 14:00pm on 04 July 2025

C.2.16.1 The tender offer validity period is 90 days.

C.2.18 Any additional information requested under this clause must be provided within 7 working days of the date of request.

The Tenderer shall, when requested by the Employer to do so, submit the names of all management and supervisory staff that will be employed to supervise the labour-intensive portion of the Works together with satisfactory evidence that such staff members satisfy the eligibility requirements.

C.2.19 Access shall be provided for inspections, tests and analyses:

Clause Number	Tender Data
C.2.23	The Tenderer is required to submit with his Tender a Certificate of Contractor Registration issued by the Construction Industry Development Board and a copy of an original valid Tax Clearance Certificate issued by the South African Revenue Services. Where a Tenderer satisfies CIDB contractor grading designation requirements through joint venture formation, such Tenderers must submit the Certificates of Contractor Registration in respect of each partner.
C.3.1.1	The Employer shall respond to clarifications received up to 7 working days before the tender closing time.
C.3.2	The Employer shall issue addenda until 7 working days before the tender closing time.
C.3.4.1	Tenders will be opened immediately after the closing time for Tenders at Municipal Offices
C.3.4.2	Location: Sekhukhune District Municipality Offices, Bareki Mall, Corner Van Riebeek & Chris Wild Street, Groblersdal 0470
C.3.5.1	The two-envelope system will not be followed for this Tender.
C.3.7	In the event of disqualification, the Employer may, at his sole discretion, impose a specified period during which tender offers will not be accepted from the offending tenderer and report same to the CIDB and National Treasury.
C.3.11.1	The procedure for the evaluation of responsive tenders is stated in T1.4 Evaluation of Tender offers.
C.3.13	In addition to the requirements of the Condition of Tender, offers will only be accepted if: • the Tenderer has in his or her possession an original valid Tax Clearance Certificate issued by the South African Revenue Services or has made arrangements to meet outstanding tax obligations; • the Tenderer is registered with the Construction Industry Development Board in an appropriate contractor grading designation; • the Tenderer or any of its directors is not listed on the Register of Tender Defaulters in terms of the Prevention and Combating of Corrupt Activities Act of 2004 as a person prohibited from doing business with the public sector; • the Tenderer has not: i) abused the Employer's Supply Chain Management System; or ii) failed to perform on any previous contract and has been given a written notice to this effect • Tenderer has completed the Compulsory Enterprise Questionnaire and there are no conflicts of interest which may impact on the Tenderer's ability to perform the contract in the best interests of the employer or potentially compromise the Tender process. • the Tenderer does not have arrears on municipal rates, levies exceeding 3 months • the Tenderer has a compliant CSD.
C.3.17	The number of paper copies of the signed contract to be provided by the Employer is 1.
C.3.18	All requests shall be in writing.

ADDITIONAL CONDITIONS OF TENDER CLAUSES:

C.3.19 **Jurisdiction**

Unless stated otherwise in the tender data, each tenderer and the Employer undertake to accept the jurisdiction of the law courts of the Republic of South Africa.

T1.3 Standard Conditions of Tender

ANNEX C:

Standard Conditions of Tender

C.1 General

C.1.1 Actions

C.1.1.1 The employer and each tenderer submitting a tender offer shall comply with these conditions of tender. In their dealings with each other, they shall discharge their duties and obligations as set out in C.2 and C.3, timeously and with integrity, and behave equitably, honestly and transparently, comply with all legal obligations and not engage in anticompetitive practices.

C.1.1.2 The employer and the tenderer and all their agents and employees involved in the tender process shall avoid conflicts of interest and where a conflict of interest is perceived or known, declare any such conflict of interest, indicating the nature of such conflict. Tenderers shall declare any potential conflict of interest in their tender submissions. Employees, agents and advisors of the employer shall declare any conflict of interest to whoever is responsible for overseeing the procurement process at the start of any deliberations relating to the procurement process or as soon as they become aware of such conflict and abstain from any decisions where such conflict exists or recuse themselves from the procurement process, as appropriate.

Note:

1) A conflict of interest may arise due to a conflict of roles which might provide an incentive for improper acts in some circumstances. A conflict of interest can create an appearance of impropriety that can undermine confidence in the ability of that person to act properly in his or her position even if no improper acts result.

2) Conflicts of interest in respect of those engaged in the procurement process include direct, indirect or family interests in the tender or outcome of the procurement process and any personal bias, inclination, obligation, allegiance or loyalty which would in any way affect any decisions taken.

C.1.1.3 The employer shall not seek and a tenderer shall not submit a tender without having a firm intention and the capacity to proceed with the contract.

C.1.2 Tender Documents

The documents issued by the employer for the purpose of a tender offer are listed in the tender data.

C.1.3 Interpretation

C.1.3.1 The tender data and additional requirements contained in the tender schedules that are included in the returnable documents are deemed to be part of these conditions of tender.

C.1.3.2 These conditions of tender, the tender data and tender schedules which are required for tender evaluation purposes, shall form part of any contract arising from the invitation to tender.

C.1.3.3 For the purposes of these conditions of tender, the following definitions apply:

a) **conflict of interest** means any situation in which:

i) someone in a position of trust has competing professional or personal interests which make it difficult to fulfil his or her duties impartially;

ii) an individual or tenderer is in a position to exploit a professional or official capacity in some way for their personal or corporate benefit; or

iii) incompatibility or contradictory interests exist between an employee and the tenderer who employs that employee.

b) **comparative offer** means the price after the factors of a non-firm price and all unconditional discounts it can be utilised to have been taken into consideration;

c) **corrupt practice** means the offering, giving, receiving or soliciting of anything of value to influence the action of the employer or his staff or agents in the tender process;

d) **fraudulent practice** means the misrepresentation of the facts in order to influence the tender process or the award of a contract arising from a tender offer to the detriment of the employer, including collusive practices intended to establish prices at artificial levels;

C.1.4 Communication and employer's agent

Each communication between the employer and a tenderer shall be to or from the employer's agent only, and in a form that can be readily read, copied and recorded. Communications shall be in the English language. The employer shall not take any responsibility for non-receipt of communications from or by a tenderer. The name and contact details of the employer's agent are stated in the tender data.

C.1.5 Cancellation and Re-Invitation of Tenders

C.1.5.1 An employer may, prior to the award of the tender, cancel a tender if-

a) due to changed circumstances, there is no longer a need for the engineering and construction works specified in the invitation;

b) funds are no longer available to cover the total envisaged expenditure; or

c) no acceptable tenders are received.

d) there is a material irregularity in the tender process.

C.1.5.2 The decision to cancel a tender invitation must be published in the same manner in which the original tender invitation was advertised

C.1.5.3 An employer may only with the prior approval of the relevant treasury cancel a tender invitation for the second time.

C.1.6 Procurement procedures

C.1.6.1 General

Unless otherwise stated in the tender data, a contract will, subject to C.3.13, be concluded with the tenderer who in terms of C.3.11 is the highest ranked or the tenderer scoring the highest number of tender evaluation points, as relevant, based on the tender submissions that are received at the closing time for tenders.

C.1.6.2 Competitive negotiation procedure

C.1.6.2.1 Where the tender data require that the competitive negotiation procedure is to be followed, tenderers shall submit tender offers in response to the proposed contract in the first round of submissions. Notwithstanding the requirements of C.3.4, the employer shall announce only the names of the tenderers who make a submission. The requirements of C.3.8 relating to the material deviations or qualifications which affect the competitive position of tenderers shall not apply.

C.1.6.2.2 All responsive tenderers or at least a minimum of not less than three responsive tenderers that are highest ranked in terms of the evaluation criteria stated in the tender data shall be invited to enter into competitive negotiations based on the principle of equal treatment, keeping confidential the proposed solutions and associated information.

Notwithstanding the provisions of C.2.17, the employer may request that tenders be clarified, specified and fine-tuned in order to improve a tenderer's competitive position provided that such clarification, specification, fine-tuning or additional information does not alter any fundamental aspects of the offers or impose substantial new requirements which restrict or distort competition or have a discriminatory effect.

C.1.6.2.3 At the conclusion of each round of negotiations, tenderers shall be invited by the employer to revise their tender offer based on the same evaluation criteria, with or without adjusted weightings. Tenderers shall be advised when they are to submit their best and final offer.

C.1.6.2.4 The contract shall be awarded in accordance with the provisions of C.3.11 and C.3.13 after tenderers have been requested to submit their best and final offer.

C.1.6.3 Proposal procedure using the two stage-system

C.1.6.3.1 Option 1

Tenderers shall in the first stage submit technical proposals and, if required, cost parameters around which a contract may be negotiated. The employer shall evaluate each responsive submission in terms of the method of evaluation stated in the tender data, and in the second stage negotiate a contract with the tenderer scoring the highest number of evaluation points and award the contract in terms of these conditions of tender.

C.1.6.3.2 Option 2

C.1.6.3.2.1 Tenderers shall submit in the first stage only technical proposals. The employer shall invite all responsive tenderers to submit tender offers in the second stage, following the issuing of procurement documents.

C.1.6.3.2.2 The employer shall evaluate tenders received during the second stage in terms of the method of evaluation stated in the tender data, and award the contract in terms of these conditions of tender.

C.2 Tenderer's obligations

C.2.1 Eligibility

C.2.1.1 Submit a tender offer only if the tenderer satisfies the criteria stated in the tender data and the tenderer, or any of his principals, is not under any restriction to do business with employer.

C.2.1.2 Notify the employer of any proposed material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used by the employer as the basis in a prior process to invite the tenderer to submit a tender offer and obtain the employer's written approval to do so prior to the closing time for tenders.

C.2.2 Cost of tendering

C.2.2.1 Accept that, unless otherwise stated in the tender data, the employer will not compensate the tenderer for any costs incurred in the preparation and submission of a tender offer, including the costs of any testing necessary to demonstrate that aspects of the offer complies with requirements.

C.2.2.2 The cost of the tender documents charged by the employer shall be limited to the actual cost incurred by the employer for printing the documents. Employers must attempt to make available the tender documents on its website so as not to incur any costs pertaining to the printing of the tender documents.

C.2.3 Check documents

Check the tender documents on receipt for completeness and notify the employer of any discrepancy or omission.

C.2.4 Confidentiality and copyright of documents

Treat as confidential all matters arising in connection with the tender. Use and copy the documents issued by the employer only for the purpose of preparing and submitting a tender offer in response to the invitation.

C.2.5 Reference documents

Obtain, as necessary for submitting a tender offer, copies of the latest versions of standards, specifications, conditions of contract and other publications, which are not attached but which are incorporated into the tender documents by reference.

C.2.6 Acknowledge addenda

Acknowledge receipt of addenda to the tender documents, which the employer may issue, and if necessary apply for an extension to the closing time stated in the tender data, in order to take the addenda into account.

C.2.7 Clarification meeting

Attend, where required, a clarification meeting at which tenderers may familiarize themselves with aspects of the proposed work, services or supply and raise questions. Details of the meeting(s) are stated in the tender data.

C.2.8 Seek clarification

Request clarification of the tender documents, if necessary, by notifying the employer at least five (5) working days before the closing time stated in the tender data.

C.2.9 Insurance

Be aware that the extent of insurance to be provided by the employer (if any) might not be for the full cover required in terms of the conditions of contract identified in the contract data. The tenderer is advised to seek qualified advice regarding insurance.

C.2.10 Pricing the tender offer

C.2.10.1 Include in the rates, prices, and the tendered total of the prices (if any) all duties, taxes except Value Added Tax (VAT), and other levies payable by the successful tenderer, such duties, taxes and levies being those applicable fourteen (14) days before the closing time stated in the tender data.

C.2.10.2 Show VAT payable by the employer separately as an addition to the tendered total of the prices.

C.2.10.3 Provide rates and prices that are fixed for the duration of the contract and not subject to adjustment except as provided for in the conditions of contract identified in the contract data.

C.2.10.4 State the rates and prices in Rand unless instructed otherwise in the tender data. The conditions of contract identified in the contract data may provide for part payment in other currencies.

C.2.11 Alterations to documents

Do not make any alterations or additions to the tender documents, except to comply with instructions issued by the employer, or necessary to correct errors made by the tenderer. All signatories to the tender offer shall initial all such alterations.

C.2.12 Alternative tender offers

C.2.12.1 Unless otherwise stated in the tender data, submit alternative tender offers only if a main tender offer, strictly in accordance with all the requirements of the tender documents, is also submitted as well as a schedule that compares the requirements of the tender documents with the alternative requirements that are proposed.

C.2.12.2 Accept that an alternative tender offer must be based only on the criteria stated in the tender data or criteria otherwise acceptable to the employer.

C.2.12.3 An alternative tender offer must only be considered if the main tender offer is the winning tender.

C.2.13 Submitting a tender offer

C.2.13.1 Submit one tender offer only, either as a single tendering entity or as a member in a joint venture to provide the whole of the works identified in the contract data and described in the scope of works, unless stated otherwise in the tender data.

C.2.13.2 Return all returnable documents to the employer after completing them in their entirety, either electronically (if they were issued in electronic format) or by writing legibly in non-erasable ink.

C.2.13.3 Submit the parts of the tender offer communicated on paper as an original plus the number of copies stated in the tender data, with an English translation of any documentation in a language other than English, and the parts communicated electronically in the same format as they were issued by the employer.

C.2.13.4 Sign the original and all copies of the tender offer where required in terms of the tender data. The employer will hold all authorized signatories liable on behalf of the tenderer. Signatories for tenderers proposing to contract as joint ventures shall state which of the signatories is the lead partner whom the employer shall hold liable for the purpose of the tender offer.

C.2.13.5 Seal the original and each copy of the tender offer as separate packages marking the packages as "ORIGINAL" and "COPY". Each package shall state on the outside the employer's address and identification details stated in the tender data, as well as the tenderer's name and contact address.

C.2.13.6 Where a two-envelope system is required in terms of the tender data, place and seal the returnable documents listed in the tender data in an envelope marked “financial proposal” and place the remaining returnable documents in an envelope marked “technical proposal”. Each envelope shall state on the outside the employer’s address and identification details stated in the tender data, as well as the tenderer's name and contact address.

C.2.13.7 Seal the original tender offer and copy packages together in an outer package that states on the outside only the employer's address and identification details as stated in the tender data.

C.2.13.8 Accept that the employer will not assume any responsibility for the misplacement or premature opening of the tender offer if the outer package is not sealed and marked as stated.

C.2.13.9 Accept that tender offers submitted by facsimile or e-mail will be rejected by the employer, unless stated otherwise in the tender data.

C.2.14 Information and data to be completed in all respects

Accept that tender offers, which do not provide all the data or information requested completely and in the form required, may be regarded by the employer as non-responsive.

C.2.15 Closing time

C.2.15.1 Ensure that the employer receives the tender offer at the address specified in the tender data not later than the closing time stated in the tender data. Accept that proof of posting shall not be accepted as proof of delivery.

C.2.15.2 Accept that, if the employer extends the closing time stated in the tender data for any reason, the requirements of these conditions of tender apply equally to the extended deadline.

C.2.16 Tender offer validity

C.2.16.1 Hold the tender offer(s) valid for acceptance by the employer at any time during the validity period stated in the tender data after the closing time stated in the tender data.

C.2.16.2 If requested by the employer, consider extending the validity period stated in the tender data for an agreed additional period with or without any conditions attached to such extension.

C.2.16.3 Accept that a tender submission that has been submitted to the employer may only be withdrawn or substituted by giving the employer's agent written notice before the closing time for tenders that a tender is to be withdrawn or substituted. If the validity period stated in C.2.16 lapses before the employer evaluating tender, the contractor reserves the right to review the price based on Consumer Price Index (CPI).

C.2.16.4 Where a tender submission is to be substituted, a tenderer must submit a substitute tender in accordance with the requirements of C.2.13 with the packages clearly marked as "SUBSTITUTE".

C.2.17 Clarification of tender offer after submission

Provide clarification of a tender offer in response to a request to do so from the employer during the evaluation of tender offers. This may include providing a breakdown of rates or prices and correction of arithmetical errors by the adjustment of certain rates or item prices (or both). No change in the competitive position of tenderers or substance of the tender offer is sought, offered, or permitted.

Note: *Sub-clause C.2.17 does not preclude the negotiation of the final terms of the contract with a preferred tenderer following a competitive selection process, should the Employer elect to do so.*

C.2.18 Provide other material

C.2.18.1 Provide, on request by the employer, any other material that has a bearing on the tender offer, the tenderer's commercial position (including notarized joint venture agreements), preferencing arrangements, or samples of materials, considered necessary by the employer for the purpose of a full and fair risk assessment.

Should the tenderer not provide the material, or a satisfactory reason as to why it cannot be provided, by the time for submission stated in the employer's request, the employer may regard the tender offer as non-responsive.

C.2.18.2 Dispose of samples of materials provided for evaluation by the employer, where required.

C.2.19 Inspections, tests and analysis

Provide access during working hours to premises for inspections, tests and analysis as provided for in the tender data.

C.2.20 Submit securities, bonds and policies

If requested, submit for the employer's acceptance before formation of the contract, all securities, bonds, guarantees, policies and certificates of insurance required in terms of the conditions of contract identified in the contract data.

C.2.21 Check final draft

Check the final draft of the contract provided by the employer within the time available for the employer to issue the contract.

C.2.22 Return of other tender documents

If so instructed by the employer, return all retained tender documents within twenty-eight (28) days after the expiry of the validity period stated in the tender data.

C.2.23 Certificates

Include in the tender submission or provide the employer with any certificates as stated in the tender data.

C.3 The employer's undertakings

C.3.1 Respond to requests from the tenderer

C.3.1.1 Unless otherwise stated in the tender Data, respond to a request for clarification received up to five (5) working days before the tender closing time stated in the Tender Data and notify all tenderers who collected tender documents.

C.3.1.2 Consider any request to make a material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used to prequalify a tenderer to submit a tender offer in terms of a previous procurement process and deny any such request if as a consequence:

a) an individual firm, or a joint venture as a whole, or any individual member of the joint venture fails to meet any of the collective or individual qualifying requirements;

b) the new partners to a joint venture were not prequalified in the first instance, either as individual firms or as another joint venture; or

c) in the opinion of the Employer, acceptance of the material change would compromise the outcome of the prequalification process.

C.3.2 Issue Addenda

If necessary, issue addenda that may amend or amplify the tender documents to each tenderer during the period from the date that tender documents are available until three (3) working days before the tender closing time stated in the Tender Data. If, as a result a tenderer applies for an extension to the closing time stated in the Tender Data, the Employer may grant such extension and, shall then notify all tenderers who collected tender documents.

C.3.3 Return late tender offers

Return tender offers received after the closing time stated in the Tender Data, unopened, (unless it is necessary to open a tender submission to obtain a forwarding address), to the tenderer concerned.

C.3.4 Opening of tender submissions

C.3.4.1 Unless the two-envelope system is to be followed, open valid tender submissions in the presence of tenderers' agents who choose to attend at the time and place stated in the tender data. Tender submissions for which acceptable reasons for withdrawal have been submitted will not be opened.

C.3.4.2 Announce at the meeting held immediately after the opening of tender submissions, at a venue indicated in the tender data, the name of each tenderer whose tender offer is opened and, where applicable, the total of his prices, number of points claimed for its BBBEE status level and time for completion for the main tender offer only.

C.3.4.3 Make available the record outlined in C.3.4.2 to all interested persons upon request.

C.3.5 Two-envelope system

C.3.5.1 Where stated in the tender data that a two-envelope system is to be followed, open only the technical proposal of valid tenders in the presence of tenderers' agents who choose to attend at the time and place stated in the tender data and announce the name of each tenderer whose technical proposal is opened.

C.3.5.2 Evaluate functionality of the technical proposals offered by tenderers, then advise tenderers who remain in contention for the award of the contract of the time and place when the financial proposals will be opened. Open only the financial proposals of tenderers, who score in the functionality evaluation more than the minimum number of points for functionality stated in the tender data, and announce the score obtained for the technical proposals and the total price and any points claimed on BBBEE status level. Return unopened financial proposals to tenderers whose technical proposals failed to achieve the minimum number of points for functionality.

C.3.6 Non-disclosure

Not disclose to tenderers, or to any other person not officially concerned with such processes, information relating to the evaluation and comparison of tender offers, the final evaluation price

and recommendations for the award of a contract, until after the award of the contract to the successful tenderer.

C.3.7 Grounds for rejection and disqualification

Determine whether there has been any effort by a tenderer to influence the processing of tender offers and instantly disqualify a tenderer (and his tender offer) if it is established that he engaged in corrupt or fraudulent practices.

C.3.8 Test for responsiveness

C.3.8.1 Determine, after opening and before detailed evaluation, whether each tender offer properly received:

a) complies with the requirements of these Conditions of Tender,

b) has been properly and fully completed and signed, and

c) is responsive to the other requirements of the tender documents.

C.3.8.2 A responsive tender is one that conforms to all the terms, conditions, and specifications of the tender documents without material deviation or qualification. A material deviation or qualification is one which, in the Employer*'s* opinion, would:

a) detrimentally affect the scope, quality, or performance of the works, services or supply identified in the Scope of Work*,*

b) significantly change the Employer*'s* or the tenderer's risks and responsibilities under the contract, or

c) affect the competitive position of other tenderers presenting responsive tenders, if it were to be rectified.

Reject a non-responsive tender offer, and not allow it to be subsequently made responsive by correction or withdrawal of the non-conforming deviation or reservation.

C.3.9 Arithmetical errors, omissions and discrepancies

C.3.9.1 Check responsive tenders for discrepancies between amounts in words and amounts in figures. Where there is a discrepancy between the amounts in figures and the amount in words, the amount in words shall govern.

C.3.9.2 Check the highest ranked tender or tenderer with the highest number of tender evaluation points after the evaluation of tender offers in accordance with C.3.11 for:

a) the gross misplacement of the decimal point in any unit rate;

b) omissions made in completing the pricing schedule or bills of quantities; or

c) arithmetic errors in:

(i) line item totals resulting from the product of a unit rate and a quantity in bills of quantities or schedules of prices; or

(ii) the summation of the prices.

C.3.9.3 Notify the tenderer of all errors or omissions that are identified in the tender offer and either confirm the tender offer as tendered or accept the corrected total of prices.

C.3.9.4 Where the tenderer elects to confirm the tender offer as tendered, correct the errors as follows:

a) If bills of quantities or pricing schedules apply and there is an error in the line item total resulting from the product of the unit rate and the quantity, the line item total shall govern and the rate shall be corrected. Where there is an obviously gross misplacement of the decimal point in the unit rate, the line item total as quoted shall govern, and the unit rate shall be corrected.

b) Where there is an error in the total of the prices either as a result of other corrections required by this checking process or in the tenderer's addition of prices, the total of the prices shall govern and the tenderer will be asked to revise selected item prices (and their rates if bills of quantities apply) to achieve the tendered total of the prices.

C.3.10 Clarification of a tender offer

Obtain clarification from a tenderer on any matter that could give rise to ambiguity in a contract arising from the tender offer.

C.3.11 Evaluation of tender offers

The Standard Conditions of Tender standardize the procurement processes, methods and procedures from the time that tenders are invited to the time that a contract is awarded. They are generic in nature and are made project specific through choices that are made in developing the Tender Data associated with a specific project.

Conditions of tender are by definition the document that establishes a tenderer's obligations in submitting a tender and the employer's undertakings in soliciting and evaluating tender offers. Such conditions establish the rules from the time a tender is advertised to the time that a contract is awarded and require employers to conduct the process of offer and acceptance in terms of a set of standard procedures.

The CIDB Standard Conditions of Tender are based on a procurement system that satisfies the following system requirements:	
Requirement	**Qualitative interpretation of goal**
Fair	The process of offer and acceptance is conducted impartially without bias, providing simultaneous and timely access to participating parties to the same information.
Equitable	Terms and conditions for performing the work do not unfairly prejudice the interests of the parties.
Transparent	The only grounds for not awarding a contract to a tenderer who satisfies all requirements are restrictions from doing business with the employer, lack of capability or capacity, legal impediments and conflicts of interest.
Competitive	The system provides for appropriate levels of competition to ensure cost effective and best value outcomes.
Cost effective	Cost effective

The activities associated with evaluating tender offers are as follows:

a) Open and record tender offers received

b) Determine whether or not tender offers are complete

c) Determine whether or not tender offers are responsive

d) Evaluate tender offers

e) Determine if there are any grounds for disqualification

f) Determine acceptability of preferred tenderer

g) Prepare a tender evaluation report

h) Confirm the recommendation contained in the tender evaluation report

C.3.11.1 General

The employer must appoint an evaluation panel of not less than three persons conversant with the proposed scope of works to evaluate each responsive tender offer using the tender evaluation methods and associated evaluation criteria and weightings that are specified in the tender data.

C.3.12 Insurance provided by the employer

If requested by the proposed successful tenderer, submit for the tenderer*'s* information the policies and / or certificates of insurance which the conditions of contract identified in the contract data, require the employer to provide.

C.3.13 Acceptance of tender offer

Accept the tender offer; if in the opinion of the employer, it does not present any risk and only if the tenderer:

a) is not under restrictions, or has principals who are under restrictions, preventing participating in the employer's procurement;

b) can, as necessary and in relation to the proposed contract, demonstrate that he or she possesses the professional and technical qualifications, professional and technical competence, financial resources, equipment and other physical facilities, managerial capability, reliability, experience and reputation, expertise and the personnel, to perform the contract;

c) has the legal capacity to enter into the contract;

d) is not; insolvent, in receivership, under Business Rescue as provided for in chapter 6 of the Companies Act No. 2008, bankrupt or being wound up, has his/her affairs administered by a court or a judicial officer, has suspended his/her business activities or is subject to legal proceedings in respect of any of the foregoing;

e) complies with the legal requirements, if any, stated in the tender data; and

f) is able, in the opinion of the employer, to perform the contract free of conflicts of interest.

C.3.14 Prepare contract documents

C.3.14.1 If necessary, revise documents that shall form part of the contract and that were issued by the employer as part of the tender documents to take account of:

a) addenda issued during the tender period,

b) inclusion of some of the returnable documents and

c) other revisions agreed between the employer and the successful tenderer.

C.3.14.2 Complete the schedule of deviations attached to the form of offer and acceptance, if any.

C.3.15 Complete adjudicator's contract

Unless alternative arrangements have been agreed or otherwise provided for in the contract, arrange for both parties to complete formalities for appointing the selected adjudicator at the same time as the main contract is signed.

C.3.16 Registration of the award

An employer must, within twenty-one (21) working days from the date on which a contractor's offer to perform a construction works contract is accepted in writing by the employer, register and publish the award on the cidb Register of Projects.

C.3.17 Provide copies of the contracts

Provide to the successful tenderer the number of copies stated in the Tender Data of the signed copy of the contract as soon as possible after completion and signing of the form of offer and acceptance.

C.3.18 Provide written reasons for actions taken

Provide upon request written reasons to tenderers for any action that is taken in applying these conditions of tender but withhold information which is not in the public interest to be divulged, which is considered to prejudice the legitimate commercial interests of tenderers or might prejudice fair competition between tenderers.

T1.4 Evaluation of Tender offers

1.4.1 General

Step 1

Tenderers will firstly be evaluated on their responsiveness, and this includes the following:

1. Valid Tax Clearance Certificate
2. Attendance of Compulsory Site meeting
3. Authority of Signatory
4. Proof of Company Registration
5. Certified copies of Identity documents
6. JV agreement in case of a Joint Venture
7. Signing of all MBD forms
8. Signing of Form of Offer
9. BoQ filled in using a black pen
10. Initial all the pages of the Tender document
11. Municipal Rates and Taxes
12. Alterations signed
13. CIDB grading certificate
14. A detailed list of returnable documents as indicated on T2.1

Step 2

According to the MFMA Circular No. 53 of the Municipal Finance Act No. 56 of 2003. Tenderers will firstly be evaluated on Functionality. The minimum Score for functionality is 70%.

Only the qualifying Tenderers will be evaluated further. The following is the criteria that will be used to evaluate the Tenderers in terms of Functionality:

FUNCTIONALITY COMPETENCE ACHIEVEMENT SCHEDULES

TABLE A1: CONTRACTOR'S EXPERIENCE

	TARGETED GOALS **Name reference with contact details**	**TENDERED GOAL**	**POINTS CLAIMED BY TENDERER**	**ALLOCATED POINTS**
1	One project of similar scope in the last 10 years (Water Retaining Structure Projects) with minimum value R40m to R75m	10		
2	One project of similar scope in the last 5 years (Water Retaining Structure Projects) with minimum value R75m to R100m	20		
3	One project of similar scope in the last 5 years (Water Retaining Structure Projects) with minimum value R100m and above.	30		
	SUB-TOTAL: Reputation and References	**30**		

N.B: TENDERERS MUST SUBMIT NAMES THE FOLLOWING:
- COMPLETE WITH VALID CONTACT DETAILS.
- SIGNED APPOINTMENT LETTERS AND PRACTICAL COMPLETION CERTIFICATES
NON-SUBMISSION OF THE ABOVE WILL RESULT IN LOSS OF POINTS.

TABLE A2: PERSONNEL EXPERIENCE

	TARGETED GOALS	**YEARS BREAKDOWN**	**TENDERED POINTS**	**POINTS CLAIMED BY TENDERER**	**ALLOCATED POINTS**
1	Contracts Manager years of experience in Water Retaining Structure related construction projects or related.	1-2	3.5		
		2-4	7.5		
		5 upwards	10		

	Sub-Total		**10**		
2	Site agent years of experience in construction of Water Retaining Structure related projects or related.	1-2	3.5		
		2-4	7.5		
		5 upwards	10		
	Sub-Total		**10**		
	TOTAL: Experience		**20**		

N.B: TENDERERS MUST SUBMIT PROOF (CV WITH REFERENCES INCLUDING QUALIFICATIONS & IDENTIFICATION DOCUMENTATION). NON-SUBMISSION WILL RESULT IN LOSS OF POINTS.

TABLE A3: ACADEMIC QUALIFICATIONS

	TARGETED GOALS	TENDERED GOAL	POINTS CLAIMED BY TENDERER	ALLOCATED POINTS
1	No formal education in construction	0		
2	Diploma in Civil Engineering or Equivalent	7.5		
3	Degree in Civil Engineering or Equivalent	15		
4	Degree in Civil Engineering or Equivalent and SACPCMP registered.	20		
	TOTAL: Academic Qualifications	**20**		

N.B: TENDERERS MUST SUBMIT QUALIFICATIONS, CERTIFICATES & IDENTIFICATION DOCUMENT OF SITE AGENT. NON-SUBMISSION WILL RESULT IN LOSS OF POINTS.

TABLE A4: PLANT AND EQUIPMENT

	TARGETED GOALS	TENDERED GOAL	POINTS Claimed by tenderer	ALLOCATED POINTS
1	35t Bulldozer	3		
2	20-ton Excavator	2		
3	Grader (14G or equivalent)	2		
4	3 ADT OFFROAD TRUCKS (4X6 / 6X6)	3		
5	1 Water truck (10000lt) (4X6 / 6X6)	2		
6	Padfoot roller (10t) and Smooth drum roller (10t)	2		
7	Crane	3		
8	2 TLB	2		
9	Concrete pump	1		
	SUB-TOTAL: Plant and Equipment	**20**		

N.B: TENDERERS MUST SUBMIT VEHICLE/EQUIPMENT PROOF OF OWNERSHIP OR LEASE AGREEMENT OR LETTER OF INTENT TO LEASE. NON-SUBMISSION WILL RESULT IN LOSS OF POINTS.

THE MINIMUM SCORE FOR FUNCTIONALITY IS 70%

Step 3

Price and B-BBEE Contribution. Reduce each responsive Tender offer to a comparative offer and evaluate it using the Tender evaluation method that is indicated in the Tender Data and described below:

Financial offer, and preferences	1) Score Tender evaluation points for financial offer.
	2) Confirm that Tenderers are eligible for the preferences claimed, and if so, score Tender evaluation points for preferencing.
	3) Calculate total Tender evaluation points.
	4) Rank Tender offers from the highest number of Tender evaluation points to the lowest.
	5) Recommend Tenderers with the highest number of Tender evaluation points for the award of the contract, unless there are compelling and justifiable reasons not to do so.

Score financial offers, preferences and quality, as relevant, to two decimal places.

F.3.11.2 Scoring Financial Offers

Score the financial offers of remaining responsive Tenderers using the following formula:

N_{FO} = W_1 x A where:
N_{FO} = the number of Tender evaluation points awarded for the financial offer.
W_1 = the maximum possible number of Tender evaluation points awarded for the financial offer as stated in the Tender Data.
A = a number calculated using either formulas 1 or 2 below as stated in the Tender Data.

Formula	Basis for comparison	Option 1	Option 2
1	Highest price or discount	$(1 + \frac{(P - P_m)}{P_m})$	P/P_m
2	Lowest price or percentage commission/fee	$(1 - \frac{(P - P_m)}{P_m})$	P_m/P

where:

Pm = the comparative offer of the most favourable Tender offer.

P = the comparative offer of Tender offer under consideration.

F.3.11.3 Scoring quality (functionality)

Score quality in each of the categories stated in the Tender Data and calculate the total score for quality.

F.3.12 Insurance provided by the employer

If requested by the proposed successful Tenderer, submit for the Tenderer's information the policies and / or certificates of insurance which the Conditions of Contract identified in the Contract Data, require the Employer to provide.

SEKHUKHUNE DISTRICT MUNICIPALITY

T2.1 List of Returnable Documents

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FORM 1: EXAMPLE FOR USE BY THE TENDERER WHEN COMPILING THE AUTHORITY CERTIFICATE

Certificate of Authority for Power of Attorney
(TO BE ISSUED ON COMPANY'S LETTER HEAD)

Indicate the status of the tenderer by ticking the appropriate box hereunder. The tenderer must use the formats to complete the certificate set out below for the relevant category.

A Company	B Partnership	C Joint Venture	D Sole Proprietor	E Close Corporation

A. Certificate for company (Example Only)

I,……, chairperson of the board of directors of ……, hereby confirm that by resolution of the board (copy attached) taken on ……20…., Mr/Mrs…….acting in the capacity of…….,was authorised to sign all documents in connection with this tender and any contract resulting from it on behalf of the company.

As witness

1……. ……

Chairman

2……. ……..

Date

B. Certificate of partnership (Example only)

We, the undersigned, being the key partners in the business trading as ……

hereby authorise Mr/Mrs……, acting in the capacity of……to sign all documents in connection with the tender for Contract……and any contract resulting from it on our behalf.

NAME	ADDRESS	SIGNATURE	DATE

NOTE: This certificate is to be completed and signed by all of the key partners upon whom rests the direction of the affairs of the Partnership as a whole.

C. Certificate for Joint Venture (Example Only)

We, the undersigned, are submitting this tender offer in Joint Venture and hereby authorise Mr/Mrs…….., authorised signatory of the company ……,

acting in the capacity of lead partner, to sign all documents in connection with the tender offer for Contract……and any other contract resulting from it on our behalf.

This authorisation is evidenced by the attached power of attorney signed by legally authorised signatories of all the partners to the Joint Venture.

NAME OF FIRM	ADDRESS	AUTHORISING SIGNATURE, NAME & CAPACITY
Lead partner		

D. Certificate for sole proprietor (Example Only)

I, ……., hereby confirm that I am the sole owner of the business trading as……...

As Witness:

1…….. ……
Signature: Sole owner

2…….. ……..
Date

E. Certificate for Close Corporation (Example Only)

We, the undersigned, being the key members in the business trading as…….hereby authorise Mr/Mrs……

Acting in the capacity of……, to sign all documents in connection with the tender for Contract…….and any contract resulting from it on our behalf.

NAME	ADDRESS	SIGNATURE	DATE

NOTE: This form are only Examples. Tendering Entities are requested to submit the information on their own company letter heads.

FORM 2: SIGNATORIES AUTHORITY (POWER OF ATTORNEY)

1. INFORMATION TO BE PROVIDED

1.1 If the Tenderer is a COMPANY

(a) Affix a certificate copy of the Certificate of Incorporation to this page.
(b) Affix a copy of the relevant resolution of the Board of Directors, duly signed and dated
(c) List the Directors

……
……

1.2 If the Tenderer is a CLOSE CORPORATION

(a) Affix a certificate copy of the Founding Statement to this page
(b) Affix a copy of the relevant resolution of the Members, duly signed and dated
(c) List the Members

……
……

1.3 If the Tenderer is a PARTNERSHIP

(a) Affix a copy of the relevant resolution on the Partners, duly signed and dated
(b) List the Partners

……
……

1.4 If the Tenderer is a ONE-MAN-CONCERN.

Provided the full name, identity number and qualifications of the person

……

1.5 If the Tenderer is a JOINT VENTURE

a) Affix a copy of the original document of information defining the conditions under which the joint venture will function, its period of duration and the participating persons, companies and/or firms
b) Affix a certificate signed for or on behalf of each participating person, company and/or firm authorizing the person who signed the tender to do so.

1.6 If the Tenderer is a CONCERN OTHER than these listed above

Provide full details of the CONCERN submitting the tender:

……

FORM 3: SITE INSPECTION CERTIFICATE

This is to certify that I,

…….

representing and duly authorized by (Tenderer) ……

……..

attended the site inspection on

……

Having prior to this site visit carefully examined the tender document, technical information and drawings supplied, I confirm that I was given unrestricted access to inspect those sections of the Site necessary for the execution of the Works.

I further confirm that I am completely satisfied with the scope of work as explained by the Engineer; and am fully aware of all Site conditions and regulations of whatsoever nature that could influence the preparation of our tender.

I therefore append my signature below in agreement that we will not institute any claim against the Employer after submission of our tender based on lack of knowledge of site conditions or regulations appertaining to the execution of this Contract.

Signature of Tenderer's Representative	Date

Signature of Engineer's Representative	Date

NB: The person who attended the briefing session to sign on this page, information to be the same as the one on the attendance register. ANY DEVIATION WILL LEAD TO DISQUALIFICATION.

FORM 4: RECORD OF ADDENDA TO TENDER DOCUMENTS

We confirm that the following communications received from the Employer before the submission of this Tender offer, amending the Tender documents, have been taken into account in this Tender offer:		
	Date	**Title or Details**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
Attach additional pages if more space is required.		

Signed		Date	
Name		Position	
Tenderer			

FORM 5: SCHEDULE OF PROPOSED SUBCONTRACTORS

We notify you that it is our intention to employ the following Subcontractors for work in this contract.

If we are awarded the contract we agree that this notification does not change the requirement for us to submit the names of proposed Subcontractors in accordance with requirements in the contract for such appointments. If there are no such requirements in the contract, then your written acceptance of this list shall be binding between us.

	Name and address of proposed Subcontractor	**Nature and extent of work**	**CIDB grading of the Subcontractor**	**Previous experience with Subcontractor.**
1.				
2.				
3.				
4.				
5.				
Signed			Date	
Name			Position	
Tenderer				

FORM 6: SCHEDULE OF CONSTRUCTION EQUIPMENT

The following are lists of major items of relevant Construction Equipment that I/we presently own or lease and will have available for this contract or will acquire or hire for this contract if my/our Tender is accepted.

(a) Details of major equipment that is owned by and immediately available for this contract.

Quantity	**Description, size, capacity, etc.**

Attach additional pages if more space is required.

(b) Details of major equipment that will be hired or acquired for this contract if my/our Tender is acceptable.

Quantity	**Description, size, capacity, etc.**

Attach additional pages if more space is required.

Signed		Date	
Name		Position	
Tenderer			

N.B: Tenderers to submit certified proof of ownership from the relevant Authority. If hiring, proof of certified ownership documents from the Plant hire company to be submitted with the tender.

FORM 7: SCHEDULE OF THE TENDERER'S EXPERIENCE

The following is a statement of similar work successfully executed by myself/ourselves:

Employer, contact person and telephone number.	**Description of contract**	**Value of work inclusive of VAT (Rand)**	**Date completed**

Signed		Date	
Name		Position	
Tenderer			

N.B: Evaluation will be based on the first four projects only. Certificates of practical completion for completed projects. Appointment letters for projects not completed.

FORM 8: PROPOSED AMENDMENTS AND QUALIFICATIONS

The Tenderer should record any deviations or qualifications he may wish to make to the Tender documents in this Form. Alternatively, a Tenderer may state such deviations and qualifications in a covering letter to his Tender and reference such letter in this schedule.

The Tenderer's attention is drawn to clause C.3.8 of the Standard Conditions of Tender referenced in the Tender Data regarding the employer's handling of material deviations and qualifications.

Page	Clause or item	Proposal

Signed		Date	
Name		Position	
Tenderer			

FORM 9: SCHEDULE OF PERSONNEL AND EMPLOYEES

The Tenderer shall state below the number of Personnel and Employees to be employed on the Works.

PERSONNEL AND EMPLOYEES	TENDER	
	FULL TIME	PART TIME
1. Technical staff 2. Clerical staff 3. Artisans 4. Semi-skilled 5. Unskilled labour (from local communities)		
Total		

State the name, qualifications (Certified proof not older than three months) and experience of proposed Contracts Manager and Site agent:

Date: ……

SIGNATURE OF TENDERER: ……..

FORM 10: PRELIMINARY PROGRAMME

The Tenderer shall detail below or attach a preliminary programme reflecting the proposed order and rate of progress for each portion of the work comprising this Contract. The programme shall be consistent with and in support of his time required for completion and shall be in accordance with the requirements of this tender.

PROGRAMME																		
ACTIVITY																		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**

Date: …… SIGNATURE OF TENDERER: ……

FORM 11: CERTIFICATE OF INSURANCE COVER

Note to tenderer:

In the event of the tenderer being a joint venture/consortium, the details of the individual members must also be provided.

The Tenderer shall provide the following details of this insurance cover:

(i) Name of tenderer: .....

(ii) Period of Validity: .....

(iii) Value of Insurance:

- Insurance for Works and Contractor's equipment

  Company: .....

  Value: .....

- Insurance for Contractor's personnel

  Company: .....

  Value: .....

- General public liability

  Company: .....

  Value: .....

- SASRIA

  Company: .....

  Value: .....

FORM 12: COMPLIANCE WITH OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 AND CONSTRUCTION REGULATIONS, 2014

The tenderer shall attach to this Form evidence that he is registered and in good standing with a compensation insurer who is approved by Department of Labour in terms of section 80 of the Compensation for Injury and Disease Act (COID) (Act 130 of 1993).

The tenderer is required to disclose, by also attaching documentary evidence to this form, all inspections, investigations and their outcomes conducted by the Department of Labour into the conduct of the tenderer at any time during the 36 months preceding the date of this tender.

SIGNED ON BEHALF OF THE TENDERER: .....

Note to tenderer:

Discovery that the tenderer has failed to make proper disclosure may result in the Employer terminating a contract that flows from this tender on the ground that it has been rendered invalid by the tenderer's misrepresentation.

FORM 13: CONSTRUCTION INDUSTRIES DEVELOPMENT BOARD REGISTRATION

The tenderer is to affix to this page either:

- Written proof of his registration with the CIDB

Or

- Written proof of his application to the CIDB for registration as a contractor in the appropriate category.

Note:

1. Failure to affix such documentation as prescribed to this page shall result in this tender not being further considered for the award of the contract.
2. Should this tender be considered for award of the contract, based on proof of submission of application for registration in the appropriate category with the CIDB, and should proof of such subsequent registration not be forthcoming to the employer by the time of award of the contract, then this tender will no longer be considered for the award of the contract.

FORM 14: PART A: INVITATION TO TENDER

YOU ARE HEREBY INVITED TO TENDER FOR REQUIREMENTS OF THE SEKHUKHUNE DISTRICT MUNICIPALITY					
TENDER NUMBER:	SK8/3/1-52/2024/25	CLOSING DATE:	04 July 2025	CLOSING TIME:	14:00
DESCRIPTION	MAMPURU BULK WATER SCHEME: PHASE 1A - RESERVOIRS				
THE SUCCESSFUL TENDERER WILL BE REQUIRED TO FILL IN AND SIGN A WRITTEN CONTRACT FORM (MBD7).					
TENDER DOCUMENTS MAY BE DEPOSITED IN THE TENDER BOX SITUATED AT THE OFFICES OF SEKHUKHUNE DISTRICT MUNICIPALITY					

SUPPLIER INFORMATION					
NAME OF TENDERER					
POSTAL ADDRESS					
STREET ADDRESS					
TELEPHONE NUMBER	CODE		NUMBER		
CELLPHONE NUMBER					
FACSIMILE NUMBER	CODE		NUMBER		
E-MAIL ADDRESS					
VAT REGISTRATION NUMBER					
	TCS PIN:		**OR**	CSD No:	

PREFERENCE POINTS WILL BE AWARDED IN LINE WITH THE MUNICIPALITY'S SPECIFIC GOALS			
ARE YOU THE ACCREDITED REPRESENTATIVE **IN SOUTH AFRICA FOR THE GOODS /SERVICES /WORKS OFFERED?**	☐ Yes ☐ No [IF YES ENCLOSE PROOF]	ARE YOU A FOREIGN BASED SUPPLIER FOR **THE GOODS /SERVICES /WORKS OFFERED?**	☐ Yes ☐No [IF YES ANSWER PART B:3 BELOW]
TOTAL NUMBER OF ITEMS OFFERED		**TOTAL TENDER PRICE (ALL INCLUSIVE)**	

TENDER PROCEDURE ENQUIRIES MAY BE DIRECTED TO:		TECHNICAL INFORMATION MAY BE DIRECTED TO:	
DEPARTMENT/ PUBLIC ENTITY		CONTACT PERSON	
CONTACT PERSON		TELEPHONE NUMBER	
TELEPHONE NUMBER		FACSIMILE NUMBER	
FACSIMILE NUMBER		E-MAIL ADDRESS	
E-MAIL ADDRESS			

PART B: TERMS AND CONDITIONS FOR TENDERING

1. TENDER SUBMISSION:

1.1. TENDERS MUST BE DELIVERED BY THE STIPULATED TIME TO THE CORRECT ADDRESS. LATE TENDERS WILL NOT BE ACCEPTED FOR CONSIDERATION.

1.2. ALL TENDERS MUST BE SUBMITTED ON THE OFFICIAL FORMS PROVIDED–(NOT TO BE RE-TYPED), ONLINE OR IN THE MANNER PRESCRIBED IN THE TENDER DOCUMENT

1.3. TENDERERS MUST REGISTER ON THE CENTRAL SUPPLIER DATABASE (CSD) TO UPLOAD MANDATORY INFORMATION NAMELY: (BUSINESS REGISTRATION/ DIRECTORSHIP/ MEMBERSHIP/IDENTITY NUMBERS; TAX COMPLIANCE STATUS; AND BANKING INFORMATION FOR VERIFICATION PURPOSES).

1.4. **WHERE A TENDERER IS NOT REGISTERED ON THE CSD, MANDATORY INFORMATION NAMELY: (BUSINESS REGISTRATION/ DIRECTORSHIP/ MEMBERSHIP/IDENTITY NUMBERS; TAX COMPLIANCE STATUS MAY NOT BE SUBMITTED WITH THE TENDER DOCUMENTATION.**

1.5. THIS TENDER IS SUBJECT TO THE PREFERENTIAL PROCUREMENT POLICY FRAMEWORK ACT 2000 AND THE PREFERENTIAL PROCUREMENT REGULATIONS, 2022, THE GENERAL CONDITIONS OF CONTRACT (GCC) AND, IF APPLICABLE, ANY OTHER LEGISLATION OR SPECIAL CONDITIONS OF CONTRACT.

2. TAX COMPLIANCE REQUIREMENTS

2.1 TENDERERS MUST ENSURE COMPLIANCE WITH THEIR TAX OBLIGATIONS.

2.2 TENDERERS ARE REQUIRED TO SUBMIT THEIR UNIQUE PERSONAL IDENTIFICATION NUMBER (PIN) ISSUED BY SARS TO ENABLE THE ORGAN OF STATE TO VIEW THE TAXPAYER'S PROFILE AND TAX STATUS.

2.3 APPLICATION FOR TAX COMPLIANCE STATUS (TCS) OR PIN MAY ALSO BE MADE VIA E-FILING. IN ORDER TO USE THIS PROVISION, TAXPAYERS WILL NEED TO REGISTER WITH SARS AS E-FILERS THROUGH THE WEBSITE WWW.SARS.GOV.ZA.

2.4 TENDERERS MAY ALSO SUBMIT A PRINTED TCS TOGETHER WITH THE TENDER.

2.5 IN TENDERS WHERE CONSORTIA / JOINT VENTURES / SUB-CONTRACTORS ARE INVOLVED, EACH PARTY MUST SUBMIT A SEPARATE PROOF OF TCS / PIN / CSD NUMBER.

2.6 WHERE NO TCS IS AVAILABLE BUT THE TENDERER IS REGISTERED ON THE CENTRAL SUPPLIER DATABASE (CSD), A CSD NUMBER MUST BE PROVIDED.

2.7 NO TENDERS WILL BE CONSIDERED FROM PERSONS IN THE SERVICE OF THE STATE, COMPANIES WITH DIRECTORS WHO ARE PERSONS IN THE SERVICE OF THE STATE, OR CLOSE CORPORATIONS WITH MEMBER PERSONS IN THE SERVICES OF THE STATE

3. QUESTIONNAIRE TO TENDERING FOREIGN SUPPLIERS

3.1.	IS THE TENDERER A RESIDENT OF THE REPUBLIC OF SOUTH AFRICA (RSA)?	☐ YES ☐ NO
3.2.	DOES THE TENDERER HAVE A BRANCH IN THE RSA?	☐ YES ☐ NO
3.3.	DOES THE TENDERER HAVE A PERMANENT ESTABLISHMENT IN THE RSA?	☐ YES ☐ NO
3.4.	DOES THE TENDERER HAVE ANY SOURCE OF INCOME IN THE RSA?	☐ YES ☐ NO

IF THE ANSWER IS "NO" TO ALL OF THE ABOVE, THEN, IT IS NOT A REQUIREMENT TO OBTAIN A TAX COMPLIANCE STATUS / TAX COMPLIANCE SYSTEM PIN CODE FROM THE SOUTH AFRICAN REVENUE SERVICE (SARS) AND IF NOT REGISTER AS PER 2.3 ABOVE.

FORM 15: CERTIFICATE OF TAX COMPLIANCE (INCORPORATING MBD2

The tenderer shall complete the declaration below.

I, ... (name)

the undersigned in my capacity as ..... (position)

on behalf of ..... (name of company)

herewith grant consent that SARS may disclose to Sekhukhune District Municipality our tax compliance status.

For this purpose, our unique security personal identification number (PIN) is ……

our tax reference number is ……..

and our tax clearance certificate number is ..... .

In the event of a Joint Venture, each member shall comply with the above requirement.

FORM 16: PRICING SCHEDULE – FIRM PRICES (PURCHASES)

NOTE: **ONLY FIRM PRICES WILL BE ACCEPTED. NON-FIRM PRICES (INCLUDING PRICES SUBJECT TO RATES OF EXCHANGE VARIATIONS) WILL NOT BE CONSIDERED**

IN CASES WHERE DIFFERENT DELIVERY POINTS INFLUENCE THE PRICING, A SEPARATE PRICING SCHEDULE MUST BE SUBMITTED FOR EACH DELIVERY POINT

Name of Tenderer…… Tender Number……...

Closing Time ……. ….. Closing Date ……..

OFFER TO BE VALID FOR …..…… DAYS FROM THE CLOSING DATE OF TENDER.

ITEM NO.	QUANTITY	DESCRIPTION	TENDER PRICE IN RSA CURRENCY **(ALL APPLICABLE TAXES INCLUDED)

- Required by: …….
- At: …….

  …….
- Brand and Model …….
- Country of Origin …….

- Does the offer comply with the specification(s)? *YES/NO
- If not to specification, indicate deviation(s) …….
- Period required for delivery …….
- *Delivery: Firm/Not firm
- Delivery basis …….

Note: All delivery costs must be included in the Tender price, for delivery at the prescribed destination.

** “all applicable taxes” includes value- added tax, pay as you earn, income tax, unemployment insurance fund contributions and skills development levies.

*Delete if not applicable

B PRICES SUBJECT TO RATE OF EXCHANGE VARIATIONS

1. Please furnish full particulars of your financial institution, state the currencies used in the conversion of the prices of the items to South African currency, which portion of the price is subject to rate of exchange variations and the amounts remitted abroad.

PARTICULARS OF FINANCIAL INSTITUTION	ITEM NO	PRICE	CURRENCY	RATE	PORTION OF PRICE SUBJECT TO ROE	AMOUNT IN FOREIGN CURRENCY REMITTED ABROAD
				ZAR=		
				ZAR=		
				ZAR=		
				ZAR=		
				ZAR=		
				ZAR=		

2. Adjustments for rate of exchange variations during the contract period will be calculated by using the average monthly exchange rates as issued by your commercial bank for the periods indicated hereunder: (Proof from bank required)

AVERAGE MONTHLY EXCHANGE RATES FOR THE PERIOD:	DATE DOCUMENTATION MUST BE SUBMITTED TO THIS OFFICE	DATE FROM WHICH NEW CALCULATED PRICES WILL BECOME EFFECTIVE	DATE UNTIL WHICH NEW CALCULATED PRICE WILL BE EFFECTIVE

FORM 17: DECLARATION OF INTEREST

1. No Tender will be accepted from persons in the service of the state*.
2. Any person, having a kinship with persons in the service of the state, including a blood relationship, may make an offer or offers in terms of this invitation to Tender. In view of possible allegations of favouritism, should the resulting Tender, or part thereof, be awarded to persons connected with or related to persons in service of the state, it is required that the Tenderer or their authorised representative declare their position in relation to the evaluating/adjudicating authority and/or take an oath declaring his/her interest.

3 In order to give effect to the above, the following questionnaire must be completed and submitted with the Tender.

3.1 Full Name: ……

3.2 Identity Number: ……

3.3 Position occupied in the Company (director, trustee, hareholder²): ……

3.4 Company Registration Number: ……

3.5 Tax Reference Number: ……

3.6 VAT Registration Number: ……

3.7 The names of all directors / trustees / shareholders members, their individual identity numbers and state employee numbers must be indicated in paragraph 4 below.

3.8 Are you presently in the service of the state***** **YES / NO**

3.8.1 If so, furnish particulars.

……

……

3.9 Have you been in the service of the state for the past twelve months? **YES / NO**

3.9.1 If so, furnish particulars.

……

……

***** MSCM Regulations: "in the service of the state" means to be –

(a) a member of –
  (i) any municipal council;
  (ii) any provincial legislature; or
  (iii) the national Assembly or the national Council of provinces;

(b) a member of the board of directors of any municipal entity;
(c) an official of any municipality or municipal entity;
(d) an employee of any national or provincial department, national or provincial public entity or constitutional institution within the meaning of the Public Finance Management Act, 1999 (Act No.1 of 1999);
(e) a member of the accounting authority of any national or provincial public entity; or
(f) an employee of Parliament or a provincial legislature.

3.10	Do you, have any relationship (family, friend, other) with persons in the service of the state and who may be involved with the evaluation and or adjudication of this Tender?	**YES / NO**
3.10.1	If so, furnish particulars.	
	……	
	……	
3.11	Are you, aware of any relationship (family, friend, other), between a Tenderer and any persons in the service of the state who may be involved with the evaluation and or adjudication of this Tender?	**YES / NO**
3.11.1	If so, furnish particulars	
	……	
	……	
3.12	Are any of the company's directors, managers, principal shareholders or stakeholders in service of the state?	**YES / NO**
3.12.1	If so, furnish particulars.	
	……	
	……	
3.13	Are any spouse, child or parent of the company's directors, managers, principal shareholders or stakeholders in service of the state?	**YES / NO**
3.13.1	If so, furnish particulars.	
	……	
	……	
3.14	Do you or any of the directors, trustees, managers, principle shareholders, or stakeholders of this company have any interest in any other related companies or business whether or not they are bidding for this contract.	**YES / NO**
3.14.1	If yes, furnish particulars:	
	……	
	……	

4. Full details of directors / trustees / members / shareholders.

Full Name	Identity Number	Personal Tax Reference Number	State Employee Number / Persal Number

CERTIFICATION

I, THE UNDERSIGNED (NAME) ……

CERTIFY THAT THE INFORMATION FURNISHED ON THIS DECLARATION FORM IS CORRECT.

I ACCEPT THAT THE STATE MAY ACT AGAINST ME SHOULD THIS DECLARATION PROVE TO BE FALSE.

…….. ……..
Signature Date

…….…… …….
Position Name of Tenderer

FORM 18: DECLARATION FOR PROCUREMENT ABOVE R10 MILLION (ALL APPLICABLE TAXES INCLUDED)

For all procurement expected to exceed R10 million (all applicable taxes included), Tenderers must complete the following questionnaire:

1 Are you by law required to prepare annual financial statements for auditing? **YES / NO**

1.1 If yes, submit audited annual financial statements for the past three years or since the date of establishment if established during the past three years.

……...

……...

2 Do you have any outstanding undisputed commitments for municipal services towards any municipality for more than three months or any other service provider in respect of which payment is overdue for more than 30 days? **YES / NO**

2.1 If no, this serves to certify that the Tenderer has no undisputed commitments for municipal services towards any municipality for more than three months or other service provider in respect of which payment is overdue for more than 30 days.

2.2 If yes, provide particulars.

……...

……...

3 Has any contract been awarded to you by an organ of state during the past five years, including particulars of any material non-compliance or dispute concerning the execution of such contract? **YES / NO**

3.1 If yes, furnish particulars

……...

……...

4. Will any portion of goods or services be sourced from outside the Republic, and, if so, what portion and whether any portion of payment from the municipality / municipal entity is expected to be transferred out of the Republic? ***YES / NO**

4.1 If yes, furnish particulars

……...

……...

* Delete if not applicable

CERTIFICATION

I, THE UNDERSIGNED (NAME) ……

CERTIFY THAT THE INFORMATION FURNISHED ON THIS DECLARATION FORM IS CORRECT.

I ACCEPT THAT THE STATE MAY ACT AGAINST ME SHOULD THIS DECLARATION PROVE TO BE FALSE.

…….. ……..
Signature Date

……..... …….
Position Name of Tenderer

FORM 19: PREFERENCE POINTS CLAIM FORM IN TERMS OF THE PREFERENTIAL PROCUREMENT REGULATIONS 2022

This preference form must form part of all tenders invited. It contains general information and serves as a claim form for preference points for specific goals.

NB: BEFORE COMPLETING THIS FORM, TENDERERS MUST STUDY THE GENERAL CONDITIONS, DEFINITIONS AND DIRECTIVES APPLICABLE IN RESPECT OF THE TENDER AND PREFERENTIAL PROCUREMENT REGULATIONS, 2022

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1. GENERAL CONDITIONS

1.1 The following preference point systems are applicable to invitations to tender:

- the 80/20 system for requirements with a Rand value of up to R50 000 000 (all applicable taxes included); and
- the 90/10 system for requirements with a Rand value above R50 000 000 (all applicable taxes included).

1.2 To be completed by the organ of state

The applicable preference point system for this tender is the 90/10 preference point system.

1.3 Points for this tender (even in the case of a tender for income-generating contracts) shall be awarded for:

(a) Price; and

(b) Specific Goals.

1.4 To be completed by the organ of state:

The maximum points for this tender are allocated as follows:

	POINTS
PRICE	90
SPECIFIC GOALS	10
Total points for Price and SPECIFIC GOALS	**100**

1.5 Failure on the part of a tenderer to submit proof or documentation required in terms of this tender to claim points for specific goals with the tender, will be interpreted to mean that preference points for specific goals are not claimed.

1.6 The organ of state reserves the right to require of a tenderer, either before a tender is adjudicated or at any time subsequently, to substantiate any claim in regard to preferences, in any manner required by the organ of state.

2. DEFINITIONS

(a) **"tender"** means a written offer in the form determined by an organ of state in response to an invitation to provide goods or services through price quotations, competitive tendering process or any other method envisaged in legislation;

(b) **"price"** means an amount of money tendered for goods or services, and includes all applicable taxes less all unconditional discounts;

(c) **"rand value"** means the total estimated value of a contract in Rand, calculated at the time of bid invitation, and includes all applicable taxes;

(d) **"tender for income-generating contracts"** means a written offer in the form determined by an organ of state in response to an invitation for the origination of income-generating contracts through any method envisaged in legislation that will result in a legal agreement between the organ of state and a third party that produces revenue for the organ of state, and includes, but is not limited to, leasing and disposal of assets and concession contracts, excluding direct sales and disposal of assets through public auctions; and

(e) **"the Act"** means the Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000).

3. FORMULAE FOR PROCUREMENT OF GOODS AND SERVICES

3.1. POINTS AWARDED FOR PRICE

3.1.1 THE 80/20 OR 90/10 PREFERENCE POINT SYSTEMS

A maximum of 80 or 90 points is allocated for price on the following basis:

80/20 **or** **90/10**

$$Ps = 80\left(1 - \frac{Pt - P\,min}{P\,min}\right) \quad \text{or} \quad Ps = 90\left(1 - \frac{Pt - P\,min}{P\,min}\right)$$

Where

Ps = Points scored for price of tender under consideration

Pt = Price of tender under consideration

Pmin = Price of lowest acceptable tender

3.2. FORMULAE FOR DISPOSAL OR LEASING OF STATE ASSETS AND INCOME GENERATING PROCUREMENT

3.2.1. POINTS AWARDED FOR PRICE

A maximum of 80 or 90 points is allocated for price on the following basis:

80/20 **or** **90/10**

$$Ps = 80\left(1 + \frac{Pt - P\,max}{P\,max}\right) \quad \text{or} \quad Ps = 90\left(1 + \frac{Pt - P\,max}{Pmax}\right)$$

Where

Ps = Points scored for price of tender under consideration

Pt = Price of tender under consideration

Pmax = Price of highest acceptable tender

4. POINTS AWARDED FOR SPECIFIC GOALS

4.1. In terms of Regulation 4(2); 5(2); 6(2) and 7(2) of the Preferential Procurement Regulations, preference points must be awarded for specific goals stated in the tender. For the purposes of this tender the tenderer will be allocated points based on the goals stated in table 1 below as may be supported by proof/ documentation stated in the conditions of this tender:

4.2. In cases where organs of state intend to use Regulation 3(2) of the Regulations, which states that, if it is unclear whether the 80/20 or 90/10 preference point system applies, an organ of state must, in the tender documents, stipulate in the case of—

(a) an invitation for tender for income-generating contracts, that either the 80/20 or 90/10 preference point system will apply and that the highest acceptable tender will be used to determine the applicable preference point system; or

(b) any other invitation for tender, that either the 80/20 or 90/10 preference point system will apply and that the lowest acceptable tender will be used to determine the applicable preference point system,

then the organ of state must indicate the points allocated for specific goals for both the 90/10 and 80/20 preference point system.

Table 1: Specific goals for the tender and points claimed are indicated per the table below.

(Note to organs of state: Where either the 90/10 or 80/20 preference point system is applicable, corresponding points must also be indicated as such.

Note to tenderers: The tenderer must indicate how they claim points for each preference point system.)

The specific goals allocated points in terms of this tender	Number of points allocated (90/10 system) (To be completed by the organ of state)	Number of points allocated (80/20 system) (To be completed by the organ of state)	Number of points claimed(90/10 system) (To be completed by the tenderer)	Number of points claimed (80/20 system) (To be completed by the tenderer)
HDI (blacks, indian, coloureds) (100%)	6	12		
Woman Ownership of more than 50%	1	2		
Disability ownership of more than 50% (physically impaired)	1	2		
Youth (18 to 35)	1	2		
Locality (Within Sekhukhune District Municipality jurisdiction)	1	2		
Total	10	20		

DECLARATION WITH REGARD TO COMPANY/FIRM

4.3. Name of company/firm…….

4.4. Company registration number: ……..

4.5. TYPE OF COMPANY/ FIRM

- ϒ Partnership/Joint Venture / Consortium
- ϒ One-person business/sole propriety
- ϒ Close corporation
- ϒ Public Company
- ϒ Personal Liability Company
- ϒ (Pty) Limited
- ϒ Non-Profit Company
- ϒ State Owned Company

[TICK APPLICABLE BOX]

4.6. I, the undersigned, who is duly authorised to do so on behalf of the company/firm, certify that the points claimed, based on the specific goals as advised in the tender, qualifies the company/ firm for the preference(s) shown and I acknowledge that:

i) The information furnished is true and correct;

ii) The preference points claimed are in accordance with the General Conditions as indicated in paragraph 1 of this form;

iii) In the event of a contract being awarded as a result of points claimed as shown in paragraphs 1.4 and 4.2, the contractor may be required to furnish documentary proof to the satisfaction of the organ of state that the claims are correct;

iv) If the specific goals have been claimed or obtained on a fraudulent basis or any of the conditions of contract have not been fulfilled, the organ of state may, in addition to any other remedy it may have –

(a) disqualify the person from the tendering process;

(b) recover costs, losses or damages it has incurred or suffered as a result of that person's conduct;

(c) cancel the contract and claim any damages which it has suffered as a result of having to make less favourable arrangements due to such cancellation;

(d) recommend that the tenderer or contractor, its shareholders and directors, or only the shareholders and directors who acted on a fraudulent basis, be restricted from obtaining business from any organ of state for a period not exceeding 10 years, after the *audi alteram partem* (hear the other side) rule has been applied; and

(e) forward the matter for criminal prosecution, if deemed necessary.

……
SIGNATURE(S) OF TENDERER(S)

SURNAME AND NAME: ……

DATE: ……

ADDRESS: ……

……

……

……

FORM 20: CONTRACT FORM - RENDERING OF SERVICES

THIS FORM MUST BE FILLED IN DUPLICATE BY BOTH THE SERVICE PROVIDER (PART 1) AND THE PURCHASER (PART 2). BOTH FORMS MUST BE SIGNED IN THE ORIGINAL SO THAT THE SERVICE PROVIDER AND THE PURCHASER WOULD BE IN POSSESSION OF ORIGINALLY SIGNED CONTRACTS FOR THEIR RESPECTIVE RECORDS.

PART 1 (TO BE FILLED IN BY THE SERVICE PROVIDER)

1. I hereby undertake to render services described in the attached Tendering documents to (name of the institution) …… in accordance with the requirements and task directives / proposals specifications stipulated in Tender Number…….. at the price/s quoted. My offer/s remain binding upon me and open for acceptance by the Purchaser during the validity period indicated and calculated from the closing date of the tender.

2. The following documents shall be deemed to form and be read and construed as part of this agreement:

   (i) Tender documents, *viz*
   - Invitation to tender;
   - Tax clearance certificate;
   - Pricing schedule(s);
   - Filled in task directive/proposal;
   - Preference claim form for Preferential Procurement in terms of the Preferential Procurement Regulations;
   - Declaration of interest;
   - Declaration of Tenderer's past SCM practices;
   - Certificate of Independent Tender Determination;
   - Special Conditions of Contract;

   (ii) General Conditions of Contract; and

   (iii) Other (specify)

3. I confirm that I have satisfied myself as to the correctness and validity of my tender; that the price(s) and rate(s) quoted cover all the services specified in the tender documents; that the price(s) and rate(s) cover all my obligations and I accept that any mistakes regarding price(s) and rate(s) and calculations will be at my own risk.

4. I accept full responsibility for the proper execution and fulfilment of all obligations and conditions devolving on me under this agreement as the principal liable for the due fulfilment of this contract.

5. I declare that I have no participation in any collusive practices with any tenderer or any other person regarding this or any other tender.

6. I confirm that I am duly authorised to sign this contract.

NAME (PRINT) …….

CAPACITY …….

SIGNATURE …….

NAME OF FIRM …….

DATE …….

WITNESSES

1 ……..

2 ……..

DATE: ……..

CONTRACT FORM – RENDERING OF SERVICES

PART 2 (TO BE FILLED IN BY THE PURCHASER)

1. I……. in my capacity as……..…… accept your tender under reference number ……dated……for the rendering of services indicated hereunder and/or further specified in the annexure(s).

2. An official order indicating service delivery instructions is forthcoming.

3. I undertake to make payment for the services rendered in accordance with the terms and conditions of the contract, within 30 (thirty) days after receipt of an invoice.

DESCRIPTION OF SERVICE	PRICE (ALL APPLICABLE TAXES INCLUDED)	COMPLETION DATE	TOTAL PREFERENCE POINTS CLAIMED	POINTS CLAIMED FOR EACH SPECIFIC GOAL

4. I confirm that I am duly authorised to sign this contract.

SIGNED AT …… ON ……..

NAME (PRINT) ……

SIGNATURE ……

OFFICIAL STAMP

WITNESSES

1 ……

2 ……

DATE: ……..

FORM 21: DECLARATION OF TENDERER'S PAST SUPPLY CHAIN MANAGEMENT PRACTICES

1 This Municipal Tendering Document must form part of all tenders invited.

2 It serves as a declaration to be used by municipalities and municipal entities in ensuring that when goods and services are being procured, all reasonable steps are taken to combat the abuse of the supply chain management system.

3 The tender of any Tenderer may be rejected if that Tenderer, or any of its directors have:

a. abused the municipality's / municipal entity's supply chain management system or committed any improper conduct in relation to such system;
b. been convicted for fraud or corruption during the past five years;
c. wilfully neglected, reneged on or failed to comply with any government, municipal or other public-sector contract during the past five years; or
d. been listed in the Register for Tender Defaulters in terms of section 29 of the Prevention and Combating of Corrupt Activities Act (No 12 of 2004).

4 In order to give effect to the above, the following questionnaire must be completed and submitted with the tender.

Item	Question	Yes	No
4.1	Is the Tenderer or any of its directors listed on the National Treasury's Database of Restricted Suppliers as companies or persons prohibited from doing business with the public sector? (Companies or persons who are listed on this Database were informed in writing of this restriction by the Accounting Officer/Authority of the institution that imposed the restriction after the *audi alteram partem* rule was applied). **The Database of Restricted Suppliers now resides on the National Treasury's website (**www.treasury.gov.za**) and can be accessed by clicking on its link at the bottom of the home page.**	Yes ☐	No ☐
4.1.1	If so, furnish particulars:		
4.2	Is the Tenderer or any of its directors listed on the Register for Tender Defaulters in terms of section 29 of the Prevention and Combating of Corrupt Activities Act (No 12 of 2004)? **The Register for Tender Defaulters can be accessed on the National Treasury's website (www.treasury.gov.za) by clicking on its link at the bottom of the home page.**	Yes ☐	No ☐
4.2.1	If so, furnish particulars:		
4.3	Was the Tenderer or any of its directors convicted by a court of law (including a court of law outside the Republic of South Africa) for fraud or corruption during the past five years?	Yes ☐	No ☐

4.3.1	If so, furnish particulars:		
Item	**Question**	**Yes**	**No**
4.4	Does the Tenderer or any of its directors owe any municipal rates and taxes or municipal charges to the municipality / municipal entity, or to any other municipality / municipal entity, that is in arrears for more than three months?	Yes ☐	No ☐
4.4.1	If so, furnish particulars:		
4.5	Was any contract between the Tenderer and the municipality / municipal entity or any other organ of state terminated during the past five years on account of failure to perform on or comply with the contract?	Yes ☐	No ☐
4.7.1	If so, furnish particulars:		

CERTIFICATION

I, THE UNDERSIGNED (FULL NAME) ……..…….

CERTIFY THAT THE INFORMATION FURNISHED ON THIS DECLARATION FORM TRUE AND CORRECT.

I ACCEPT THAT, IN ADDITION TO CANCELLATION OF A CONTRACT, ACTION MAY BE TAKEN AGAINST ME SHOULD THIS DECLARATION PROVE TO BE FALSE.

……... **……..**
Signature **Date**

…… **……..**
Position **Name of Tenderer**

FORM 22: CERTIFICATE OF INDEPENDENT TENDER DETERMINATION

1 This Municipal Tendering Document (MBD) must form part of all tenders[1] invited.

2 Section 4 (1) (b) (iii) of the Competition Act No. 89 of 1998, as amended, prohibits an agreement between, or concerted practice by, firms, or a decision by an association of firms, if it is between parties in a horizontal relationship and if it involves collusive Tendering (or tender rigging).[2] Collusive Tendering is a *pe se* prohibition meaning that it cannot be justified under any grounds.

3 Municipal Supply Regulation 38 (1) prescribes that a supply chain management policy must provide measures for the combating of abuse of the supply chain management system, and must enable the accounting officer, among others, to:

a. take all reasonable steps to prevent such abuse;

b. reject the tender of any Tenderer if that Tenderer or any of its directors has abused the supply chain management system of the municipality or municipal entity or has committed any improper conduct in relation to such system; and

c. cancel a contract awarded to a person if the person committed any corrupt or fraudulent act during the Tendering process or the execution of the contract.

4 This MBD serves as a certificate of declaration that would be used by institutions to ensure that, when tenders are considered, reasonable steps are taken to prevent any form of tender-rigging.

5 In order to give effect to the above, the attached Certificate of Tender Determination (MBD 9) must be completed and submitted with the tender:

[1] Includes price quotations, advertised competitive tenders, limited tenders and proposals.

[2] Tender rigging (or collusive Tendering) occurs when businesses, that would otherwise be expected to compete, secretly conspire to raise prices or lower the quality of goods and / or services for purchasers who wish to acquire goods and / or services through a Tendering process. Tender rigging is, therefore, an agreement between competitors not to compete.

MBD 9

CERTIFICATE OF INDEPENDENT TENDER DETERMINATION

I, the undersigned, in submitting the accompanying tender:

_____

(Tender Number and Description)

in response to the invitation for the tender made by:

_____

_

(Name of Municipality / Municipal Entity)

do hereby make the following statements that I certify to be true and complete in every respect:

I certify, on behalf of:_____that:

(Name of Tenderer)

1. I have read, and I understand the contents of this Certificate;
2. I understand that the accompanying tender will be disqualified if this Certificate is found not to be true and complete in every respect;
3. I am authorized by the Tenderer to sign this Certificate, and to submit the accompanying tender, on behalf of the Tenderer;
4. Each person whose signature appears on the accompanying tender has been authorized by the Tenderer to determine the terms of, and to sign, the tender, on behalf of the Tenderer;
5. For the purposes of this Certificate and the accompanying tender, I understand that the word “competitor” shall include any individual or organization, other than the Tenderer, whether or not affiliated with the Tenderer, who:
   (a) has been requested to submit a tender in response to this tender invitation;
   (b) could potentially submit a tender in response to this tender invitation, based on their qualifications, abilities or experience; and
   (c) provides the same goods and services as the Tenderer and/or is in the same line of business as the Tenderer
6. The Tenderer has arrived at the accompanying tender independently from, and without consultation, communication, agreement or arrangement with any competitor. However communication between partners in a joint venture or consortium[3] will not be construed as collusive Tendering.

7. In particular, without limiting the generality of paragraphs 6 above, there has been no consultation, communication, agreement or arrangement with any competitor regarding:

   (a) prices;

   (b) geographical area where product or service will be rendered (market allocation)

   (c) methods, factors or formulas used to calculate prices;

   (d) the intention or decision to submit or not to submit, a tender;

   (e) the submission of a tender which does not meet the specifications and conditions of the tender; or

   (f) Tendering with the intention not to win the tender.

8. In addition, there have been no consultations, communications, agreements or arrangements with any competitor regarding the quality, quantity, specifications and conditions or delivery particulars of the products or services to which this tender invitation relates.

9. The terms of the accompanying tender have not been, and will not be, disclosed by the Tenderer, directly or indirectly, to any competitor, prior to the date and time of the official tender opening or of the awarding of the contract.

10. I am aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practices related to tenders and contracts, tenders that are suspicious will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No 89 of 1998 and or may be reported to the National Prosecuting Authority (NPA) for criminal investigation and or may be restricted from conducting business with the public sector for a period not exceeding ten (10) years in terms of the Prevention and Combating of Corrupt Activities Act No 12 of 2004 or any other applicable legislation.

…… ……

Signature Date

…… ……

Position Name of Tenderer

[3] Joint venture or Consortium means an association of persons for the purpose of combining their expertise, property, capital, efforts, skill and knowledge in an activity for the execution of a contract.

FORM 23: COMPULSORY ENTERPRISE QUESTIONNAIRE

The following particulars must be furnished. In the case of a joint venture, **separate** enterprise questionnaires in respect of each partner must be completed and submitted.

Section 1: Name of enterprise . . . . . .

Section 2: VAT registration number, if any: . . . . . .

Section 3: CIDB registration number, if any: . . . .

Section 4: Particulars of sole proprietors and partners in partnerships

Name*	Identity number*	Personal income tax numb

***** Complete only if sole proprietor or partnership and attach separate page if more than 3 partners

Section 5: Particulars of companies and close corporations

Company registration number . . . . . .

Close corporation number . . . . . .

Tax reference number . . . . . .

Section 6: Record in the service of the state

Indicate by marking the relevant boxes with a cross, if any sole proprietor, partner in a partnership or director, manager, principal shareholder or stakeholder in a company or close corporation is currently or has been within the last 12 months in the service of any of the following:

a member of any municipal council a member of any provincial legislature a member of the National Assembly or the National Council of Province a member of the board of directors of any municipal entity an official of any municipality or municipal entity	☐ an employee of any provincial department national or provincial public entity o constitutional institution within the meaning o the Public Finance Management Act, 199 (Act 1 of 1999) ☐ a member of an accounting authority of any national or provincial public entity ☐ an employee of Parliament or a provincia legislature

If any of the above boxes are marked, disclose the following:

Name of sole proprietor, partner, director, manager, principal shareholder or stakeholder	Name of institution, public office, board or organ of state and position held	Status of service (tick appropriate columr	
		Current	Within last months

*insert separate page if necessary

Section 7: Record of spouses, children and parents in the service of the state

Indicate by marking the relevant boxes with a cross, if any spouse, child or parent of a sole proprietor, partner in a partnership or director, manager, principal shareholder or stakeholder in a company or close corporation is currently or has been within the last 12 months been in the service of any of the following:

a member of any municipal council a member of any provincial legislature a member of the National Assembly or the National Council of Province a member of the board of directors of any municipal entity an official of any municipality or municipal entity	□ an employee of any provincial department, national provincial public entity or constitutional institution within t meaning of the Public Finance Management Act, 1999 (1 of 1999) □ a member of an accounting authority of any national provincial public entity □ an employee of Parliament or a provincial legislature

Name of spouse, child or parent	**Name of institution, public office, board or organ of state and position held**	**Status of service (tick appropriate column**	
		Current	**Within last months**

*insert separate page if necessary

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise:

i) authorizes the Employer to obtain a tax clearance certificate from the South African Revenue Services that my / our tax matters are in order;

ii) confirms that the neither the name of the enterprise or the name of any partner, manager, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears on the Register of Tender Defaulters established in terms of the Prevention and Combating of Corrupt Activities Act of 2004;

iii) confirms that no partner, member, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears, has within the last five years been convicted of fraud or corruption;

iv) confirms that I / we are not associated, linked or involved with any other tendering entities submitting tender offers and have no other relationship with any of the tenderers or those responsible for compiling the scope of work that could cause or be interpreted as a conflict of interest; and

iv) confirms that the contents of this questionnaire are within my personal knowledge and are to the best of my belief both true and correct.

Signed		Date	
Name		Position	
Enterprise name			

SIGNED ON BEHALF OF THE TENDERER: .....

FORM 24: MECHANICAL DATA SHEETS

The following Mechanical Data Sheets form part of the Returnable Schedules:

Number	Description
1000936-3000-DST-MM-0001	STEEL PIPE (UP TO DN 150)
1000936-3000-DST-MM-0002	STEEL PIPE (ABOVE DN 150)
1000936-3000-DST-MM-0003	RSV GATE VALVE
1000936-3000-DST-MM-0004	BALL VALVE
1000936-3000-DST-MM-0006	FLANGE ADAPTER
1000936-3000-DST-MM-0007	AIR VALVES
1000936-3000-DST-MM-0008	STRAINER
1000936-3000-DST-MM-0009	ELECTROMAGNETIC FLOW METER
1000936-3000-DST-MM-0010	DISMANTLING JOINT
1000936-3000-DST-MM-0015	FLOW AND ALTITUDE CONTROL VALVE
1000936-3000-DST-MM-0017	PRESSURE REDUCING VALVE

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **STEEL PIPE (UP TO DN 150) DATA SHEET**	CLIENT Nº.	PAGE 1/1
	ZUTARI Nº. 1000936-3000-DST-MM-0001	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY | C – FOR TENDER | E – FOR CONSTRUCTION | G – AS BUILT
B – FOR APPROVAL | D – FOR QUOTATION | F – AS PURCHASED | H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024

Instructions on Filling Out This Form

I - Potential Suppliers should fill out the left column of the "Proposed" field with one of the following options: "MR" (Meets Requirements) or "D" (Deviation).

II - Suppliers must list any items marked "D" and any other clarifications in the "Deviations List", of the Technical Requisition. To include information in addition to the contents of this datasheet, suppliers should proceed in the same manner.

III - The explanatory notes at the end of the Data Sheet are to be filled out by the Issuer and not by Suppliers.

Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to BOQ

Item	Description	Unit	Specified	Proposed	
1	**PIPE DETAILS**				
1.1	Type of pipe (SANS 719, SANS 62-1, etc.)	-	SANS 62		
1.2	Pipe nominal bore	mm	As per drawings		
1.3	Pipe wall thickness	mm	SANS 62 Heavy Duty		
1.4	Actual outer diameter	mm	SANS 62 Heavy Duty		
1.5	Actual inner diameter	mm	SANS 62 Heavy Duty		
1.6	Material grade (API5L, EN, SANS Grades, etc.)	-	As per SANS 62		
1.7	Design pressure rating	kPa	As per drawings		
1.8	Pipe ends (flanged, bevelled, etc.)	-	Varies, as per drawings		
1.9	Connection Type (SANS 1123, BS4504, BSP, NPT)	-	Varies, as per drawings		
2	**COATING & LINER DETAILS**				
2.1	Buried pipes				
2.1.1	Type of Coating	-	Rigid Polyurethane		
2.1.2	Coating thickness	-	1.5mm		
2.1.3	Type of Lining	-	CML		
2.1.4	Lining thickness (DFT)	-	6mm		
2.2	Pipes in chambers				
2.2.1	Type of Coating and Lining (PMB, PU, FBE, HDG, etc.)	-	Galvanised		
2.2.2	Coating and Lining thickness/ application	-	SANS121 (Heavy Duty)		
2.2.3	Additional coating	-	Not required		
2.2.4	Additional Coating thickness (DFT)	-	N/A		
3	**PIPE TESTING**				
3.1	Hydraulic pipe testing	Yes/No	Yes		
3.2	Test pressure	kPa	1.5 X Design Pressure		
3.3	Radiographic testing	Yes/No	Yes		
4	**GENERAL DETAILS**				
4.1	Total length of pipe required	m	As per drawings		
4.2	Pipe lengths	m	(Specify)		
4.3	Allowable tolerance on pipe length	mm	As per SANS 62		
4.4	Total weight of pipe per meter (pipe and coating)	kg/m	(Specify)		
4.5	Percentage local production and content	%	70		
5	**FINANCIAL DETAILS**				
5.1	Cost per meter (uncoated)	ZAR			Price in BOQ
5.2	Cost per meter (coating and lining)	ZAR			Price in BOQ
5.3	Expected delivery time	Weeks	(Specify)		

Explanatory Notes

01 - Supplier shall refer to reference documents listed on the requisition to complete equipment specification.

02 - Supplier shall confirm and/or provide all equipment data while filing the proposed column.

REFERENCE DOCUMENTS

ZUT 0003: ZUTARI Specification - Corrosion Protection

ZUT 7001: ZUTARI Specification - Steel Specials

ZUT 7002: ZUTARI Specification - Medium Pressure Pipelines

ZUT 7003: ZUTARI Specification - Laying and Jointing of Steel Pipes

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **STEEL PIPE (ABOVE DN 150) DATA SHEET**	CLIENT Nº.	PAGE 1/1
	ZUTARI Nº. 1000936-3000-DST-MM-0002	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY | B – FOR APPROVAL | C – FOR TENDER | D – FOR QUOTATION | E – FOR CONSTRUCTION | F – AS PURCHASED | G – AS BUILT | H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024

Instructions on Filling Out This Form

I - Potential Suppliers should fill out the left column of the "Proposed" field with one of the following options: "MR" (Meets Requirements) or "D" (Deviation).

II - Suppliers must list any items marked "D" and any other clarifications in the "Deviations List", of the Technical Requisition. To include information in addition to the contents of this datasheet, suppliers should proceed in the same manner.

III - The explanatory notes at the end of the Data Sheet are to be filled out by the Issuer and not by Suppliers.

Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to BOQ

Item	Description	Unit	Specified	Proposed	
1	**PIPE DETAILS**				
1.1	Type of pipe (SANS 719, SANS 62-1, etc.)	-	SANS 719		
1.2	Pipe nominal bore	mm	As per drawings		
1.3	Pipe wall thickness	mm	As per drawings		
1.4	Actual outer diameter	mm	As per SANS 719		
1.5	Actual inner diameter	mm	As per SANS 719		
1.6	Material grade (API5L, EN, SANS Grades, etc.)	-	SANS 719 Grade C		
1.7	Design pressure rating	kPa	As per drawings		
1.8	Pipe ends (flanged, bevelled, etc.)	-	Flanged		
1.9	Connection Type (SANS 1123, BS4504, BSP, NPT)	-	As per ZUT 7001		
2	**COATING & LINER DETAILS**				
2.1	Buried pipes				
2.1.1	Type of Coating	-	Rigid Polyurethane		
2.1.2	Coating thickness	-	1.5mm		
2.1.3	Type of Lining	-	CML		
2.1.4	Lining thickness (DFT)	-	9mm		
2.2	Pipes in chambers				
2.2.1	Type of Coating and Lining (PMB, PU, FBE, HDG, etc.)	-	Galvanised		
2.2.2	Coating and Lining thickness/ application	-	SANS121 (Heavy Duty)		
2.2.3	Additional coating	-	Not required		
2.2.4	Additional Coating thickness (DFT)	-	N/A		
3	**PIPE TESTING**				
3.1	Hydraulic pipe testing	Yes/No	Yes		
3.2	Test pressure	kPa	1.5 X Design Pressure		
3.3	Radiographic testing	Yes/No	Yes		
4	**GENERAL DETAILS**				
4.1	Total length of pipe required	m	As per drawings		
4.2	Pipe lengths	m	(Specify)		
4.3	Allowable tolerance on pipe length	mm	As per SANS 719		
4.4	Total weight of pipe per meter (pipe and coating)	kg/m	(Specify)		
4.5	Percentage local production and content	%	70		
5	**FINANCIAL DETAILS**				
5.1	Cost per meter (uncoated)	ZAR			Price in BOQ
5.2	Cost per meter (coating and lining)	ZAR			Price in BOQ
5.3	Expected delivery time	Weeks	(Specify)		

Explanatory Notes

01 - Supplier shall refer to reference documents listed on the requisition to complete equipment specification.

02 - Supplier shall confirm and/or provide all equipment data while filing the proposed column.

REFERENCE DOCUMENTS

ZUT 0003: ZUTARI Specification - Corrosion Protection

ZUT 7001: ZUTARI Specification - Steel Specials

ZUT 7002: ZUTARI Specification - Medium Pressure Pipelines

ZUT 7003: ZUTARI Specification - Laying and Jointing of Steel Pipes

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **RSV GATE VALVE**	CLIENT Nº.	PAGE 1/2
	ZUTARI Nº. 1000936-3000-DST-MM-0003	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY | B – FOR APPROVAL | C – FOR TENDER | D – FOR QUOTATION | E – FOR CONSTRUCTION | F – AS PURCHASED | G – AS BUILT | H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024
.	.	.	.	.	.	.	.

Instructions on Filling Out This Form

I - Potential Suppliers should fill out the left column of the "Proposed" field with one of the following options: "MR" (Meets Requirements) or "D" (Deviation).

II - Suppliers must list any items marked "D" and any other clarifications in the "Deviations List", of the Technical Requisition. To include information in addition to the contents of this datasheet, suppliers should proceed in the same manner.

III - The explanatory notes at the end of the Data Sheet are to be filled out by the Issuer and not by Suppliers.

Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to BoQ

Item	Description	Unit	Specified	Proposed	
1	**MEDIUM DETAILS**				
1.1	Water quality	-	Potable Water		
1.2	SG	-	1		
1.3	PH	pH	6 to 8		
1.4	Operating Temperature	°C	-5 to 40		
2	**VALVE DETAILS**				
2.1	Manufacturer	-	OZ-KAN, VOSA, VAG or similar approved		
2.2	Mode	-	(Specify)		
2.3	Country of Manufacture	-	(Specify)		
2.4	Nominal Size DN	mm	As per drawings		
2.5	Gate Type	-	Resilient Seal		
2.6	Rated Pressure	kPa	As per drawings		
2.7	Body Test pressure	kPa	1.5 x Design Pressure		
2.8	Seat Test pressure	kPa	1.1 x Design Pressure		
2.9	Flanges	-	SANS 1123		
2.10	Raised Faced Flanges	-	Yes		
2.11	Flange Pattern	-	Short Pattern		
2.12	Face to Face distance	mm	(Specify)		
2.13	Hand wheel operated	(Yes/No)	Yes		
2.14	Closing Direction	-	Clockwise		
2.15	Gearbox	(Yes/No)	Yes (where maximum peripheral force exceeds 250 N)		
2.16	Rising-, non-rising spindle	-	As per drawings		
2.17	Welded-, bolted bonnet	-	Bolted		
2.18	Actual inner bore	mm	(Specify)		
2.19	Loss coefficient K = (hm)/(v^2/(2g))	K	(Specify)		
3	**ACTUATOR DETAILS**				
3.1	Manufacturer	-	(Specify)		
3.2	Type of Actuation	-	Manual		
3.3	Electrical Operated:				
3.3.1	- Motor shaft output at site conditions	kW	N/A		
3.3.2	- Motor torque	N.m	N/A		
3.3.3	- Rotational speed	rpm	N/A		
3.3.4	- Full load current	A	N/A		
3.3.5	- Voltage	V	N/A		
3.3.6	- Enclosure rating	IP	N/A		
3.3.7	- Communication Module	-	N/A		
3.4	Pneumatic Operated:				
3.4.1	- Mode of Operation	-	N/A		
3.4.2	- Position indicator	Yes/No	N/A		
3.4.3	- Closing direction	-	N/A		
3.4.4	- Operating pressure range	bar	N/A		
3.4.5	- Nominal Operating Pressure	bar	N/A		
3.4.6	- Operating time at 4.5 bar pressure supply	s	N/A		
3.4.7	- Operating Medium	-	N/A		
3.4.8	- Torque at Rated Operating Pressure	Nm	N/A		
3.4.9	- Air Consumption at 6 bar per cycle 0°-90°-0°	l	N/A		

SEKHUKHUNE District Municipality	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **RSV GATE VALVE**	CLIENT Nº.	PAGE 2/2
	ZUTARI Nº. 1000936-3000-DST-MM-0003	REV. **B**

Item	Description	Unit	Specified	Proposed	
4	**CONSTRUCTION MATERIALS**				
4.1	Body	-	Ductile Iron or Cast Steel		
4.2	Bonnet/Stuffing Box	-	Ductile Iron or Cast Steel		
4.3	Gate material	-	Ductile Iron, EPDM encapsulated		
4.4	Body Seat Trim	-	N/A		
4.5	Gate Seat Trim	-	N/A		
4.6	Spindle	-	Stainless Steel		
4.7	Spindle Nut	-	Bronze		
4.8	Scrapers - if applicable	-	N/A		
4.9	Gland Packing	-	(Specify)		
4.10	Handwheel	-	Cast Steel		
4.11	Type of interior lining	-	FBE (250 micron DFT)		
4.12	Type of exterior coating	-	FBE (250 micron DFT)		
5	**GENERAL DETAILS**				
5.1	Total weight of valve	kg	(Specify)		
5.2	Lifting lugs	Yes/No	Yes (for DN300 or larger and/or above 75 kg)		
5.3	Nameplate	Yes/No	Yes		
5.4	Main dimensions of valve	mm	(Specify)		
5.5	Life expectancy (# open/close cycles)	No	(Specify)		
5.6	Hand wheel dimensions	mm	Refer to ZUT 7004		
5.7	Percentage local production and content	%	70		
6	**FINANCIAL DETAILS**				
6.1	Cost per unit	ZAR			Price in BOQ
6.2	Pressure testing cost per unit	ZAR			Price in BOQ
6.3	Cost per actuator	ZAR	N/A		Price in BOQ
6.4	Assembly delivery time	Weeks	(Specify)		

Explanatory Notes

01 - Supplier shall refer to reference documents listed on the requisition to complete equipment specification.

02 - Supplier shall confirm and/or provide all equipment data while filing the proposed column.

REFERENCE DOCUMENTS

ZUT 7001: ZUTARI Specification - Steel Specials

ZUT 7004: ZUTARI Specification - Valves for Water and Wastewater Installations

ZUT 7016: ZUTARI Specification - Resilient Seal Gate Valve

SEKHUKHUNE District Municipality	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **BALL VALVE**	CLIENT Nº.	PAGE 1/1
	ZUTARI Nº. 1000936-3000-DST-MM-0004	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY | B – FOR APPROVAL | C – FOR TENDER | D – FOR QUOTATION | E – FOR CONSTRUCTION | F – AS PURCHASED | G – AS BUILT | H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024
.	.	.	.	.	.	.	.

Instructions on Filling Out This Form

I - Potential Suppliers should fill out the left column of the "Proposed" field with one of the following options: "MR" (Meets Requirements) or "D" (Deviation).

II - Suppliers must list any items marked "D" and any other clarifications in the "Deviations List", of the Technical Requisition. To include information in addition to the contents of this datasheet, suppliers should proceed in the same manner.

III - The explanatory notes at the end of the Data Sheet are to be filled out by the Issuer and not by Suppliers.

Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to BoQ

Item	Description	Unit	Specified		Proposed
1	**VALVE DETAILS**				
1.1	Manufacturer	-	(Specify)		
1.2	Model #	-	(Specify)		
1.3	Country of Manufacture	-	(Specify)		
1.4	Nominal Size DN	mm	As per drawings		
1.5	Connection type	-	BSP Threaded		
1.6	Seat	-	Soft-seated		
1.7	Rated Pressure	kPa	As per drawings		
1.8	Body Test pressure	kPa	1.5 x Design Pressure		
1.9	Seat Test pressure	kPa	1.1 x Design Pressure		
1.10	Face to Face Distance	mm	(Specify)		
1.11	Hand wheel/Lever operated	(Yes/No)	Lever operated		
1.12	Gearbox	(Yes/No)	No		
1.13	Loss coefficient K = (hm)/(v^2/(2g))	K	(Specify)		
2	**VALVE CHARACTERISTICS AND PERFORMANCE**				
2.1	Rated flow rate (max)	l/sec	(Specify)		
2.2	Reduced/ Full bore	-	Full Bore		
3	**MATERIAL OF CONSTRUCTION**				
3.1	Body	-	Stainless steel		
3.2	Lever	-	Stainless steel		
3.3	Ball	-	Stainless steel		
3.4	Seals	-	(Specify)		
3.5	Trunnion	-	(Specify)		
3.6	Stem	-	(Specify)		
4	**GENERAL DETAILS**				
4.1	Total weight of valve	kg	(Specify)		
4.2	Lifting lugs	Yes/No	No		
4.3	Nameplate	Yes/No	No		
4.4	Main dimensions of valve	mm	(Specify)		
4.5	Life expectancy (# open/close cycles)	No	(Specify)		
4.6	Percentage local production and content	%	70		
5	**FINANCIAL DETAILS**				
5.1	Cost per unit	ZAR			Price in BOQ
5.2	Pressure testing cost per unit	ZAR			Price in BOQ
5.3	Cost per actuator	ZAR	N/A		Price in BOQ
5.4	Assembly delivery time	Weeks	(Specify)		

Explanatory Notes

01 - Supplier shall refer to reference documents listed on the requisition to complete equipment specification.

02 - Supplier shall confirm and/or provide all equipment data while filing the proposed column.

REFERENCE DOCUMENTS

ZUT 0001: ZUTARI Specification - General Mechanical Requirements

ZUT 7004: ZUTARI Specification - Valves for Water and Wastewater Installations

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3088 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **FLANGE ADAPTER**	CLIENT Nº.	PAGE 1/1
	ZUTARI Nº. 1000936-3000-DST-MM-0006	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY
B – FOR APPROVAL
C – FOR TENDER
D – FOR QUOTATION
E – FOR CONSTRUCTION
F – AS PURCHASED
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H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024
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Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to BoQ

Item	Description	Unit	Specified	Proposed	
1	**MEDIUM DETAILS**				
1.1	Water quality	-	Potable Water		
1.2	SG	-	1		
1.3	PH	pH	6 to 8		
1.4	Operating Temperature	°C	-5 to 40		
2	**FLANGE ADAPTOR DETAILS**				
2.1	Manufacturer	-	Kamflex, Viking Johnson or similar approved		
2.2	Model #	-	(Specify)		
2.3	Country of Manufacture	-	(Specify)		
2.5	Nominal Size DN	mm	As per drawings		
2.6	Flange Adapter Type	-	As per drawings		
2.7	Pipe Standard	-	SANS 62 (Smaller than DN150) SANS 719 (Larger than DN 150)		
2.8	Rated Pressure	kPa	As per drawings		
2.9	Flanges	-	SANS 1123		
2.10	Raised Faced Flanges	Yes/No	Yes		
2.11	Recommended setting gap	mm	(Specify)		
2.12	Face to Face distance	mm	(Specify)		
2.13	Coating material	-	FBE		
2.14	Lining material	-	EPDM		
3	**CONSTRUCTION MATERIALS**				
3.1	Spigot Piece	-	Mild Steel, Ductile Iron		
3.2	Flange Adaptor	-	Mild Steel, Ductile Iron		
3.3	Clamping bolts	-	High tensile steel		
3.4	Tie rods	-	High tensile steel		
3.5	Adaptor sealing rubber	-	EPDM		
3.6	Gaskets	-	(Specify)		
4	**GENERAL DETAILS**				
4.1	Total weight of device	kg	(Specify)		
4.2	Length of device	mm	(Specify)		
43	Percentage local production and content	%	70		
5	**FINANCIAL DETAILS**				
5.1	Cost per unit	ZAR			Price in BOQ
5.2	Expected delivery time	Weeks	(Specify)		

Explanatory Notes

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REFERENCE DOCUMENTS

ZUT 0003: ZUTARI Specification - Corrosion Protection

ZUT 7001: ZUTARI Specification - Steel Specials

ZUT 7023: ZUTARI Specification - Pipe Couplings

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3088 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **AIR VALVE**	CLIENT Nº.	PAGE 1/1
	ZUTARI Nº. 1000936-3000-DST-MM-0007	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY | B – FOR APPROVAL | C – FOR TENDER | D – FOR QUOTATION | E – FOR CONSTRUCTION | F – AS PURCHASED | G – AS BUILT | H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024
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Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to BoQ

Item	Description	Unit	Specified	Proposed	
1	**MEDIUM DETAILS**				
1.1	Water quality	-	Potable Water		
1.2	SG	-	1		
1.3	PH	pH	6 to 8		
1.4	Operating Temperature	°C	-5 to 40		
2	**VALVE DETAILS**				
2.1	Manufacturer	-	Vent-O-Mat, ARI or similar approved		
2.2	Model #	-	(Specify)		
2.3	Country of Manufacture	-	(Specify)		
2.4	Nominal Size DN	mm	As per drawings		
2.5	Valve Type	-	Double Acting, Anti-shock, Single Chamber		
2.6	Design Pressure	kPa	As per drawings		
2.7	Connection type	-	As per drawings		
2.8	Thread Type	-	As per drawings		
2.9	Flanges	-	As per drawings		
2.10	Raised Face Flanges	Yes/No	Yes		
2.11	Bleeding Nipple (1/4" BSP/NPT connection)	Yes/No	Yes		
3	**VALVE CHARACTERISTICS (HYDRAULIC DATA)**				
3.1	Large intake and exhaust orifice size same as valve DN?	Yes/No	Yes		
3.2	Is Intake Capacity Curve submitted with this data sheet?	Yes/No	Yes		
3.3	Min. guaranteed sealing pressure	m	5		
3.4	Max. guaranteed sealing pressure	kPa	1.5 x Design Pressure		
3.5	Small orifice size	mm	(Specify)		
3.6	Anti-shock orifice size	mm	(Specify)		
4	**CONSTRUCTION MATERIALS**				
4.1	Body material	-	Stainless steel		
4.2	Cylinder Float	-	(Specify)		
4.3	Ball Float	-	(Specify)		
4.4	Seals	-	(Specify)		
4.5	Stem and guide components	-	(Specify)		
5	**GENERAL DETAILS**				
5.1	Total weight of valve	kg	(Specify)		
5.2	Lifting lugs	Yes/No	Yes (if above 75 kg)		
5.3	Nameplate	Yes/No	Yes		
5.4	Main dimensions of valve	mm	(Specify)		
5.5	Life expectancy (# open/close cycles)	No	(Specify)		
5.6	Percentage local production and content	%	70		

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **AIR VALVE**	CLIENT Nº.	PAGE 1/2
	ZUTARI Nº. 1000936-3000-DST-MM-0007	REV. **B**

Item	Description	Unit	Specified		Proposed
6	**FINANCIAL DETAILS**				
6.1	Cost per unit	ZAR			Price in BOQ
6.2	Expected delivery time	Weeks	(Specify)		

Explanatory Notes

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02 - Supplier shall confirm and/or provide all equipment data while filing the proposed column.

REFERENCE DOCUMENTS

ZUT 7001: ZUTARI Specification - Steel Specials

ZUT 7004: ZUTARI Specification - Valves for Water and Waste Water Installations

ZUT 7022: ZUTARI Specification - Air Valves

SEKHUKHUNE District Municipality	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **STRAINER**	CLIENT Nº.	PAGE 1/2
	ZUTARI Nº. 1000936-3000-DST-MM-0008	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY | C – FOR TENDER | E – FOR CONSTRUCTION | G – AS BUILT

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024

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Supplier:	**Proposal:**
Identification (TAG):	**Quantity:**

Item	Description	Unit	Specified	Proposed	
1	**VALVE DETAILS**				
1.1	Manufacturer	-	BERMAD or similar		
1.2	Model #	-	(Specify)		
1.3	Country of Manufacture	-	South Africa		
1.4	Nominal Size DN	mm	As per drawings		
1.5	Rated Pressure	kPa	As per drawings		
1.6	Body Test pressure	kPa	1.5 x Design Pressure		
1.7	Seat Test pressure	kPa	N/A		
1.8	Selected valve is suitable for operation under settled raw water	Yes/No	No (Potable Water)		
1.9	Pressure gauges up/downstream of valve	Yes/No	Yes		
1.10	Valve Type	-	Y-type basket strainer		
1.11	Basket Mesh Size	-	Suitable for Stone and Gravel		
1.12	Flanges (BS, SABS, ANSI, etc.)	-	SANS 1123		
1.13	Raised Face Flanges	Yes/No	Yes		
1.14	Face to Face distance	mm	(Specify)		
1.15	Method to Remove Basket	-	Bolted Connection		
1.16	Vertical Distance Required to Remove Basket	mm	(Specify)		
2	**VALVE CHARACTERISTICS (HYDRAULIC DATA)**				
	Nominal Flow	L/s	Specify		
2.1	Loss coefficient K = (hm)/(v^2/(2g)) @ nominal flowrate	K	Specify		
3	**CONSTRUCTION MATERIALS**				
3.1	Body and cap material (CI, DI, CS, etc.)	-	Ductile Iron		
3.2	Drain plug		Stainless Steel		
3.3	O-ring		(Specify)		
3.4	Basket		Stainless Steel		
3.5	Fasteners		Stainless Steel		
3.6	Type of interior lining (2-pack Epoxy, FBE, etc.)	-	Fusion-bonded Epoxy Coating (250microns DFT)		
3.7	Type of exterior coating (2-pack Epoxy, FBE, etc.)	-	Fusion-bonded Epoxy Coating (250 microns DFT)		
4	**GENERAL DETAILS**				
4.1	Total weight of valve	kg	(Specify)		
4.2	Hydraulic Power Pack (if required)	kg	N/A		
4.3	Main dimensions of valve (L x W x H)	mm	(Specify)		
4.4	Life expectancy (# open/close cycles)	No	(Specify)		
4.5	Percentage local production and content	%	70		
5	**FINANCIAL DETAILS**				
5.1	Cost per unit	ZAR			Price in BOQ
5.2	Pressure testing cost per unit	ZAR			Price in BOQ
5.3	Cost per actuator	ZAR			Price in BOQ
5.4	Assembly delivery time	Weeks	(Specify)		

Explanatory Notes

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REFERENCE DOCUMENTS

ZUT 0001: ZUTARI Specification - General Mechanical Requirements

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **ELECTROMAGNETIC FLOW METER**	CLIENT Nº. 	PAGE 1/2
	ZUTARI Nº. 1000936-3000-DST-MM-0009	REV. **B**

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Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to Drawings

Item	Description	Unit	Specified	Proposed	
1	**MEDIUM DETAILS**				
1.1	Water quality (potable, raw, sewage, etc.)	-	Potable Water		
1.2	SG	-	1		
1.3	Solid content	%	Less than 5%		
1.4	PH	pH	6 to 8		
1.5	Operating Temperature	°C	-5 to 40		
2	**METER DETAILS**				
2.1	Manufacturer	-	Siemens, Krohne or similar approved		
2.2	Model	-	(Specify)		
2.3	Type of flow meter (electromagnetic, ultrasonic)	-	Electromagnetic		
2.4	Type of installation (in-line, clamp-on, etc.)	-	Inline (Horizontal)		
2.5	Required minimum flow velocity	m/s	1.5		
2.6	Nominal Size DN	mm	200		
2.7	Pressure Rating	PN	PN25		
2.8	Flange (face-to-face) dimension	mm	(Specify)		
2.9	Version (compact or remote)	-	Compact		
2.10	Connection type (Flanged, Screwed)	-	Flanged		
2.11	Flanges (BS, SABS, ANSI, etc.)	-	SANS1123 (RF)		
2.12	Flow rate measuring range capability	l/s	(Specify)		
3	**FLOW SENSOR**				
3.1	Type of flow device (electrodes, transducers)	-	Electrodes		
3.2	Degree of Protection (Ingress Protection)	IP	67		
3.3	Min. Upstream straight lengths required	m	5 x DN		
3.4	Min. Downstream straight lengths required	m	3 x DN		
3.5	Corrosion Protection (FBE, Epoxy,PU, etc.)	-	(Specify)		
3.6	Materials of Construction:				
3.6.1	- Flanges (SS, CS, etc.)	-	Carbon Steel, protective coating in accordance with supplier's standard		
3.6.2	- Measuring Tube (SS, CS, etc.)	-	Stainless Steel		
3.6.3	- Type of liner (PTFE, PFA, Neoprene, EPDM, etc.)	-	Polyurethane		
3.6.4	- Housing (SS, CS, etc.)	-	Carbon Steel, protective coating in accordance with supplier's standard		
3.6.5	- Connection Box (SS, DCA, etc.)	-	(Specify)		
3.6.6	- Electrodes	-	Stainless Steel (316)		
3.6.7	- Grounding Rings	-	(Specify)		

SEKHUKHUNE District Municipality	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **ELECTROMAGNETIC FLOW METER**	CLIENT Nº.	PAGE 2/2
	ZUTARI Nº. 1000936-3000-DST-MM-0009	REV. **B**

Item	Description	Unit	Specified	Proposed	
4	**TRANSMITTER**				
4.1	Type (compact, remote)	-	Compact		
4.2	Measuring Accuracy	%	2%		
4.3	Calibrated range	L/s	(Specify)		
4.4	Maximum Solids	%	Less than 5%		
4.5	Display:				
4.5.1	- Display and User Interface	-	4-line display with back light		
4.5.2	- Display Function	-	Flowrate and Totalizer		
4.5.3	- Language options	-	English		
4.5.4	- Units	-	Metric, British, US selectable		
4.6	Communication (HART, MODBUS, Profibus, etc.)		4-20 mA		
4.7	Electical Connection:				
4.7.1	- Voltage	V	230		
4.7.2	- Cable	-	(TBC)		
4.7.3	- Cable entries	-	M20 x 1		
4.7.4	- Degree of Protection (Ingress Protection)	IP	67		
4.8	Materials of Construction:				
4.8.1	- Transmitter Housing (Al, Polycarbonate plastic, etc.)		Aluminium (coated)		
4.8.2	- Window (Glass, Plastic)		(Specify)		
5	**GENERAL DETAILS**				
5.1	Insulating Kit included	Yes/No	Yes		
5.2	Total weight of meter	kg	(Specify)		
5.3	Main dimensions of meter (L x W x H)	mm	(Specify)		
5.4	Percentage local production and content	%	70		
6	**FINANCIAL DETAILS**				
6.1	Cost per unit	ZAR			Price in BOQ
6.2	Expected delivery time	Weeks	(Specify)		

Explanatory Notes

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REFERENCE DOCUMENTS

ZUT 0001 - General Mechanical Requirements

ZUT 8004 - Magnetic Flow Meters

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3686 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **DISMANTLING JOINT**	CLIENT Nº. 	PAGE 1/1
	ZUTARI Nº. 1000936-3000-DST-MM-0010	REV. **B**

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Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024
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Supplier:	**Proposal:**
Identification (TAG):	**Quantity:** Refer to BoQ

Item	Description	Unit	Specified		Proposed
1	**MEDIUM DETAILS**				
1.1	Water quality	-	Potable Water		
1.2	SG	-	1		
1.3	PH	pH	6 to 8		
1.4	Operating Temperature	°C	-5 to 40		
2	**FLANGE ADAPTOR DETAILS**				
2.1	Manufacturer	-	Kamflex, Viking Johnson or similar approved		
2.2	Model	-	(Specify)		
2.3	Country of Manufacture	-	(Specify)		
2.4	D/J Type	-	Restrained		
2.5	Pipe nominal bore	mm	As per drawings		
2.6	Pipe Outside Diameter	mm	As per SANS 62/SANS 719		
2.7	Rated Pressure	kPa	As per drawings		
2.8	Flanges	-	SANS 1123		
2.9	Raised Faced Flanges	Yes/No	Yes		
2.10	Recommended setting gap	mm	(Specify)		
2.11	Face to Face distance	mm	(Specify)		
2.12	Coating material	-	FBE (min. 250 microns DFT)		
2.13	Lining material	-	FBE (min. 250 microns DFT)		
3	**CONSTRUCTION MATERIALS**				
3.1	Spigot Piece	-	Ductile Iron		
3.2	Clamping Ring	-	Ductile Iron		
3.3	Clamping bolts	-	High Tensile Steel		
3.4	Tie rods	-	High Tensile Steel		
3.5	Rubber Ring	-	EPDM		
3.6	Gaskets	-	EPDM		
4	**GENERAL DETAILS**				
4.1	Total weight of device	kg	(Specify)		
4.2	Length of device	mm	(Specify)		
4.3	Percentage local production and content	%	70		
5	**FINANCIAL DETAILS**				
5.1	Cost per unit	ZAR			Price in BOQ
5.2	Expected delivery time	Weeks	(Specify)		

Explanatory Notes

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SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **FLOW AND ALTITUDE CONTROL VALVE**	CLIENT Nº.	PAGE 1/2
	ZUTARI Nº. 1000936-3000-DST-MM-0015	REV. **B**

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Supplier:	**Proposal:**
Identification (TAG):	**Quantity:**

Item	Description	Unit	Specified	Proposed	
1	**VALVE DETAILS**				
1.1	Manufacturer	-	BERMAD or similar		
1.2	Model #	-	(Specify)		
1.3	Country of Manufacture	-	South Africa		
1.4	Nominal Size DN	mm	As per drawings		
1.5	Rated Pressure	kPa	As per drawings		
1.6	Body Test pressure	kPa	1.5 x Design Pressure		
1.7	Seat Test pressure	kPa	1.1 x Design Pressure		
1.8	Seat subjected to cavitation	Yes/No	No		
1.9	Selected valve is suitable for operation under settled raw water	Yes/No	No (Potable Water)		
1.10	Pressure gauges up/downstream of valve	Yes/No	Yes		
1.11	Valve Type	-	Hydraulically Operated Flow Control Valve with Altitude Level Control and Anti-surge Closing		
1.12	Body Design	-	Diaphragm Actuated Globe Type		
1.13	Body Pattern	-	Y-pattern		
1.14	Number of Control Pilots	#	3		
1.15	Pilot Types	-	3-way		
1.16	Flow Control (Upstream/downstream)	-	Downstream		
1.17	Flanges (BS, SABS, ANSI, etc.)	-	SANS 1123 T1600/3		
1.18	Raised Face Flanges	Yes/No	No (RF)		
1.19	Face to Face distance	mm	(Specify)		
1.20	Plug Type	-	V-port		
1.21	Control Filter	Yes/No	Yes (Large Area)		
2	**VALVE CHARACTERISTICS (HYDRAULIC DATA)**				
2.1	Nominal flow rate through valve	l/s	(Specify)		
2.2	Upstream pressure at nominal flow	kPa	(Specify)		
2.3	Required downstream pressure	kPa	(Specify)		
2.4	Expected valve turndown ratio	-	3.0		
2.7	Valve flow coefficient (C_V)	-	(Specify)		
2.8	Max. allowable differential pressure across valve (ΔP)	kPa	(Specify)		
2.9	Loss coefficient K = (hm)/(v^2/(2g)) @ nominal flowrate	K	(Specify)		
2.10	Flow control pilot valve range settings (…. to …. kPa)	kPa	(Specify)		

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **FLOW AND ALTITUDE CONTROL VALVE**	CLIENT Nº.	PAGE 2/2
	ZUTARI Nº. 1000936-3000-DST-MM-0015	REV. **B**

Item	Description	Unit	Specified	Proposed	
3	**CONSTRUCTION MATERIALS**				
3.1	Body and Cover material (CI, DI, CS, etc.)	-	Ductile Iron		
3.2	Body seat and guide (Bronze, Gunmetal, etc.)	-	(Specify)		
3.3	Sealing Ring (EPDM, etc.)	-	(Specify)		
3.4	Diaphragm material (Neoprene, etc.)	-	(Specify)		
3.5	Guide rod, bolts (Stainless Steel, etc.)	-	(Specify)		
3.6	Pilot Valve (Stainless Steel, Bronze, etc.)	-	Stainless Steel		
3.7	Pilot Circuit fittings (Stainless Steel, Brass, Nickel Plated, etc.)	-	Stainless Steel		
3.8	Ball Valves/Filter (Stainless Steel, Brass, etc.)	-	Stainless Steel		
3.9	Type of interior lining (2-pack Epoxy, FBE, etc.)	-	Fusion-bonded Epoxy Coating (250 microns DFT)		
3.10	Type of exterior coating (2-pack Epoxy, FBE, etc.)	-	Fusion-bonded Epoxy Coating (250 microns DFT)		
4	**GENERAL DETAILS**				
4.1	Total weight of valve	kg	(Specify)		
4.2	Hydraulic Power Pack (if required)	kg	N/A		
4.3	Main dimensions of valve (L x W x H)	mm	(Specify)		
4.4	Life expectancy (# open/close cycles)	No	(Specify)		
4.5	Percentage local production and content	%	(Specify)		
5	**FINANCIAL DETAILS**				
5.1	Cost per unit	ZAR			Price in BOQ
5.2	Pressure testing cost per unit	ZAR			Price in BOQ
5.3	Cost per actuator	ZAR			Price in BOQ
5.4	Assembly delivery time	Weeks	(Specify)		

Explanatory Notes

01 - Supplier shall refer to reference documents listed on the requisition to complete equipment specification.

02 - Supplier shall confirm and/or provide all equipment data while filing the proposed column.

REFERENCE DOCUMENTS

ZUT 7025: ZUTARI Specification - Diaphragm Control Valves

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **PRESSURE REDUCING VALVE**	CLIENT Nº.	PAGE 1/2
	ZUTARI Nº. 1000936-3000-DST-MM-0017	REV. **B**

TI: TYPE OF ISSUE

A - PRELIMINARY | C – FOR TENDER | E – FOR CONSTRUCTION | G – AS BUILT
B – FOR APPROVAL | D – FOR QUOTATION | F – AS PURCHASED | H - CANCELLED

Rev.	TI	Description	By	Ckd	APP.	Aut.	Date
B	C	FOR TENDER	L.G.	M.B.	V.W.	.	14.10.2024

Instructions on Filling Out This Form

I - Potential Suppliers should fill out the left column of the "Proposed" field with one of the following options: "MR" (Meets Requirements) or "D" (Deviation).

II - Suppliers must list any items marked "D" and any other clarifications in the "Deviations List", of the Technical Requisition. To include information in addition to the contents of this datasheet, suppliers should proceed in the same manner.

III - The explanatory notes at the end of the Data Sheet are to be filled out by the Issuer and not by Suppliers.

Supplier:	**Proposal:**
Identification (TAG):	**Quantity:**

Item	Description	Unit	Specified	Proposed	
1	**VALVE DETAILS**				
1.1	Manufacturer	-	BERMAD or similar		
1.2	Model	-	(Specify)		
1.3	Country of Manufacture	-	South Africa		
1.4	Nominal Size DN	mm	As per drawings		
1.5	Rated Pressure	kPa	As per drawings		
1.6	Body Test pressure	kPa	1.5 x Design Pressure		
1.7	Seat Test pressure	kPa	1.1 x Design Pressure		
1.8	Seat subjected to cavitation	Yes/No	No		
1.9	Selected valve is suitable for operation under settled raw water	Yes/No	No (Potable Water)		
1.10	Pressure gauges up/downstream of valve	Yes/No	Yes		
1.11	Valve Type	-	Hydraulically Operated Pressure Reducing Valve		
1.12	Body Design	-	Diaphragm Actuated Globe Type		
1.13	Body Pattern	-	Y-pattern		
1.14	Number of Control Pilots	#	1		
1.15	Pilot Types	-	N/A		
1.16	Flow Control (Upstream/downstream)	-	N/A		
1.17	Flanges (BS, SABS, ANSI, etc.)	-	SANS 1123 T1600/3		
1.18	Raised Face Flanges	Yes/No	No (RF)		
1.19	Face to Face distance	mm	(Specify)		
1.20	Plug Type	-	V-port		
1.21	Control Filter	Yes/No	Yes (Large Area)		
2	**VALVE CHARACTERISTICS (HYDRAULIC DATA)**				
2.1	Nominal flow rate through valve	l/s	(Specify)		
2.2	Upstream pressure at nominal flow	kPa	(Specify)		
2.3	Required downstream pressure	kPa	(Specify)		
2.4	Expected valve turndown ratio	-	3.0		
2.7	Valve flow coefficient (C_V)	-	(Specify)		
2.8	Max. allowable differential pressure across valve (ΔP)	kPa	(Specify)		
2.9	Loss coefficient K = (hm)/(v^2/(2g)) @ nominal flowrate	K	(Specify)		
2.10	Flow control pilot valve range settings (…. to …. kPa)	kPa	(Specify)		

SEKHUKHUNE District Municipality 3 WEST STREET GROBLERSDAL 0470 TEL: (013) 262 7300 FAX: (013) 262 3688 EMAIL: sekinfo@sekhukhune.co.za	ZUTARI IMPACT. ENGINEERED.	**1000936** **MAMPURU BULK WATER SCHEME : PHASE 1**

TITLE **PRESSURE REDUCING VALVE**	CLIENT Nº.	PAGE 2/2
	ZUTARI Nº. 1000936-3000-DST-MM-0017	REV. **B**

Item	Description	Unit	Specified	Proposed	
3	**CONSTRUCTION MATERIALS**				
3.1	Body and Cover material (CI, DI, CS, etc.)	-	Ductile Iron		
3.2	Body seat and guide (Bronze, Gunmetal, etc.)	-	(Specify)		
3.3	Sealing Ring (EPDM, etc.)	-	(Specify)		
3.4	Diaphragm material (Neoprene, etc.)	-	(Specify)		
3.5	Guide rod, bolts (Stainless Steel, etc.)	-	(Specify)		
3.6	Pilot Valve (Stainless Steel, Bronze, etc.)	-	Stainless Steel		
3.7	Pilot Circuit fittings (Stainless Steel, Brass, Nickel Plated, etc.)	-	Stainless Steel		
3.8	Ball Valves/Filter (Stainless Steel, Brass, etc.)	-	Stainless Steel		
3.9	Type of interior lining (2-pack Epoxy, FBE, etc.)	-	Fusion-bonded Epoxy Coating (250 microns DFT)		
3.10	Type of exterior coating (2-pack Epoxy, FBE, etc.)	-	Fusion-bonded Epoxy Coating (250 microns DFT)		
4	**GENERAL DETAILS**				
4.1	Total weight of valve	kg	(Specify)		
4.2	Hydraulic Power Pack (if required)	kg	N/A		
4.3	Main dimensions of valve (L x W x H)	mm	(Specify)		
4.4	Life expectancy (# open/close cycles)	No	(Specify)		
4.5	Percentage local production and content	%	(Specify)		
5	**FINANCIAL DETAILS**				
5.1	Cost per unit	ZAR			Price in BOQ
5.2	Pressure testing cost per unit	ZAR			Price in BOQ
5.3	Cost per actuator	ZAR			Price in BOQ
5.4	Assembly delivery time	Weeks	(Specify)		

Explanatory Notes

01 - Supplier shall refer to reference documents listed on the requisition to complete equipment specification.

02 - Supplier shall confirm and/or provide all equipment data while filing the proposed column.

REFERENCE DOCUMENTS

ZUT 7025: ZUTARI Specification - Diaphragm Control Valves

FORM 25: RETURNABLE DOCUMENT CHECKLIST

Form	Description	Tick if completed
1	Example for use by the Tenderer when compiling the Authority Certificate	
2	Signatories Authority (Power of Attorney)	
3	Site Inspection Certificate	
4	Record of Addenda to Tender Documents	
5	Schedule of Proposed Subcontractors	
6	Schedule of Construction Equipment	
7	Schedule of the Tenderer's Experience	
8	Proposed Amendments and Qualifications	
9	Schedule of Personnel and Employees	
10	Preliminary Programme	
11	Certificate of Insurance Cover	
12	Compliance with Occupational Health and Safety Act, 1993 and Construction Regulations, 2014	
13	Construction Industries Development Board Registration	
14	Invitation to Tender	
15	Certificate of Tax Compliance (Incorporating MBD2)	
16	Pricing Schedule – Firm Prices (Purchases)	
17	Declaration of Interest	
18	Declaration for Procurement above R10 Million (All Applicable Taxes Included)	
19	Preference Points Claim Form in terms of the Preferential Procurement Regulations 2022	
20	Contract Form - Rendering of Services	
21	Declaration of Tenderer's Past Supply Chain Management Practices	
22	Certificate of Independent Tender Determination	
23	Compulsory Enterprise Questionnaire	
24	Mechanical Datasheets	
25	Returnable Document Checklist	

In addition to the returnable schedules listed on the previous page, the tenderer must also submit the information listed below and the tenderer must take note which of the information is marked as compulsory.

Administrative Requirements	**Tick if completed**
Certificate of Authority for Joint Venture *(Compulsory where applicable)*	
Original Certified copy of identity documents for directors not older than six months	
Copy of Company Registration Documents or CK1 for Close Corporations	
Valid Tax Clearance Certificate Issued by the South African Revenue Service*/ PIN issued by SARS*	
Compliant CSD Registration/CSD Summary Report	
Initial All Pages (Required for Evaluation)	
Legislation Requirements (Compulsory)	**Tick if completed**
Invitation to Bid, Part A & B (MBD 1)	
Declaration of Interest (MBD4)	
enders less than R10 million • If the estimated value of the transaction is less than R10 million, the bid documentation must require the bidders to furnish: • The Municipal rates for the bidder and its directors in respect of which payment is not overdue for more than 90 days or proof of lease agreement including rates for the landlord. In case where the Company or Director is registered in a rural area where the rates are not paid, please attach proof from Local Authority and Affidavit under oath indicating that there are no municipal rates payable	
Tenders exceeding R10 million • If the estimated value of the transaction exceeds R10 million, the bid documentation must require the bidders to furnish: • if the bidder is required by law to prepare annual financial statements for auditing, their audited annual financial statements for the past three years, or • since their establishment if established during the past three years. • A certificate signed by the bidder certifying that the bidder and any of its directors has no undisputed commitments for municipal services towards a municipality or other service provider in respect of which payment is overdue for more than 30 days. • Municipal rates for the bidder and its directors in respect of which payment is not overdue for more than 30 days or proof of lease agreement including rates for the landlord. In case where the company or Director is registered in a rural area where the rates are not paid, please attach proof from Local Authority and Affidavit under oath indicating that there are no municipal rates payable.	
Declaration For Procurement Above R10 Million (Vat Included) (MBD 5)	
Preference Points Claim Form in Terms of the Preferential Procurement Regulations 2022 (MBD 6.1)	
Contract Form - Rendering of Services (MBD 7.2)	
Declaration of Bidder's Past Supply Chain Management Practices (MBD8)	
Certificate of Independent Bid Determination (MBD9)	
Schedule 1A**:** Compulsory Enterprise Questionnaire	
Schedule 1B: Authority for Signatory	
Form of offer to be properly signed	
Proof of CIDB grading	
COIDA (Compulsory)	
Proof of Insurance	

Notes:

The meaning of the *cursive* text is as follows*:*

- *Compulsory*: Documentation or Information that must be submitted with the tender (Failing to submit any one of these will result in the tender being deemed non-responsive and be rejected).
- *Required for evaluation*: Additional documentation is required to be submitted with the tender and will be used as part of the tender evaluation:
- It is the responsibility of the tenderer to bind the tender document.

SEKHUKHUNE DISTRICT MUNICIPALITY

C1.1 Form of Offer and Acceptance

Offer

The Employer, identified in the Acceptance signature block, has solicited offers to enter into a Contract in respect of the following works:

CONTRACT No. SK8/3/1-52/2024/25: MAMPURU BULK WATER SCHEME: PHASE 1A - RESERVOIRS

The Tenderer, identified in the Offer signature block below, has examined the documents listed in the Tender Data and addenda thereto as listed in the Tender Schedules, and by submitting this Offer has accepted the Conditions of Tender.

By the representative of the Tenderer, deemed to be duly authorised, signing this part of this Form of Offer and Acceptance, the Tenderer offers to perform all of the obligations and liabilities of the Contractor under the Contract including compliance with all its terms and conditions according to their true intent and meaning for an amount to be determined in accordance with the Conditions of Contract identified in the Contract Data.

THE OFFERED TOTAL OF THE PRICES INCLUSIVE OF VALUE ADDED TAX IS:

……..

……Rand (in words);

R …….. (in figures)

This Offer may be accepted by the Employer by signing the Acceptance part of this Form of Offer and Acceptance and returning one copy of this document to the Tenderer before the end of the period of validity stated in the Tender Data, whereupon the Tenderer becomes the party named as the Contractor in the Conditions of Contract identified in the Contract Data.

Signature . . . . . Date . . . . . .

Name . . . . . .

Capacity . . . . . .
for the Tenderer

(Name and address of organization) . . . . . .

. . . . . .

. . . . . .

Name and signature of witness . . . . .

Acceptance

By signing this part of this Form of Offer and Acceptance, the Employer identified below accepts the Tenderer's Offer. In consideration thereof, the Employer shall pay the Contractor the amount due in accordance with the Conditions of Contract identified in the Contract Data. Acceptance of the Tenderer's Offer shall form an agreement between the Employer and the Tenderer upon the terms and conditions contained in this Agreement and in the Contract that is the subject of this Agreement.

The terms of the Contract, are contained in:

Part C1: Agreements and contract data, (which includes this agreement)
Part C2: Pricing data
Part C3: Scope of work.
Part C4: Site information
Part C5: Drawings

and drawings and documents or parts thereof, which may be incorporated by reference into Parts C1 to C5 above.

Deviations from and amendments to the documents listed in the Tender Data and any Addenda thereto listed in the Tender Schedules, as well as any changes to the terms of the Offer agreed by the Tenderer and the Employer during this process of offer and acceptance, are contained in the Schedule of Deviations attached to and forming part of this Agreement. No amendments to or deviations from the said documents are valid unless contained in this Schedule, which must be duly signed by the authorised representative(s) of both parties.

The Tenderer shall within the time required to submit documentation in accordance with clause 5.3.2 of the Contract Data (C1.2) after receiving a completed copy of this Agreement, including the Schedule of Deviations (if any), contact the Employer's agent (whose details are given in the Contract Data) to arrange the delivery of any bonds, guarantees, proof of insurance and any other documentation to be provided in terms of the Conditions of Contract identified in the Contract Data at, or just after, the date this Agreement comes into effect. Failure to fulfil any of these obligations in accordance with those terms shall constitute a repudiation of this Agreement.

Notwithstanding anything contained herein, this Agreement comes into effect on the date when the Tenderer receives one fully completed original copy of this document, including the Schedule of Deviations (if any). Unless the Tenderer (now Contractor) within five working days of the date of such receipt notifies the Employer in writing of any reason why he cannot accept the contents of this Agreement, this Agreement shall constitute a binding Contract between the parties..

Signature . . . . . Date . . . . . .

Name . . . . . .

Capacity . . . . . .

for the Employer SEKHUKHUNE DISTRICT MUNICIPALITY
Private Bag X8611
GROBLERSDAL
0470

Name and signature of witness . . . . . Date . . . . . .

Schedule of Deviations

Notes:

1. The extent of deviations from the Tender Documents issued by the Employer prior to the Tender closing date is limited to those permitted in terms of the Conditions of Tender.

2. A Tenderer's covering letter shall not be included in the final Contract Document. Should any matter in such letter, which constitutes a deviation as aforesaid, become the subject of agreements reached during the process of offer and acceptance, the outcome of such agreement shall be recorded here.

3. Any other matter arising from the process of offer and acceptance either as a confirmation, clarification or change to the Tender Documents and which is agreed by the Parties becomes an obligation of the Contract and shall also be recorded here.

4. Any change or addition to the Tender Documents arising from the above agreements and recorded here, shall also be incorporated into the final draft of the Contract.

1 Subject . . . . . .

Details . . . . . .

. . . . . .

. . . . . .

. . . . . .

2 Subject . . . . . .

Details . . . . . .

. . . . . .

. . . . . .

. . . . . .

3 Subject . . . . . .

Details . . . . . .

. . . . . .

. . . . . .

. . . . . .

4 Subject . . . . . .

Details . . . . . .

. . . . . .

. . . . . .

. . . . . .

By the duly authorised representatives signing this Schedule of Deviations, the Employer and the Tenderer agree to and accept the foregoing Schedule of Deviations as the only deviations from and amendments to the documents listed in the Tender Data and Addenda thereto as listed in the Tender Schedules, as well as any confirmation, clarification or change to the terms of the offer agreed by the Tenderer and the Employer during this process of offer and acceptance.

It is expressly agreed that no other matter whether in writing, oral communication or implied during the period between the issue of the Tender Documents and the receipt by the Tenderer of a completed signed copy of this Agreement shall have any meaning or effect in the Contract between the parties arising from this Agreement.

FOR THE TENDERER:

Signature(s) _____ _____

Name(s) _____ _____

Capacity _____ _____

_____

[Name and address of organisation]

Name and signature of witness _____ Date_____

FOR THE EMPLOYER:

Signature(s) _____ _____

Name(s) _____ _____

Capacity _____ _____

_____

[Name and address of organisation]

Name and signature of witness _____ Date_____

CONFIRMATION OF RECEIPT

The Tenderer (now Contractor), identified in the Offer part of this Agreement, hereby confirms receipt from the Employer, identified in the Acceptance part of this Agreement, of one fully completed original copy of this Agreement, including the Schedule of Deviations (if any) today:

The..... *[day]*

of ..... *[month]*

20.....*[year]*

at .....*[place]*

For the Contractor: .....
Signature

.....
Name

.....
Capacity

Signature and name of witness: .....
Signature

.....
Name

C1.2 Contract Data

The General Conditions of Contract for Construction Works, Third Edition, Second print, (2015) published by the South African Institution of Civil Engineering, are applicable to this contract and forms Volume 1 of the Contract Document. Volume 2 is the Contract Drawings Copies of these conditions of contract may be obtained from the South African Institution of Civil Engineering from www.saice.org.za.

The General Conditions of Contract for Construction Works make several references to the Contract Data for specific data, which together with these conditions collectively describe the risks, liabilities and obligations of the contracting parties and the procedures for the administration of the Contract. The Contract Data shall have precedence in the interpretation of any ambiguity or inconsistency between it and the general conditions of contract.

Each item of data given below is cross-referenced to the clause in the General Conditions of Contract for construction works to which it mainly applies.

Part 1: Contract Data completed by the Employer

Clause	
1.1.1.13	The Defects Liability Period is 12 calendar months (365 days) after completion date.
1.1.1.14	The time for achieving Practical Completion is as follows: For the whole of the Works: - 572 days (19 months) comprising of 18 months Construction Period and approximately 30 days (1 month) Pre-Construction Period.
1.1.1.35	Pre-Construction Period: - Approximately 30 days (1 month)
1.1.1.36	Construction Period: 542 days
1.1.1.15	The name of the Employer is the Sekhukhune District Municipality.
1.2.1.2	The Employer's address for receipt of communications is: Private Bag X8611, GROBLERSDAL, 0470 Telephone: (013) 262 7300 Fax: (013) 262 3688
1.1.16	The Employer's Agent means Zutari (Pty) Ltd, (hereinafter referred to as "Zutari") represented by an employee duly authorised thereto in writing.
1.2.1.2	The Employer's Agent address for receipt of communication is: Baobab Corner, Clivicola Street Cnr Munnik & De Wet Drive PO Box 3519 POLOKWANE 0700 Telephone: (015) 287 3800
1.1.1.26	The Pricing Strategy is Re-measurement Contract.
1.3.2	The governing law is the law of the Republic of South Africa
1.3.3	The language of the Contract and for written communications is English
3.2.3	The Employer's Agent is required to obtain the specific approval from the Employer before executing any of the following functions or duties: 1. Nominating the Employer's Agent Representative in terms of Clause 3.2.1. 2. Delegation of Employer's Agent authority in terms of Clause 3.2.4. 3. Providing consent for subcontracting part of the contract in terms of Clause 4.4.3. 4. The issuing of further drawings or instructions in terms of Clause 5.9.1. 5. The approving extension of Time for Practical Completion in terms of Clause 5.12 6. The issuing of instructions for dealing with fossils and the like in terms of Clause 4.7.1. 7. Authorizing the Contractor to repair and make good excepted risks in terms of Clause 8.3. 8. The issuing of a variation order in terms of Clause 6.3.1. 9. Issuing of instructions to carry out work on a day work basis in terms of Clause 6.5. 10. Granting permission to work during non-working times in terms of Clause 5.8.1. 11. Suspend the progress of the works in terms of Clause 5.11.1 12. The issuing of an instruction to accelerate progress in terms of Clause 5.7.3. 13. The reduction of a penalty for delay in terms of Clause 5.13.2. 14. The determination of additional or reduced costs arising from changes in legislation in terms of Clause 6.8.2.

	15. The giving of a ruling on a contractor's claim in terms of Clause 10.1.5. 16. The agreeing of an extension to the 28 period in terms of Clause 10.1.5. 17. The inclusion of credits in the next payment certificate in terms of Clause 5.12.3.
5.3.1	The documentation required before commencement with works execution are: 1. Health and Safety Plan (Refer to Clause 4.3) 2 Initial Programme (Refer to Clause 5.6) 3. Security (Refer to Clause 6.2) 4. Insurance (Refer to Clause 8.6) 5. Cash flow projection
5.3.2	The time to submit the documentation required before commencement with works execution is: **14 days**.
5.4.2	The access and possession of Site shall be exclusive to the Contractor.
5.8.1	The non-working days are Sundays. The special non-working days are: 1. Public holidays and 2. the days on which the contractor grants the majority of his permanent workforce leave around the 15th December and the first Monday of the subsequent year.
5.13.1	The penalty for failing to complete the Works as set out in the Scope of Works is 1/20 of a % of the value of the Works (excluding VAT) per day**.**
5.14.1	The requirements for achieving Practical Completion are: All quality control procedures adhered to and approved by Engineer Water retaining structures tested and approved Reservoir related pipe and mechanical components tested and approved Rising main and gravity main pipe work tested and approved Roadworks, complete in all respects (incl guardrails, gabions) and approved Payment facilitated to all labourers, sub-contractors and suppliers.
5.16.3	The latent defect period is **Ten (10) years**
6.5.1.2.3	The percentage allowance to cover overhead charges is **10%**
6.10.1.5	The percentage advance on materials not yet built into the Permanent Works is **80%**
6.8.2	Contract Price Adjustment: Is applicable The value of the certificates issued shall be adjusted in accordance with the Contract Price Adjustment Schedule included in the General Conditions of Contract. The value of "x" is 0,15 The values of the coefficients are: a = 0.25- Labour b = 0.30 - Contractor's equipment c = 0.35 - Material d = 0.10 - Fuel The urban area nearest to the Site is **Steelpoort** The base month is the month prior to the closing of the Tender. 'L' is the 'Labour Index' and shall be the price index for 'Consumer Price Index' for the Limpopo province (1), and as published in the Statistical News Release, P0141, Additional Tables: Table A "Consumer Price Index: Main indices" of Statistics South Africa.

	'P' is the 'Contractor's Equipment' and shall be the Producer Price Index applicable to Plant and Equipment – Total (2) and as published in the Statistical Release P0151.1, Table 4 of Statistics South Africa. 'M' is the 'Materials Index' and shall be the Producer Price Index applicable to Material – Total Construction (3) and as published in the Statistical Release P0151.1, Table 2 and 3 or Table 6 of Statistics South Africa. 'F' is the 'Fuel Index' and shall be the Producer Price Index for Coal and Petroleum Products - Diesel.(4) and as published in the Statistical News Release P01421.1, Table 1 of Statistics South Africa." The base month is the month and year preceding the month in which the tender closed.
6.8.3	Price adjustments for variations in the cost of special materials are allowed.
6.10.1	Minimum amount of interim payment certificate is **R 200 000.00**
6.10.3	The percentage retention is 10% to a maximum of 5% of the Contract Sum. A Retention Money Guarantee is not permitted**.**
8.6.1.1.2	The Value of Plant and material supplied by the Employer to be included in the insurance sum is **R0.00**
8.6.1.1.3	The amount to cover professional fees for repairing damage and loss included in the insurance sum is **Nil**.
8.6.1.1	The value of the sum to be insured shall be the amount of the Contract Price.
8.6.1.3	The limit of indemnity for liability insurance is R25 000 000 for any single claim, the number of claims to be unlimited during construction and Defects Liability Period.
10.5.1	Dispute resolution is to be my means of adjudication
10.5.3	The number of adjudication Board Members to be appointed is **One (1)**
10.7.1	Disputes are to be referred for final settlement to arbitration.
10.8.1	The determination of unresolved disputes shall be by Court proceedings.

Part 2: Data provided by the Contractor

<table>
<tr><td>Clause</td><td></td></tr>
<tr><td>1.1.1.9</td><td>The Contractor is ……</td></tr>
<tr><td>1.2.1.2</td><td>The Contractor’s address for receipt of communication is:

Telephone: .....

Mobile phone: .....

Facsimile: .....

e-mail: …….

Address:
.....

.....

.....

.....</td></tr>
<tr><td>6.2.1</td><td>Performance guarantee of 10 % of the Contract Sum plus retention to a maximum of 5% of the Contract Sum.</td></tr>
<tr><td>6.5.1.2.3</td><td>The percentage allowances to cover all charges for the Contractor’s and subcontractor’s profits, timekeeping, clerical work, insurance, establishment, superintendence and the use of hand tools is
…….%.</td></tr>
<tr><td>6.8.3</td><td>The variation in cost of special materials is:
<table>
<tr><th rowspan="2">Special material</th><th colspan="2">Unit on which variation will be determined</th><th>Price for base month ex-factory, excluding transport, labour or any other costs.</th></tr>
<tr><td>Containers</td><td>Delivered in bulk</td><td></td></tr>
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Part 3: Amendments to the Standard Conditions of Contract

The following amendments to, omissions of or additions to certain clauses of the "General Conditions of Contract for Construction Works, Third Edition, Second print (2015)", shall be applicable to the Works. In the case of conflict with the mentioned General Conditions of Contract, these amendments to the General Conditions of Contract shall be binding and applicable to the contract.

Each clause with the prefix SCC shall refer to the concurrent clause in the general conditions of contract. Such clause shall substitute, supplement or amend the clause with the same number in the general conditions of contract. Where there is no such concurrent clause in the General Conditions of Contract the SCC clause shall be numbered as a new clause.

SCC 1.1 DEFINITIONS

SCC 1.1.1.16 EMPLOYER'S AGENT

Add the following after the first paragraph:

"Employer's Agent shall have the same meaning and be synonymous with Engineer/engineer throughout the Contract document."

Add the following new clauses 1.1.1.35 and 1.1.1.36

"**SCC1.1.1.35 PRE-CONSTRUCTION PERIOD**

'Pre-Construction Period' means the period as stated in the Contract Data, or the period between the Commencement Date and the date that the Contractor starts with the construction of the Works (Commencement of the Works Clause 5.3.3), whichever is the shortest.

SCC1.1.1.36 CONSTRUCTION PERIOD'

'Construction Period' means the number of days within which the Contractor has to complete the construction of the works as detailed in Part C3."

SCC 2.4 AMBIGUITY OR DISCREPANCY

Add the following sub-clause:

2.4.3 The several documents forming the Contract shall have the following order of precedence:

a) Form of Offer and Acceptance;
b) Amendments to the General Conditions of Contract;
c) General Conditions of Contract;
d) Project specifications;
e) Standard specifications;
f) Particular specifications;
g) Drawings;
h) Bill of quantities and summary;
i) Statutory regulations and requirements;

If the requirements of any part of the tender document contradict any other part, the document with the highest ranking in the above order of precedence, shall have preference and shall apply.

SCC 4.3 LEGAL PROVISIONS

SCC 4.3.1 COMPLIANCE WITH APPLICABLE LAWS

Add the following after subclause 4.3.1.

"The Contractor shall be conversant with all the requirements, regulations, and standards of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), hereinafter referred to as "the Act" and undertakes to execute all the works forming part of this Contract and to operate and utilise all machinery, plant, and equipment in accordance with the Act.

The Contractor shall, from the commencement date of the Contract up to completion or termination thereof, be the Employer's mandatory regarding occupational health and safety for all activities on the site but without derogating from his status in his own right as an employer or a user in accordance with the Act.

The Contractor is responsible for the compliance with the Act by all his subcontractors, whether or not nominated and/or approved by the Employer.

The Contractor shall, when called upon to do so, enter into and execute an Agreement, as provided for under Section 37(2) of the Act, with the Employer. The Agreement in the relevant form shall be prepared at the expense of the Employer."

SCC 4.10 CONTRACTOR'S EMPLOYEES

SCC 4.10.1 ENGAGEMENT OF EMPLOYEES

Add the following to clause 4.10.1:

"In the event that the Contractor does not pay local labour or any outside agency employed on a monthly basis, the Employer has the right to deduct such wages from the Contractor's next payment certificate. This will be deducted from either monies due to the Contractor or from retention already retained on the project. Payments to the local labour or outside agency will be made by cession."

Replace Clause 5.3.3 with the following:

"SCC 5.3.3 TIME TO INSTRUCT COMMENCEMENT OF THE WORKS

"If the Employer's Agent's instruction to commence carrying out the Works, or to resubmit documentation, is not received by the Contractor within 7 days from the actual date of submission of the documentation referred to in Clause 5.3.1, commencement of the Works shall be taken:

SCC5.3.3.1 In respect of works not requiring a construction work permit to be on the expiry of such 7 days.

SCC5.3.3.2 In respect of works requiring a construction work permit to be on the expiry of the 60 days (2 months) Pre-Construction Period, unless otherwise instructed."

SCC 5.6 PROGRAMME

SCC 5.6.1 PROGRAMME OF THE WORKS

Add the following to GCC 5.6.1

"The critical path of the works shall also be stipulated clearly in the programme."

SCC 5.9 INSTRUCTIONS

SCC 5.9.1 DRAWINGS AND INSTRUCTIONS

Add the following after this clause

"The Contractor is entitled to one (1) free set of paper drawings for normal use and one (1) free set of paper drawings on which to enter "as built" information. He shall also be supplied with one (1) copy of the contract document. These drawings and the contract document shall be issued to the Contractor, at the time of commencement of the Contract, by the Employer's Agent."

SCC 5.9.7 EMPLOYER'S AGENT TO APPROVE CONTRACTOR'S DESIGNS AND DRAWINGS

Add the following to GCC 5.9.7:

"Although the Employer's Agent may approve drawings and designs of the Contractor, this does not exempt the Contractor from his responsibility. The professional responsibility for such designs shall be that of the Contractor and his design engineer."

SCC 5.11 SUSPENSION OF THE WORKS

SCC 5.11.7 CONSTRUCTION PROGRAMME

Add the following clause to GCC 5.11:

"No payment shall be made to the Contractor for costs incurred by recompiling a construction programme. In the case of suspension of work, either for a change in sequence or as a result of GCC 5.11.2 to 5.11.3, no payment shall be made for such costs resulting from this."

SCC 5.12 EXTENSION OF TIME FOR PRACTICAL COMPLETION

SCC 5.12.1 EXTENSION OF TIME FOR PRACTICAL COMPLETION

Add the following to GCC 5.12.1:

"Extension of the time for completion as a result of extra or additional work and unfavourable physical conditions shall only be granted if such work or conditions influence work on the critical path of the programme."

SCC 5.12.2 SOME REASONS FOR EXTENSIONS OF TIME

Add the following to GCC 5.12.2:

"Abnormal climatic conditions.

No extension of the time for completion shall be granted on the grounds of normal rainfall conditions, but extension of time in terms of this clause of the General Conditions of Contract on the grounds of abnormal rainfall or wet conditions shall be calculated separately for each calendar month or part thereof, according to the following formula. It shall be calculated as follows for the time for completion, including any extension thereof:

$$V = (Nw - Nn) + \left(\frac{Rw + Rn}{X}\right)$$

Where Y = 10 and X = 20

V = Extension of time for calendar days of the calendar month concerned. If the value of V is negative and the absolute value thereof is greater than Nn, V is taken as negative Nn.

Nw = Actual number of days during calendar month on which a rainfall of Y mm or more is recorded.
Nn = Average number of days in the calendar month concerned on which a rainfall of Y mm or more is recorded in terms of existing rainfall data.
Rw = Actual rainfall for the calendar month concerned in mm.
Rn = Average rainfall for the calendar month in mm deduced from existing rainfall data.

The total extension of time is the algebraic sum of the monthly totals for the period concerned. Extension of time for parts of a month shall be calculated by using pro rata values of Nn and Rn. If the algebraic sum of the monthly totals is negative, no reduction of the time for completion as a result of rainfall shall be applicable.

This formula does not take any delays as a result of flood damage, which may cause further or simultaneous delays; into consideration and flood damage shall be treated separately for purposes of extension of time for completion.

The factor (Nw - Nn) is considered as a fair allowance for deviation from the normal for the number of days on which the rainfall exceeds Y mm. The factor (Rw - Rn)/X is considered as a fair allowance for deviation from the normal for the number of days on which the rainfall does not exceed Y mm, but on which wet conditions will hamper or disrupt work.

For the purpose of this contract the values of Nn and Rn will be the relevant values of the nearest weather station to the site as supplied by the South African Weather Service. It is the sole responsibility of the Contractor to acquaint himself with the relevant values. These values shall, at the start of the contract be submitted to the Employer's Agent for scrutiny and approval."

SCC 5.12.2.5 AVAILABILITY OF PETROLEUM PRODUCTS

Add the following to GCC 5.12.2:

"The tender shall be based on the available supply of petroleum products required for the completion of the works. If, during the contract period, for reasons outside the control of the Contractor, a restriction or breakdown in the supply of petroleum products may occur, which has an actual influence on the execution of the works for a period of at least thirty (30) days, the Contractor shall make all reasonable efforts to complete the Works and he shall be entitled to an extension of the time for completion and he shall also be entitled to such an adjustment of the Contract Price as deemed reasonable by the Employer's Agent, with consideration of all materials and relevant factors directly responsible or having a direct effect on such restriction or breakdown, with the inclusion of the Contractor's site and overhead costs relevant to the Contract."

SCC 5.12.2.6 EXTENSION OF TIME DUE TO SHORTAGE OF MATERIAL

Add the following to GCC 5.12.2:

"If, during the preparation of his tender or during construction, the Contractor bases his unit prices on prices obtained from specific material or specific suppliers, it will be accepted that the Contractor has ascertained that such material shall be available on a continuous basis for the execution of the Contract.

No extension of time shall be granted if material cannot be obtained locally, but is available from other sources in the country, and no additional remuneration shall be granted for increased costs due to obtaining material from sources in other parts of the country.

If suppliers cannot adhere to the quoted delivery dates, any delays resulting from this shall be considered as a matter between the supplier and the Contractor. Extension of time could be granted under such conditions after sufficient proof have been submitted to and accepted by the Employer's Agent, but without any financial implications for the Employer."

SCC 5.14.1 PRACTICAL COMPLETION

Replace the last sentence of the second paragraph:

"Should the Employer's Agent … on expiry of 14 days."

with the following:

"Should the Employer's Agent not issue such a list within 14 days, Practical Completion shall be deemed to have been achieved on the said fourteenth day."

SCC 5.14.2 ISSUE OF CERTIFICATE OF PRACTICAL COMPLETION

Replace "the Employer's Agent" *in the second and third lines with the following:*

", the Contractor shall notify the Employer's Agent, who shall inspect the Works and the Employer's Agent"

SCC 5.14.4 CERTIFICATE OF COMPLETION

Replace "the Employer's Agent" *in the third line of the first paragraph with:*

", the Contractor shall notify the Employer's Agent, who shall inspect the works and the Employer's Agent"

SCC 5.15 CLEARANCE OF SITE

SCC 5.15.1 CLEARANCE OF SITE ON COMPLETION

Add the following to GCC 5.15.1:

“After completion of the works, the Contractor shall obtain certificates from all concerned land owners on whose property works have been executed, stating that they are satisfied with the condition of their property, which will normally include finishing of pipe trenches and structures, clearance and finishing of all stone quarries, borrow pits, diversions, private or tertiary or haulage roads that have been used for the transport of material, waste material, fencing, gates, etc. on their properties. These certificates shall all be handed to the Employer’s Agent before he issues the Certificate of Completion. Notwithstanding a Certificate of Completion will not be issued if the work is not to the satisfaction of the Employer’s Agent.”

SCC 6.5 DAYWORKS

Add the following to GCC 6.5.1.2.1:

"Gross remuneration" shall include the following:

- Basic wage
- Holiday fund stamp
- Unemployment insurance
- Employee’s compensation
- Service bonus”

Add the following to SCC 6.5.4:

“The allowance stated in the Bill of Quantifies shall also include travelling cost or travelling allowance (transport of workmen with the Contractor's transport vehicles or transport vehicles hired by the Contractor or for which the Contractor paid), and residence allowance and other wages that are payable to the workmen on the date for submission of tenders.”

SCC 6.10 PAYMENTS

SCC 6.10.1.9 VALUE ADDED TAX

Add the following clause to GCC 6.10.1:

"Value added tax (VAT) shall be calculated on each payment certificate, but it shall remain the responsibility of the Contractor to issue a tax invoice for the certified amount. The Contractor is responsible for the payment of VAT."

SCC 6.10.2 VALUATION OF MATERIAL BROUGHT ONTO SITE

Add the following to GCC 6.10.2:

"Material or goods for which payment is made in terms of this clause, shall be identified uniquely and be stored in a space approved by the Employer's Agent, and which will only be used for the purposes of the Employer."

SCC 6.10.5 PAYMENT OF RETENTION MONEY

Replace the first paragraph of GCC 6.10.5 with the following:

"One half of the retention money shall become due when the Employer's Agent has issued a Certificate of Completion in terms of clause 5.14.4. The other half of the retention money shall become due and shall be paid to the Contractor on the expiration of the Defects Liability Period.

The Employer's Agent shall deliver to the Employer and the Contractor the payment certificate referred to in clause 6.10.3 within 7 (seven) days after the receipt by the Employer's Agent of the Contractor's said statement, and the Employer shall pay the amount due to the Contractor within 65 (sixty five) days after receipt by the Employer of the payment certificate signed by the Employer's Agent.

The Defects Liability Period may be extended in terms of clauses 5.14.4 or 7.8.1, if necessary;"

SCC 6.11 VARIATIONS EXCEEDING 15 PER CENT

Replace the title with the following: "VARIATIONS EXCEEDING 50 PER CENT".

Replace paragraph 6.11.1.3 with the following:

"The adjustment upon measurement of the estimated quantities set out in the Bill of Quantities for a Re-measurement Contract, results in an increase or decrease in the Contract Price, determined before adjustment in terms of this Clause, greater than 50 per cent of the prices provided for in the Contract Sum, excluding any allowance for contingencies therein and excluding from both Contract Price and Contract Sum, all payments or allowances for:"

SCC 7 QUALITY AND RELATED MATTERS

SCC 7.1 QUALITY OF PLANT, WORKMANSHIP AND MATERIALS

Add the following to GCC 7.2.1:

"No second-hand or reject material shall be used without written permission from the Employer's Agent."

SCC 7.4.4 COST OF TEST SPECIMENS AND TESTS

Replace clause 7.4.4 with the following:

"It is deemed that the Contractor has made provision in his tender prices for all services and tests that are required from him. It is the duty of the Contractor to, at his own cost and by means of the necessary tests, prove to the Employer's Agent that the works and compaction prescribed, comply with the specifications."

SCC 7.5 EXAMINATION OF THE WORKS

SCC 7.5.1 EXAMINATION OF WORK BEFORE COVERING UP

Add the following to GCC 7.5.1:

"The Contractor shall give the Employer's Agent a reasonable time to accommodate examinations in his programme, in which case a time for inspection can be agreed upon."

SCC 7.5.3 NOTICE TO BE GIVEN WHEN READY FOR TESTING

Add the following to paragraph 2 of GCC 7.5.3:

"If the Employer's Agent attends with the purpose of examining any part or materials of the works at any time and date as agreed upon with the Contractor, and it is found that the works or materials are not yet ready for inspection, the Contractor shall be responsible for the costs of such a visit by the Employer's Agent."

SCC 7.8 DEFECTS

SCC 7.8.1 MAKING GOOD OF DEFECTS IN THE DEFECTS LIABILITY PERIOD

Add the following to GCC 7.8.1:

"If it is deemed necessary in the opinion of the Employer's Agent, the Defects Liability Period after repairs can be extended for a further period of twelve months or for a period to the discretion of the Employer's Agent, for the relevant part of the works that is made good."

SCC 8.4 INDEMNIFICATIONS

SCC 8.4.2 INDEMNITY BY EMPLOYER

Add the following to GCC 8.4.2:

"The Contractor indemnifies the Employer against any liability in respect of damage to or physical loss of the property of any person or injury to or death of any person due to not complying with the Occupational Health and Safety Act No 85 of 1993.

Attached in the tender document is the form "Contract between Employer and Contractor" to be completed by the successful Contractor."

SCC 8.6 INSURANCES

SCC 8.6.1 INSURANCES TO BE EFFECTED

Add the following to GCC 8.6.1:

"The amount shall be per occurrence. The number of occurrences is unlimited."

Add the following to GCC 8.6.6:

"Within 14 days of receipt of the letter of acceptance of his tender, the Contractor shall submit proof of payment to the Employer's Agent."

SCC 10.1.5 EMPLOYER'S AGENT'S RULING ON CONTRACTOR'S CLAIM

Add the following to Clause 10.1.5 before the last sentence:

"If the Employer's Agent does not respond in accordance with the foregoing procedure and timetable, either Party may consider that the claim has been rejected by the Employer's Agent and either Party may submit the dispute by issuing a Dispute Notice in terms of Clause 10.3.1.'

SCC 10.3.1 DISPUTE NOTICE

Replace Clause 10.3.1.1 with the following:

"10.3.1.1 The dispute arises from any ruling."

SEKHUKHUNE DISTRICT MUNICIPALITY

C1.3 PERFORMANCE GUARANTEE (PRO FORMA)

GUARANTOR DETAILS AND DEFINITIONS

"Guarantor" means: .....

Physical address: .....

"Employer" means: .....

"Contractor" means: .....

"Employer's Agent" means: .....

"Works" means: .....

"Site" means: .....

"Contract" means: The Agreement made in terms of the Form of Offer and Acceptance and such amendments or additions to the Contract as may be agreed in writing between the parties.

"Contract Sum" means: The accepted amount inclusive of tax of R .....

Amount in words: .....

"Guaranteed Sum" means: The maximum aggregate amount of R .....

Amount in words: .....

"Expiry Date" means: …… (*give date*) or any other later date set by the Contractor and/or Employer provided such instruction is received prior to the Expiry Date as indicated here.

CONTRACT DETAILS

Employer's Agent issues: Interim Payment Certificates, Final Payment Certificate and the Certificate Completion of the Works as defined in the Contract.

PERFORMANCE GUARANTEE

1 The Guarantor's liability shall be limited to the amount of the Guaranteed Sum.

2 The Guarantor's period of liability shall be from and including the date of issue of this Performance Guarantee and up to and including the Expiry Date or the date of issue by the Employer's Agent of the Certificate of Completion of the Works or the date of payment in full of the Guaranteed Sum, whichever occurs first. The Employer's Agent and/or the Employer shall advise the Guarantor in writing of the date on which the Certificate of Completion of the Works has been issued.

3 The Guarantor hereby acknowledge that:

3.1 any reference in this Performance Guarantee to the Contract is made for the purpose of convenience and shall not be construed as any intention whatsoever to create an accessory obligation or any intention whatsoever to create a suretyship;

3.2 its obligation under this Performance Guarantee is restricted to the payment of money.

4 Subject to the Guarantor's maximum liability referred to in 1, the Guarantor hereby undertakes to pay the Employer the sum certified upon receipt of the documents identified in 4.1 to 4.3:

4.1 A copy of a first written demand issued by the Employer to the Contractor stating that payment of a sum certified by the Employer's Agent in an Interim or Final Payment Certificate has not been made in terms of the Contract and failing such payment within seven (7) calendar days, the Employer intends to call upon the Guarantor to make payment in terms of 4.2;

4.2 A first written demand issued by the Employer to the guarantor at the Guarantor's physical address with a copy to the Contractor stating that a period of seven (7) days has elapsed since the first written demand in terms of 4.1 and the sum certified has still not been paid;

4.3 A copy of the aforesaid payment certificate which entitles the Employer to receive payment in terms of the Contract of the sum certified in 4.

5 Subject to the Guarantor's maximum liability referred to in 1, the Guarantor undertakes to pay to the Employer the Guaranteed Sum or the full outstanding balance upon receipt of a first written demand from the Employer to the Guarantor at the Guarantor's physical address calling up this Performance Guarantee, such demand stating that:

5.1 the Contract has been terminated due to the Contractor's default and that this Performance Guarantee is called up in terms of 5; or

5.2 a provisional or final sequestration or liquidation court order has been granted against the Contractor and that the Performance Guarantee is called up in terms of 5; and

5.3 the aforesaid written demand is accompanied by a copy of the notice of termination and/or the provisional/final sequestration and/or the provisional liquidation court order.

6 It is recorded that the aggregate amount of payments required to be made by the Guarantor in terms of 4 and 5 shall not exceed the Guarantor's maximum liability in terms of 1.

7 Where the Guarantor has made payment in terms of 5, the Employer shall upon the date of issue of the Final Payment Certificate submit an expense account to the Guarantor showing how all monies received in terms of this Performance Guarantee have been expended and shall refund to the Guarantor any resulting surplus. All monies refunded to the Guarantor in terms of this Performance Guarantee shall bear interest at the prime overdraft rate of the Employer's bank compounded monthly and calculated from the date payment was made by the Guarantor to the Employer until the date of refund.

8 Payment by the Guarantor in terms of 4 or 5 shall be made within seven (7) calendar days upon receipt of the first written demand to the Guarantor.

9 Payment by the Guarantor in terms of 5 will only be made against the return of the original Performance Guarantee by the Employer.

10 The Employer shall have the absolute right to arrange his affairs with the Contractor in any manner which the Employer may deem fit and the Guarantor shall not have the right to claim his release from this Performance Guarantee on account of any conduct alleged to be prejudicial to the Guarantor.

11 The Guarantor chooses the physical address as stated above for the service of all notices for al purposes in connection herewith.

12 This Performance Guarantee is neither negotiable nor transferable and shall expire in terms of 2, where after no claims will be considered by the Guarantor. The original of this Guarantee shall be returned to the Guarantor after it has expired.

13 This Performance Guarantee, with the required demand notices in terms of 4 or 5, shall be regarded as a liquid document for the purposes of obtaining a court order.

14 Where this Performance Guarantee is issued in the Republic of South Africa the Guarantor hereby consents in terms of Section 45 of the Magistrate's Courts Act No 32 of 1944, as amended, to the jurisdiction of the Magistrate's Court of any district having jurisdiction in terms

of Section 28 of the said Act, notwithstanding that the amount of the claim may exceed the jurisdiction of the Magistrate's Court.

Signed at .....

Date .....

Guarantor's signatory: (1) .....

Capacity.....

Guarantor's signatory: (2) .....

SEKHUKHUNE DISTRICT MUNICIPALITY

C1.4 RETENTION MONEY GUARANTEE (PRO FORMA)

ISSUED TO ..... *[INSERT NAME OF EMPLOYER]*
.....(hereinafter called "the Employer")

ON BEHALF OF ..... *[INSERT NAME OF CONTRACTOR]*
..... (hereinafter called "the Contractor")

in connection with CONTRACT NO: .....(hereinafter called "the Contract").

WHEREAS the Employer and the Contractor have agreed that the Contractor may provide a guarantee in lieu of the whole or a portion of the retention moneys provided for under the Contract;

NOW THEREFORE we, the undersigned, undertake, in accordance with the following provisions, to pay to the Employer such amounts as the Employer may, from time to time, demand from us.

1 Each demand by the Employer shall be in writing, signed by the Employer and delivered to us at .....*[INSERT GUARANTOR'S FULL STREET ADDRESS]* or such other address in ..... *[INSERT NAME OF COUNTRY]* ..... as we shall in writing notify to the Employer, and shall be accompanied by a certificate complying with Clause 2, signed by the Employer's Agent in office as such in terms of the Contract.

2 The Employer's Agent certificate referred to in Clause 1 shall certify that:

(a) he is the Employer's Agent in office as such in terms of the Contract,

(b) the Contractor is in breach of his obligations under the Contract, and

(c) the amount demanded, which amount the certificate shall specify, does not exceed

(i) the amount of retention moneys which, but for this guarantee, would have been retained by the Employer in terms of the Contract at the date of the certificate, less the aggregate of the amounts of retention money actually retained by the Employer and the amounts previously paid by us to the Employer in terms hereof,

(ii) a genuine estimate of the cost to the Employer of having the breach referred to in paragraph (b) remedied less the aggregate of any amounts withheld by the Employer from payments due to the Contractor in terms of the Contract by reason of the breach referred to, and any amount of retention money actually held by the Employer save to the extent that the same had been deducted from any previous demand in terms hereof;

3 We shall within ..... days after our receipt of a demand complying with the provisions in Clauses 1 and 2 make payment to the Employer of the amount demanded at ..... *[INSERT EMPLOYER'S STREET ADDRESS]* ..... or at such other address in ..... *[INSERT EMPLOYER'S COUNTRY]* .....as the Employer shall in writing notify to us.

4 Subject to compliance with the provisions hereof, our liability to make the payments herein referred to shall be unconditional and shall not be affected or diminished by any disputes, claims or counterclaims between the Employer and the Contractor.

5 Our aggregate liability under this guarantee is limited to *.....[INSERT AMOUNT OF GUARANTEE IN WORDS]* ..... (R..... *[INSERT AMOUNT OF GUARANTEE IN FIGURES]*).

6 This guarantee shall expire on the date on which the last of the retention moneys, which but for this guarantee would have been retained by the Employer, becomes payable to the Contractor.

7 This guarantee is not transferable and must be produced for endorsement if any part payment is made and must be returned to us against final payment of our aggregate liability or on the date of the expiry of the guarantee in terms of Clause 6, whichever is the earlier.

Signed in the presence of the subscribing witnesses:

At .....for and on behalf of .....

.....

on this the ..... day of ..... 20.....

SIGNATURE : .....

CAPACITY : .....

ADDRESS : .....

: .....

: .....

AS WITNESSES : 1 .....

2 .....

SEKHUKHUNE DISTRICT MUNICIPALITY

C1.5 ADJUDICATOR'S AGREEMENT

This agreement is made on the ..... day of ..... between:

.....*[name of company/organisation]*

of.....

..... *[address]* and

.....*[name of company/organisation]*

of.....

.....*[address]*

(the Parties) and

..... *[name]*

of.....

.....*[address]*

(the Adjudicator).

Disputes or differences may arise/have arisen* between the Parties under a Contract dated .....

..... and known as .....

.....

and these disputes or differences shall be/have been* referred to adjudication in accordance with the CIDB Adjudication Procedure *[hereinafter called "the Procedure"],* and the Adjudicator may be or has been requested to act.

**Delete as necessary.*

IT IS NOW AGREED as follows:

1 The rights and obligations of the Adjudicator and the Parties shall be as set out in the Procedure.

2 The Adjudicator hereby accepts the appointment and agrees to conduct the adjudication in accordance with the Procedure.

3 The Parties bind themselves jointly and severally to pay the Adjudicator's fees and expenses in accordance with the Procedure as set out in the Contract Data.

4 The Parties and the Adjudicator shall at all times maintain the confidentiality of the adjudication and shall endeavour to ensure that anyone acting on their behalf or through them will do likewise, save with the consent of the other Parties which consent shall not be unreasonably refused.

5 The Adjudicator shall inform the Parties if he intends to destroy the documents which have been sent to him in relation to the adjudication and he shall retain documents for a further period at the request of either Party.

SIGNED BY: _____	SIGNED BY _____	SIGNED BY _____
Name: _____	Name: _____	Name:_____
who warrants that he/she is duly authorised to sign for and on behalf of the first Party in the presence of	who warrants that he/she is duly authorised to sign for on behalf of the second Party in the presence of	the Adjudicator in the presence of

Witness: _____ Witness: _____ Witness: _____

Name: _____ Name: _____ Name: _____

Address: _____ Address: _____ Address: _____

_____ _____ _____

_____ _____ _____

Date: _____ Date: _____ Date: _____

Contract Data

1 The Adjudicator shall be paid at the hourly rate of R……. in respect of all time spent upon, or in connection with, the adjudication including time spent travelling.

2 The Adjudicator shall be reimbursed in respect of all disbursements properly made including, but not restricted to:

(a) Printing, reproduction and purchase of documents, drawings, maps, records and photographs
(b) Telegrams, telex, faxes and telephone calls
(c) Postage and similar delivery charges
(d) Travelling, hotel expenses and other similar disbursements
(e) Room charges
(f) Charges for legal or technical advice obtained in accordance with the Procedure.

3 The Adjudicator shall be paid an appointment fee of R…… This fee shall become payable in equal amounts by each Party within 14 days of the appointment of the Adjudicator, subject to an invoice being provided. This fee will be deducted from the final statement of any sums which shall become payable under item 1 and/or item 2 of the Contract Data. If the final statement is less than the appointment fee the balance shall be refunded to the Parties.

4 The Adjudicator is/is not* currently registered for VAT.

5 Where the Adjudicator is registered for VAT it shall be charged additionally in accordance with the rates current at the date of invoice.

6 All payments, other than the appointment fee (item 3) shall become due 7 days after receipt of invoice, thereafter interest shall be payable at 5% per annum above the Reserve Bank base rate for every day the amount remains outstanding.

**Delete as necessary*

SEKHUKHUNE DISTRICT MUNICIPALITY

C1.6 OCCUPATIONAL HEALTH AND SAFETY

AGREEMENT IN TERMS OF THE OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (ACT NO 85 OF 1993)

THIS AGREEMENT IS made at .....

on the ..... day of ..... in the year ……

Between SEKHUKHUNE DISTRICT MUNICIPALITY (hereinafter called "the Employer") of the one part, herein represented by .....

In his capacity as .....

and delegate of the Employer in terms of the Employer's standard powers of delegation pursuant to the provisions of Act No 7 of 1998,

and .....

(hereinafter called "the Mandatory") of the other part, herein represented by .....

.....

in his capacity as .....

and being duly authorized by virtue of a resolution appended hereto as Annexure A;

WHEREAS the Employer requires certain works be constructed, viz **MAMPURU BULK WATER SCHEME: PHASE 1A - RESERVOIRS_CONTRACT No. SK8/3/1-52/2024/25**
and has accepted a Tender by the Mandatory for the construction, completion and maintenance of such Works and whereas the Employer and the Mandatory have agreed to certain arrangements and procedures to be followed in order to ensure compliance by the Mandatory with the provisions of the Occupational Health and Safety Act, 1993 (Act 85 of 1993).

NOW THEREFORE THIS AGREEMENT WITNESSES AS FOLLOWS:

1 The Mandatary shall execute the work in accordance with the Contract Documents pertaining to this Contract.

2 This Agreement shall hold good from its Commencement Date, which shall be the date of a written notice from the Employer or engineer requiring him to commence the execution of the Works, to either -

(a) the date of the Final Certificate issued in terms of the GCC, as contained in Volume 1 of the Contract Documents pertaining to this Contract, or

(b) The date of termination of the Contract in terms of the GCC.

3 The Mandatory declares himself to be conversant with the following:

(a) All the requirements, regulations and standards of the Occupational Health and Safety Act (Act 85 of 1993), hereinafter referred to as "The Act", together with its amendments and with special reference to the following Sections of The Act:

(i) Section 8 : General duties of Employers to their employees

(ii) Section 9 : General duties of Employers and self-employed persons to persons other than employees

(iii) Section 37 : Acts or omissions by employees or mandataries

(iv) Sub-section 37(2) relating to the purpose and meaning of this Agreement

(b) The procedures and safety rules of the Employer as pertaining to the Mandatory and to all his subcontractors.

4 In addition to the requirements of the GCC (as amended by Special Condition of Contract contained in the Contract Documents pertaining to this Contract) and all relevant requirements of the above-mentioned, the Mandatory agrees to execute all the Works forming part of this Contract and to operate and utilize all machinery, Plant and equipment in accordance with the Act.

5 The Mandatory is responsible for the compliance with the Act by all his subcontractors, whether or not selected and/or approved by the Employer.

6. The Mandatory warrants that all his and his subcontractors' workmen are covered in terms of the Compensation for Occupational Injuries and Diseases Act, 1993 (Act No 130 of 1993), which cover, shall remain in force whilst any such workmen are present on site. A letter of good standing from the Compensation Commissioner to this effect must be produced to the Employer upon signature of the agreement.

7. The Mandatary undertakes to ensure that he and/or subcontractors and/or their respective employers will at all times comply with the following conditions:

a) The Mandatary shall assume the responsibility in terms of Section 16.1 of the Act. The Mandatary shall not delegate any duty in terms of Section 16.2 of this Act without the prior written approval of the Employer. If the Mandatary obtains such approval and delegates any duty in terms of section 16.2 a copy of such written delegation shall immediately be forwarded to the Employer.
b) All incidents referred to in the Act shall be reported by the Mandatary to the Department of Labour as well as to the Employer. The Employer will further be provided with copies of all written documentation relating to any incident.
c) The Employer hereby obtains an interest in the issue of any formal enquiry conducted in terms of section 32 of the Act into any incident involving the Mandatary and/or his employees and/or his subcontractors.

In witness thereof the parties hereto have set their signatures hereon in the presence of the subscribing witnesses:

SIGNED FOR AND ON BEHALF OF THE EMPLOYER : .....

Witness ..... Witness .....

(Name) ..... (Name) .....
(Print) (Print)

SIGNED FOR AND ON BEHALF OF THE MANDATORY : .....

Witness ..... Witness .....
(Name) ..... (Name) . .....
(Print) (Print)

ANNEXURE A

CERTIFICATE OF AUTHORITY FOR SIGNATORY TO AGREEMENT IN TERMS OF OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (ACT NO 85 OF 1993)

The signatory for the company that is the Contractor in terms of the above-mentioned Contract and the Mandatory in terms of the above-mentioned Act shall confirm his or her authority thereto by attaching to this page a duly signed and dated copy of the relevant resolution of the board of directors.

By resolution of the board of directors passed at a meeting held on ..... 20....., Mr//Ms ..... whose signature appears below, has been duly authorised to sign the AGREEMENT IN TERMS OF THE OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (ACT 85 OF 1993) on behalf of .....

.....

SIGNED ON BEHALF OF THE COMPANY : .....

IN HIS/HER CAPACITY AS : .....

DATE : .....

SIGNATURE OF SIGNATORY : .....

WITNESS : ..... WITNESS : .....

NAME (in capitals): ..... NAME : .....

SEKHUKHUNE DISTRICT MUNICIPALITY

C2. Bill of Quantities

C2.1 Preamble to Bill of Quantities

1. The General Conditions of Contract, the amendments to the General Conditions of Contract (if any), the specifications (including the project specification) and the drawings are to be read in conjunction with the Bill of Quantities.

2. a) The Bill of Quantities comprises items covering the Contractor's profit and costs of general liabilities and of the construction of temporary and permanent works.
   b) The Contractor is at liberty to insert a rate of his own choosing for each item in the schedule and his attention is drawn to the fact that the Contractor has the right, under various circumstances, to payment for additional works carried out and that the Engineer is obliged to base his assessment of the rates to be paid for such additional work on the rates inserted in the schedule by the Contractor.
   c) Clause 8 of each standardised specification and the measurement and payment clause of each particular specification, read together with the relevant clauses of the project specification, set out what ancillary or associated activities are included in the rates for the operations specified.

3. Descriptions in the Bill of Quantities are abbreviated and the schedule has been drawn up generally in accordance with the latest issue of Civil Engineering Quantities[1]. Should any requirement of the measurement and payment clause of the applicable standardised specification[2], or the project specification[2], or the particular specification(s)[2] conflict with the terms of the schedule or, when relevant, Civil Engineering Quantities[1], the requirement of the standardised, project or particular specification, as applicable, shall prevail.

4. Unless otherwise stated, items are measured net in accordance with the drawings, and no allowance has been made for waste.

5. The prices and rates to be inserted in the Bill of Quantities are to be the full inclusive prices to the Employer for the work described under the several items, value added tax excluded. Such prices shall cover all costs and expenses that may be required in and for the construction of the work described, and shall cover the cost of all general risks, liabilities and obligations set forth or implied in the documents on which the quotation is based.

6. A price or rate is to be entered against each item in the Bill of Quantities, whether the quantities are stated or not. An item against which no price is entered will be considered to be covered by the other prices or rates in the Bill of Quantities.

7. The Tenderer must price each item in the Bill of Quantities in **BLACK INK**.

8. **All prices and rates shall exclude value added tax (VAT)**. The Tenderers shall calculate value added tax and enter it at the end of the summary of the Bill of Quantities.

9. For the purposes of this Bill of Quantities, the following words shall have the meanings hereby assigned to them:

Unit	:	The unit of measurement for each item of work as defined in the Specifications.
Quantity	:	The number of units of work for each item
Rate	:	The payment per unit of measurement at which the Tenderer tenders to do the work.
Amount	:	The product of the quantity and the rate tendered for an item
Sum	:	An amount tendered for an item, the extent of which is described in Bill of Quantities, the specifications or elsewhere but the quantity of work of which is not measured in any units.
Prime Cost (or PC item)	:	A sum fixed by the Engineer and entered in the Bill of Quantities as the net sum provided to cover the cost of specific goods or materials to be supplied under the contract, or the net sum to be paid by the Contractor to merchants or others for such articles or materials.[1]
Provisional Sum	:	A sum of money fixed by the Engineer and entered in the Bill of Quantities to provide for work not defined at the tender stage and includes any allowance specifically made for unforeseen contingencies.[1]
Extra Over (or EO)	:	Qualifies an operation (or combination of operations) which is common in a varying degree to a number of other operations and which is scheduled once as "extra over" those other operations in order to avoid a multiplicity of items each reflecting the degree to which the common operations apply. The term "extra over" invariably denoted double measurement, no deduction being made from one on account of the other.[1]

10. The units of measurements indicated in the Bill of Quantities are metric units.

    The following abbreviations are used in the Bill of Quantities:

mm	=	millimetre
m	=	metre
km	=	kilometre
km-pass	=	kilometre-pass
m²	=	square metre
m²-pass	=	square metre-pass
ha	=	hectare
m³	=	cubic metre
m³-km	=	cubic metre-kilometre
l	=	litre
kl	=	kilolitre
kg	=	kilogram
t	=	ton (1 000 kg)
no	=	number
%	=	percentage
kW	=	kilowatt
PC Sum	=	prime cost sum
Prov. Sum	=	provisional sum
kPa	=	kilopascal
R/only	=	Rate only
W/day	=	Work day

11. Those parts of the contract to be constructed using labour-intensive methods have been marked in the Bill of Quantities with the letters LI in a separate column or as a prefix or suffix against every item so designated. The works, or parts of the works so designated are to be constructed using labour-intensive methods only. The use of plant to provide such works, other than plant specifically provided for in the scope of works, is a deviation from the contract. The items marked with the letters 'LI' are not necessarily an exhaustive list of all the activities which must be done by hand, and this clause does not over-ride any of the requirements in the generic labour-intensive specification in the Scope of Works.

12. Where minimum labour intensity is specified by the design the contractor is expected to use their initiative to identify additional activities that can be done labour-intensively in order to comply with the set minimum labour intensity target.

13. Payment for items which are designated to be constructed labour-intensively (either in this schedule or in the scope of works) will not be made unless they are constructed using labour-intensive methods. Any unauthorised use of plant to carry out work, which was to be done labour-intensively will not be condoned, and any works so constructed will not be certified for payment.

1) The standard system of measurement of Civil Engineering Quantities of South Africa published by the South African Institution of Civil Engineers.
2) See definition in sub clause 2.1 of Part 1 of SABS 0120: Format and Contents.

C2.2 Bill of Quantities

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CALCULATION OF TENDER SUM 297

SANS 1200 A

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 A**				
SANS 1200A	**1.1**	**GENERAL**				
	1.1.1	**Scheduled fixed-charge and value-related items:**				
PSA 8.3.1	1.1.1.1	Fixed preliminary and general charges	sum	1		
PSA 8.3.2	1.1.1.2	Value-related preliminary and general charges	sum	1		
PSA 8.3.1	1.1.1.3	De-establishment	sum	1		
PSA 8.3.1	1.1.1.4	Re-establishment	sum	1		
	1.1.2	**Scheduled time-related items:**				
PSA 8.4.1	1.1.2.1	Time-related preliminary and general charges				
	1.1.2.1.1	Pre-Construction period	days	30		
	1.1.2.1.2	Construction period	sum	1		
PSA 8.5.1	**1.1.3**	**Sums stated provisionally by the Engineer:**				
	1.1.3.1	Works executed by the Contractor:				
	1.1.3.1.1	Geotechnical Investigation	Prov sum	1	R300,000.00	R300,000.00
	1.1.3.1.2	Charge required by Contractor on subitem 1.1.3.1.1 above	%	300,000	. . . . . .%	
	1.1.3.1.3	Slope stabilisation: refer to LE08 for specifications	Prov sum	1	R2,000,000.00	R2,000,000.00
	1.1.3.1.4	Charge required by Contractor on subitem 1.1.3.1.3 above	%	2,000,000	. . . . . .%	
	1.1.3.1.5	Wayleaves	Prov sum	1	R50,000.00	R50,000.00
	1.1.3.1.6	Charge required by Contractor on subitem 1.1.3.1.5 above	%	50,000	. . . . . .%	
	1.1.3.1.7	Providing mechanical and electrical spares	Prov sum	1	R50,000.00	R50,000.00
	1.1.3.1.8	Charge required by Contractor on subitem 1.1.3.1.7 above	%	50,000	. . . . . .%	
SECTION 1	CARRIED FORWARD					

SANS 1200 A

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
PSA 8.6	**1.1.4**	**Prime Cost Sums:**				
	1.1.4.1	Additional tests required by the Engineer	PC sum	1	R100,000.00	R100,000.00
	1.1.4.2	Charge required by Contractor on subitem 1.1.4.1 above	%	100,000	. . . . . .%	
	1.1.4.3	Housing for Engineer's representative	PC sum	1	R750,000.00	R750,000.00
	1.1.4.4	Charge required by Contractor on subitem 1.1.4.3 above	%	750,000	. . . . . .%	
	1.1.4.5	The cost of the Employer's Agent calls, emails, internet services, etc. in connection with contract administration.	PC sum	1	R100,000.00	R100,000.00
	1.1.4.6	Charge required by Contractor on subitem 1.1.4.5 above	%	100,000	. . . . . .%	
	1.1.4.7	The provision of Computers, printers and other consumables as specified in SANS 1200 AB for the Engineer representatives in connection with contract administration.	PC sum	1	R100,000.00	R100,000.00
	1.1.4.8	Charge required by Contractor on subitem 1.1.4.7 above	%	100,000	. . . . . .%	
	1.1.4.9	Survey and register servitude by a registered Land Surveyor on completion of the contract.	PC sum	1	R100,000.00	R100,000.00
	1.1.4.10	Charge required by Contractor on subitem 1.1.4.9 above	%	100,000	. . . . . .%	
	1.1.4.11	Community Liaison, Labour Coordination Officer and Project Steering Committee for contract duration.	PC sum	1	R210,000.00	R210,000.00
	1.1.4.12	Charge required by Contractor on subitem 1.1.4.11 above	%	210,000	. . . . . .%	
	1.1.4.13	Accredited Skill Training	PC sum	1	R150,000.00	R150,000.00
	1.1.4.14	Charge required by Contractor on subitem 1.1.4.13 above	%	150,000	. . . . . .%	
	1.1.4.15	Rental Vehicles for Engineer's site staff	PC sum	1	R1,600,000.00	R1,600,000.00
	1.1.4.16	Charge required by Contractor on subitem 1.1.4.15 above	%	1,600,000	. . . . . .%	
SECTION 1	CARRIED FORWARD					

SANS 1200 A

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
PSA 8.7	**1.1.5**	**Daywork**				
	1.1.5.1	Contractor's Own Plant and equipment: (Rates to include overheads, fuel, operators costs,charges and profit)				
	1.1.5.1.1	Motor Graders up to 82 kW and 10t mass	h	48		
	1.1.5.1.2	Rubber tyred loaders up to 60 kW and 8 ton mass	h	48		
	1.1.5.1.3	Trench Excavator, more than 75kW	h	48		
	1.1.5.1.4	Vibrating roller more than 80 kW and 6 ton mass	h	48		
	1.1.5.1.5	Tipper Truck, 10m^3 capacity	h	48		
	1.1.5.1.6	Water Trucks up to 10 kl capacity	h	48		
	1.1.5.1.7	Concrete Mixer, more than 400kl capacity	h	48		
	1.1.5.1.8	Water Pump, more than 1000l/minute capacity	h	48		
	1.1.5.1.9	Bulldozer with flywheel power greater than 220 kW	h	48		
	1.1.5.1.10	Sludge pump (100mm dia with hoses)	h	48		
	1.1.5.1.11	T.L.B with minimum power 50 kW (similar to case 580G)	h	48		
	1.1.5.1.12	Mobile crane truck with minimum capacity of 10t	h	48		
	1.1.5.1.13	Generating set (minimum output power 10kW)	h	48		
	1.1.5.1.14	Tractor with trailer (minimum power of 50 kW)	h	48		
	1.1.5.2	Labour: (Rates to include overheads, on cost charges and profit)				
	1.1.5.2.1	Labourer	h	48		
	1.1.5.2.2	Artisan	h	48		
SECTION 1	CARRIED FORWARD					

SANS 1200 A

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	1.1.5.2.3	Team leader	h	48		
	1.1.5.2.4	Surveyor	h	48		
	1.1.5.2.5	Foreman	h	48		
	1.1.5.2.6	Electrician	h	48		
	1.1.5.3	Plant hired by Contractor				
	1.1.5.3.1	Net cost of hired plant	Prov Sum	1	R50,000.00	R50,000.00
	1.1.5.3.2	Charge required by Contractor on subitem 1.1.5.3.1 above	%	50,000	. . . . . .%	
	1.1.5.4	Materials				
	1.1.5.4.1	Materials (Copies of invoices to be submitted)	PC Sum	1	R50,000.00	R50,000.00
	1.1.5.4.2	Charge required by Contractor on subitem 1.1.5.4.1 above	%	50,000	. . . . . .%	
PSA 8.8.4	**1.1.6**	**Location and protection of existing services**				
	1.1.6.1	Provision of detecting devices for:				
	1.1.6.1.1	Water and sewer pipes	Prov Sum	1	R50,000.00	R50,000.00
	1.1.6.1.2	Electrical and other cables	Prov Sum	1	R50,000.00	R50,000.00
	1.1.6.1.3	Charge required by Contractor on subitem 1.1.6.1.1 and 1.1.6.1.2 above	%	100,000	. . . . . .%	
	1.1.6.2	Hand excavation necessary for locating and exposing existing services in all naterial				
	1.1.6.2.1	In roadways	m³	1		
	1.1.6.2.2	In all other areas	m³	1		
	1.1.7	**Boardroom, offices, furniture, ablution facilities and carports for Employer's Agent and his**	sum	1		
SECTION 1	CARRIED FORWARD					

SANS 1200 A

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
PSA 8.8.7	**1.1.8**	**Dealing with water**				
	1.1.8.1	Dealing with subsurface water	sum	1		
	1.1.8.2	Dealing with surface water	sum	1		
PSA 8.10	**1.1.9**	**Compliance with OHS Act and Regulations (including the Construction Regulations, 2014)**				
	1.1.9.1	Compilation of Health and Safety Plan and File (CR 7(1)(a)(b))	sum	1		
	1.1.9.2	Employment of a Construction Health and Safety Officer who is SACPCMP registered and in good standing (CR 8(5))	month	18		
	1.1.9.3	Provide PPE: Overalls,Hard hat,Gloves,Safety shoes,Reflective vest etc (GSR 2)	sum	1		
	1.1.9.4	Provide training as identified in hte training needs analyses				
	1.1.9.4.1	First Aid Level 1 (GSR 3)	sum	1		
	1.1.9.4.2	Fire fighting (CR 29(i))	sum	1		
	1.1.9.4.3	Working at heights (CR 10)	sum	1		
	1.1.9.4.4	Health and Safety Representative (Section 17)	sum	1		
	1.1.9.4.5	Incident investigation (GAR 8)	sum	1		
	1.1.9.4.6	Scaffolding (Erector,Inspector)(CR 16)	sum	1		
	1.1.9.5	Medicals				
	1.1.9.5.1	Pre-employment assessment	sum	1		
	1.1.9.5.2	Exist medical assessment	sum	1		
	1.1.9.6	Driver operator competency training				
	1.1.9.6.1	Operator certificate of competency (CR 23)	sum	1		
	1.1.9.6.2	PrDP Permit (National traffic act, act 93 of 1996)	sum	1		
SECTION 1	CARRIED FORWARD					

SANS 1200 A

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	1.1.9.7	Hygiene Facilities				
	1.1.9.7.1	Mobile toilets	sum	1		
	1.1.9.7.2	Oil Spill kits	sum	1		
	1.1.9.8	General warning safety signage (SANS 1186)	sum	1		
PSA 8.11	**1.1.10**	**Contract nameboards**	sum	1		
PSA 8.13	**1.1.11**	**Environmental management**	sum	1		
PSA 8.14	**1.1.12**	**Quality management plan**	sum	1		
PSA 8.16	**1.1.13**	**Provision of security personnel**	sum	1		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 1: PRELIMINARY & GENERAL

SECTION 1	SANS 1200 A - GENERAL	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE** **Refer to drawing 1000936-DRG-1110-CC-0001**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m²	2,584		
8.2.3	**1.1.2**	**Remove and grub all trees and tree stumps regardless of girth**	ha	0.1		
PSC 8.2.12	**1.1.3**	**Remove topsoil to spoil site furnished by Contractor**	m³	517		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 D**				
SANS 1200D	**2.1**	**EARTHWORKS**				
		Refer to drawings: 1000936-DRG-1100-CC-0001 to 0002 & 1000936-DRG-1110-SS-0004 & 0005				
PSD 8.3.2	**2.1.1**	**Bulk excavation:**				
	2.1.1.1	Excavate in all materials and use for embankment or backfill as ordered from:				
	2.1.1.1.1	Necessary excavations	m³	907		
	2.1.1.1.2	Commercial sources	m³	646		
	2.1.1.2	Excavate in all materials and dispose	m³	16,174		
	2.1.1.3	Extra over items 2.1.1.1,and 2.1.1.2 above for:				
	2.1.1.3.1	Intermediate excavation	m³	2,392		
	2.1.1.3.2	Hard rock excavation	m³	7,175		
	2.1.1.3.3	Boulder excavation, class A	m³	1,196		
	2.1.1.3.4	Boulder excavation, class B	m³	1,196		
	2.1.1.3.5	Overbreak not exceeding 200 mm, only on instruction from the engineer	m³	79		
PSD 8.3.3	**2.1.2**	**Restricted excavation:**				
	2.1.2.1	Excavate for footings (at) 625 mm in all materials, and use for backfill or embankment, or dispose	m³	86		
	2.1.2.2	Excavate for restricted foundations for foor slab, subsurface drainage and mass concrete base in all materials, and use for backfill or embankment, or dispose	m³	203		
	2.1.2.3	Extra over items 2.1.2.1 to 2.1.2.2 above for:				
	2.1.2.3.1	Hard rock excavation	m³	60.9		
SECTION 2	CARRIED FORWARD					

SECTION 2 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
8.3.9	**2.1.3**	**Extra over items 2.1.1 and 2.1.2 for backfill or for fill material against structures**	m^3	20		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 DB** **Refer to drawings: 1000936-DRG-1100-CC-0001 to 0002 & 1000936-DRG-1120-CC-0003 to 0006**				
SANS 1200DB	**3.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
PSDB 8.3.2	**3.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	3.1.1.1	Pipes over 125 mm dia up to 400 mm dia for depths:				
	3.1.1.1.1	Over 1,0 m up to 2,0 m	m	59		
	3.1.1.1.2	Over 2,0 m up to 3,0 m	m	26		
PSDB 8.3.2	**3.1.2**	**Extra over item 3.1.1 above for:**				
	3.1.2.1	Intermediate excavation	m³	16		
	3.1.2.2	Hard rock excavation	m³	140		
PSDB 8.3.2	**3.1.3**	**Excavate and dispose of unsuitable material from trench bottom**	m³	20		
PSDB 8.3.3	**3.1.4**	**Excavation ancillaries:**				
	3.1.4.1	Backfill and compact trench:				
	3.1.4.1.1	From other necessary excavations on Site	m³	160		
	3.1.4.1.2	By importation from commercial or off-site sources selected by the Contractor	m³	56		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 DK**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 DK** **Refer to drawings 1000936-DRG-1100-CC-0001 to 0002**				
SANS 1200DK	**4.1**	**GABIONS AND PITCHING**				
8.2.1	**4.1.1**	**Surface preparation for bedding of gabions:**				
	4.1.1.1	Cavities filled with approved excavated material or rock	m²	63		
	4.1.1.2	Cavities filled with grade 15/19 concrete	m³	7		
8.2.2	**4.1.2**	**Gabions:**				
	4.1.2.1	Gabion boxes of PVC-coated galvanized wire:				
	4.1.2.1.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 1.0 m x 1.0 m x 1.0 m boxes	m³	70		
	4.1.2.2	Gabion mattresses of galvanized wire, up to 0,3 m deep:				
	4.1.2.2.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 0.3 m mattress	m³	2.4		
8.2.4	**4.1.3**	**Geotextile:**				
	4.1.3.1	Bidim U24 or approved equivalent	m²	140		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 H**				
SANS 1200H	**5.1**	**STRUCTURAL STEELWORK**				
8.3.1	**5.1.1**	**Supply and fabrication of steelwork:**				
	5.1.1.1	Jointing by bolting:				
	5.1.1.1.1	IPE140 Beam complete as per drawing 1000936-DRG-1120-SS-0003 & 0004	t	0.05		
8.3.8	**5.1.2**	**Ladders, complete and installed:**				
	5.1.2.1	Interior Ladder complete as per drawing 1000936-DRG-1110-SS-0006	number	1		
	5.1.2.2	Exterior Ladder complete as per drawing 1000936-DRG-0230-SS-0008	number	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 1200 LB**				
SANS 1200LB	**6.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES** **Refer to drawings: 1000936-DRG-1100-CC-0001 and 1000936-DRG-0210-CC-0003**				
PSLB 8.2.2	**6.1.1**	**Supply only of bedding by importation:**				
	6.1.1.1	From other necessary excavations:				
	6.1.1.1.1	Selected granular material	m³	5		
	6.1.1.1.2	Selected fill material	m³	5		
	6.1.1.2	From commercial sources:				
	6.1.1.2.1	Selected granular material	m³	34		
	6.1.1.2.2	Selected fill material	m³	20		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 7 **SANS 1200 LC**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	7	**SANS 1200 LC**				
SANS 1200LC	**7.1**	**CABLE DUCTS**				
PSLC 8.2.5	**7.1.1**	**Supply, lay, bed and prove duct:**				
	7.1.1.1	uPVC pipes: Refer to drawing 1000936-DRG-1120-SS-0004 & 0006				
	7.1.1.1.1	75 mm diameter wall sleeve	m	11		
SECTION 7	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 8 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	8	**SANS 1200 LE** **Refer to drawing: 1000936-DRG-1110-SS-0001**				
SANS 1200LE	**8.1**	**STORMWATER DRAINAGE**				
8.2.8	**8.1.1**	**Supply and install manholes and the like:**				
	8.1.1.1	Brickwork manholes:				
	8.1.1.1.1	As shown on drawing 1000936-DRG-1110-SS-0001 & 0004 standard depth 1,5m	number	2		
	8.1.1.2	Grid inlets:				
	8.1.1.2.1	As shown on drawing 1000936-DRG-1110-SS-0001 standard depth 0,5m	number	1		
PSLE 8.2.14	**8.1.2**	**Pipes in subsurface drains:**				
	8.1.2.1	Normal duty uPVC pipes complete with couplings:				
	8.1.2.1.1	100 mm internal dia, perforated	m	115		
	8.1.2.1.2	100 mm internal dia, unperforated	m	52		
	8.1.2.1.3	150 mm internal dia, unperforated	m	2		
	8.1.2.2	Heavy-duty fittings:				
	8.1.2.2.1	Stop ends, 110 mm internal dia	number	6		
PSLE 8.2.15	**8.1.3**	**Geofabric (BIDIM A2)**	m²	168		
SECTION 8	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	9	**SANS 2001CC1** **Refer to drawings: 1000936-DRG-1110-SS-0001 to 0005 and 1000936-DRG-1120-SS-0004**				
SANS 2001 CC1	**9.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**9.1.1**	**Rough:**				
	9.1.1.1	Vertical formwork to:				
	9.1.1.1.1	External face of wall footing, circular in plan to 13,8 m radius	m²	48		
	9.1.1.1.2	Internal face of wall footing, circular in plan to 11,9 m radius	m²	15		
	9.1.1.1.3	Internal panels of floor slab	m²	37		
	9.1.1.1.4	Concrete pads in lieu of no fines below column bases	m²	9		
	9.1.1.1.5	Concrete V-Drains	m²	13		
SD8.2.2	**9.1.2**	**Smooth:**				
	9.1.2.1	Vertical formwork to:				
	9.1.2.1.1	Wall, circular on plan to 13,3 m radius	m²	544		
	9.1.2.1.2	Wall, circular on plan to 13,0 m radius	m²	531		
	9.1.2.1.3	Reservoir roof slab, circular on plan to 13,3 m radius	m²	42		
	9.1.2.1.4	Columns	m²	161		
	9.1.2.2	Horizontal formwork to:				
	9.1.2.2.1	Soffit of reservoir roof slab	m²	556		
SD8.2.5	**9.1.3**	**Narrow widths (up to 300 mm wide):**				
	9.1.3.1	Different widths in the following ranges:				
	9.1.3.1.1	Over 20 mm and up to 100 mm (Divider strips)	m	151		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	9.1.3.1.2	Over 200 mm and up to 300 mm (Roof slab ring beam circular in plan to 13.3 m radius and reservoir entrance ring beam)	m	49		
	9.1.3.1.3	Over 200 mm and up to 300 mm (Column bases)	m	110		
SANS 2001 CC1	**9.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**9.2.1**	**Steel bars in the following:**				
	9.2.1.1	Mild steel				
	9.2.1.1.1	All diameter bars	t	2.03		
	9.2.1.2	High-tensile steel				
	9.2.1.2.1	All diameter bars	t	81.65		
SD8.3.2	**9.2.2**	**High-tensile welded mesh in the following:**				
	9.2.2.1	Mesh ref 193 in concrete v-drain	m²	136		
SANS 2001 CC1	**9.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**9.3.1**	**Blinding layer in concrete:**				
	9.3.1.1	Class 15 MPa/19 mm concrete of:				
	9.3.1.1.1	50 mm thickness	m²	496		
	9.3.1.1.2	75 mm thickness	m²	112		
SD8.4.3	**9.3.2**	**Strength concrete:**				
	9.3.2.1	Class 15 MPa/19 mm concrete in:				
	9.3.2.1.1	Divider strips	m³	1.2		
	9.3.2.1.2	Concrete pads in lieu of no fines below column bases	m³	2.7		
	9.3.2.1.3	V- Drain	m³	10.9		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	9.3.2.1.4	Subsoil pipe encasement	m³	2.3		
	9.3.2.1.5	Inspection manhole floor slab	m³	0.3		
	9.3.2.2	Class 30 MPa/19 mm concrete in:				
	9.3.2.2.1	Floor slabs	m³	164		
	9.3.2.2.2	Walls complete with with cast in 75mm dia PVC sleeve	m³	162		
	9.3.2.2.3	Column bases	m³	10.7		
	9.3.2.2.4	Column	m³	12.1		
	9.3.2.2.5	Roof slab including ring beams with cast in ventilators, spool pipes, and PVC spout outlets as per drawing 1000936-DRG-1110-SS-0003	m³	145		
	9.3.2.2.6	Pipework concrete base	m³	19		
SD8.4.4.1	**9.3.3**	**Unformed surface finishes:**				
	9.3.3.1	Steel-floated finishes to:				
	9.3.3.1.1	Floor slab	m²	531		
	9.3.3.2	Power-floated finishes to:				
	9.3.3.2.1	Roof slab	m²	536		
SD8.4.7	**9.3.4**	**No fines concrete layer (Class NF19) with mortar skim in the following layer thicknesses:**				
	9.3.4.1	75 mm No fines concrete with the top 15 mm to be mortar	m²	348		
	9.3.4.2	450 mm No fines concrete with the top 15 mm to be mortar	m²	46		
SD8.4.9	**9.3.5**	**Bond breaker below floor**	m²	445		
SD8.4.10	**9.3.6**	**Casting pipes and specials in concrete**	number	6		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.5	**9.3.7**	**Joints:** **Refer to drawing 1000936-DRG-1100-CC-0001**				
	9.3.7.0.1	Horizontal construction joint type 1, on plan to 13.3 m radius in 300 mm thick wall, 150 mm Hypalon sealing strip by Sika or similar approved, complete as per detail 1 on drawing No 1000936-DRG-1100-CC-0001	m	168		
	9.3.7.0.2	Joint type 2, at wall and footing corner, on plan to 13,0 m radius, with Sonder SPX 120 or similar approved joint filler, 350 mm Hypalon sealing strip by Sika or similar approved, complete as per detail 1 on drawing No 1000936-DRG-1100-CC-0001	m	82		
	9.3.7.0.3	Vertical contraction joint type 3, on plan with 11,9 m radius in 200 mm thick floor slab with 10 mm ABE Durasheet 100 joint filler, 350 mm Hypalon sealing strip by Sika or similar approved, complete as per detail on drawing No 1000936-DRG-1100-CC-0001	m	75		
	9.3.7.0.4	Vertical contraction joint type 4, in 200 mm floor slab with two layers of bitumenous paint, 350 mm wide Hypalon sealing strip by Sika or similar approved, 200 mm ABE external C complete as per detail on drawing 1000936-DRG-1100-CC-0001	m	180		
	9.3.7.0.5	Vertical isolation joint formed of 10mm jointex or similar approved between 80 mm thick v-drain and reservoir floor or reservoir wall, sealed with ABE Durakol polysulphide sealant	m	87		
	9.3.7.0.6	10 mm Jointex or similar approved after every fifth 900 mm v-drain panel.	m	21		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.7	**9.3.8**	**Grouting:**				
	9.3.8.1	Bearings:				
	9.3.8.1.1	Kilcher Limitgliss 3t/m 240 mm wide continuous bearing	m	87		
SD8.8	**9.3.9**	**HD bolts and miscellaneous metal work:**				
	9.3.9.1	250 mm long x 110 mm diameter sleeve aligned with wall 75 mm sleeve	number	1		
	9.3.9.2	250 mm long x 110 mm diameter sleeve reduced to 75 mm and cast into concrete slab	number	3		
	9.3.9.3	Vastrap plate with 2 heavy hinges welded to base and bolted to concrete, opening for cast in lock ring, and two handles welded to cover plate complete and installed asper drawing 1000936-DRG-1100-SS-0006	number	1		
	9.3.9.4	Service landing complete and installed as per drawing 1000936-DRG-1100-SS-0006	number	1		
SD8.10	**9.3.10**	**Testing for watertightness:**				
	9.3.10.1	3.1Ml concrete reservoir	sum	1		
SD8.11	**9.3.11**	**Fill reservoir with water**	kl	3,100		
SECTION 9	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 10 **PARTICULAR SPECIFICATION PART PA**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	10	**PARTICULAR SPECIFICATION PART PA**				
	10.1	**FENCING**				
		Refer to drawing 1000936-DRG-1100-CC-0001				
PA.01	**10.1.1**	**Supply and erection of new fencing material:**				
	10.1.1.1	Provide a 2200 mm (Minimum height) fence carbon hardened and galvanised steel mesh panels, support posts with security spikes on top. Security spikes to be 100 mm electro-galvanised, 2 mm thick, toughened steel. The fence should be clamber proof with see-through capabilities and have a top coat finish of baked enamel paint of synthetic coating in colours grey or black. Mesh strands to be 4 mm diameter minimum, cut resistant and with an aperture not exceeding 12 x 75 mm. The fence design must be complete and inclusive of concrete footings for fence posts. The product must be manufactured and installed in accordance with the manufacturers specifications and should carry at least a SABS or better certificate	m	205		
PA.02	**10.1.2**	**New gates:**				
	10.1.2.1	5 m wide gate with similar shared specifications as the fence, supplied by the same manufacturer as the fence, manufactured and installed in accordance with the manufacturers specifications and should carry at least a SABS or better certificate.	number	1		
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SECTION 11 **PARTICULAR SPECIFICATION PART PB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	11	**PARTICULAR SPECIFICATION PART PB** **Refer to drawing 1000936-DRG-1110-SS-0003 to 0005**				
	11.1	**MISCELLANEOUS WORK FOR RESERVOIRS**				
PB.01	**11.1.1**	**Lightning protection**	sum	1		
PB.02	**11.1.2**	**Sterilization**	sum	1		
PB.04	**11.1.3**	**Crushed stone on roof**	m^3	33		
PB.05	**11.1.4**	**Miscellaneous items:**				
	11.1.4.1	Measured by number:				
	11.1.4.1.1	Ventilator fabricated from 200 mm dia x 4 mm thickness Epoxy (Copon 2300) steel pipe and painted, cast into concrete as per drawing 1000936-DRG-1110-SS-0003	number	8		
	11.1.4.1.2	150 mm dia steel flanged sleeve pipes cast into roof slab as per drawing 1000936-DRG-1110-SS-0003	number	2		
	11.1.4.2	Measured by area:				
	11.1.4.2.1	Roof waterproofing: modified bituminous torch-applied waterproofing membrane, minimum 4mm thick, reinforced with dimensionally stable non-woven polyester	m^2	536		
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SECTION 12 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	12	**RESERVOIR MECHANICAL**				
ZUT 7001	**12.1**	**MANUFACTURING OF STEEL SPECIALS**				
	12.1.1	**Reservoir pipework: Drawings 1000936-DRG-1120-SS-0003, 0004 & 0005: Supply and deliver to site steel specials; PN20 steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers and gaskets according to ZUT 7001**				
	12.1.1.1	Item No. 1.1: DN200 Bellmouth scour pipe (Stainless steel)	number	1		
	12.1.1.2	Item No. 2.1: DN250 long radius bend overflow pipe (Stainless steel)	number	1		
	12.1.1.3	Item No. 2.2: DN250 Bellmouth overflow pipe (Stainless steel)	number	1		
	12.1.1.4	Item No. 3.1: DN200 Bellmouth outlet pipe (Stainless steel)	number	1		
	12.1.1.5	Item No. 4.15: DN150 90 degree bend (Grade C)	number	4		
	12.1.1.6	Item No. 4.16: DN150 spool pipe (Grade C)	number	2		
	12.1.1.7	Item No. 4.17: DN150 45 degree bend (Grade C)	number	4		
	12.1.1.8	Item No. 4.18: DN150 spool pipe (Grade C)	number	5		
	12.1.1.9	Item No. 4.18a: DN150 spool pipe (Grade C)	number	1		
	12.1.1.10	Item No. 4.19: DN150 spool pipe (Grade C)	number	1		
	12.1.1.11	Item No. 4.20: DN150 spool pipe (Grade C)	number	1		
	12.1.1.12	Item No. 4.21: DN150 spool pipe (Grade C)	number	1		
	12.1.1.13	Item No. 4.22: DN150 spool pipe (Grade C)	number	1		
SECTION 12	CARRIED FORWARD					

SECTION 12 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	12.1.1.14	Item No. 4.23: DN150 spool pipe (Grade C)	number	1		
	12.1.1.15	Item No. 4.24: DN150 spool pipe (Grade C)	number	1		
ZUT 7003	**12.2**	**INSTALLATION OF STEEL SPECIALS**				
	12.2.1	**Reservoir pipework: Drawings 1000936-DRG-1120-SS-0003, 0004 & 0005: Installation of steel specials, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	12.2.1.1	Item No. 1.1: DN200 Bellmouth scour pipe (Stainless steel)	number	1		
	12.2.1.2	Item No. 2.1: DN250 long radius bend overflow pipe (Stainless steel)	number	1		
	12.2.1.3	Item No. 2.2: DN250 Bellmouth overflow pipe (Stainless steel)	number	1		
	12.2.1.4	Item No. 3.1: DN200 Bellmouth outlet pipe (Stainless steel)	number	1		
	12.2.1.5	Item No. 4.15: DN150 90 degree bend (Grade C)	number	4		
	12.2.1.6	Item No. 4.16: DN150 spool pipe (Grade C)	number	2		
	12.2.1.7	Item No. 4.17: DN150 45 degree bend (Grade C)	number	4		
	12.2.1.8	Item No. 4.18: DN150 spool pipe (Grade C)	number	5		
	12.2.1.9	Item No. 4.18a: DN150 spool pipe (Grade C)	number	1		
	12.2.1.10	Item No. 4.19: DN150 spool pipe (Grade C)	number	1		
	12.2.1.11	Item No. 4.20: DN150 spool pipe (Grade C)	number	1		
SECTION 12	CARRIED FORWARD					

SECTION 12 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	12.2.1.12	Item No. 4.21: DN150 spool pipe (Grade C)	number	1		
	12.2.1.13	Item No. 4.22: DN150 spool pipe (Grade C)	number	1		
	12.2.1.14	Item No. 4.23: DN150 spool pipe (Grade C)	number	1		
	12.2.1.15	Item No. 4.24: DN150 spool pipe (Grade C)	number	1		
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SUMMARY OF BILL 2: KALKFONTEIN COMMAND RESERVOIR

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SECTION 1 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 D**				
SANS 1200D	**1.1**	**EARTHWORKS**				
		Refer to drawings: 1000936-DRG-1100-CC-0001 & 1000936-DRG-1120-SS-0001 & 0002				
PSD 8.3.2	**1.1.1**	**Bulk excavation:**				
	1.1.1.1	Excavate in all materials and dispose	m³	104		
	1.1.1.2	Extra over items 1.1.1.1 above for:				
	1.1.1.2.1	Intermediate excavation	m³	11		
	1.1.1.2.2	Hard rock excavation	m³	83		
	1.1.1.2.3	Boulder excavation, class A	m³	6		
	1.1.1.2.4	Boulder excavation, class B	m³	6		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 H**				
SANS 1200H	**2.1**	**STRUCTURAL STEELWORK**				
8.3.8	**2.1.1**	**Ladders, complete and installed:**				
	2.1.1.1	Access ladder complete as per drawings 1000936-DRG-1120-SS-0001 & 0002	number	1		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 LE**				
SANS 1200LE	**3.1**	**STORMWATER DRAINAGE**				
8.2.1	**3.1.1**	**Supply and lay concrete pipe culverts on class B bedding:**				
	3.1.1.1	Type SC 50-D-load pipes with ogee joints:				
	3.1.1.1.1	DN 300	m	27		
PSLE 8.2.17	**3.1.2**	**Class 20/19 concrete outlet structures for subsurface drains (including framework) refer to drawing 1000936-DRG-1100-RR-0042 for typical details**	m^3	5		
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SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 2001CC1** **Refer to drawings: 1000936-DRG-1120-SS-0001 to 0005**				
SANS 2001 CC1	**4.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**4.1.1**	**Rough:**				
	4.1.1.1	Vertical formwork to:				
	4.1.1.1.1	Drainage Sump	m²	10.8		
	4.1.1.1.2	Floor slab	m²	8.4		
	4.1.1.1.3	Walls	m²	100.1		
SD8.2.2	**4.1.2**	**Smooth:**				
	4.1.2.1	Vertical formwork to:				
	4.1.2.1.1	Roof slab	m²	4.1		
	4.1.2.2	Horizontal formwork to:				
	4.1.2.2.1	Soffit of chamber roof slab	m²	21.7		
SD8.2.5	**4.1.3**	**Narrow widths (up to 300 mm wide):**				
	4.1.3.1	Different widths in the following ranges:				
	4.1.3.1.1	Over 100 mm and up to 200 mm	m	12		
SD8.2.6	**4.1.4**	**Box out holes/form voids:**				
	4.1.4.1	Large, other than circular, of area over 5 m² and up to and including 15 m², and in the following depth ranges:				
	4.1.4.1.1	0 m up to and including 0,5 m	number	1		
SANS 2001 CC1	**4.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**4.2.1**	**Steel bars in the following:**				
	4.2.1.1	Mild steel				
	4.2.1.1.1	All diameter bars	t	0.5		
SECTION 4 CARRIED FORWARD						

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	4.2.1.2	High-tensile steel				
	4.2.1.2.1	All diameter bars	t	4.31		
SANS 2001 CC1	**4.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**4.3.1**	**Blinding layer in concrete:**				
	4.3.1.1	Class 15 MPa/19 mm concrete of:				
	4.3.1.1.1	50 mm thickness	m²	32		
SD8.4.3	**4.3.2**	**Strength concrete:**				
	4.3.2.1	Class 30 MPa/19 mm concrete in:				
	4.3.2.1.1	Drainage Sump	m³	1.5		
	4.3.2.1.2	Floor slab	m³	16.1		
	4.3.2.1.3	Walls	m³	15.6		
	4.3.2.1.4	Roof slab	m³	5.6		
SD8.4.4.1	**4.3.3**	**Unformed surface finishes:**				
	4.3.3.1	Steel-floated finishes to:				
	4.3.3.1.1	Roof slab	m²	27.8		
SD8.4.10	**4.3.4**	**Casting pipes and specials in concrete**	number	5		
SD8.6	**4.3.5**	**Manufacture (or supply) and erect precast elements for small units not exceeding 0,5 m³ of formed concrete:**				
	4.3.5.1	The following types and sizes:				
	4.3.5.1.1	3230 mm x 520 mm x 150 mm Precast cover slabs complete as per drawings 1000936-DRG-1120-SS-0002 & 1000936-DRG-0210-CC-0032	m³	1.1		
SECTION 4	CARRIED FORWARD					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.8	**4.3.6**	**HD bolts and miscellaneous metal work:**				
	4.3.6.1	Manhole access hatch complete as per drawing 1000936-DRG-1120-SS-0002	number	1		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**CHAMBER MECHANICAL**				
ZUT 7001	**5.1**	**MANUFACTURING OF STEEL SPECIALS**				
	5.1.1	**Chamber pipework: Drawings 1000936-DRG-1120-SS-0004, 0005 & 0006: Supply and deliver to site steel specials; PN20 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers gaskets in accordance with ZUT 7001**				
	5.1.1.1	Item No. 1.3: DN200 spool pipe	number	1		
	5.1.1.2	Item No. 1.4: DN200 90 degree bend	number	1		
	5.1.1.3	Item No. 1.5: DN200 spool pipe	number	1		
	5.1.1.4	Item No. 3.3: DN200 spool pipe	number	1		
	5.1.1.5	Item No. 3.5: DN200 spool pipe	number	1		
	5.1.1.6	Item No. 3.7: DN200 equal tee	number	1		
	5.1.1.7	Item No. 3.8: DN200 spool pipe	number	1		
	5.1.1.8	Item No. 3.11: DN200 spool pipe	number	1		
	5.1.1.9	Item No. 4.1: DN250 spool pipe	number	1		
	5.1.1.10	Item No. 4.2: DN250 x DN150 reducing pipe	number	1		
	5.1.1.11	Item No. 4.3: DN150 equal tee	number	1		
	5.1.1.12	Item No. 4.4: DN100 spool pipe	number	2		
	5.1.1.13	Item No. 4.9: DN150 spool pipe	number	1		
	5.1.1.14	Item No. 4.11: DN150 spool pipe	number	1		
	5.1.1.15	Item No. 4.13: orifice flange	number	1		
	5.1.1.16	Item No. 4.14: DN150 spool pipe	number	1		
	5.1.1.17	Item No. 4.25: DN315 x DN250 reducer	number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7003	**5.2**	**INSTALLATION OF STEEL SPECIALS**				
	5.2.1	**Chamber pipework: Drawings 1000936-DRG-1120-SS-0003, 0004 & 0005: Installation of steel specials, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.2.1.1	Item No. 1.3: DN200 spool pipe	number	1		
	5.2.1.2	Item No. 1.4: DN200 90 degree bend	number	1		
	5.2.1.3	Item No. 1.5: DN200 spool pipe	number	1		
	5.2.1.4	Item No. 3.3: DN200 spool pipe	number	1		
	5.2.1.5	Item No. 3.5: DN200 spool pipe	number	1		
	5.2.1.6	Item No. 3.7: DN200 equal tee	number	1		
	5.2.1.7	Item No. 3.8: DN200 spool pipe	number	1		
	5.2.1.8	Item No. 3.11: DN200 spool pipe	number	1		
	5.2.1.9	Item No. 4.1: DN250 spool pipe	number	1		
	5.2.1.10	Item No. 4.2: DN250 x DN150 reducing pipe	number	1		
	5.2.1.11	Item No. 4.3: DN150 equal tee	number	1		
	5.2.1.12	Item No. 4.4: DN100 spool pipe	number	2		
	5.2.1.13	Item No. 4.11: DN150 spool pipe	number	1		
	5.2.1.14	Item No. 4.13: orifice flange	number	1		
	5.2.1.15	Item No. 4.14: DN150 spool pipe	number	1		
	5.2.1.16	Item No. 4.25: DN315 x DN250 reducer	number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7004	**5.3**	**VALVES AND FITTINGS FOR WATER AND WASTERWATER INSTALLATION**				
	5.3.1	**Chamber pipework: Drawings 1000936-DRG-1120-SS-0004, 0005 & 0006: Supply and deliver valves and fittings to site, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.1.1	Item No. 1.2: DN200 butterfly valve	number	1		
	5.3.1.2	Item No. 3.2: DN200 butterfly valve	number	1		
	5.3.1.3	Item No. 3.4: DN200 mechanical flow meter	number	1		
ZUT 7023	5.3.1.4	Item No. 3.6: DN200 dismantling joint	number	1		
ZUT 7016	5.3.1.5	Item No. 3.9: DN100 RSV gate valve	number	1		
ZUT 7022	5.3.1.6	Item No. 3.10: DN100 dual action air valve	number	1		
	5.3.1.7	Item No. 4.5: DN100 RSV gate valve	number	1		
	5.3.1.8	Item No. 4.6: DN100 dual action air valve	number	1		
	5.3.1.9	Item No. 4.7: DN150 butterfly valve	number	2		
	5.3.1.10	Item No. 4.8: DN150 dismantling joint	number	3		
	5.3.1.11	Item No. 4.10: DN150 Bermad 750 strainer	number	1		
	5.3.1.12	Item No. 4.12: DN150 Bermad 750 altitude control valve	number	1		
	5.3.2	**Chamber pipework: Drawings 1000936-DRG-1120-SS-0004, 0005 & 0006: Installation of valves and fittings, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.2.1	Item No. 1.2: DN200 butterfly valve	number	1		
	5.3.2.2	Item No. 3.2: DN200 butterfly valve	number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	5.3.2.3	Item No. 3.4: DN200 mechanical flow meter	number	1		
	5.3.2.4	Item No. 3.6: DN200 dismantling joint	number	1		
	5.3.2.5	Item No. 3.9: DN100 RSV gate valve	number	1		
	5.3.2.6	Item No. 3.10: DN100 dual action air valve	number	1		
	5.3.2.7	Item No. 4.5: DN100 RSV gate valve	number	1		
	5.3.2.8	Item No. 4.6: DN100 dual action air valve	number	1		
	5.3.2.9	Item No. 4.7: DN150 butterfly valve	number	2		
	5.3.2.10	Item No. 4.8: DN150 dismantling joint	number	3		
	5.3.2.11	Item No. 4.10: DN150 Bermad 750 strainer	number	1		
	5.3.2.12	Item No. 4.12: DN150 Bermad 750 altitude control valve	number	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 3: KALKFONTEIN CHAMBERS

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SECTION 3	SANS 1200 LE	R . . . . .
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SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m²	3,600		
8.2.2	**1.1.2**	**Remove and grub large trees and tree stumps of girth:**				
	1.1.2.1	Over 1,0 m and up to and including 2,0 m	number	15		
	1.1.2.2	Over 2,0 m and up to and including 3,0 m	number	5		
8.2.10	**1.1.3**	**Remove topsoil to nominal depth of 150 mm and stockpile**	m³	324		
PSC 8.2.11	**1.1.4**	**Take down and re-erect existing fences**	m	60		
PSC 8.2.12	**1.1.5**	**Remove topsoil to spoil site furnished by Contractor**	m³	216		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DK**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DK**				
SANS 1200DK	**2.1**	**GABIONS AND PITCHING**				
8.2.1	**2.1.1**	**Surface preparation for bedding of gabions:**				
	2.1.1.1	Cavities filled with approved excavated material or rock	m²	29		
	2.1.1.2	Cavities filled with grade 15 concrete	m²	50		
8.2.2	**2.1.2**	**Gabions:**				
	2.1.2.1	Gabion boxes of galvanized wire:				
	2.1.2.1.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 1.0 m boxes	m³	391		
	2.1.2.2	Gabion mattresses of galvanized wire, up to 0,3 m deep:				
	2.1.2.2.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 0.3 m mattress	m³	2.4		
8.2.4	**2.1.4**	**Geotextile:**				
	2.1.4.1	Bidim U24 or approved equivalent	m²	486		
8.2.5	**2.1.5**	**Pitching:**				
	2.1.5.1	Plain pitching:				
	2.1.5.1.1	Heavy pitching	m²	173		
	2.1.5.2	Grouted pitching:				
	2.1.5.2.1	Extra heavy pitching	m²	531		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 DM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 DM**				
SANS 1200DM	**3.1**	**EARTHWORKS (ROADS, SUBGRADE)**				
PSDM 8.3.3	**3.1.1**	**Treatment of roadbed:**				
	3.1.1.1	Roadbed preparation and compaction of material to:				
	3.1.1.1.1	Minimum of 93% of modified AASHTO maximum density (G9)	m³	320		
	3.1.1.2	In-place treatment of roadbed in intermediate or hard rock material by:				
	3.1.1.2.1	Ripping	m³	96		
	3.1.1.2.2	Blasting	m³	160		
	3.1.1.3	Three-pass roller compaction:				
	3.1.1.3.1	Vibratory roller	m³	64		
PSDM 8.3.4	**3.1.2**	**Cut to fill:**				
	3.1.2.1	Compact to 93% of modified AASHTO maximum density (G9)	m³	1,952		
8.3.5	**3.1.3**	**Selected layer compacted to 93% of modified AASHTO maximum density**	m³	310		
PSDM 8.3.7	**3.1.4**	**Cut to spoil from:**				
	3.1.4.1	Soft excavation	m³	98		
	3.1.4.2	Intermediate excavation	m³	196		
	3.1.4.3	Hard excavation	m³	586		
	3.1.4.4	Boulder excavation, class A	m³	49		
	3.1.4.5	Boulder excavation, class B	m³	49		
8.3.8	**3.1.5**	**Removal of oversize material**	m³	60		
8.3.11	**3.1.6**	**Extra over items 3.1.1, 3.1.2 and 3.1.3 for temporary stockpiling of material**	m³	326		
SECTION 3	CARRIED FORWARD					

SECTION 3 **SANS 1200 DM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
8.3.13	**3.1.7**	**Surface finishes:**				
	3.1.7.1	Topsoiling	m²	324		
8.3.15	**3.1.8**	**Catchwater mounds and channels and mitre banks and channels**	m³	68		
PSDM 8.3.17	**3.1.9**	**Extra over items 3.1.3 and 3.1.4 for obtaining material from commercial sources**	m³	310		
PSDM 8.3.18	**3.1.10**	**Final finishing and cleaning up of the site of the Works**	sum	1		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 LE**				
SANS 1200LE	**4.1**	**STORMWATER DRAINAGE**				
8.2.1	**4.1.1**	**Supply and lay concrete pipe culverts on class B bedding:**				
	4.1.1.1	Type Interlocking 100-D pipe:				
	4.1.1.1.1	DN 450 (provisional)	m	12		
8.2.7	**4.1.2**	**Supply and lay precast concrete inlets and outlets to culverts:**				
	4.1.2.1	As shown on 1000936-DRG-1100-RR-0042	number	2		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 MM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 MM**				
SANS 1200MM	**5.1**	**ANCILLARY ROADWORKS GUARDRAILS**				
8.2.1	**5.1.1**	**Guardrails on timber posts:**				
	5.1.1.1	Galvanized (half spacing)	m	97		
8.2.2	**5.1.2**	**Extra over items 5.1.1 for horizontally curved guardrails factory-bent to a radius of less than 150 m**	m	97		
8.2.3	**5.1.3**	**End units**				
	5.1.3.1	End wings	number	3		
	5.1.3.2	Terminal sections as per drawing .100936-DRG-1100-RR-0047 , using single guardrail sections	number	3		
8.2.4	**5.1.4**	**Additional guardrail posts:**				
	5.1.4.1	Timber	number	26		
SANS 1200MM	**5.2**	**ANCILLARY ROADWORKS PERMANENT ROAD SIGNS**				
8.3.1	**5.2.1**	**Sign faces with painted/galvanized background, with painted symbols, characters, legend and borders and with signboards constructed from:**				
	5.2.1.1	Aluminium sheet (2,0 mm thick), of area:				
	5.2.1.1.1	Up to 2 m²	m²	2		
8.3.3	**5.2.2**	**Sign supports:**				
	5.2.2.1	Timber, . . .200mm dia treated poles, complying with Clause 3.2.10	m	6		
8.3.4	**5.2.3**	**Excavation and backfilling and concreting for sign supports:**				
	5.2.3.1	Backfill with excavated material	m³	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 2001CC1**				
SANS 2001 CC1	**6.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
8.2.1	**6.1.1**	**Rough:**				
	6.1.1.1	Vertical formwork to:				
	6.1.1.1.1	Sides of all slabs/benching/plinths	m²	342		
SANS 2001 CC1	**6.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
8.3.2	**6.2.1**	**High-tensile welded mesh in the following:**				
	6.2.1.1	All reinforcing mesh ref 311	m²	1,460		
SANS 2001 CC1	**6.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
PSG 8.4.3	**6.3.1**	**Strength concrete:**				
	6.3.1.1	Class 30 MPa/19 mm concrete in:				
	6.3.1.1.1	All applicable structures as per drawings & project specification	m³	287		
PSG 8.4.4	**6.3.2**	**Unformed surface finishes:**				
	6.3.2.1	Wood-floated finishes to:				
	6.3.2.1.1	All floor slab	m²	1,460		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 4: ACCESS ROAD TO KALKFONTEIN COMMAND RESERVOIR

SECTION 1	SANS 1200 C	R . . . . .
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SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m²	5.6		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DB**				
SANS 1200DB	**2.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
PSDB 8.3.2	**2.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	2.1.1.1	Pipes up to 125 mm dia for depths:				
	2.1.1.1.1	Over 1,0 m up to 2,0 m	m	2		
PSDB 8.3.2	**2.1.2**	**Extra over item 2.1.1 above for:**				
	2.1.2.1	Intermediate excavation	m³	3		
PSDB 8.3.3	**2.1.3**	**Excavation ancillaries:**				
	2.1.3.1	Make up deficiency in backfill material:				
	2.1.3.1.1	From other necessary excavations on Site	m³	3		
	2.1.3.1.2	By importation from commercial or off-site sources selected by the Contractor	m³	1		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 D**				
SANS 1200D	**3.1**	**EARTHWORKS**				
PSD 8.3.2	**3.1.1**	**Bulk excavation:**				
	3.1.1.1	Excavate in all materials and dispose	m^3	12		
	3.1.1.2	Extra over items 3.1.1.1 above for:				
	3.1.1.2.1	Intermediate excavation	m^3	6		
	3.1.1.2.2	Hard rock excavation	m^3	6		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 H**				
SANS 1200H	**4.1**	**STRUCTURAL STEELWORK**				
8.3.8	**4.1.1**	**Ladders, complete and installed:**				
	4.1.1.1	Internal access ladder complete as per drawings 1000936-DRG-1320-SS-0002 & 0004	number	1		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 LB**				
SANS 1200LB	**5.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES**				
PSLB 8.2.2	**5.1.1**	**Supply only of bedding by importation:**				
	5.1.1.1	From commercial sources:				
	5.1.1.1.1	Selected granular material	m³	0.6		
	5.1.1.1.2	Selected fill material	m³	0.5		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 1200 LE**				
SANS 1200LE	**6.1**	**STORMWATER DRAINAGE**				
PSLE 8.2.14	**6.1.1**	**Pipes in subsurface drains:**				
	6.1.1.1	Normal duty uPVC pipes complete with couplings:				
	6.1.1.1.1	100 mm internal dia, unperforated	m	10		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	7	**SANS 2001CC1**				
SANS 2001 CC1	**7.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**7.1.1**	**Rough:**				
	7.1.1.1	Vertical formwork to:				
	7.1.1.1.1	Drainage Sump	m²	1.2		
	7.1.1.1.2	Floor slab	m²	2.8		
	7.1.1.1.3	Walls	m²	35		
	7.1.1.2	Horizontal formwork to:				
	7.1.1.2.1	Soffit of chamber roof slab	m²	5.6		
SD8.2.2	**7.1.2**	**Smooth:**				
	7.1.2.1	Vertical formwork to:				
	7.1.2.1.1	Roof slab	m²	1.7		
SANS 2001 CC1	**7.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**7.2.1**	**Steel bars in the following:**				
	7.2.1.1	High-tensile steel				
	7.2.1.1.1	All diameter bars	t	0.65		
SANS 2001 CC1	**7.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**7.3.1**	**Blinding layer in concrete:**				
	7.3.1.1	Class 15 MPa/19 mm concrete of:				
	7.3.1.1.1	50 mm thickness	m²	5.6		
SD8.4.3	**7.3.2**	**Strength concrete:**				
	7.3.2.1	Class 30 MPa/19 mm concrete in:				
	7.3.2.1.1	Drainage sump	m³	0.3		
	7.3.2.1.2	Floor slab	m³	1.1		
	7.3.2.1.3	Walls	m³	3.5		
SECTION 7	CARRIED FORWARD					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	7.3.2.1.4	Roof slab	m³	0.95		
SD8.4.4.1	**7.3.3**	**Unformed surface finishes:**				
	7.3.3.1	Steel-floated finishes to:				
	7.3.3.1.1	Roof slab	m²	5.6		
SD8.4.10	**7.3.4**	**Casting pipes and specials in concrete**	number	6		
SD8.8	**7.3.5**	**HD bolts and miscellaneous metal work:**				
	7.3.5.1	Manhole access hatch complete as per drawing 1000936-DRG-1310-SS-0002 & 0004	number	1		
SECTION 7	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 8 **MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	8	**MECHANICAL**				
	8	**MEDIUM-PRESSURE PIPELINES**				
ZUT 7001	**8.1**	**MANUFACTURING OF STEEL SPECIALS**				
	8.1.1	**Pipework: Drawings 1000936-DRG-1410-SS-0001: Supply and deliver to site steel specials; PN16 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003**				
	8.1.1.1	Item No. 1.1: DN50 spool pipe	Number	1		
	8.1.1.2	Item No. 1.2: DN50 equal tee	Number	1		
	8.1.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
	8.1.1.4	Item No. 1.8: DN80 spool pipe	Number	1		
	8.1.1.5	Item No. 1.10: DN80 spool pipe	Number	1		
	8.1.1.6	Item No. 1.12: DN80 spool pipe	Number	2		
	8.1.1.7	Item No. 1.13: DN80 orifice flange	Number	1		
	8.1.1.8	Item No. 1.14: DN80 spool pipe	Number	1		
	8.1.1.9	Item No. 1.15: DN80 90 degree bend	Number	1		
	8.1.1.10	Item No. 1.16: DN 80 Spool pipe (Length to be confirmed on site)	Number	1		
	8.1.1.11	Item No. 1.17: DN80 dual 90 degree bend welded spool pipe	Number	1		
	8.1.1.12	Item No.1.18: DN80 spool pipe	Number	1		
	8.1.1.13	Item No.1.20:DN100 x DN80 reducing pipe	Number	1		
ZUT 7003	**8.2**	**INSTALLATION OF STEEL SPECIALS**				
	8.2.1	**Pipework: Drawings 1000936-DRG-1410-SS-0001: Installation of steel specials**				
	8.2.1.1	Item No. 1.1: DN50 spool pipe	Number	1		
	8.2.1.2	Item No. 1.2: DN50 equal tee	Number	1		
	8.2.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
SECTION 8	CARRIED FORWARD					

SECTION 8 **MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	8.2.1.4	Item No. 1.8: DN80 spool pipe	Number	1		
	8.2.1.5	Item No. 1.10: DN80 spool pipe	Number	1		
	8.2.1.6	Item No. 1.12: DN80 spool pipe	Number	2		
	8.2.1.7	Item No. 1.13: DN80 orifice flange	Number	1		
	8.2.1.8	Item No. 1.14: DN80 spool pipe	Number	1		
	8.2.1.9	Item No. 1.15: DN80 90 degree bend	Number	1		
	8.2.1.10	Item No. 1.16: DN 80 Spool pipe (Length to be confirmed on site)	Number	1		
	8.2.1.11	Item No. 1.17: DN80 dual 90 degree bend welded spool pipe	Number	1		
	8.2.1.12	Item No.1.18: DN80 spool pipe	Number	1		
	8.2.1.13	Item No.1.20:DN100 x DN80 reducing pipe	Number	1		
	8.2.2	**Allow for alterations to existing tank structure to accommodate new inlet pipework.**	Number	1		
ZUT 7004	**8.3**	**VALVES AND FITTINGS FOR WATER AND WASTERWATER INSTALLATION**				
	8.3.1	**Pipework: Drawings 1000936-DRG-1410-SS-0001: Supply and deliver valves and fittings to site**				
	8.3.1.1	Item No. 1.4: DN25 ball valve	Number	1		
	8.3.1.2	Item No. 1.5: DN25 dual acting air valve	Number	1		
	8.3.1.3	Item No. 1.6: DN80 butterfly valve	Number	2		
ZUT 7023	8.3.1.4	Item No. 1.7: DN80 dismantling joint	Number	1		
	8.3.1.5	Item No. 1.9: DN80 Bermad 750 strainer	Number	1		
	8.3.1.6	Item No. 1.11: DN80 Bermad 750 altitude control valve	Number	1		
SECTION 8	CARRIED FORWARD					

SECTION 8 **MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	8.3.2	**Pipework: Drawings 1000936-DRG-1410-SS-0001: Installation of valves and fittings**				
	8.3.2.1	Item No. 1.4: DN25 ball valve	Number	1		
	8.3.2.2	Item No. 1.6: DN80 butterfly valve	Number	2		
	8.3.2.3	Item No. 1.7: DN80 dismantling joint	Number	1		
	8.3.2.4	Item No. 1.9: DN80 Bermad 750 strainer	Number	1		
	8.3.2.5	Item No. 1.11: DN80 Bermad 750 altitude control valve	Number	1		
SECTION 8	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 5: KALKFONTEIN RESERVOIR A INLET WORKS

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DB	R . . . . .
SECTION 3	SANS 1200 D	R . . . . .
SECTION 4	SANS 1200 H	R . . . . .
SECTION 5	SANS 1200 LB	R . . . . .
SECTION 6	SANS 1200 LE	R . . . . .
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TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m²	17.6		
PSC 8.2.11	**1.1.2**	**Take down and re-erect existing fences**	m	26		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DB**				
SANS 1200DB	**2.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
PSDB 8.3.2	**2.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	2.1.1.1	Pipes up to 125 mm dia for depths:				
	2.1.1.1.1	Over 1,0 m up to 2,0 m	m	12		
PSDB 8.3.2	**2.1.2**	**Extra over item 2.1.1 above for:**				
	2.1.2.1	Intermediate excavation	m³	15		
PSDB 8.3.3	**2.1.3**	**Excavation ancillaries:**				
	2.1.3.1	Make up deficiency in backfill material:				
	2.1.3.1.1	From other necessary excavations on Site	m³	9		
	2.1.3.1.2	By importation from commercial or off-site sources selected by the Contractor	m³	6		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 D**				
SANS 1200D	**3.1**	**EARTHWORKS**				
PSD 8.3.2	**3.1.1**	**Bulk excavation:**				
	3.1.1.1	Excavate in all materials and dispose	m^3	12		
	3.1.1.2	Extra over items 3.1.1.1 above for:				
	3.1.1.2.1	Intermediate excavation	m^3	6		
	3.1.1.2.2	Hard rock excavation	m^3	6		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 H**				
SANS 1200H	**4.1**	**STRUCTURAL STEELWORK**				
8.3.8	**4.1.1**	**Ladders, complete and installed:**				
	4.1.1.1	Internal access ladder complete as per drawings 1000936-DRG-1320-SS-0002 & 0004	number	1		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 LB**				
SANS 1200LB	**5.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES**				
PSLB 8.2.2	**5.1.1**	**Supply only of bedding by importation:**				
	5.1.1.1	From commercial sources:				
	5.1.1.1.1	Selected granular material	m^3	3		
	5.1.1.1.2	Selected fill material	m^3	2		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 1200 LE**				
SANS 1200LE	**6.1**	**STORMWATER DRAINAGE**				
PSLE 8.2.14	**6.1.1**	**Pipes in subsurface drains:**				
	6.1.1.1	Normal duty uPVC pipes complete with couplings:				
	6.1.1.1.1	100 mm internal dia, unperforated	m	10		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	7	**SANS 2001CC1**				
SANS 2001 CC1	**7.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**7.1.1**	**Rough:**				
	7.1.1.1	Vertical formwork to:				
	7.1.1.1.1	Drainage Sump	m²	1.2		
	7.1.1.1.2	Floor slab	m²	2.8		
	7.1.1.1.3	Walls	m²	35		
	7.1.1.2	Horizontal formwork to:				
	7.1.1.2.1	Soffit of chamber roof slab	m²	5.6		
SD8.2.2	**7.1.2**	**Smooth:**				
	7.1.2.1	Vertical formwork to:				
	7.1.2.1.1	Roof slab	m²	1.7		
SANS 2001 CC1	**7.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**7.2.1**	**Steel bars in the following:**				
	7.2.1.1	High-tensile steel				
	7.2.1.1.1	All diameter bars	t	0.65		
SANS 2001 CC1	**7.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**7.3.1**	**Blinding layer in concrete:**				
	7.3.1.1	Class 15 MPa/19 mm concrete of:				
	7.3.1.1.1	50 mm thickness	m²	5.6		
SD8.4.3	**7.3.2**	**Strength concrete:**				
	7.3.2.1	Class 30 MPa/19 mm concrete in:				
	7.3.2.1.1	Drainage sump	m³	0.3		
	7.3.2.1.2	Floor slab	m³	1.1		
	7.3.2.1.3	Walls	m³	3.5		
SECTION 7	CARRIED FORWARD					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	7.3.2.1.4	Roof slab	m^3	0.95		
SD8.4.4.1	**7.3.3**	**Unformed surface finishes:**				
	7.3.3.1	Steel-floated finishes to:				
	7.3.3.1.1	Roof slab	m^2	5.6		
SD8.4.10	**7.3.4**	**Casting pipes and specials in concrete**	number	6		
SD8.8	**7.3.5**	**HD bolts and miscellaneous metal work:**				
	7.3.5.1	Manhole access hatch complete as per drawing 1000936-DRG-1310-SS-0002 & 0004	number	1		
SECTION 7	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 8 **MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	8	**MECHANICAL**				
	8	**MEDIUM-PRESSURE PIPELINES**				
ZUT 7001	**8.1**	**MANUFACTURING OF STEEL SPECIALS**				
	8.1.1	**Pipework: Drawings 1000936-DRG-1420-SS-0001: Supply and deliver to site steel specials; PN16 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003**				
	8.1.1.1	Item No. 1.1: DN80 spool pipe	Number	1		
	8.1.1.2	Item No. 1.2: DN80 equal tee	Number	1		
	8.1.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
	8.1.1.4	Item No. 1.8: DN80 spool pipe	Number	1		
	8.1.1.5	Item No. 1.10: DN80 spool pipe	Number	1		
	8.1.1.6	Item No. 1.12: DN80 spool pipe	Number	2		
	8.1.1.7	Item No. 1.13: DN80 orifice flange	Number	1		
	8.1.1.8	Item No. 1.14: DN80 spool pipe	Number	1		
	8.1.1.9	Item No. 1.15: DN80 90 degree bend	Number	1		
	8.1.1.10	Item No. 1.16: DN80 spool pipe	Number	1		
	8.1.1.11	Item No. 1.17: DN80 spool pipe (length to be determind on site)	Number	1		
	8.1.1.12	Item No. 1.18: DN80 90 degree bend	Number	1		
	8.1.1.13	Item No. 1.19: DN80 spool pipe (Length to be confirmed on site)	Number	1		
	8.1.1.14	Item No. 1.20: DN80 90x2 degree short bend	Number	1		
	8.1.1.15	Item No. 1.21: DN80 spool pipe	Number	1		
SECTION 8	CARRIED FORWARD					

SECTION 8 **MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7003	**8.2**	**INSTALLATION OF STEEL SPECIALS**				
	8.2.1	**Pipework: Drawings 1000936-DRG-1420-SS-0001: Installation of steel specials**				
	8.2.1.1	Item No. 1.1: DN80 spool pipe	Number	1		
	8.2.1.2	Item No. 1.2: DN80 equal tee	Number	1		
	8.2.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
	8.2.1.4	Item No. 1.8: DN80 spool pipe	Number	1		
	8.2.1.5	Item No. 1.10: DN80 spool pipe	Number	1		
	8.2.1.6	Item No. 1.12: DN80 spool pipe	Number	2		
	8.2.1.7	Item No. 1.13: DN80 orifice flange	Number	1		
	8.2.1.8	Item No. 1.14: DN80 spool pipe	Number	1		
	8.2.1.9	Item No. 1.15: DN80 90 degree bend	Number	1		
	8.2.1.10	Item No. 1.16: DN80 spool pipe	Number	1		
	8.2.1.11	Item No. 1.17: DN80 spool pipe (length to be determind on site)	Number	1		
	8.2.1.12	Item No. 1.18: DN80 90 degree bend	Number	1		
	8.2.1.13	Item No. 1.19: DN80 spool pipe (Length to be confirmed on site)	Number	1		
	8.2.1.14	Item No. 1.20: DN80 90x2 degree short bend	Number	1		
	8.2.1.15	Item No. 1.21: DN80 spool pipe	Number	1		
	8.2.2	**Allow for alterations to existing tank structure to accommodate new inlet pipework.**	Number	1		
SECTION 8	CARRIED FORWARD					

SECTION 8 **MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7004	**8.3**	**VALVES AND FITTINGS FOR WATER AND WASTERWATER INSTALLATION**				
	8.3.1	**Pipework: Drawings 1000936-DRG-1420-SS-0001: Supply and deliver valves and fittings to site**				
	8.3.1.1	Item No. 1.4: DN25 ball valve	Number	1		
	8.3.1.2	Item No. 1.5: DN25 dual acting air valve	Number	1		
	8.3.1.3	Item No. 1.6: DN80 butterfly valve	Number	2		
ZUT 7023	8.3.1.4	Item No. 1.7: DN80 dismantling joint	Number	1		
	8.3.1.5	Item No. 1.9: DN80 Bermad 750 strainer	Number	1		
	8.3.1.6	Item No. 1.11: DN80 Bermad 750 altitude control valve	Number	1		
	8.3.2	**Pipework: Drawings 1000936-DRG-1420-SS-0001: Installation of valves and fittings**				
	8.3.2.1	Item No. 1.4: DN25 ball valve	Number	1		
	8.3.2.2	Item No. 1.6: DN80 butterfly valve	Number	2		
	8.3.2.3	Item No. 1.7: DN80 dismantling joint	Number	1		
	8.3.2.4	Item No. 1.9: DN80 Bermad 750 strainer	Number	1		
	8.3.2.5	Item No. 1.11: DN80 Bermad 750 altitude control valve	Number	1		
SECTION 8	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 6: KALKFONTEIN RESERVOIR B INLET WORKS

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SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C** **Refer to drawing 1000936-DRG-1320-CC-0001**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m^2	925		
8.2.3	**1.1.2**	**Remove and grub all trees and tree stumps regardless of girth**	ha	0.1		
PSC 8.2.12	**1.1.3**	**Remove topsoil to spoil site furnished by Contractor**	m^3	79		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 D** **Refer to drawings: 1000936-DRG-1310-CC-0001 to 0002 & 1000936-DRG-1310-SS-0003**				
SANS 1200D	**2.1**	**EARTHWORKS**				
PSD 8.3.2	**2.1.1**	**Bulk excavation:**				
	2.1.1.1	Excavate in all materials and use for embankment or backfill as ordered from:				
	2.1.1.1.1	Necessary excavations	m³	81		
	2.1.1.1.2	Commercial sources	m³	42		
	2.1.1.2	Excavate in all materials and dispose	m³	2,070		
	2.1.1.3	Extra over items 2.1.1.1 and 2.1.1.2 above for:				
	2.1.1.3.1	Intermediate excavation	m³	302		
	2.1.1.3.2	Hard rock excavation	m³	904		
	2.1.1.3.3	Boulder excavation, class A	m³	151		
	2.1.1.3.4	Boulder excavation, class B	m³	151		
	2.1.1.3.5	Overbreak not exceeding 200 mm, only on instruction from the engineer	m³	10		
8.3.9	**2.1.2**	**Extra over items 2.1.1 and 2.1.2 for backfill or for fill material against structures**	m³	10		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 DB**				
SANS 1200DB	**3.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
		Refer to drawing: 1000936-DRG-1310-CC-0001 & 1000936-DRG-1310-SS-0005				
PSDB 8.3.2	**3.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	3.1.1.1	Pipes up to 125 mm dia for depths:				
	3.1.1.1.1	Up to 1,0 m	m	13		
PSDB 8.3.2	**3.1.2**	**Extra over item 3.1.1 above for:**				
	3.1.2.1	Hard rock excavation	m³	7		
PSDB 8.3.3	**3.1.3**	**Excavation ancillaries:**				
	3.1.3.1	Make up deficiency in backfill material:				
	3.1.3.1.1	From other necessary excavations on Site	m³	4		
	3.1.3.1.2	By importation from commercial or off-site sources selected by the Contractor	m³	3		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 DK**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 DK** **Refer to drawings 1000936-DRG-1310-CC-0001 to 0002**				
SANS 1200DK	**4.1**	**GABIONS AND PITCHING**				
8.2.1	**4.1.1**	**Surface preparation for bedding of gabions:**				
	4.1.1.1	Cavities filled with approved excavated material or rock	m²	63		
	4.1.1.2	Cavities filled with grade 15 concrete	m²	7		
8.2.2	**4.1.2**	**Gabions:**				
	4.1.2.1	Gabion boxes of PVC-coated galvanized wire:				
	4.1.2.1.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 1.0 m x 1.0 m x 1.0 m boxes	m³	70		
	4.1.2.2	Gabion mattresses of galvanized wire, up to 0,3 m deep:				
	4.1.2.2.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 0.3 m mattress	m³	2.4		
8.2.4	**4.1.3**	**Geotextile:**				
	4.1.3.1	Bidim U24 or approved equivalent	m²	140		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 H**				
SANS 1200H	**5.1**	**STRUCTURAL STEELWORK**				
8.3.7	**5.1.1**	**Handrails:**				
	5.1.1.1	Handrail assembly complete:				
	5.1.1.1.1	As shown on drawing 1000936-DRG-1310-SS-0002	sum	1		
8.3.8	**5.1.2**	**Ladders, complete and installed:**				
	5.1.2.1	Access ladder as per drawing 1000936-DRG-1310-SS-0002	number	1		
PSH 8.3.14	**5.1.3**	**Manufacture, supply, erection and testing including filling with water of a 250 kilolitre storage tank as per drawing 1000936-DRG-1310-SS-0001**	sum	1		
PSH 8.3.15	**5.1.4**	**Lightning protection for a 250 kilolitre storage tank**	sum	1		
PSH 8.3.15	**5.1.5**	**Sterilization of a 250 kilolitre storage tank**	sum	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 1200 LE**				
SANS 1200LE	**6.1**	**STORMWATER DRAINAGE**				
PSLE 8.2.14	**6.1.1**	**Pipes in subsurface drains:**				
	6.1.1.1	Normal duty uPVC pipes complete with couplings:				
	6.1.1.1.1	100 mm internal dia, unperforated	m	13		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	7	**SANS 2001CC1**				
SANS 2001 CC1	**7.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
		Refer to drawings: 1000936-DRG-1310-SS-0003 & 0004				
SD8.2.2	**7.1.1**	**Smooth:**				
	7.1.1.1	Vertical formwork to:				
	7.1.1.1.1	Foundation slab	m²	14		
	7.1.1.1.2	Concrete dwarf walls	m²	75		
SANS 2001 CC1	**7.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**7.2.1**	**Steel bars in the following:**				
	7.2.1.1	Mild steel				
	7.2.1.1.1	All diameter bars	t	0.06		
	7.2.1.2	High-tensile steel				
	7.2.1.2.1	All diameter bars	t	7.45		
SANS 2001 CC1	**7.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**7.3.1**	**Blinding layer in concrete:**				
	7.3.1.1	Class 15 MPa/19 mm concrete of:				
	7.3.1.1.1	75 mm thickness	m²	60		
SD8.4.3	**7.3.2**	**Strength concrete:**				
	7.3.2.1	Class 30 MPa/19 mm concrete in:				
	7.3.2.1.1	Foundation slab	m³	30		
	7.3.2.1.2	Concrete dwarf walls	m³	8		
SD8.7	**7.3.3**	**Grouting:**				
	7.3.3.1	HD bolts:				
	7.3.3.1.1	Non Shrink grout under steel capping strip	m³	0.6		
SECTION 7	CARRIED FORWARD					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.8	**7.3.4**	**HD bolts and miscellaneous metal work:**				
	7.3.4.1	HD bolts:				
	7.3.4.1.1	375 mm long M12 HD Bolt Gr 8.8 @350 mm C/C complete installed with with 75 x 75 x 6 mm washer and adjustable nut as per drawing 1000936-DRG-1310-SS-0003	Number	152		
	7.3.4.1.2	80 x 8 FLT (Steel capping strip)	t	0.3		
SECTION 7	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 8 **PARTICULAR SPECIFICATION PART PA**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	8	**PARTICULAR SPECIFICATION PART PA**				
	8.1	**FENCING**				
		Refer to drawing 1000936-DRG-1310-CC-0001				
PA.01	**8.1.1**	**Supply and erection of new fencing material:**				
	8.1.1.1	Provide a 2200 mm (Minimum height) fence carbon hardened and galvanised steel mesh panels, support posts with security spikes on top. Security spikes to be 100 mm electro-galvanised, 2 mm thick, toughened steel. The fence should be clamber proof with see-through capabilities and have a top coat finish of baked enamel paint of synthetic coating in colours grey or black. Mesh strands to be 4 mm diameter minimum, cut resistant and with an aperture not exceeding 12 x 75 mm. The fence design must be complete and inclusive of concrete footings for fence posts. The product must be manufactured and installed in accordance with the manufacturers specifications and should carry at least a SABS or better certificate.	m	133		
PA.02	**8.1.2**	**New gates:**				
	8.1.2.1	5m wide gate with similar shared specifications as the fence, supplied by the same manufacturer as the fence, manufactured and installed in accordance with the manufacturers specifications and should carry at least a SABS or better certificate.	number	1		
SECTION 8	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 9 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	9	**RESERVOIR MECHANICAL**				
ZUT 7001	**9.1**	**MANUFACTURING OF STEEL SPECIALS**				
	9.1.1	**Reservoir pipework: Drawings 1000936-DRG-1310-SS-0005 & 0006: Supply and deliver to site steel specials; PN16 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers and gaskets according to ZUT 7001**				
	9.1.1.1	Item No. 1.16: DN80 90 degree bend	Number	2		
	9.1.1.2	Item No. 1.17: DN80 spool pipe	Number	1		
	9.1.1.3	Item No. 1.18: DN80 90 degree bend	Number	1		
	9.1.1.4	Item No. 1.19: DN80 spool pipe	Number	1		
	9.1.1.5	Item No. 2.1: DN100 Welded goose neck	Number	1		
	9.1.1.6	Item No. 2.2: DN100 spool pipe	Number	1		
	9.1.1.7	Item No. 3.1: DN80 90 degree bend	Number	1		
	9.1.1.8	Item No. 3.2: DN80 spool pipe	Number	1		
	9.1.1.9	Item No. 3.3: DN80 90 degree bend	Number	1		
	9.1.1.10	Item No. 3.4: DN80 spool pipe	Number	1		
	9.1.1.11	Item No. 4.1: DN65 90 degree bend	Number	1		
	9.1.1.12	Item No. 4.2: DN65 spool pipe	Number	1		
ZUT 7003	**9.2**	**INSTALLATION OF STEEL SPECIALS**				
	9.2.1	**Reservoir pipework: Drawings 1000936-DRG-1310-SS-0005 & 0006: Installation of steel specials complete with bolts, nuts, washers and gaskets according to ZUT 7001**				
	9.2.1.1	Item No. 1.16: DN80 90 degree bend	Number	2		
	9.2.1.2	Item No. 1.17: DN80 spool pipe	Number	1		
	9.2.1.3	Item No. 1.18: DN80 90 degree bend	Number	1		
SECTION 9	CARRIED FORWARD					

SECTION 9 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	9.2.1.4	Item No. 1.19: DN80 spool pipe	Number	1		
	9.2.1.5	Item No. 2.1: DN100 90 degree bend	Number	1		
	9.2.1.6	Item No. 2.2: DN100 spool pipe	Number	1		
	9.2.1.7	Item No. 3.1: DN80 90 degree bend	Number	1		
	9.2.1.8	Item No. 3.2: DN80 spool pipe	Number	1		
	9.2.1.9	Item No. 3.3: DN80 90 degree bend	Number	1		
	9.2.1.10	Item No. 3.4: DN80 spool pipe	Number	1		
	9.2.1.11	Item No. 4.1: DN65 90 degree bend	Number	1		
	9.2.1.12	Item No. 4.2: DN65 spool pipe	Number	1		
SECTION 9	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF SCHEDULE OF QUANTITIES

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SECTION 2	SANS 1200 D	R . . . . .
SECTION 3	SANS 1200 DB	R . . . . .
SECTION 4	SANS 1200 DK	R . . . . .
SECTION 5	SANS 1200 H	R . . . . .
SECTION 6	SANS 1200 LE	R . . . . .
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SECTION 1 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 D**				
SANS 1200D	**1.1**	**EARTHWORKS**				
		Refer to drawings: 1000936-1310-CC-0001 & 1000936-DRG-1310-SS-0002 & 0004				
PSD 8.3.2	**1.1.1**	**Bulk excavation:**				
	1.1.1.1	Excavate in all materials and dispose	m^3	5.2		
	1.1.1.2	Extra over items 1.1.1.1 above for:				
	1.1.1.2.1	Intermediate excavation	m^3	0.52		
	1.1.1.2.2	Hard rock excavation	m^3	4.68		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 H**				
SANS 1200H	**2.1**	**STRUCTURAL STEELWORK**				
8.3.8	**2.1.1**	**Ladders, complete and installed:**				
	2.1.1.1	Internal access ladder complete as per drawings 1000936-DRG-1320-SS-0002 & 0004	number	2		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 LE**				
SANS 1200LE	**3.1**	**STORMWATER DRAINAGE**				
PSLE 8.2.14	**3.1.1**	**Pipes in subsurface drains:**				
	3.1.1.1	Normal duty uPVC pipes complete with couplings:				
	3.1.1.1.1	100 mm internal dia, unperforated	m	13		
PSLE 8.2.17	**3.1.2**	**Class 20/19 concrete outlet structures for subsurface drains (including framework) refer to drawing 1000936-DRG-1310-RR-0042 for typical details**	m^3	5		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 2001CC1** **Refer to drawings: 1000936-DRG-1310-SS-0002 & 0004**				
SANS 2001 CC1	**4.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**4.1.1**	**Rough:**				
	4.1.1.1	Vertical formwork to:				
	4.1.1.1.1	Drainage sump	m²	6.4		
	4.1.1.1.2	Floor slab	m²	6.5		
SD8.2.2	**4.1.2**	**Smooth:**				
	4.1.2.1	Vertical formwork to:				
	4.1.2.1.1	Walls	m²	71.4		
	4.1.2.1.2	Roof slab	m²	3.6		
	4.1.2.1.3	Soffit of chamber roof slab	m²	12.8		
SANS 2001 CC1	**4.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**4.2.1**	**Steel bars in the following:**				
	4.2.1.1	Mild steel				
	4.2.1.1.1	All diameter bars	t	0.5		
	4.2.1.2	High-tensile steel				
	4.2.1.2.1	All diameter bars	t	1.48		
SANS 2001 CC1	**4.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**4.3.1**	**Blinding layer in concrete:**				
	4.3.1.1	Class 15 MPa/19 mm concrete of:				
	4.3.1.1.1	50 mm thickness	m²	12.8		
SECTION 4	CARRIED FORWARD					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.4.3	**4.3.2**	**Strength concrete:**				
	4.3.2.1	Class 30 MPa/19 mm concrete in:				
	4.3.2.1.1	Drainage sump	m³	1.3		
	4.3.2.1.2	Floor slab	m³	2.5		
	4.3.2.1.3	Walls	m³	7.3		
	4.3.2.1.4	Roof slab	m³	2.2		
SD8.4.4.1	**4.3.3**	**Unformed surface finishes:**				
	4.3.3.1	Steel-floated finishes to:				
	4.3.3.1.1	Roof slab	m²	12.8		
SD8.4.10	**4.3.4**	**Casting pipes and specials in concrete**	number	6		
SD8.8	**4.3.5**	**HD bolts and miscellaneous metal work:**				
	4.3.5.1	Manhole access hatch complete as per drawing 1000936-DRG-1310-SS-0002 & 0004	number	2		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**CHAMBER MECHANICAL**				
	5	**MEDIUM-PRESSURE PIPELINES**				
ZUT 7001	**5.1**	**MANUFACTURING OF STEEL SPECIALS**				
	5.1.1	**Chamber pipework: Drawings 1000936-DRG-1310-SS-0005 & 0006: Supply and deliver to site steel specials; PN16 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.1.1.1	Item No. 1.1: DN50 spool pipe	Number	1		
	5.1.1.2	Item No. 1.2: DN50 equal tee	Number	1		
	5.1.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
	5.1.1.4	Item No. 1.6: DN80 x DN50 reducing pipe	Number	1		
	5.1.1.5	Item No. 1.9: DN80 spool pipe	Number	1		
	5.1.1.6	Item No. 1.11: DN80 spool pipe	Number	1		
	5.1.1.7	Item No. 1.13: DN80 spool pipe	Number	1		
	5.1.1.8	Item No. 1.14: orifice flange	Number	1		
	5.1.1.9	Item No. 1.15: DN80 spool pipe	Number	1		
	5.1.1.10	Item No. 2.4: DN100 spool pipe	Number	1		
	5.1.1.11	Item No. 2.6: DN100 spool pipe	Number	1		
	5.1.1.12	Item No. 2.8: DN100 equal tee	Number	1		
	5.1.1.13	Item No. 2.9: DN100 x DN25 orifice flange	Number	1		
	5.1.1.14	Item No. 2.12: DN100 spool pipe	Number	1		
	5.1.1.15	Item No. 4.4: DN65 90 degree bend	Number	1		
	5.1.1.16	Item No. 1.21: DN90 x DN50 reducing pipe	Number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7003	**5.2**	**INSTALLATION OF STEEL SPECIALS**				
	5.2.1	**Chamber pipework: Drawings 1000936-DRG-1310-SS-0005 & 0006: Installation of steel specials, complete with bolts, nuts, washers and gaskets**				
	5.2.1.1	Item No. 1.1: DN50 spool pipe	Number	1		
	5.2.1.2	Item No. 1.2: DN50 equal tee	Number	1		
	5.2.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
	5.2.1.4	Item No. 1.6: DN80 x DN50 reducing pipe	Number	1		
	5.2.1.5	Item No. 1.9: DN80 spool pipe	Number	1		
	5.2.1.6	Item No. 1.11: DN80 spool pipe	Number	1		
	5.2.1.7	Item No. 1.13: DN80 spool pipe	Number	1		
	5.2.1.8	Item No. 1.14: orifice flange	Number	1		
	5.2.1.9	Item No. 1.15: DN80 spool pipe	Number	1		
	5.2.1.10	Item No. 2.4: DN100 spool pipe	Number	1		
	5.2.1.11	Item No. 2.6: DN100 spool pipe	Number	1		
	5.2.1.12	Item No. 2.8: DN100 equal tee	Number	1		
	5.2.1.13	Item No. 2.9: DN100 x DN25 orifice flange	Number	1		
	5.2.1.14	Item No. 2.12: DN100 spool pipe	Number	1		
	5.2.1.15	Item No. 4.4: DN65 90 degree bend	Number	1		
	5.2.1.16	Item No. 1.21: DN90 x DN50 reducing pipe	Number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7004	**5.3**	**VALVES AND FITTINGS FOR WATER AND WASTEWATER INSTALLATION**				
	5.3.1	**Chamber pipework: Drawings 1000936-DRG-1310-SS-0005 & 0006: Supply and deliver valves and fittings to site, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.1.1	Item No. 1.4: DN25 ball valve	Number	1		
	5.3.1.2	Item No. 1.7: DN80 butterfly valve	Number	2		
ZUT 7023	5.3.1.3	Item No. 1.8: DN80 dismantling joint	Number	1		
	5.3.1.4	Item No. 1.10: DN80 Bermad 750 strainer	Number	1		
	5.3.1.5	Item No. 1.12: DN80 Bermad 750 altitude control valve	Number	1		
	5.3.1.6	Item No. 1.22: DN80 Bermad 750 pressure reducing valve	Number	1		
	5.3.1.7	Item No. 2.3: DN100 butterfly valve	Number	2		
	5.3.1.8	Item No. 2.5: DN100 mechanical flow meter	Number	1		
	5.3.1.9	Item No. 2.7: DN100 dismantling joint	Number	1		
	5.3.1.10	Item No. 2.10: DN25 ball valve	Number	1		
	5.3.1.11	Item No. 2.11: DN25 dual acting air valve	Number	1		
	5.3.1.12	Item No. 4.3: DN65 butterfly valve	Number	1		
	5.3.2	**Chamber pipework: Drawings 1000936-DRG-1310-SS-0005 & 0006: Installation of valves and fittings, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.2.1	Item No. 1.4: DN25 ball valve	Number	1		
	5.3.2.2	Item No. 1.7: DN80 butterfly valve	Number	2		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	5.3.2.3	Item No. 1.8: DN80 dismantling joint	Number	1		
	5.3.2.4	Item No. 1.10: DN80 Bermad 750 strainer	Number	1		
	5.3.2.5	Item No. 1.12: DN80 Bermad 750 altitude control valve	Number	1		
	5.3.2.6	Item No. 1.22: DN80 Bermad 750 pressure reducing valve	Number	1		
	5.3.2.7	Item No. 2.3: DN100 butterfly valve	Number	2		
	5.3.2.8	Item No. 2.5: DN100 mechanical flow meter	Number	1		
	5.3.2.9	Item No. 2.7: DN100 dismantling joint	Number	1		
	5.3.2.10	Item No. 2.10: DN25 ball valve	Number	1		
	5.3.2.11	Item No. 2.11: DN25 dual acting air valve	Number	1		
	5.3.2.12	Item No. 4.3: DN65 butterfly valve	Number	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 8: TSAKANE CHAMBERS

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SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m^2	2,592		
8.2.2	**1.1.2**	**Remove and grub large trees and tree stumps of girth:**				
	1.1.2.1	Over 1,0 m and up to and including 2,0 m	number	10		
	1.1.2.2	Over 2,0 m and up to and including 3,0 m	number	3		
8.2.10	**1.1.3**	**Remove topsoil to nominal depth of 150 mm and stockpile**	m^3	78		
PSC 8.2.11	**1.1.4**	**Take down and re-erect existing fences**	m	100		
PSC 8.2.12	**1.1.5**	**Remove topsoil to spoil site furnished by Contractor**	m^3	312		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DK**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DK**				
SANS 1200DK	**2.1**	**GABIONS AND PITCHING**				
8.2.1	**2.1.1**	**Surface preparation for bedding of gabions:**				
	2.1.1.1	Cavities filled with approved excavated material or rock	m²	31		
	2.1.1.2	Cavities filled with grade 15 concrete	m²	50		
8.2.2	**2.1.2**	**Gabions:**				
	2.1.2.1	Gabion boxes of galvanized wire:				
	2.1.2.1.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 1.0 m boxes	m³	101		
	2.1.2.2	Gabion mattresses of galvanized wire, up to 0,3 m deep:				
	2.1.2.2.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 0.3 m mattress	m³	2.4		
8.2.4	**2.1.4**	**Geotextile:**				
	2.1.4.1	Bidim U24 or approved equivalent	m²	202		
8.2.5	**2.1.5**	**Pitching:**				
	2.1.5.1	Plain pitching:				
	2.1.5.1.1	Heavy pitching	m²	184		
	2.1.5.2	Grouted pitching:				
	2.1.5.2.1	Extra heavy pitching	m²	889		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 DM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 DM**				
SANS 1200DM	**3.1**	**EARTHWORKS (ROADS, SUBGRADE)**				
PSDM 8.3.3	**3.1.1**	**Treatment of roadbed:**				
	3.1.1.1	Roadbed preparation and compaction of material to:				
	3.1.1.1.1	Minimum of 93% of modified AASHTO maximum density (G9)	m³	290		
	3.1.1.2	In-place treatment of roadbed in intermediate or hard rock material by:				
	3.1.1.2.1	Ripping	m³	87		
	3.1.1.2.2	Blasting	m³	145		
	3.1.1.3	Three-pass roller compaction:				
	3.1.1.3.1	Vibratory roller	m³	58		
PSDM 8.3.4	**3.1.2**	**Borrow to fill:**				
	3.1.2.1	Compact to 90% of modified AASHTO maximum density	m³	200		
8.3.5	**3.1.3**	**Selected layer compacted to 93% of modified AASHTO maximum density**	m³	275		
PSDM 8.3.7	**3.1.4**	**Cut to spoil from:**				
	3.1.4.1	Soft excavation	m³	32		
	3.1.4.2	Intermediate excavation	m³	63		
	3.1.4.3	Hard excavation	m³	189		
	3.1.4.4	Boulder excavation, class A	m³	16		
	3.1.4.5	Boulder excavation, class B	m³	16		
8.3.8	**3.1.5**	**Removal of oversize material**	m³	60		
8.3.13	**3.1.6**	**Surface finishes:**				
	3.1.6.1	Topsoiling	m²	78		
SECTION 3	CARRIED FORWARD					

SECTION 3 **SANS 1200 DM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
8.3.15	**3.1.7**	**Catchwater mounds and channels and mitre banks and channels**	m^3	49		
PSDM 8.3.17	**3.1.8**	**Extra over items 3.1.2 and 3.1.3 for obtaining material from commercial sources**	m^3	475		
PSDM 8.3.18	**3.1.9**	**Final finishing and cleaning up of the site of the Works**	sum	1		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 LE**				
SANS 1200LE	**4.1**	**STORMWATER DRAINAGE**				
8.2.1	**4.1.1**	**Supply and lay concrete pipe culverts on class B bedding:**				
	4.1.1.1	Type interlocking 100D-load pipes:				
	4.1.1.1.1	DN 450 (Provisional)	m	8		
8.2.7	**4.1.2**	**Supply and lay precast concrete inlets and outlets to culverts:**				
	4.1.2.1	As shown on 1000936-DRG-1310-RR-0042	number	2		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 MM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 MM**				
SANS 1200MM	**5.1**	**ANCILLARY ROADWORKS GUARDRAILS**				
8.2.1	**5.1.1**	**Guardrails on timber posts:**				
	5.1.1.1	Galvanized (half spacing)	m	150		
8.2.2	**5.1.2**	**Extra over items 5.1.1 for horizontally curved guardrails factory-bent to a radius of less than 150 m**	m	150		
8.2.3	**5.1.3**	**End units**				
	5.1.3.1	End wings	number	3		
	5.1.3.2	Terminal sections as per drawing As shown on 1000936-DRG-1310-RR-0047, using single guardrail sections	number	3		
8.2.4	**5.1.4**	**Additional guardrail posts:**				
	5.1.4.1	Timber	number	40		
SANS 1200MM	**5.2**	**ANCILLARY ROADWORKS PERMANENT ROAD SIGNS**				
8.3.1	**5.2.1**	**Sign faces with painted/galvanized background, with painted symbols, characters, legend and borders and with signboards constructed from:**				
	5.2.1.1	Aluminium sheet (2,0 mm thick), of area:				
	5.2.1.1.1	Up to 2 m²	m²	2		
8.3.3	**5.2.2**	**Sign supports:**				
	5.2.2.1	Timber, 200 mm dia treated poles, complying with Clause 3.2.10	m	6		
8.3.4	**5.2.3**	**Excavation and backfilling and concreting for sign supports:**				
	5.2.3.1	Backfill with excavated material	m³	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 2001CC1**				
SANS 2001 CC1	**6.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
8.2.1	**6.1.1**	**Rough:**				
	6.1.1.1	Vertical formwork to:				
	6.1.1.1.1	Sides of all slabs/benching/plinths	m²	529		
SANS 2001 CC1	**6.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
8.3.2	**6.2.1**	**High-tensile welded mesh in the following:**				
	6.2.1.1	All reinforcing mesh Ref 311	m²	1,041		
SANS 2001 CC1	**6.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
PSG 8.4.3	**6.3.1**	**Strength concrete:**				
	6.3.1.1	Class 30 MPa/19 mm concrete in:				
	6.3.1.1.1	All applicable structures as per drawings & project specification	m³	209		
PSG 8.4.4	**6.3.2**	**Unformed surface finishes:**				
	6.3.2.1	Wood-floated finishes to:				
	6.3.2.1.1	All floor slab	m²	1,041		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 9: ACCESS ROAD TO TSAKANE RESERVOIR

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DK	R . . . . .
SECTION 3	SANS 1200 DM	R . . . . .
SECTION 4	SANS 1200 LE	R . . . . .
SECTION 5	SANS 1200 MM	R . . . . .
SECTION 6	SANS 2001CC1	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C** **Refer to drawing 1000936-DRG-1100-CC-0001**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m^2	2,058		
8.2.3	**1.1.2**	**Remove and grub all trees and tree stumps regardless of girth**	ha	0.1		
PSC 8.2.12	**1.1.3**	**Remove topsoil to spoil site furnished by Contractor**	m^3	128		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 D** **Refer to drawings: 1000936-DRG-1320-CC-0001 to 0002 & 1000936-DRG-1320-SS-0001 to 0005**				
SANS 1200D	**2.1**	**EARTHWORKS**				
PSD 8.3.2	**2.1.1**	**Bulk excavation:**				
	2.1.1.1	Excavate in all materials and use for embankment or backfill as ordered from:				
	2.1.1.1.1	Necessary excavations	m³	1,196		
	2.1.1.1.2	Commercial sources	m³	459		
	2.1.1.2	Excavate in all materials and dispose	m³	7,151		
	2.1.1.3	Extra over items 2.1.1.1 and 2.1.1.2 above for:				
	2.1.1.3.1	Intermediate excavation	m³	1,241		
	2.1.1.3.2	Hard rock excavation	m³	3,722		
	2.1.1.3.3	Boulder excavation, class A	m³	621		
	2.1.1.3.4	Boulder excavation, class B	m³	182		
	2.1.1.3.5	Overbreak not exceeding 200 mm, only on instruction from the engineer	m³	62		
PSD 8.3.3	**2.1.2**	**Restricted excavation:**				
	2.1.2.1	Excavate for footings (at) 625 mm in all materials, and use for backfill or embankment, or dispose	m³	70		
	2.1.2.2	Excavate for restricted foundations for foor slab, subsurface drainage and mass concrete base in all materials, and use for backfill or embankment, or dispose	m³	135		
	2.1.2.3	Extra over items 2.1.2.1 to 2.1.2.2 above for:				
	2.1.2.3.2	Hard rock excavation	m³	41		
8.3.9	**2.1.3**	**Extra over items 2.1.1 and 2.1.2 for backfill or for fill material against structures**	m³	20		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 DB** **Refer to drawings: 1000936-DRG-1320-CC-0001 to 0002 & 1000936-DRG-1320-SS-0023 to 0026**				
SANS 1200DB	**3.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
PSDB 8.3.2	**3.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	3.1.1.1	Pipes over 125 mm dia up to 400 mm dia for depths:				
	3.1.1.1.1	Over 1,0 m up to 2,0 m	m	50		
	3.1.1.1.2	Over 3,0 m up to 4,0 m	m	24		
PSDB 8.3.2	**3.1.2**	**Extra over item 3.1.1 above for:**				
	3.1.2.1	Intermediate excavation	m³	14		
	3.1.2.2	Hard rock excavation	m³	124		
PSDB 8.3.2	**3.1.3**	**Excavate and dispose of unsuitable material from trench bottom**	m³	138		
PSDB 8.3.3	**3.1.4**	**Excavation ancillaries:**				
	3.1.4.1	Make up deficiency in backfill material:				
	3.1.4.1.1	From other necessary excavations on Site	m³	116		
	3.1.4.1.2	By importation from commercial or off-site sources selected by the Contractor	m³	47		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 DK**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 DK** **Refer to drawings 1000936-DRG-1320-CC-0001 to 0002**				
SANS 1200DK	**4.1**	**GABIONS AND PITCHING**				
8.2.1	**4.1.1**	**Surface preparation for bedding of gabions:**				
	4.1.1.1	Cavities filled with approved excavated material or rock	m²	121		
	4.1.1.2	Cavities filled with grade 15 concrete	m²	14		
8.2.2	**4.1.2**	**Gabions:**				
	4.1.2.1	Gabion boxes of PVC-coated galvanized wire:				
	4.1.2.1.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 1.0 m x 1.0 m x 1.0 m boxes	m³	65		
	4.1.2.2	Gabion mattresses of galvanized wire, up to 0,3 m deep:				
	4.1.2.2.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 0.3 m mattress	m³	2.4		
8.2.4	**4.1.3**	**Geotextile:**				
	4.1.3.1	Bidim U24 or approved equivalent	m²	280		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 H**				
SANS 1200H	**5.1**	**STRUCTURAL STEELWORK**				
8.3.1	**5.1.1**	**Supply and fabrication of steelwork:**				
	5.1.1.1	Jointing by bolting:				
	5.1.1.1.1	IPE140 Beam complete as per drawing 1000936-DRG-1320-SS-0023 & 0024	t	0.05		
8.3.8	**5.1.2**	**Ladders, complete and installed:**				
	5.1.2.1	Interior Ladder complete as per drawing 1000936-DRG-1320-SS-0006	number	1		
	5.1.2.2	Exterior Ladder complete as per drawing 1000936-DRG-0230-SS-0008	number	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 1200 LB**				
SANS 1200LB	**6.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES** **Refer to drawings: 1000936-DRG-1320-CC-0001 and 1000936-DRG-0210-CC-0003**				
PSLB 8.2.2	**6.1.1**	**Supply only of bedding by importation:**				
	6.1.1.1	From other necessary excavations:				
	6.1.1.1.1	Selected granular material	m³	5		
	6.1.1.1.2	Selected fill material	m³	5		
	6.1.1.2	From commercial sources:				
	6.1.1.2.1	Selected granular material	m³	30		
	6.1.1.2.2	Selected fill material	m³	17		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 7 **SANS 1200 LC**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	7	**SANS 1200 LC**				
SANS 1200LC	**7.1**	**CABLE DUCTS**				
PSLC 8.2.5	**7.1.1**	**Supply, lay, bed and prove duct:**				
	7.1.1.1	uPVC pipes: Refer to drawing 1000936-DRG-1320-SS-0024 & 0026				
	7.1.1.1.1	75 mm dia	m	9		
SECTION 7	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 8 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	8	**SANS 1200 LE** **Refer to drawing: 1000936-DRG-1320-SS-0001**				
SANS 1200LE	**8.1**	**STORMWATER DRAINAGE**				
8.2.8	**8.1.1**	**Supply and install manholes and the like:**				
	8.1.1.1	Brickwork manholes:				
	8.1.1.1.1	As shown on drawings 1000938-DRG-1320-SS-0001 & 0004 standard depth 1.5 m	number	2		
	8.1.1.2	Grid inlets:				
	8.1.1.2.1	As shown on drawing 1000936-DRG-1320-SS-0001 standard depth 0.5m	number	1		
PSLE 8.2.14	**8.1.2**	**Pipes in subsurface drains:**				
	8.1.2.1	Normal duty uPVC pipes complete with couplings:				
	8.1.2.1.1	100 mm internal dia, perforated	m	78		
	8.1.2.1.2	100 mm internal dia, unperforated	m	41		
	8.1.2.1.3	150 mm internal dia, unperforated	m	2		
	8.1.2.2	Heavy-duty fittings:				
	8.1.2.2.1	Stop ends, 110 mm internal dia	number	5		
PSLE 8.2.15	**8.1.3**	**Geofabric (BIDIM A2)**	m^2	116		
SECTION 8	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	9	**SANS 2001CC1** **Refer to drawings: 1000936-DRG-1320-SS-0001 to 0005**				
SANS 2001 CC1	**9.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**9.1.1**	**Rough:**				
	9.1.1.1	Vertical formwork to:				
	9.1.1.1.1	External face of wall footing, circular in plan to 11.2 m radius	m²	39		
	9.1.1.1.2	Internal face of wall footing, circular in plan to 9.3 m radius	m²	12		
	9.1.1.1.3	Internal panels of floor slab	m²	23		
	9.1.1.1.4	Concrete pads in lieu of no fines below column bases	m²	5		
	9.1.1.1.5	Concrete V-Drains	m²	11		
SD8.2.2	**9.1.2**	**Smooth:**				
	9.1.2.1	Vertical formwork to:				
	9.1.2.1.1	Wall, circular on plan to 10,7 m radius	m²	303		
	9.1.2.1.2	Wall, circular on plan to 10,4 m radius	m²	295		
	9.1.2.1.3	Reservoir roof slab, circular on plan to 10.7 m radius	m²	17		
	9.1.2.1.4	Columns	m²	63		
	9.1.2.2	Horizontal formwork to:				
	9.1.2.2.1	Soffit of reservoir roof slab	m²	360		
SD8.2.5	**9.1.3**	**Narrow widths (up to 300 mm wide):**				
	9.1.3.1	Different widths in the following ranges:				
	9.1.3.1.1	Over 20 mm and up to 100 mm (Divider strips)	m	94		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	9.1.3.1.2	Over 200 mm and up to 300 mm (Roof slab ring beam circular in plan to 10.7 m radius and reservoir entrance ring beam)	m	75		
	9.1.3.1.3	Over 200 mm and up to 300 mm (Column bases)	m	63		
SANS 2001 CC1	**9.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**9.2.1**	**Steel bars in the following:**				
	9.2.1.1	Mild steel				
	9.2.1.1.1	All diameter bars	t	1.15		
	9.2.1.2	High-tensile steel				
	9.2.1.2.1	All diameter bars	t	51.28		
SD8.3.2	**9.2.2**	**High-tensile welded mesh in the following:**				
	9.2.2.1	Mesh ref 193 in concrete v-drain	m²	112		
SANS 2001 CC1	**9.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**9.3.1**	**Blinding layer in concrete:**				
	9.3.1.1	Class 15 MPa/19 mm concrete of:				
	9.3.1.1.1	50 mm thickness	m²	312		
	9.3.1.1.2	75 mm thickness	m²	90		
SD8.4.3	**9.3.2**	**Strength concrete:**				
	9.3.2.1	Class 15 MPa/19 mm concrete in:				
	9.3.2.1.1	Divider strips	m³	0.8		
	9.3.2.1.2	Concrete pads in lieu of no fines below column bases	m³	1.6		
	9.3.2.1.3	V- Drain	m³	8.9		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	9.3.2.1.4	Subsoil pipe encasement	m³	2.3		
	9.3.2.1.5	Inspection manhole floor slab	m³	0.3		
	9.3.2.2	Class 30 MPa/19 mm concrete in:				
	9.3.2.2.1	Floor slabs	m³	114		
	9.3.2.2.2	Walls complete with with cast in 75mm dia PVC sleeve	m³	90		
	9.3.2.2.3	Column bases	m³	6.1		
	9.3.2.2.4	Column	m³	4.7		
	9.3.2.2.5	Roof slab including ring beams with cast in ventilators, spool pipes, and PVC spout outlets as per drawing 1000936-DRG-1320-SS-0003	m³	95		
	9.3.2.2.6	Pipework concrete base	m³	19		
SD8.4.4.1	**9.3.3**	**Unformed surface finishes:**				
	9.3.3.1	Steel-floated finishes to:				
	9.3.3.1.1	Floor slab	m²	340		
	9.3.3.2	Power-floated finishes to:				
	9.3.3.2.1	Roof slab	m²	344		
SD8.4.7	**9.3.4**	**No fines concrete layer (Class NF19) with mortar skim in the following layer thicknesses:**				
	9.3.4.1	75 mm No fines concrete with the top 15 mm to be mortar	m²	208		
	9.3.4.2	450 mm No fines concrete with the top 15 mm to be mortar	m²	208		
SD8.4.9	**9.3.5**	**Bond breaker below floor**	m²	272		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.5	**9.3.6**	**Joints:**				
		Refer to drawing 1000936-DRG-1100-CC-0001				
	9.3.6.0.1	Horizontal construction joint type 1, on plan to 13.3 m radius in 300 mm thick wall, 150 mm Hypalon sealing strip by Sika or similar approved, complete as per detail 1 on drawing No 1000936-DRG-1100-CC-0001	m	68		
	9.3.6.0.2	Joint type 2, at wall and footing corner, on plan to 13,0 m radius, with Sonder SPX 120 or similar approved joint filler, 350 mm Hypalon sealing strip by Sika or similar approved, complete as per detail 1 on drawing No 1000936-DRG-1100-CC-0001	m	68		
	9.3.6.0.3	Vertical contraction joint type 3, on plan with 11,9 m radius in 200 mm thick floor slab with 10 mm ABE Durasheet 100 joint filler, 350 mm Hypalon sealing strip by Sika or similar approved, complete as per detail on drawing No 1000936-DRG-1100-CC-0001	m	59		
	9.3.6.0.4	Vertical contraction joint type 4, in 200 mm floor slab with two layers of bitumenous paint, 350 mm wide Hypalon sealing strip by Sika or similar approved, 200 mm ABE external C complete as per detail on drawing 1000936-DRG-1100-CC-0001	m	105		
	9.3.6.0.5	Vertical isolation joint formed of 10mm jointex or similar approved between 80 mm thick v-drain and reservoir floor or reservoir wall, sealed with ABE Durakol polysulphide sealant	m	21		
	9.3.6.0.6	10 mm Jointex or similar approved after every fifth 900 mm v-drain panel.	m	17		
SECTION 9	CARRIED FORWARD					

SECTION 9 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.7	**9.3.7**	**Grouting:**				
	9.3.7.1	Bearings:				
	9.3.7.1.1	Kilcher Limitgliss 3t/m 240 mm wide continuous bearing	m	71		
SD8.8	**9.3.8**	**HD bolts and miscellaneous metal work:**				
	9.3.8.1	250 mm long x 110 mm diameter sleeve aligned with wall 75 mm sleeve	number	1		
	9.3.8.2	250 mm long x 110 mm diameter sleeve reduced to 75 mm and cast into concrete slab	number	3		
	9.3.8.3	Vastrap plate with 2 heavy hinges welded to base and bolted to concrete, opening for cast in lock ring, and two handles welded to cover plate complete and installed asper drawing 1000936-DRG-1320-SS-0006	number	1		
	9.3.8.4	Service landing complete and installed as per drawing 1000936-DRG-1320-SS-0006	number	1		
SD8.10	**9.3.9**	**Testing for watertightness:**				
	9.3.9.1	1.3Ml concrete reservoir	sum	1		
SD8.11	**9.3.10**	**Fill reservoir with water**	kl	1,300		
SECTION 9	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 10 **PARTICULAR SPECIFICATION PART PA**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	10	**PARTICULAR SPECIFICATION PART PA**				
	10.1	**FENCING**				
		Refer to drawing 1000936-DRG-1320-CC-0001				
PA.01	**10.1.1**	**Supply and erection of new fencing material:**				
	10.1.1.1	Provide a 2200 mm (Minimum height) fence carbon hardened and galvanised steel mesh panels, support posts with security spikes on top. Security spikes to be 100 mm electro-galvanised, 2 mm thick, toughened steel. The fence should be clamber proof with see-through capabilities and have a top coat finish of baked enamel paint of synthetic coating in colours grey or black. Mesh strands to be 4 mm diameter minimum, cut resistant and with an aperture not exceeding 12 x 75 mm. The fence design must be complete and inclusive of concrete footings for fence posts.The product must be manufactured and installed in accordance with the manufacturers specifications and should carry at least	m	200		
PA.02	**10.1.2**	**New gates:**				
	10.1.2.1	5m wide gate with similar shared specifications as the fence, supplied by the same manufacturer as the fence, manufactured and installed in accordance with the manufacturers specifications and should carry at least a SABS or higher certificate.	number	1		
SECTION 10	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 11 **PARTICULAR SPECIFICATION PART PB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	11	**PARTICULAR SPECIFICATION PART PB** **Refer to drawing 1000936-DRG-1320-SS-0003 to 0005**				
	11.1	**MISCELLANEOUS WORK FOR RESERVOIRS**				
PB.01	**11.1.1**	**Lightning protection**	sum	1		
PB.02	**11.1.2**	**Sterilization**	sum	1		
PB.04	**11.1.3**	**Crushed stone on roof**	m^3	21		
PB.05	**11.1.4**	**Miscellaneous items:**				
	11.1.4.1	Measured by number:				
	11.1.4.1.1	Ventilator fabricated from 200 mm dia x 4 mm thickness Epoxy (Copon 2300) steel pipe and painted, cast into concrete as per drawing 1000936-DRG-1320-SS-0003	number	4		
	11.1.4.1.2	150 mm dia steel flanged sleeve pipes cast into roof slab as per drawing 1000936-DRG-1320-SS-0003	number	2		
	11.1.4.2	Measured by area:				
	11.1.4.2.1	Roof waterproofing: modified bituminous torch-applied waterproofing membrane, minimum 4mm thick, reinforced with dimensionally stable non-woven polyester	m^2	344		
SECTION 11	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 12 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	12	**RESERVOIR MECHANICAL**				
ZUT 7001	**12.1**	**MANUFACTURING OF STEEL SPECIALS**				
	12.1.1	**Reservoir pipework: Drawings 1000936-DRG-1320-SS-0023, 0024 & 0025: Supply and deliver to site steel specials; PN16 steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	12.1.1.1	Item No. 1.1: DN125 Bellmouth scour pipe (Stainless steel)	Number	1		
	12.1.1.2	Item No. 2.1: DN150 long radius bend overflow pipe (Stainless steel)	Number	1		
	12.1.1.3	Item No. 2.2: DN150 Bellmouth overflow pipe (Stainless steel)	Number	1		
	12.1.1.4	Item No. 3.1: DN160 Bellmouth outlet pipe (Stainless steel)	Number	1		
	12.1.1.5	Item No. 4.12: DN150 spool pipe (Grade C)	Number	1		
	12.1.1.6	Item No. 4.13a: DN150 90 degree bend (Grade C)	Number	1		
	12.1.1.7	Item No. 4.13b: DN150 90 degree bend (Grade C)	Number	1		
	12.1.1.8	Item No. 4.13c: DN150 90 degree bend (Grade C)	Number	2		
	12.1.1.9	Item No. 4.14: DN150 45 degree bend (Grade C)	Number	4		
	12.1.1.10	Item No. 4.15: DN150 spool pipe (Grade C)	Number	5		
	12.1.1.11	Item No. 4.16: DN150 spool pipe (Grade C)	Number	1		
	12.1.1.12	Item No. 4.17: DN150 spool pipe (Grade C)	Number	1		
	12.1.1.13	Item No. 4.18: DN150 spool pipe (Grade C)	Number	1		
SECTION 12	CARRIED FORWARD					

SECTION 12 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	12.1.1.14	Item No. 4.19: DN150 spool pipe (Grade C)	Number	1		
	12.1.1.15	Item No. 4.20: DN150 spool pipe (Grade C)	Number	1		
	12.1.1.16	Item No. 4.21: DN150 spool pipe (Grade C)	Number	1		
ZUT 7003	**12.2**	**INSTALLATION OF STEEL SPECIALS**				
	12.2.1	**Reservoir pipework: Drawings 1000936-DRG-1320-SS-0023, 0024 & 0025: Installation of steel specials, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	12.2.1.1	Item No. 1.1: DN250 Bellmouth scour pipe (Stainless steel)	Number	1		
	12.2.1.2	Item No. 2.1: DN150 long radius bend overflow pipe (Stainless steel)	Number	1		
	12.2.1.3	Item No. 2.2: DN150 Bellmouth overflow pipe (Stainless steel)	Number	1		
	12.2.1.4	Item No. 3.1: DN160 Bellmouth outlet pipe (Stainless steel)	Number	1		
	12.2.1.5	Item No. 4.12: DN150 spool pipe (Grade C)	Number	1		
	12.2.1.6	Item No. 4.13a: DN150 90 degree bend (Grade C)	Number	1		
	12.2.1.7	Item No. 4.13b: DN150 90 degree bend (Grade C)	Number	1		
	12.2.1.8	Item No. 4.13c: DN150 90 degree bend (Grade C)	Number	2		
	12.2.1.9	Item No. 4.14: DN150 45 degree bend (Grade C)	Number	4		
	12.2.1.10	Item No. 4.15: DN150 spool pipe (Grade C)	Number	5		
SECTION 12	CARRIED FORWARD					

SECTION 12 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	12.2.1.11	Item No. 4.16: DN150 spool pipe (Grade C)	Number	1		
	12.2.1.12	Item No. 4.17: DN150 spool pipe (Grade C)	Number	1		
	12.2.1.13	Item No. 4.18: DN150 spool pipe (Grade C)	Number	1		
	12.2.1.14	Item No. 4.19: DN150 spool pipe (Grade C)	Number	1		
	12.2.1.15	Item No. 4.20: DN150 spool pipe (Grade C)	Number	1		
	12.2.1.16	Item No. 4.21: DN150 spool pipe (Grade C)	Number	1		
SECTION 12	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 10: NEW MAMPURU RESERVOIR

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SECTION 1 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 D**				
SANS 1200D	**1.1**	**EARTHWORKS**				
		Refer to drawings: 1000936-DRG-1320-CC-0001 and 1000936-DRG-1320-SS-0021 & 0022				
PSD 8.3.2	**1.1.1**	**Bulk excavation:**				
	1.1.1.1	Excavate in all materials and dispose	m^3	67.3		
	1.1.1.2	Extra over items 1.1.1.1 above for:				
	1.1.1.2.1	Intermediate excavation	m^3	6.73		
	1.1.1.2.2	Hard rock excavation	m^3	53.84		
	1.1.1.2.3	Boulder excavation, class A	m^3	3.365		
	1.1.1.2.4	Boulder excavation, class B	m^3	3.365		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 H**				
SANS 1200H	**2.1**	**STRUCTURAL STEELWORK**				
8.3.8	**2.1.1**	**Ladders, complete and installed:**				
	2.1.1.1	Access ladder complete as per drawings 1000936-DRG-1320-SS-0021 & 0022	number	1		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 LE**				
SANS 1200LE	**3.1**	**STORMWATER DRAINAGE**				
8.2.1	**3.1.1**	**Supply and lay concrete pipe culverts on class B bedding:**				
	3.1.1.1	Type SC 50D-load pipes with ogee joints:				
	3.1.1.1.1	DN 300	m	40		
PSLE 8.2.17	**3.1.2**	**Class 20/19 concrete outlet structures for subsurface drains (including framework) refer to drawing 1000936-DRG-1320-RR-0042 for typical details**	m^3	5		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 2001CC1** **Refer to drawings: 1000936-DRG-1320-SS-0020 to 0025**				
SANS 2001 CC1	**4.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**4.1.1**	**Rough:**				
	4.1.1.1	Vertical formwork to:				
	4.1.1.1.1	Drainage sump	m²	10.8		
	4.1.1.1.2	Floor slab	m²	9.7		
	4.1.1.1.3	Walls	m²	74.4		
SD8.2.2	**4.1.2**	**Smooth:**				
	4.1.2.1	Vertical formwork to:				
	4.1.2.1.1	Roof slab	m²	3.7		
	4.1.2.2	Horizontal formwork to:				
	4.1.2.2.1	Soffit of chamber roof slab	m²	17.8		
SD8.2.5	**4.1.3**	**Narrow widths (up to 300 mm wide):**				
	4.1.3.1	Different widths in the following ranges:				
	4.1.3.1.1	Over 100 mm and up to 200 mm	m	12		
SD8.2.6	**4.1.4**	**Box out holes/form voids:**				
	4.1.4.1	Small circular, of diameter up to and including 0,35 m, and in the following depth ranges:				
	4.1.4.1.1	0 m up to and including 0,5 m	number	1		
SANS 2001 CC1	**4.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**4.2.1**	**Steel bars in the following:**				
	4.2.1.1	Mild steel				
	4.2.1.1.1	All diameter bars	t	1		
SECTION 4	CARRIED FORWARD					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	4.2.1.2	High-tensile steel				
	4.2.1.2.1	All diameter bars	t	2.77		
SANS 2001 CC1	**4.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**4.3.1**	**Blinding layer in concrete:**				
	4.3.1.1	Class 15 MPa/19 mm concrete of:				
	4.3.1.1.1	50 mm thickness	m²	27.2		
SD8.4.3	**4.3.2**	**Strength concrete:**				
	4.3.2.1	Class 30 MPa/19 mm concrete in:				
	4.3.2.1.1	Drainage sump	m³	1.5		
	4.3.2.1.2	Floor slab	m³	11		
	4.3.2.1.3	Walls	m³	7.5		
	4.3.2.1.4	Roof slab	m³	4.9		
SD8.4.4.1	**4.3.3**	**Unformed surface finishes:**				
	4.3.3.1	Power-floated finishes to:				
	4.3.3.1.1	Roof slab	m²	24.3		
SD8.4.10	**4.3.4**	**Casting pipes and specials in concrete**	number	5		
SD8.6	**4.3.5**	**Manufacture (or supply) and erect precast elements for small units not exceeding 0,5 m³ of formed concrete:**				
	4.3.5.1	The following types and sizes:				
	4.3.5.1.1	3230 mm x 520 mm x 150 mm Precast cover slabs complete as per drawings 1000936-DRG-1320-SS-0022 & 1000936-DRG-0210-CC-0032	m³	1.1		
SECTION 4	CARRIED FORWARD					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.8	**4.3.6**	**HD bolts and miscellaneous metal work:**				
	4.3.6.1	Manhole access hatch complete as per drawing 1000936-DRG-1320-SS-0022	number	1		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**CHAMBER MECHANICAL**				
ZUT 7001	**5.1**	**MANUFACTURING OF STEEL SPECIALS**				
	5.1.1	**Chamber pipework: Drawings 1000936-DRG-1320-SS-00024, 00025 & 00026: Supply and deliver to site steel specials; PN16 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.1.1.1	Item No. 1.3: DN125 spool pipe	number	1		
	5.1.1.2	Item No. 1.4: DN125 90 degree bend	number	1		
	5.1.1.3	Item No. 1.5: DN125 spool pipe	number	1		
	5.1.1.4	Item No. 3.3: DN150 spool pipe	number	1		
	5.1.1.5	Item No. 3.5: DN150 spool pipe	number	1		
	5.1.1.6	Item No. 3.8: DN150 equal tee	number	1		
	5.1.1.7	Item No. 3.9: DN150 spool pipe	number	1		
	5.1.1.8	Item No. 3.12: DN150 spool pipe	number	1		
	5.1.1.9	Item No. 3.13: DN150 Blank flange	number	1		
	5.1.1.10	Item No. 4.1: DN150 spool pipe	number	1		
	5.1.1.11	Item No. 4.2: DN150 equal tee	number	1		
	5.1.1.12	Item No. 4.3: DN50 spool pipe	number	1		
	5.1.1.13	Item No. 4.6a: DN50 orifice flange	number	1		
	5.1.1.14	Item No. 4.8: DN150 spool pipe	number	2		
	5.1.1.15	Item No. 4.10: DN150 spool pipe	number	1		
	5.1.1.16	Item No. 4.22: DN250 x DN150 reducing pipe	number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7003	**5.2**	**INSTALLATION OF STEEL SPECIALS**				
	5.2.1	**Chamber pipework: Drawings 1000936-DRG-1320-SS-00024, 00025 & 00026: Installation of steel specials, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.2.1.1	Item No. 1.3: DN125 spool pipe	number	1		
	5.2.1.2	Item No. 1.4: DN125 90 degree bend	number	1		
	5.2.1.3	Item No. 1.5: DN125 spool pipe	number	1		
	5.2.1.4	Item No. 3.3: DN150 spool pipe	number	1		
	5.2.1.5	Item No. 3.5: DN150 spool pipe	number	1		
	5.2.1.6	Item No. 3.8: DN150 equal tee	number	1		
	5.2.1.7	Item No. 3.9: DN150 spool pipe	number	1		
	5.2.1.8	Item No. 3.12: DN150 spool pipe	number	1		
	5.2.1.9	Item No. 3.13: DN150 Blank flange	number	1		
	5.2.1.10	Item No. 4.1: DN150 spool pipe	number	1		
	5.2.1.11	Item No. 4.2: DN150 equal tee	number	1		
	5.2.1.12	Item No. 4.3: DN50 spool pipe	number	1		
	5.2.1.13	Item No. 4.8: DN150 spool pipe	number	2		
	5.2.1.14	Item No. 4.10: DN150 spool pipe	number	1		
	5.2.1.15	Item No. 4.22: DN250 x DN150 reducing pipe	number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7004	**5.3**	**VALVES AND FITTINGS FOR WATER AND WASTEWATER INSTALLATION**				
	5.3.1	**Chamber pipework: Drawings 1000936-DRG-1320-SS-00024, 00025 & 00026: Supply and deliver valves and fittings to site, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.1.1	Item No. 1.2: DN125 butterfly valve	number	1		
	5.3.1.2	Item No. 3.2: DN160 butterfly valve	number	1		
	5.3.1.3	Item No. 3.4: DN150 mechanical flow meter	number	1		
	5.3.1.4	Item No. 3.6: DN150 dismantling joint	number	1		
	5.3.1.5	Item No. 3.7: DN150 butterfly valve	number	1		
	5.3.1.6	Item No. 3.10: DN50 ball valve	number	1		
	5.3.1.7	Item No. 3.11: DN50 dual acting air valve	number	1		
	5.3.1.8	Item No. 4.4: DN50 ball valve	number	1		
ZUT 7022	5.3.1.9	Item No. 4.5: DN50 dual acting air valve	number	1		
	5.3.1.10	Item No. 4.6: DN150 butterfly valve	number	2		
ZUT 7023	5.3.1.11	Item No. 4.7: DN150 dismantling joint	number	3		
	5.3.1.12	Item No. 4.9: DN150 Bermad 750 strainer	number	1		
	5.3.1.13	Item No. 4.11: DN150 Bermad 750 altitude control valve	number	1		
	5.3.1.14	Item No. 4.23: DN150 Bermad 750 pressure reducing valve	number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	5.3.2	**Chamber pipework: Drawings 1000936-DRG-1320-SS-00024, 00025 & 00026: Installation of valves and fittings, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.2.1	Item No. 1.2: DN250 butterfly valve	number	1		
	5.3.2.2	Item No. 3.2: DN160 butterfly valve	number	1		
	5.3.2.3	Item No. 3.4: DN150 mechanical flow meter	number	1		
	5.3.2.4	Item No. 3.6: DN150 dismantling joint	number	1		
	5.3.2.5	Item No. 3.7: DN150 butterfly valve	number	1		
	5.3.2.6	Item No. 3.10: DN50 ball valve	number	1		
	5.3.2.7	Item No. 3.11: DN50 dual acting air valve	number	1		
	5.3.2.8	Item No. 4.4: DN50 ball valve	number	1		
	5.3.2.9	Item No. 4.5: DN50 dual acting air valve	number	1		
	5.3.2.10	Item No. 4.6: DN150 butterfly valve	number	1		
	5.3.2.11	Item No. 4.7: DN150 dismantling joint	number	3		
	5.3.2.12	Item No. 4.9: DN150 Bermad 750 strainer	number	1		
	5.3.2.13	Item No. 4.11: DN150 Bermad 750 altitude control valve	number	1		
	5.3.2.14	Item No. 4.23: DN150 Bermad 750 pressure reducing valve	number	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 11: MAMPURU CHAMBERS

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SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m²	3,545		
8.2.2	**1.1.2**	**Remove and grub large trees and tree stumps of girth:**				
	1.1.2.1	Over 1,0 m and up to and including 2,0 m	number	8		
	1.1.2.2	Over 2,0 m and up to and including 3,0 m	number	4		
8.2.10	**1.1.3**	**Remove topsoil to nominal depth of 150 mm and stockpile**	m³	107		
PSC 8.2.11	**1.1.4**	**Take down and re-erect existing fences**	m	30		
PSC 8.2.12	**1.1.5**	**Remove topsoil to spoil site furnished by Contractor**	m³	426		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DK**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DK**				
SANS 1200DK	**2.1**	**GABIONS AND PITCHING**				
8.2.1	**2.1.1**	**Surface preparation for bedding of gabions:**				
	2.1.1.1	Cavities filled with approved excavated material or rock	m²	13		
	2.1.1.2	Cavities filled with grade 15 concrete	m²	50		
8.2.2	**2.1.2**	**Gabions:**				
	2.1.2.1	Gabion boxes of galvanized wire:				
	2.1.2.1.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 1.0 m boxes	m³	41		
	2.1.2.2	Gabion mattresses of galvanized wire, up to 0,3 m deep:				
	2.1.2.2.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 0.3 m mattress	m³	2.4		
8.2.4	**2.1.4**	**Geotextile:**				
	2.1.4.1	Bidim U24 or approved equivalent	m²	82		
8.2.5	**2.1.5**	**Pitching:**				
	2.1.5.1	Plain pitching:				
	2.1.5.1.1	Heavy pitching	m²	204		
	2.1.5.2	Grouted pitching:				
	2.1.5.2.1	Extra heavy pitching	m²	977		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 DM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 DM**				
SANS 1200DM	**3.1**	**EARTHWORKS (ROADS, SUBGRADE)**				
PSDM 8.3.3	**3.1.1**	**Treatment of roadbed:**				
	3.1.1.1	Roadbed preparation and compaction of material to:				
	3.1.1.1.1	Minimum of 93% of modified AASHTO maximum density (G9)	m³	398		
	3.1.1.2	In-place treatment of roadbed in intermediate or hard rock material by:				
	3.1.1.2.1	Ripping	m³	119.4		
	3.1.1.2.2	Blasting	m³	199		
	3.1.1.3	Three-pass roller compaction:				
	3.1.1.3.1	Vibratory roller	m³	79.6		
PSDM 8.3.4	**3.1.2**	**Borrow to fill:**				
	3.1.2.1	Compact to 90% of modified AASHTO maximum density	m³	245		
8.3.5	**3.1.3**	**Selected layer compacted to 93% of modified AASHTO maximum density**	m³	378		
PSDM 8.3.7	**3.1.4**	**Cut to spoil from:**				
	3.1.4.1	Soft excavation	m³	201		
	3.1.4.2	Intermediate excavation	m³	401		
	3.1.4.3	Hard excavation	m³	1,203		
	3.1.4.4	Boulder excavation, class A	m³	101		
	3.1.4.5	Boulder excavation, class B	m³	101		
8.3.8	**3.1.5**	**Removal of oversize material**	m³	50		
8.3.13	**3.1.7**	**Surface finishes:**				
	3.1.7.1	Topsoiling	m²	107		
8.3.15	**3.1.8**	**Catchwater mounds and channels and mitre banks and channels**	m³	77		
SECTION 3	CARRIED FORWARD					

SECTION 3 **SANS 1200 DM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
PSDM 8.3.17	**3.1.9**	**Extra over items 3.1.2 and 3.1.3 for obtaining material from commercial sources**	m^3	623		
PSDM 8.3.18	**3.1.10**	**Final finishing and cleaning up of the site of the Works**	sum	1		
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SECTION 4 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 LE**				
SANS 1200LE	**4.1**	**STORMWATER DRAINAGE**				
8.2.1	**4.1.1**	**Supply and lay concrete pipe culverts on class B bedding:**				
	4.1.1.1	Type interlocking 100D-load pipes:				
	4.1.1.1.1	DN 450	m	8		
8.2.7	**4.1.2**	**Supply and lay precast concrete inlets and outlets to culverts:**				
	4.1.2.1	As shown on 1000936-DRG-1320-RR-0042	number	2		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 MM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 MM**				
SANS 1200MM	**5.1**	**ANCILLARY ROADWORKS GUARDRAILS**				
8.2.1	**5.1.1**	**Guardrails on timber posts:**				
	5.1.1.1	Galvanized	m	32		
8.2.2	**5.1.2**	**Extra over items 5.1.1 for horizontally curved guardrails factory-bent to a radius of less than 150 m**	m	32		
8.2.3	**5.1.3**	**End units**				
	5.1.3.1	End wings	number	3		
	5.1.3.2	Terminal sections as per drawing 1000936-DRG-1320-RR-0047 , using single guardrail sections	number	3		
8.2.4	**5.1.4**	**Additional guardrail posts:**				
	5.1.4.1	Timber	number	9		
SANS 1200MM	**5.2**	**ANCILLARY ROADWORKS PERMANENT ROAD SIGNS**				
8.3.1	**5.2.1**	**Sign faces with painted/galvanized background, with painted symbols, characters, legend and borders and with signboards constructed from:**				
	5.2.1.1	Aluminium sheet (2,0 mm thick), of area:				
	5.2.1.1.1	Up to 2 m²	m²	2		
8.3.3	**5.2.2**	**Sign supports:**				
	5.2.2.1	Timber, 200 mm dia treated poles, complying with Clause 3.2.10	m	6		
8.3.4	**5.2.3**	**Excavation and backfilling and concreting for sign supports:**				
	5.2.3.1	Backfill with excavated material	m³	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 2001CC1**				
SANS 2001 CC1	**6.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
8.2.1	**6.1.1**	**Rough:**				
	6.1.1.1	Vertical formwork to:				
	6.1.1.1.1	Sides of all slabs/benching/plinths	m²	469		
SANS 2001 CC1	**6.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
8.3.2	**6.2.1**	**High-tensile welded mesh in the following:**				
	6.2.1.1	All reinforcing mesh ref 311	m²	1,460		
SANS 2001 CC1	**6.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
PSG 8.4.3	**6.3.1**	**Strength concrete:**				
	6.3.1.1	Class 30 MPa/19 mm concrete in:				
	6.3.1.1.1	All applicable structures as per drawings & project specification	m³	287		
PSG 8.4.4	**6.3.2**	**Unformed surface finishes:**				
	6.3.2.1	Wood-floated finishes to:				
	6.3.2.1.1	All floor slab	m²	1,460		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 12: ACCESS ROAD TO MAMPURU RESERVOIR

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DK	R . . . . .
SECTION 3	SANS 1200 DM	R . . . . .
SECTION 4	SANS 1200 LE	R . . . . .
SECTION 5	SANS 1200 MM	R . . . . .
SECTION 6	SANS 2001CC1	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C** **Refer to drawing 1000936-DRG-1430-CC-0001**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m^2	926		
8.2.3	**1.1.2**	**Remove and grub all trees and tree stumps regardless of girth**	ha	0.1		
PSC 8.2.12	**1.1.3**	**Remove topsoil to spoil site furnished by Contractor**	m^3	106		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 D** **Refer to drawings: 1000936-DRG-1430-CC-0001 to 0002 & 1000936-DRG-1430-SS-0003**				
SANS 1200D	**2.1**	**EARTHWORKS**				
PSD 8.3.2	**2.1.1**	**Bulk excavation:**				
	2.1.1.1	Excavate in all materials and use for embankment or backfill as ordered from:				
	2.1.1.1.1	Commercial sources	m³	580		
	2.1.1.2	Excavate in all materials and dispose	m³	76		
	2.1.1.3	Extra over items 2.1.1.1 and 2.1.1.2 above for:				
	2.1.1.3.1	Intermediate excavation	m³	11		
	2.1.1.3.2	Hard rock excavation	m³	32		
	2.1.1.3.3	Boulder excavation, class A	m³	6		
	2.1.1.3.4	Boulder excavation, class B	m³	6		
	2.1.1.3.5	Overbreak not exceeding 200 mm, only on instruction from the engineer	m³	10		
8.3.9	**2.1.2**	**Extra over items 2.1.1 for backfill or for fill material against structures**	m³	10		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 DB**				
SANS 1200DB	**3.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
		Refer to drawing: 1000936-DRG-1430-CC-0001 & 1000936-DRG-1430-SS-0005				
PSDB 8.3.2	**3.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	3.1.1.1	Pipes up to 125 mm dia for depths:				
	3.1.1.1.1	Up to 1,0 m	m	13		
PSDB 8.3.2	**3.1.2**	**Extra over item 3.1.1 above for:**				
	3.1.2.1	Hard rock excavation	m^3	7		
PSDB 8.3.3	**3.1.3**	**Excavation ancillaries:**				
	3.1.3.1	Make up deficiency in backfill material:				
	3.1.3.1.1	From other necessary excavations on Site	m^3	4		
	3.1.3.1.2	By importation from commercial or off-site sources selected by the Contractor	m^3	3		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 DK**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 DK** **Refer to drawings 1000936-DRG-1430-CC-0001 to 0002**				
SANS 1200DK	**4.1**	**GABIONS AND PITCHING**				
8.2.1	**4.1.1**	**Surface preparation for bedding of gabions:**				
	4.1.1.1	Cavities filled with approved excavated material or rock	m²	28		
	4.1.1.2	Cavities filled with grade 15 concrete	m²	4		
8.2.2	**4.1.2**	**Gabions:**				
	4.1.2.1	Gabion boxes of PVC-coated galvanized wire:				
	4.1.2.1.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 1.0 m x 1.0 m x 1.0 m boxes	m³	102		
	4.1.2.2	Gabion mattresses of galvanized wire, up to 0,3 m deep:				
	4.1.2.2.1	80 mm x 80 mm mesh, 2.7 mm dia wire, 2.0 m x 1.0 m x 0.3 m mattress	m³	2.4		
8.2.4	**4.1.3**	**Geotextile:**				
	4.1.3.1	Bidim U24 or approved equivalent	m²	136		
8.2.5	**4.1.4**	**Pitching:**				
	4.1.4.1	Grouted pitching:				
	4.1.4.1.1	Heavy pitching	m²	2		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**SANS 1200 H**				
SANS 1200H	**5.1**	**STRUCTURAL STEELWORK**				
8.3.7	**5.1.1**	**Handrails:**				
	5.1.1.1	Handrail assembly complete:				
	5.1.1.1.1	As shown on drawing 1000936-DRG-1430-SS-0002	sum	1		
8.3.8	**5.1.2**	**Ladders, complete and installed:**				
	5.1.2.1	Access ladder as per drawing 1000936-DRG-1430-SS-0002	number	1		
PSH 8.3.14	**5.1.3**	**Manufacture, supply, erection and testing including filling with water of a 250 kilolitre storage tank as per drawing 1000936-DRG-1430-SS-0001**	sum	1		
PSH 8.3.15	**5.1.4**	**Lightning protection for a 250 kilolitre storage tank**	sum	1		
PSH 8.3.15	**5.1.5**	**Sterilization of a 250 kilolitre storage tank**	sum	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 6 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	6	**SANS 1200 LE**				
SANS 1200LE	**6.1**	**STORMWATER DRAINAGE**				
PSLE 8.2.14	**6.1.1**	**Pipes in subsurface drains:**				
	6.1.1.1	Normal duty uPVC pipes complete with couplings:				
	6.1.1.1.1	100 mm internal dia, unperforated	m	35		
SECTION 6	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	7	**SANS 2001CC1**				
SANS 2001 CC1	**7.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
		Refer to drawings: 1000936-DRG-1430-SS-0003 & 0004				
SD8.2.2	**7.1.1**	**Smooth:**				
	7.1.1.1	Vertical formwork to:				
	7.1.1.1.1	Foundation slab	m²	14		
	7.1.1.1.2	Concrete dwarf walls	m²	75		
SD8.2.6	**7.1.2**	**Box out holes/form voids:**				
	7.1.2.1	Small circular, of diameter up to and including 0,35 m, and in the following depth ranges:				
	7.1.2.1.1	0 m up to and including 0,5 m	number	1		
SANS 2001 CC1	**7.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**7.2.1**	**Steel bars in the following:**				
	7.2.1.1	Mild steel				
	7.2.1.1.1	All diameter bars	t	0.06		
	7.2.1.2	High-tensile steel				
	7.2.1.2.1	All diameter bars	t	7.45		
SANS 2001 CC1	**7.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**7.3.1**	**Blinding layer in concrete:**				
	7.3.1.1	Class 15 MPa/19 mm concrete of:				
	7.3.1.1.1	75 mm thickness	m²	60		
SD8.4.3	**7.3.2**	**Strength concrete:**				
	7.3.2.1	Class 30 MPa/19 mm concrete in:				
	7.3.2.1.1	Foundation slab	m³	30		
SECTION 6	CARRIED FORWARD					

SECTION 7 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	7.3.2.1.2	Concrete dwarf walls	m³	8		
SD8.7	**7.3.3**	**Grouting:**				
	7.3.3.1	HD bolts:				
	7.3.3.1.1	Non Shrink grout under steel capping strip	m³	0.6		
SD8.8	**7.3.4**	**HD bolts and miscellaneous metal work:**				
	7.3.4.1	HD bolts:				
	7.3.4.1.1	375 mm long M12 HD Bolt Gr 8.8 @350 mm C/C complete installed with with 75 x 75 x 6 mm washer and adjustable nut as per drawing 1000936-DRG-1310-SS-0003	Number	152		
	7.3.4.1.2	80 x 8 FLT (Steel capping strip)	t	0.3		
SECTION 7	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 8 **PARTICULAR SPECIFICATION PART PA**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	8	**PARTICULAR SPECIFICATION PART PA**				
	8.1	**FENCING**				
		Refer to drawing 1000936-DRG-1430-CC-0001				
PA.01	**8.1.1**	**Supply and erection of new fencing material:**				
	8.1.1.1	Provide a 2200 mm (Minimum height) fence carbon hardened and galvanised steel mesh panels, support posts with security spikes on top. Security spikes to be 100 mm electro-galvanised, 2 mm thick, toughened steel. The fence should be clamber proof with see-through capabilities and have a top coat finish of baked enamel paint of synthetic coating in colours grey or black. Mesh strands to be 4 mm diameter minimum, cut resistant and with an aperture not exceeding 12 x 75 mm. The fence design must be complete and inclusive of concrete footings for fence posts.The product must be manufactured and installed in accordance with the manufacturers specifications and should carry at least a SABS or better certificate.	m	95		
PA.02	**8.1.2**	**New gates:**				
	8.1.2.1	5m wide gate with similar shared specifications as the fence, supplied by the same manufacturer as the fence, manufactured and installed in accordance with the manufacturers specifications and should carry at least a SABS or better certificate.	number	1		
SECTION 8	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 9 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	9	**RESERVOIR MECHANICAL**				
ZUT 7001	**9.1**	**MANUFACTURING OF STEEL SPECIALS**				
	9.1.1	**Reservoir pipework: Drawings 1000936-DRG-1430-SS-0005 & 0006: Supply and deliver to site steel specials; PN16 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers and gaskets according to ZUT 7001**				
	9.1.1.1	Item No. 1.16: DN80 90 degree bend	Number	2		
	9.1.1.2	Item No. 1.17: DN80 spool pipe	Number	1		
	9.1.1.3	Item No. 1.18: DN80 90 degree bend	Number	1		
	9.1.1.4	Item No. 1.19: DN80 spool pipe	Number	1		
	9.1.1.5	Item No. 2.1: DN100 Welded goose neck	Number	1		
	9.1.1.6	Item No. 2.2: DN100 spool pipe	Number	1		
	9.1.1.7	Item No. 3.1: DN80 90 degree bend	Number	1		
	9.1.1.8	Item No. 3.2: DN80 spool pipe	Number	1		
	9.1.1.9	Item No. 3.3: DN80 90 degree bend	Number	1		
	9.1.1.10	Item No. 3.4: DN80 spool pipe	Number	1		
	9.1.1.11	Item No. 4.1: DN65 90 degree bend	Number	1		
	9.1.1.12	Item No. 4.2: DN65 spool pipe	Number	1		
ZUT 7003	**9.2**	**INSTALLATION OF STEEL SPECIALS**				
	9.2.1	**Reservoir pipework: Drawings 1000936-DRG-1430-SS-0005 & 0006: Installation of steel specials complete with bolts, nuts, washers and gaskets according to ZUT 7001**				
	9.2.1.1	Item No. 1.16: DN80 90 degree bend	Number	2		
	9.2.1.2	Item No. 1.17: DN80 spool pipe	Number	1		
	9.2.1.3	Item No. 1.18: DN80 90 degree bend	Number	1		
SECTION 9	CARRIED FORWARD					

SECTION 9 **RESERVOIR MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	9.2.1.4	Item No. 1.19: DN80 spool pipe	Number	1		
	9.2.1.5	Item No. 2.1: DN100 90 degree bend	Number	1		
	9.2.1.6	Item No. 2.2: DN100 spool pipe	Number	1		
	9.2.1.7	Item No. 3.1: DN80 90 degree bend	Number	1		
	9.2.1.8	Item No. 3.2: DN80 spool pipe	Number	1		
	9.2.1.9	Item No. 3.3: DN80 90 degree bend	Number	1		
	9.2.1.10	Item No. 3.4: DN80 spool pipe	Number	1		
	9.2.1.11	Item No. 4.1: DN65 90 degree bend	Number	1		
	9.2.1.12	Item No. 4.2: DN65 spool pipe	Number	1		
SECTION 9	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 13: NEW MAMPURU EXT TANK

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 D	R . . . . .
SECTION 3	SANS 1200 DB	R . . . . .
SECTION 4	SANS 1200 DK	R . . . . .
SECTION 5	SANS 1200 H	R . . . . .
SECTION 6	SANS 1200 LE	R . . . . .
SECTION 7	SANS 2001CC1	R . . . . .
SECTION 8	PARTICULAR SPECIFICATION PART PA	R . . . . .
SECTION 9	RESERVOIR MECHANICAL	R . . . . .
TOTAL OF SCHEDULE OF QUANTITIES		R . . . . .

SECTION 1 **SANS 1200 D**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 D**				
SANS 1200D	**1.1**	**EARTHWORKS** **Refer to drawings: 1000936-1430-CC-0001 & 1000936-DRG-1430-SS-0002 & 0004**				
PSD 8.3.2	**1.1.1**	**Bulk excavation:**				
	1.1.1.1	Excavate in all materials and dispose	m^3	5.2		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 H**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 H**				
SANS 1200H	**2.1**	**STRUCTURAL STEELWORK**				
8.3.8	**2.1.1**	**Ladders, complete and installed:**				
	2.1.1.1	Internal access ladder complete as per drawings 1000936-DRG-1430-SS-0002 & 0004	number	2		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 LE**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 LE**				
SANS 1200LE	**3.1**	**STORMWATER DRAINAGE**				
PSLE 8.2.14	**3.1.1**	**Pipes in subsurface drains:**				
	3.1.1.1	Normal duty uPVC pipes complete with couplings:				
	3.1.1.1.1	100 mm internal dia, unperforated	m	20		
PSLE 8.2.17	**3.1.2**	**Class 20/19 concrete outlet structures for subsurface drains (including framework)**	m^3	5		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 2001CC1** **Refer to drawings: 1000936-DRG-1430-SS-0002 & 0004**				
SANS 2001 CC1	**4.1**	**CONCRETE (STRUCTURAL) SCHEDULED FORMWORK ITEMS**				
SD8.2.1	**4.1.1**	**Rough:**				
	4.1.1.1	Vertical formwork to:				
	4.1.1.1.1	Drainage sump	m²	6.4		
	4.1.1.1.2	Floor slab	m²	6.5		
SD8.2.2	**4.1.2**	**Smooth:**				
	4.1.2.1	Vertical formwork to:				
	4.1.2.1.1	Walls	m²	71.4		
	4.1.2.1.2	Roof slab	m²	3.6		
	4.1.2.1.3	Soffit of chamber roof slab	m²	12.8		
SANS 2001 CC1	**4.2**	**CONCRETE (STRUCTURAL) SCHEDULED REINFORCEMENT ITEMS**				
SD8.3.1	**4.2.1**	**Steel bars in the following:**				
	4.2.1.1	Mild steel				
	4.2.1.1.1	All diameter bars	t	0.5		
	4.2.1.2	High-tensile steel				
	4.2.1.2.1	All diameter bars	t	1.48		
SANS 2001 CC1	**4.3**	**CONCRETE (STRUCTURAL) SCHEDULED CONCRETE ITEMS**				
SD8.4.2	**4.3.1**	**Blinding layer in concrete:**				
	4.3.1.1	Class 15 MPa/19 mm concrete of:				
	4.3.1.1.1	50 mm thickness	m²	12.8		
SECTION 4	CARRIED FORWARD					

SECTION 4 **SANS 2001CC1**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
SD8.4.3	**4.3.2**	**Strength concrete:**				
	4.3.2.1	Class 30 MPa/19 mm concrete in:				
	4.3.2.1.1	Drainage sump	m³	1.3		
	4.3.2.1.2	Floor slab	m³	2.5		
	4.3.2.1.3	Walls	m³	7.3		
	4.3.2.1.4	Roof slab	m³	2.2		
SD8.4.4.1	**4.3.3**	**Unformed surface finishes:**				
	4.3.3.1	Steel-floated finishes to:				
	4.3.3.1.1	Roof slab	m²	12.8		
SD8.4.10	**4.3.4**	**Casting pipes and specials in concrete**	number	6		
SD8.8	**4.3.5**	**HD bolts and miscellaneous metal work:**				
	4.3.5.1	Manhole access hatch complete as per drawing 1000936-DRG-1430-SS-0002 & 0004	number	2		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	5	**CHAMBER MECHANICAL**				
	5	**MEDIUM-PRESSURE PIPELINES**				
ZUT 7001	**5.1**	**MANUFACTURING OF STEEL SPECIALS**				
	5.1.1	**Chamber pipework: Drawings 1000936-DRG-1430-SS-0005 & 0006: Supply and deliver to site steel specials; PN16 Grade C steel with corrosion protection for pipes in accordance with ZUT 0003, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.1.1.1	Item No. 1.1: DN50 spool pipe	Number	1		
	5.1.1.2	Item No. 1.2: DN50 equal tee	Number	1		
	5.1.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
	5.1.1.4	Item No. 1.6: DN80 x DN50 reducing pipe	Number	1		
	5.1.1.5	Item No. 1.9: DN80 spool pipe	Number	1		
	5.1.1.6	Item No. 1.11: DN80 spool pipe	Number	1		
	5.1.1.7	Item No. 1.13: DN80 spool pipe	Number	1		
	5.1.1.8	Item No. 1.14: orifice flange	Number	1		
	5.1.1.9	Item No. 1.15: DN80 spool pipe	Number	1		
	5.1.1.10	Item No. 2.4: DN100 spool pipe	Number	1		
	5.1.1.11	Item No. 2.6: DN100 spool pipe	Number	1		
	5.1.1.12	Item No. 2.8: DN100 equal tee	Number	1		
	5.1.1.13	Item No. 2.9: DN100 x DN25 orifice flange	Number	1		
	5.1.1.14	Item No. 2.12: DN100 spool pipe	Number	1		
	5.1.1.15	Item No. 4.4: DN65 90 degree bend	Number	1		
	5.1.1.16	Item No. 1.21: DN90 x DN50 reducing pipe	Number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7003	**5.2**	**INSTALLATION OF STEEL SPECIALS**				
	5.2.1	**Chamber pipework: Drawings 1000936-DRG-1430-SS-0005 & 0006: Installation of steel specials, complete with bolts, nuts, washers and gaskets**				
	5.2.1.1	Item No. 1.1: DN50 spool pipe	Number	1		
	5.2.1.2	Item No. 1.2: DN50 equal tee	Number	1		
	5.2.1.3	Item No. 1.3: DN50 x DN25 orifice flange	Number	1		
	5.2.1.4	Item No. 1.6: DN80 x DN50 reducing pipe	Number	1		
	5.2.1.5	Item No. 1.9: DN80 spool pipe	Number	1		
	5.2.1.6	Item No. 1.11: DN80 spool pipe	Number	1		
	5.2.1.7	Item No. 1.13: DN80 spool pipe	Number	1		
	5.2.1.8	Item No. 1.14: orifice flange	Number	1		
	5.2.1.9	Item No. 1.15: DN80 spool pipe	Number	1		
	5.2.1.10	Item No. 2.4: DN100 spool pipe	Number	1		
	5.2.1.11	Item No. 2.6: DN100 spool pipe	Number	1		
	5.2.1.12	Item No. 2.8: DN100 equal tee	Number	1		
	5.2.1.13	Item No. 2.9: DN100 x DN25 orifice flange	Number	1		
	5.2.1.14	Item No. 2.12: DN100 spool pipe	Number	1		
	5.2.1.15	Item No. 4.4: DN65 90 degree bend	Number	1		
	5.2.1.16	Item No. 1.21: DN90 x DN50 reducing pipe	Number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
ZUT 7004	**5.3**	**VALVES AND FITTINGS FOR WATER AND WASTERWATER INSTALLATION**				
	5.3.1	**Chamber pipework: Drawings 1000936-DRG-1430-SS-0005 & 0006: Supply and deliver valves and fittings to site, including bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.1.1	Item No. 1.4: DN25 ball valve	Number	1		
	5.3.1.2	Item No. 1.7: DN80 butterfly valve	Number	2		
ZUT 7023	5.3.1.3	Item No. 1.8: DN80 dismantling joint	Number	1		
	5.3.1.4	Item No. 1.10: DN80 Bermad 750 strainer	Number	1		
	5.3.1.5	Item No. 1.12: DN80 Bermad 750 altitude control valve	Number	1		
	5.3.1.6	Item No. 1.22: DN80 Bermad 750 pressure reducing valve	Number	1		
	5.3.1.7	Item No. 2.3: DN100 butterfly valve	Number	2		
	5.3.1.8	Item No. 2.5: DN100 mechanical flow meter	Number	1		
	5.3.1.9	Item No. 2.7: DN100 dismantling joint	Number	1		
	5.3.1.10	Item No. 2.10: DN25 ball valve	Number	1		
	5.3.1.11	Item No. 2.11: DN25 dual acting air valve	Number	1		
	5.3.1.12	Item No. 4.3: DN65 butterfly valve	Number	1		
	5.3.2	**Chamber pipework: Drawings 1000936-DRG-1430-SS-0005 & 0006: Installation of valves and fittings, complete with bolts, nuts, washers and gaskets in accordance with ZUT 7001**				
	5.3.2.1	Item No. 1.4: DN25 ball valve	Number	1		
SECTION 5	CARRIED FORWARD					

SECTION 5 **CHAMBER MECHANICAL**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
	5.3.2.2	Item No. 1.7: DN80 butterfly valve	Number	2		
	5.3.2.3	Item No. 1.8: DN80 dismantling joint	Number	1		
	5.3.2.4	Item No. 1.10: DN80 Bermad 750 strainer	Number	1		
	5.3.2.5	Item No. 1.12: DN80 Bermad 750 altitude control valve	Number	1		
	5.3.2.6	Item No. 1.22: DN80 Bermad 750 pressure reducing valve	Number	1		
	5.3.2.7	Item No. 2.3: DN100 butterfly valve	Number	2		
	5.3.2.8	Item No. 2.5: DN100 mechanical flow meter	Number	1		
	5.3.2.9	Item No. 2.7: DN100 dismantling joint	Number	1		
	5.3.2.10	Item No. 2.10: DN25 ball valve	Number	1		
	5.3.2.11	Item No. 2.11: DN25 dual acting air valve	Number	1		
	5.3.2.12	Item No. 4.3: DN65 butterfly valve	Number	1		
SECTION 5	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 14: MAMPURU EXT CHAMBERS

SECTION 1	SANS 1200 D	R . . . . .
SECTION 2	SANS 1200 H	R . . . . .
SECTION 3	SANS 1200 LE	R . . . . .
SECTION 4	SANS 2001CC1	R . . . . .
SECTION 5	CHAMBER MECHANICAL	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Areas	m²	1,520		
8.2.2	**1.1.2**	**Remove and grub large trees and tree stumps of girth:**				
	1.1.2.1	Over 1,0 m and up to and including 2,0 m	number	2		
	1.1.2.2	Over 2,0 m and up to and including 3,0 m	number	1		
8.2.10	**1.1.3**	**Remove topsoil to nominal depth of 150 mm and stockpile**	m³	46		
PSC 8.2.11	**1.1.4**	**Take down and re-erect existing fences**	m	20		
PSC 8.2.12	**1.1.5**	**Remove topsoil to spoil site furnished by Contractor**	m³	228		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DM**				
SANS 1200DM	**2.1**	**EARTHWORKS (ROADS, SUBGRADE)**				
PSDM 8.3.3	**2.1.1**	**Treatment of roadbed:**				
	2.1.1.1	Roadbed preparation and compaction of material to:				
	2.1.1.1.1	Minimum of 93% of modified AASHTO maximum density (G9)	m³	137		
	2.1.1.2	In-place treatment of roadbed in intermediate or hard rock material by:				
	2.1.1.2.1	Ripping	m³	41.1		
	2.1.1.2.2	Blasting	m³	68.5		
	2.1.1.3	Three-pass roller compaction:				
	2.1.1.3.1	Vibratory roller	m³	27.4		
PSDM 8.3.4	**2.1.2**	**Cut to fill:**				
	2.1.2.1	Compact to 90% of modified AASHTO maximum density	m³	500		
PSDM 8.3.4	**2.1.3**	**Borrow to fill:**				
	2.1.3.1	Compact to 90% of modified AASHTO maximum density	m³	135		
8.3.8	**2.1.4**	**Removal of oversize material**	m³	50		
PSDM 8.3.17	**2.1.5**	**Extra over items 2.1.3 for obtaining material from commercial sources**	m³	135		
PSDM 8.3.18	**2.1.6**	**Final finishing and cleaning up of the site of the Works**	sum	1		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 MM**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 MM**				
SANS 1200MM	**3.1**	**ANCILLARY ROADWORKS PERMANENT ROAD SIGNS**				
8.3.1	**3.1.1**	**Sign faces with painted/galvanized background, with painted symbols, characters, legend and borders and with signboards constructed from:**				
	3.1.1.1	Aluminium sheet (2,0 mm thick), of area:				
	3.1.1.1.1	Up to 2 m²	m²	2		
8.3.3	**3.1.2**	**Sign supports:**				
	3.1.2.1	Timber, 200 mm dia treated poles, complying with Clause 3.2.10	m	6		
8.3.4	**3.1.3**	**Excavation and backfilling and concreting for sign supports:**				
	3.1.3.1	Backfill with excavated material	m³	1		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 15: ACCESS ROAD TO MAMPURU EXTENSION

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DM	R . . . . .
SECTION 3	SANS 1200 MM	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 L**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 L**				
SANS 1200L	**1.1**	**MEDIUM-PRESSURE PIPELINES**				
		DN250 gravity pipe and DN315 rising main to be laid in common trench from CH0 to CH350 as per 1000936-DRG-3110-CC-0001.				
8.2.1	**1.1.1**	**Supply, lay and bed pipes on class B bedding, complete with couplings:**				
	1.1.1.1	PE100 HDPE PN20 (butt welded) pipes:				
	1.1.1.1.1	DN 315	m	350		
8.2.2	**1.1.2**	**Extra over items 1.1.1 for the supplying, laying, and bedding of PE 100 HDPE PN 25 specials complete with couplings:**				
	1.1.2.1	45° Segmented bends:				
	1.1.2.1.1	DN 315	number	5		
	1.1.2.2	90° bends:				
	1.1.2.2.1	DN 315	number	5		
	1.1.2.3	End caps:				
	1.1.2.3.1	DN 315	number	1		
8.2.2	**1.1.3**	**HDPE to steel connection complete as per detail on drawing 1000936-DRG-0240-MM-0007 including HDPE stub, backing flange and steel flange to match for the following HDPE pipe diameters :**				
	1.1.3.1	315 mm dia	number	2		
PSL 8.2.17	**1.1.4**	**Marker blocks:**				
	1.1.4.1	Pipe marker complete as per drawing 1000936-DRG-0210-CC-0004	number	10		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 16: RISING MAIN TO KALKFONTEIN

SECTION 1	SANS 1200 L	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE** **DN250 gravity pipe and DN315 rising main to be laid in common trench from CH0 to CH350 as per 1000936-DRG-3110-CC-0001.**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Strips,3m wide	m	350		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DB**				
SANS 1200DB	**2.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
		DN250 gravity pipe and DN315 rising main to be laid in common trench from CH0 to CH350 as per 1000936-DRG-3110-CC-0001.				
PSDB 8.3.2	**2.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	2.1.1.1	Pipes over 125 mm dia up to 400 mm dia for depths in single trench:				
	2.1.1.1.1	Over 1,0 m up to 2,0 m	m	350		
PSDB 8.3.2	**2.1.2**	**Extra over item 2.1.1 above for:**				
	2.1.2.1	Hard rock excavation	m^3	5		
	2.1.2.2	Soilcrete backfill where directed by the Engineer	m^3	425		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 L**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 L**				
SANS 1200L	**3.1**	**MEDIUM-PRESSURE PIPELINES**				
		DN250 gravity pipe and DN315 rising main to be laid in common trench from CH0 to CH350 as per 1000936-DRG-3110-CC-0001.				
8.2.1	**3.1.1**	**Supply, lay and bed pipes on class B bedding, complete with couplings:**				
	3.1.1.1	PE 100 HDPE PN16 pipes:				
	3.1.1.1.1	DN 250	m	350		
8.2.2	**3.1.2**	**Extra over items 3.1.1 for the supplying, laying, and bedding of HDPE PE 100 PN 20 specials complete with couplings:**				
	3.1.2.1	45° Segmented bends:				
	3.1.2.1.1	DN 250	number	5		
	3.1.2.2	90° Segented bends:				
	3.1.2.2.1	DN 250	number	5		
	3.1.2.3	End caps:				
	3.1.2.3.1	DN 250	number	1		
8.2.2	**3.1.3**	**HDPE to steel connection complete as per detail on drawing 1000936-DRG-0240-MM-0007 including HDPE stub, backing flange and steel flange to match for the following HDPE pipe diameters :**				
	3.1.3.1	250 mm dia	number	4		
PSL 8.2.17	**3.1.4**	**Marker blocks:**				
	3.1.4.1	Pipe marker complete as per drawing 1000936-DRG-0210-CC-0004	number	10		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 LB**				
SANS 1200LB	**4.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES** **DN250 gravity pipe and DN315 rising main to be laid in common trench from CH0 to CH350 as per 1000936-DRG-3110-CC-0001.**				
PSLB 8.2.2	**4.1.1**	**Supply only of bedding by importation:**				
	4.1.1.1	From commercial sources:				
	4.1.1.1.1	Selected granular material	m^3	20		
	4.1.1.1.2	Selected fill material	m^3	10		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 17: GRAVITY MAIN TO KALKFONTEIN

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DB	R . . . . .
SECTION 3	SANS 1200 L	R . . . . .
SECTION 4	SANS 1200 LB	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE** **Refer to Drawing: 1000936-DRG-3150-0001**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Strips,3m wide	m	343		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DB**				
SANS 1200DB	**2.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES** **Refer to Drawing: 1000936-DRG-3150-0002 & 1000936-DRG-0210-0002/3**				
PSDB 8.3.2	**2.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	2.1.1.1	Pipes up to 125 mm dia for depths:				
	2.1.1.1.1	Over 1,0 m up to 2,0 m	m	343		
PSDB 8.3.2	**2.1.2**	**Extra over item 2.1.1 above for:**				
	2.1.2.1	Hard rock excavation	m^3	50		
	2.1.2.2	Soilcrete backfill where directed by the Engineer	m^3	165		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 L**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 L**				
SANS 1200L	**3.1**	**MEDIUM-PRESSURE PIPELINES**				
PSL 8.2.1	**3.1.1**	**Supply, lay and bed pipes on class B bedding, complete with couplings:**				
	3.1.1.1	PE100 HDPE PN10 pipes:				
	3.1.1.1.1	DN 110	m	334		
	3.1.1.2	PE100 HDPE PN16 pipes:				
	3.1.1.2.1	DN 90	m	334		
8.2.2	**3.1.2**	**Extra over items 3.1.1 for the supplying, laying, and bedding of PE100 HDPE specials complete with couplings:**				
	3.1.2.1	45° segmented bends:				
	3.1.2.1.1	DN 90 PN20	number	5		
	3.1.2.1.2	DN 110 PN10	number	5		
	3.1.2.2	90° segmented bends:				
	3.1.2.2.1	DN 90 PN20	number	5		
	3.1.2.2.2	DN 110 PN10	number	5		
	3.1.2.3	End caps:				
	3.1.2.3.1	DN 90 PN20	number	1		
	3.1.2.3.2	DN 110 PN10	number	1		
8.2.2	**3.1.3**	**HDPE to steel connection complete as per detail on drawing 1000936-DRG-0240-MM-0007 including HDPE stub, backing flange and steel flange to match with for the folowing HDPE pipe diameters :**				
	3.1.3.1	90 mm dia	number	2		
	3.1.3.2	110 mm dia	number	1		
SECTION 3	CARRIED FORWARD					

SECTION 3 **SANS 1200 L**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
PSL 8.2.17	**3.1.4**	**Marker blocks:**				
	3.1.4.1	Pipe marker as per drawing 1000936-DRG-0210-CC-0004	number	15		
PSL 8.2.18	**3.1.5**	**Connection to existing main supply pipe**	number	1		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 LB**				
SANS 1200LB	**4.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES** **Refer to Drawing: 1000936-DRG-0210-CC-0002/3**				
PSLB 8.2.2	**4.1.1**	**Supply only of bedding by importation:**				
	4.1.1.1	From commercial sources:				
	4.1.1.1.1	Selected granular material	m^3	5		
	4.1.1.1.2	Selected fill material	m^3	5		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 18: PIPELINE ON ACCESS ROAD TO TSAKANE TANK

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DB	R . . . . .
SECTION 3	SANS 1200 L	R . . . . .
SECTION 4	SANS 1200 LB	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE** **Refer to drawing 1000936-DRG-3160-CC-0001**				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Strips,3m wide	m	230		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DB**				
SANS 1200DB	**2.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
		Refer to drawing 1000936-DRG-0210-CC-0003 & 1000936-DRG-3160-CC-0001				
PSDB 8.3.2	**2.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	2.1.1.1	Pipes up to 125 mm dia for depths:				
	2.1.1.1.1	Over 1,0 m up to 2,0 m	m	230		
PSDB 8.3.2	**2.1.2**	**Extra over item 2.1.1 above for:**				
	2.1.2.1	Hard rock excavation	m^3	5		
	2.1.2.2	Soilcrete backfill where directed by the Engineer	m^3	65		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 L**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 L**				
SANS 1200L	**3.1**	**MEDIUM-PRESSURE PIPELINES**				
		Refer to drawing 1000936-DRG-3160-CC-0001				
8.2.1	**3.1.1**	**Supply, lay and bed pipes on class B bedding, complete with couplingsas per drawing 1000936-DRG-3160-CC-0001**				
	3.1.1.1	PE100 HDPE PN16 (butt welded) pipes:				
	3.1.1.1.1	DN 90	m	230		
8.2.2	**3.1.2**	**Extra over items 3.1.1 for the supplying, laying, and bedding of PE 100 HDPE PN 20 specials complete with couplings:**				
	3.1.2.1	45° Segmented bends:				
	3.1.2.1.1	DN 90	number	3		
	3.1.2.2	90° Segented bends:				
	3.1.2.2.1	DN90	number	3		
	3.1.2.3	End caps:				
	3.1.2.3.1	DN 90	number	1		
8.2.2	**3.1.3**	**HDPE to steel connection complete as per detail on drawing 1000936-DRG-0240-MM-0007 including HDPE stub, backing flange and steel flange to match with for the folowing HDPE pipe diameters :**				
	3.1.3.1	90 mm dia		2		
PSL 8.2.17	**3.1.4**	**Marker blocks:**				
	3.1.4.1	Pipe markers as per drawing 1000936-DRG-0210-CC-0004	number	6		
PSL 8.2.18	**3.1.5**	**Connection to existing main supply pipe**	number	1		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 LB**				
SANS 1200LB	**4.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES** **Refer to drawing 1000936-DRG-0210-CC-0003 & 1000936-DRG-3110-CC-0001**				
PSLB 8.2.2	**4.1.1**	**Supply only of bedding by importation:**				
	4.1.1.1	From commercial sources:				
	4.1.1.1.1	Selected granular material	m^3	5		
	4.1.1.1.2	Selected fill material	m^3	5		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 19: PIPELINE TO MAMPURU EXTENSION

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DB	R . . . . .
SECTION 3	SANS 1200 L	R . . . . .
SECTION 4	SANS 1200 LB	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SECTION 1 **SANS 1200 C**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	1	**SANS 1200 C**				
SANS 1200C	**1.1**	**SITE CLEARANCE**				
		DN200 gravity pipe and DN250 rising main to be laid in common trench from CH0 to CH4050 as per 1000936-DRG-3110-CC-0001. The DN200 gravity pipe continues as single pipe from CH4050 to CH17804				
PSC 8.2.1	**1.1.1**	**Clear and grub:**				
	1.1.1.1	Strips,3m wide	m	377		
SECTION 1	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 2 **SANS 1200 DB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	2	**SANS 1200 DB**				
SANS 1200DB	**2.1**	**EARTHWORKS (PIPE TRENCHES) TRENCHES FOR WATER PIPES**				
		DN200 gravity pipe and DN250 rising main to be laid in common trench from CH0 to CH4050 as per 1000936-DRG-3110-CC-0001. The DN200 gravity pipe continues as single pipe from CH4050 to CH17804				
PSDB 8.3.2	**2.1.1**	**Excavate in all materials for trenches, backfill, compact and dispose of surplus material:**				
	2.1.1.1	Pipes over 125 mm dia up to 400 mm dia for depths in single trench:				
	2.1.1.1.1	Over 1,0 m up to 2,0 m	m	377		
PSDB 8.3.2	**2.1.2**	**Extra over item 2.1.1 above for:**				
	2.1.2.1	Hard rock excavation	m^3	5		
	2.1.2.2	Soilcrete backfill where directed by the Engineer	m^3	175		
SECTION 2	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 3 **SANS 1200 L**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	3	**SANS 1200 L**				
SANS 1200L	**3.1**	**MEDIUM-PRESSURE PIPELINES**				
8.2.1	**3.1.1**	**Supply, lay and bed pipes on class B bedding, complete with couplings:**				
	3.1.1.1	PE100 HDPE PN10 (butt welded) pipes:				
	3.1.1.1.1	DN 250	m	240		
	3.1.1.2	PE100 HDPE PN16 (butt welded) pipes:				
	3.1.1.2.1	DN 250	m	367		
8.2.2	**3.1.2**	**Extra over items 3.1.1 for the supplying, laying, and bedding of PE100 HDPE specials complete with couplings:**				
	3.1.2.1	45° segmented bends:				
	3.1.2.1.1	DN 250 PN10	number	2		
	3.1.2.1.2	DN 250 PN20	number	4		
	3.1.2.2	90° segmented bends:				
	3.1.2.2.1	DN 250 PN10	number	2		
	3.1.2.2.2	DN 250 PN20	number	4		
	3.1.2.3	End caps:				
	3.1.2.3.1	DN 250 PN10	number	1		
	3.1.2.3.2	DN 250 PN20	number	1		
8.2.2	**3.1.3**	**HDPE to steel connection complete as per detail on drawing 1000936-DRG-0240-MM-0007 including HDPE stub, backing flange and steel flange to match with for the folowing HDPE pipe diameters :**				
	3.1.3.1	250 mm dia		3		
SECTION 3	CARRIED FORWARD					

SECTION 3 **SANS 1200 L**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	BROUGHT FORWARD					
8.2.2	**3.1.4**	**Extra over items 3.1.1 for supplying, laying and bedding of steel specials complete with couplings:**				
	3.1.4.1	DN200 X DN25 unequal air valve tee as per item 1 on drawing 1000936-0210-DRG-CC-0033:				
	3.1.4.1.1	Over 1,0 m up to 2 m	number	1		
8.2.3	**3.1.5**	**Extra over items 3.1.1 for supplying, fixing and bedding of air release valves, including pipe work complete as per drawings: 1000936-DRG-0210-CC-0034, (items 4.1 to 4.6)**				
	3.1.5.1	Double:				
	3.1.5.1.1	DN 25 Vent-O-Mat RBX Dual acting air valve or similar approved	number	1		
8.2.13	**3.1.6**	**Valve and hydrant chambers, etc.:**				
	3.1.6.1	Air valve chamber civils complete as per drawing: 1000936-DRG-0210-CC-0033	number	1		
PSL 8.2.17	**3.1.7**	**Marker blocks:**				
	3.1.7.1	Pipe marker complete as per drawing 1000936-DRG-0210-CC-0004	number	4		
PSL 8.2.18	**3.1.8**	**Connection to existing main supply pipe**	number	1		
SECTION 3	**TOTAL CARRIED TO SUMMARY PAGE**					

SECTION 4 **SANS 1200 LB**

PAYMENT REFERS TO	ITEM NO	DESCRIPTION	UNIT	QUANTITY	RATE	AMOUNT
	4	**SANS 1200 LB**				
SANS 1200LB	**4.1**	**BEDDING (PIPES)** **BEDDING FOR WATER PIPES**				
PSLB 8.2.2	**4.1.1**	**Supply only of bedding by importation:**				
	4.1.1.1	From commercial sources:				
	4.1.1.1.1	Selected granular material	m^3	5		
	4.1.1.1.2	Selected fill material	m^3	5		
SECTION 4	**TOTAL CARRIED TO SUMMARY PAGE**					

SUMMARY OF BILL 20: PIPELINE TO MAMPURU RESERVOIR

SECTION 1	SANS 1200 C	R . . . . .
SECTION 2	SANS 1200 DB	R . . . . .
SECTION 3	SANS 1200 L	R . . . . .
SECTION 4	SANS 1200 LB	R . . . . .
TOTAL CARRIED FORWARD TO SUMMARY PAGE		R . . . . .

SUMMARY OF SCHEDULE OF QUANTITIES

BILL 1	PRELIMINARY AND GENERAL	R . . . . .
BILL 2	NEW 3.1 ML KALKFONTEIN COMMAND RESERVOIR (CIVIL AND MECHANICAL)	R . . . . .
BILL 3	KALKFONTEIN CHAMBERS (CIVIL AND MECHANICAL)	R . . . . .
BILL 4	ACCESS ROAD TO KALKFONTEIN COMMAND RESERVOIR	R . . . . .
BILL 5	EXSTING KALKFONTEIN TANK A INLET WORKS (CIVIL AND MECHANICAL)	R . . . . .
BILL 6	EXSTING KALKFONTEIN TANK B INLET WORKS (CIVIL AND MECHANICAL)	R . . . . .
BILL 7	NEW 250kL TSAKANE STEEL TANK (CIVIL AND MECHANICAL)	R . . . . .
BILL 8	TSAKANE CHAMBERS (CIVIL AND MECHANICAL)	R . . . . .
BILL 9	ACCESS ROAD TO TSAKANE RESERVOIR	R . . . . .
BILL 10	NEW 1.2 ML MAMPURU RESERVOIR (CIVIL AND MECHANICAL)	R . . . . .
BILL 11	MAMPURU CHAMBERS (CIVIL AND MECHANICAL)	R . . . . .
BILL 12	ACCESS ROAD TO MAMPURU RESERVOIR	R . . . . .
BILL 13	NEW 250kL MAMPURU EXT STEEL TANK (CIVIL AND MECHANICAL)	R . . . . .
BILL 14	MAMPURU EXT TANK CHAMBERS (CIVIL AND MECHANICAL)	R . . . . .
BILL 15	ACCESS ROAD TO MAMPURU EXTENSION TANK	R . . . . .
BILL 16	RISING MAIN ALONG ACCESS ROAD TO KALKFONTEIN	R . . . . .
BILL 17	GRAVITY MAIN TO KALKFONTEIN	R . . . . .
BILL 18	PIPELINE ON ACCESS ROAD TO TSAKANE TANK	R . . . . .
BILL 19	PIPELINE TO MAMPURU EXTENSION TANK	R . . . . .
BILL 20	PIPELINE TO MAMPURU RESERVOIR	R . . . . .
TOTAL OF SCHEDULE OF QUANTITIES		R . . . . .
10% CONTRACT PRICE ADJUSTMENT Sum provided in terms of the provisions of the General Conditions of Contract		R . . . . .
SUBTOTAL		R . . . . .
15% CONTINGENCIES The sum provided here is under the sole control of the Engineer and may be deducted in whole or in part		R . . . . .
SUBTOTAL		R . . . . .
VALUE-ADDED TAX (VAT) The Tenderer shall add 15% of the subtotal for VAT		R . . . . .
CONTRACT SUM CARRIED TO FORM OF TENDER		R . . . . .

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STATUS

In the event of any discrepancy between the Scope of Works and a part or parts of the SANS 1200 Standardized Specifications, the Bill of Quantities or the Drawings, the Project Specifications shall take precedence and prevail in the Contract.

C3.1 DESCRIPTION OF THE WORK

C3.1.1 EMPLOYER'S OBJECTIVES

The Employer's objective is to deliver Bulk Water Infrastructure, which will benefit 14 settlements in the Fetakgomo- Greater Tubatse area. The provision of potable bulk water up to distribution reservoirs level in the area, will then activate and enable various other project initiatives by mines and other stakeholders, to distribute this water downstream through water articulation networks to the various settlements earmarked as part of this initiative.

During the implementation of the project, local labour and businesses will benefit from this initiative by getting involved in the project. On the job training in skills relevant to the works to be performed, will also be given to workers, hence improving the skill set of the workers during construction.

The Works shall be constructed by maximising the use of local workers who are temporarily employed in terms of the Scope of works

In summary, the Employer's objective is to improve the existing services, socio economic development of the community, satisfy the needs of the community, and upgrading the system based on future socio- economic developments.

C3.1.2 OVERVIEW OF THE WORKS

The infrastructure to be constructed under the Mampuru Bulk Water Scheme, is to provide purified potable water to a distribution reservoir, from where it will be distributed to the following fourteen identified settlements:.

1. Kalkfontein
2. Tsakane
3. Mampuru
4. Mampuru Ext
5. Annex A
6. Dithamaga
7. Eastern Chrome Mine Residence
8. Ga-Phasha
9. Mapodile
10. Mapodile LCH
11. Tukakgomo A
12. Tukakgomo Ext
13. Legotong
14. Stoking

The project entails the construction of two pumpstations (civil , mechanical, electrical), combination of rising mains and gravity mains of approximately 70 km, connection pipe lines to reservoirs, 8 reservoirs (combination of concrete and steel tanks), access roads to the reservoirs and CP and ACIM provision

The intended concept is to have two separate projects (phase 1 and phase 2) obtaining treated water from two different sources (Ga-Malekana WTW and Spitskop WTW), each project consisting of one command reservoir which then distributes water to local distribution reservoirs. Future projects can then connect to the bulk supply and reticulate water to all communities in the vicinity.

The implementation of Phase 1 (Ga- Malekana distribution), serves the settlements of Kalkfontein, Tsakane, Mampuru and Mampuru Extension.

The implementation of Phase 2 (Spitskop), serves the settlements of Annex A, Dithamaga, Eastern Chrome Mine Residence, Ga-Phasha, Mapodile, Mapodile LCH, Tukakgomo A, Tutakgomo Ext and Legotong

C3.1.3 EXTENT OF WORKS

Phase 1 of the Mampuru Bulk Water Scheme, consists mainly of three distinct components, of which only one forms part of this contract. They are:

1. **Reservoir Implementation** (**THIS PROJECT – Phase 1A**)
   This entails the construction of the following elements:
   a. Kalkfontein 3.1Ml concrete reservoir and related chambers and pipe work
   b. Kalkfontein, 340 m concrete strip access road
   c. Kalkfontein Bulk Pipelines (rising and gravity along the access road only)
   d. Tsakane 250 kl Steel Tank and related chambers and pipe work
   e. Tsakane 320 m concrete strip access road
   f. Tsakane Bulk Pipelines (rising and gravity along the access road only)
   g. Mampuru Extension 250 kl Steel Tank and related chambers and pipe work
   h. Mampuru Extension 220 m gravel access road
   i. Mampuru Extension Bulk Pipelines (rising and gravity along the access road only)
   j. Mampuru 1.3 Ml Concrete Reservoir and related chambers and pipe work
   k. Mampuru 460 m concrete strip access road
   l. Mampuru Bulk Pipelines (rising and gravity along the access road only)

2. Pumpstation Implementation **(Separate project – Phase 1B**)
   This entails the construction of the following elements:
   a. Pumpstation building
   b. Gravel access road – 240m
   c. Pumps and related pipe work
   d. Switchgear and related electricity related work
   e. Controls and Instrumentation

3. Pipe-line Implementation **(Separate project – Phase 1C)**
   This entails the construction of the following elements:
   a. Rising main from the pumpstation to Kalkfontein – 8.7 km long, DN250 Steel pipe.
   b. Gravity Line from Kalkfontein to Mampuru – 17.8 km long, DN200 Steel pipe.
   c. Kalkfontein Reservoir A Offtake pipeline – 0.41 km long, DN100 Steel pipe
   d. Kalkfontein Reservoir B Offtake pipeline – 1.05 km long, DN80 Steel pipe
   e. Tsakane Reservoir Offtake (and gravity) pipeline – 0.77 km long, DN80 Steel pipe
   f. Mampuru Extension Reservoir Offtake (and gravity) pipeline – 0.5 km long, DN80 Steel pipe
   g. Mampuru Reservoir Offtake (and gravity) pipeline – 5 km long, 250 mm dia steel pipe
   h. Cathodic Protection and Alternating Current Induction Mitigation
   i. Six (6) Road crossings (by trench method)
   j. Four (4) Road crossings (by Directional Horizontal Drilling)
   k. Two (2) River crossings (by Directional Horizontal Drilling)

This description of the Works is not necessarily complete and shall not limit the work to be carried out by the Contractor under this Contract.

Approximate quantities of each type of work are given in the Bill of Quantities.

C3.1.4 LOCATION OF THE WORKS

On the Reservoir (Phase 1A) project, the works are to be conducted at 4 different sites, which are situated in the villages of Kalkfontein, Tsakane, Mampuru Extension and Mampuru respectively.

The Kalkfontein site is situated in close proximity to coordinates 24°53'3.32"S, 30° 4'15.24"E and can be accessed from provincial road, D212.

The Tshkane site is situated in close proximity to coordinates 24°51'42.34"S, 30° 30° 2'32.47"E and can be accessed from provincial road, D1392.

The Mampuru Extension site is situated in close proximity to coordinates 24°50'40.91"S, 30° 3'34.77"E and can be accessed from provincial road, D1392.

The Mampuru site is situated in close proximity to coordinates 24°47'31.23"S, 30° 5'54.98"E and can be accessed from provincial road, D1392.

C3.1.5 TEMPORARY WORKS

Contracting temporary works requires adherence to the specifications and guidelines for civil engineering construction works, ensuring safety, stability, and compliance with the contract terms. Temporary works refer to structures or systems that are necessary during construction but are not part of the permanent works, such as scaffolding, formwork, excavation supports, and temporary access routes

The Contractor shall be responsible for selecting what Temporary Works are required.

The Contractor and his designer shall accept full responsibility and liability for compliance with the Occupational Health and Safety Act, 1993 (Act 85 of 1993) and the Construction Regulations, 2014, for the design of the Temporary Works and those parts of the Permanent Works which the Contractor is responsible to design in terms of the Contract.

Upon erecting / constructing the Temporary works, an independent Professional Engineer needs to inspect and approve the Temporary works, prior to implementation and use thereof. This needs to happen for each section of new work, as well as daily monitoring of previous approved work.

Once the Temporary works are no longer needed, they must be dismantled safely and efficiently. The removal process should be planned and carried out with minimal disruption to ongoing or completed works. Any areas affected by temporary works must be restored to their original condition or as specified in the Contract.

C3.2 ENGINEERING

C3.2.1 DESIGN

(a) The Employer is responsible for the design of the permanent Works as reflected in the Contract Documents unless otherwise stated.

(b) The Contractor is responsible for the design of the Temporary works and their compatibility with the permanent Works.

(c) The Contractor shall supply all details necessary to assist the Engineer in the compilation of the as-built drawings.

C3.2.2 EMPLOYER'S DESIGN

The Employer is responsible for the design of the permanent works as set out in paragraph 3.1.3 above

C3.2.3 CONTRACTOR'S DESIGN

Where the Contractor is to supply the design of designated parts of the permanent Works or Temporary works he shall supply full working drawings supported by a professional engineer's design certificate.

C3.2.4 DRAWINGS

The reduced drawings that form part of the Tender Documents are to be used for tender purposes only.

The Contractor will be supplied with one set of A1 paper prints of each of the Drawings for construction purposes.

The Contractor shall use only the dimensions stated in figures on the Drawings in setting out the Works, and dimensions shall not be scaled from the Drawings, unless required by the Engineer. The Engineer will, on the request of the Contractor in accordance with the provisions of the Conditions of Contract, provide such dimensions as may have been omitted from the Drawings.

The levels given on the Structural Drawings, if applicable, are subject to confirmation on the Site and the Contractor shall submit all levels to the Engineer for confirmation before he commences construction of any structure. The Contractor shall also check all clearances given on the Drawings and shall inform the Engineer of discrepancies.

The Contractor shall notify the Engineer in writing of any additional drawings or specifications required for the proper execution of the works, 14 days before these are required.

The Contractor shall ensure that accurate as-built records are kept of all infrastructure installed or relocated during the Contract. The position of pipe bends, junction boxes, duct ends and all other underground infrastructure shall be given by either co-ordinates, or stake value and offset. Where necessary, levels shall also be given. A marked-up set of drawings shall also be kept and updated by the Contractor. This information shall be supplied to the Engineer's Representative on a regular basis.

All information in possession of the Contractor, required by the Engineer and/or the Engineer’s Representative to complete the as-built/record drawings, must be submitted to the Engineer's Representative before a Certificate of Completion will be issued.

The Tender drawings prepared by the Employer for the permanent Works are listed in Part C5. The Employer reserves the right to issue amended and/or additional drawings during the Contract.

C3.2.5 DESIGN PROCEDURES

Tender Stage Alternative Design Procedure

Alternative Design specifications

The alternative designs shall be executed in strict accordance with the codes of practice and the requirements specified in the Project Specifications or as prescribed by the Engineer for the type of alternative offered. Where no such specifications are given, the Tenderer shall obtain the Engineer's requirements before submitting his alternative offer.

Calculations

Preliminary calculations and all relevant data shall be submitted with the Tender. Such calculations shall be set out in a clear and logical manner in order to facilitate their checking. A full description of the design assumptions and codes of practice used shall accompany the calculations.

Drawings

Drawings of the alternative designs, prepared in accordance with the requirements of ISO 128, shall, when applicable, also be submitted with the Tender. These drawings shall be to a suitable scale. Sufficient large-scale sections and other details shall also be submitted to show up clearly all dimensions. Foundation levels and sizes shall also be given in the case of structures.

Further details

If the Engineer should find that the calculations and drawings submitted for alternative designs are not sufficiently complete for proper evaluation, it may mean that no further consideration will be given to such alternative designs. The Engineer, however, reserves the right to call on the Tenderer to submit such further calculations and drawings as may be required.

If such further details are not submitted within ten days of being requested, the alternative designs may not be given further consideration.

Completion of accepted alternative design

If the Tender for an alternative design is accepted by the Engineer, a complete set of working drawings, conforming in all respects to the requirements of the Engineer, shall be submitted for approval before construction may be proceeded with. The Engineer will indicate which drawings are acceptable and which are not.

Drawings submitted by the Contractor and which are accepted and signed by the Engineer shall form an integral part of the Contract Documents. Drawings not accepted and signed by the Engineer shall neither be permitted on the Site of Works for construction purposes nor be used for the manufacture of any item. Notwithstanding the approval and/or acceptance and signing of the drawings, the Contractor shall take full responsibility for all details, discrepancies, omissions, errors, etc., in respect of the said drawings as well as for the integrity of the design. The Contractor shall submit only fully completed drawings and shall not be entitled to claim for delays resulting from the submission of incomplete drawings. The Engineer shall require a period of four to eight weeks, depending on circumstances, for reviewing the complete drawing(s).

Separate payment will not be made for the design, preparation and submission of drawings, and all such costs shall be included in the rates tendered for the relevant pay items of the alternative offer.

Acceptance of alternative designs

Tenderers shall note that the acceptance of a Tender which includes alternative designs signifies that the alternative designs have been approved only in principle and on the basis of an examination of the broad details supplied with the Tender. Once the Tender has been accepted, the Contractor shall supply detailed working drawings and calculations which shall be checked by the Engineer. Should the design not comply with all the requirements specified, or not be in accordance with

accepted design practice or applicable codes, or should there be obvious deficiencies that would prejudice its intended function or structural integrity, the Contractor shall suitably amend the designs in accordance with the Engineer's instructions. Such amendments shall not entitle the Contractor to adjust the price or prices tendered for the alternative designs offered.

Responsibility for design

The Contractor shall be held solely responsible for conforming to the specified design requirements and for the integrity and functionality of the alternative design offered. He shall be liable for all damages, direct and consequential, resulting from the design which has proved to be deficient in any respect, regardless of when this deficiency is discovered.

As regards the design of the alternative, Tenderers shall state under which governing Body of Act for Engineering Professionals they practice.

The Tenderer shall offer to take out Professional Indemnity Insurance and the amount offered and the period for which it will be maintained shall be indicated by the Tenderer in a covering letter to his Tender. Allowance shall be made in the rates or amounts tendered for the alternative for the cost of such insurance.

The Engineer's approval of the design will neither relieve the Contractor of his responsibilities as stated above nor will it constitute an assumption of any such responsibilities or liabilities by the Engineer on behalf of the Contractor.

Basis of payment for alternative designs

The Tenderer shall submit his price for each alternative design by way of a lump-sum price, together with a fully priced Schedule of Quantities, in accordance with the measurement and payment clauses of the relevant sections of the Specifications, suitably amended where necessary, showing how the lump sum is made up.

This Bill of Quantities shall be used for purposes of monthly progress payments as the work proceeds, up to a maximum equal to the lump sum tendered for the alternative offer.

The tendered lump sum shall, if accepted, be the full and inclusive price for the alternative, which sum shall not be subject to alteration, except as provided hereinafter.

Tenderers who have submitted Tenders for alternative designs that do not conform to the design requirements may be requested to modify such designs in order to conform to the design requirements, but no alteration to the tendered lump sum for the structure will be allowed on account of such modifications. Furthermore, alterations to the tendered lump sum will not be allowed on account of any errors in the quantities, extensions or additions in the Bill of Quantities.

Where the Engineer requires modifications in the design for reasons other than failure to conform to the design requirements or errors in designs, as for example foundation conditions which differ materially from those indicated by the test holes, the Contractor shall effect such modifications. Where this results in a variation in the quantities of work to be done, such variations in quantities shall be valued in accordance with the rates and prices in the Bill of Quantities and the tendered lump sum for the structure shall be adjusted upwards or downwards, depending on whether the modifications result in an increase or decrease in the quantity of work done.

Construction Stage Design Change Procedure

The Contractor should submit any proposed Design Change request to the Engineer in writing through an agreed RFA (request for approval) process, accompanied by all the required designs and drawings (approved and signed off by an independent professional Engineer). The Contractor needs to allow for 5% of the value of the proposed changed design work, as remuneration of the Engineer for reviewing and commenting on the proposed alternative design.

C3.3 PROCUREMENT

C3.3.1 PREFERENTIAL PROCUREMENT

C3.3.1.1 Requirements

The works shall be executed in accordance with the conditions attached to preferences granted in accordance with the referencing schedule.

C3.3.1.2 Resource standard pertaining to targeted procurement

It is required that the Contractor commit to the number of personnel employed from the local communities as indicated in the tender document.

The minimum requirement on Labour Intensity is however set as 10% of the project value and that local business are supported as first option of choice.

C3.3.2 SUBCONTRACTING

C3.3.2.1 Scope of mandatory subcontract works

The following portions of the works shall be subcontracted in accordance with the subcontracting procedures described hereunder:

- Accredited Training Institution to facilitate the required skills training

Competitive Tenders shall be invited in respect of each of the above portions of the works in accordance with the relevant provisions of the latest edition of the CIDB Standard for Uniformity in Construction Procurement. The Contract Data in the associated procurement documents shall be based on the General Conditions of Contract 2015 third edition.

The Employer or Employer's Agent together with the Contractor shall evaluate the Tenders received in accordance with the provisions of the Standard Conditions of Tender contained in Annex C of Standard for Uniformity in Construction Procurement. The evaluation panel shall comprise equal representatives from the Employer and from the Contractor.

The Contractor shall without delay enter into contract with the successful Tendering subcontractor based on their accepted Tender submission. The Contractor shall remain responsible for providing the subcontracted portion of the works as if the work had not been subcontracted.

C3.3.2.2 Preferred subcontractors/suppliers

Ensure that an approved / registered Applicator is procured for the application of the flexible joints in the concrete reservoirs. The name, details, references and experience of the Applicator should be submitted to the Engineer for approval prior to establishing on site.

Depending on the mechanical capacity of the main contractor, it is advisable that a specialised mechanical sub-contractor be considered to form part of the Construction team.

C3.3.2.3 Subcontracting procedures

The Contractor is to enter into a contract with his sub-contractor(s) including any other subcontractors (for specialised work, if any) in accordance with the requirements of the Standard Conditions of Contract. The sub-contractor(s)' nomination will be determined by the scope of work and the amount of work that is to be carried out.

The sub-contractors will be required to utilise local labour for the completion of unskilled labour-based sections of the works, where practical.

C3.3.2.4 Attendance on subcontractors

The Contractor is responsible for all work executed (QUALITY, CONTRACTUAL LIABILITIES) on his behalf or under his supervision and/or management by all sub-contractors. The Engineer shall, prior to the commencement date of the Contract, determine the scope of work and the amount of work that is to be carried out by the selected subcontractor(s). If applicable, the Contractor shall be expected to enter into a contract with the selected subcontractor(s) in accordance with the requirements of the Standard Conditions of Contract.

The Engineer shall not negotiate directly with sub-contractors and all problems relating to payments, programming, workmanship, etc., are matters between the Contractor and his sub-contractors.

C3.4 CONSTRUCTION

C3.4.1 WORKS SPECIFICATIONS

C3.4.1.1 Applicable SANS 1200 and 2001 Standardized Specifications

The SANS 1200 and 2001 Standardized Specifications for civil engineering construction that are applicable are listed in C3.7.1.

C3.4.1.2 Particular Specifications

The Particular Specifications for work not covered by the SANS 1200 or 2001 Standardized Specifications are listed in C3.7.1 and included in C3.7.3.

C3.4.1.3 National and International Standards

References to these standards are included in the variations to the standard SANS 1200 and 2001 specifications and the particular specifications, if applicable.

C3.4.1.4 Variations and Additions to the SANS 1200 and 2001 Standardized Specifications

Variations and additions to the SANS 1200 and 2001 Standardized Specifications listed in C3.7.1 are given in section C3.7.2.

C3.4.2 SITE ESTABLISHMENT

C3.4.2.1 Services and facilities provided by the Employer

(a) Water sources

There is no reticulated water supply available in close proximity to the Site.

The Contractor shall, in accordance with the provisions of subclause C3.4.2.2(b), and at his own cost, make all arrangements necessary for the supply and distribution of water required for construction purposes as well as for use in and about his site establishment and for human consumption.

(b) Electricity supply

There is no reticulated electrical power supply available in close proximity to the Site.

The Contractor shall, in accordance with the provisions of subclause C3.4.2.2(c), and at his own cost, make all arrangements necessary for the supply and distribution of electrical power required for construction purposes as well as for use in and about his site establishment.

The Contractor shall comply with all prevailing legislation in respect of the generation and distribution of electricity and shall, when required by the Engineer, produce proof of such compliance.

(c) Excrement disposal

No water-borne sewage or other off-site excrement disposal systems are available in the vicinity of the Site.

(d) Area for Contractor's site establishment

The Employer has no suitable areas available where the Contractor may erect offices, workshops, stores and other facilities that he requires for the purposes of the Contract. The Contractor shall, at his own cost, be responsible for locating and making all arrangements necessary for securing an area suitable to meet his needs in respect of the erection of the

Contractor's offices, stores and other facilities, including the facilities to be provided for the Engineer in accordance with the Contract.

Any potential area proposed by the Contractor shall be within reasonable proximity to the Site of the Works and its location shall be subject to the joint approval of the Engineer and the SDI Section of SDM, which approval shall not be unreasonably withheld.

(e) Rail facilities

There are no goods stations in the vicinity of the site.

C3.4.2.2 <u>Facilities provided by the Contractor</u>

(a) Facilities for the Engineer

The Contractor shall provide on the Site, for the duration of the Contract and for the exclusive use of the Engineer and/or his Representative (as applicable), the various facilities described hereunder. All such facilities shall be provided promptly on the commencement of the Contract and failure on the part of the Contractor to provide any facility required in terms of this specification shall constitute grounds for the Engineer to withhold payment of the Contractor's tendered Preliminary and General items until the facility has been provided or restored as the case may be.

(i) Office accommodation

Offices must be provided for the Engineer and his Representatives as specified in SANS 1200AB as amended.

The Engineer and his Representative shall be allowed free use of all the Contractor's site facilities.

The Engineer and the Engineer's Representative shall be allowed free use of survey equipment and assistants to carry out control work as and when required, and the Contractor shall provide all pegs, concrete, tools and other necessary items as well as all necessary labour for excavation, bush clearing, mixing and placing of concrete, as and when required for the control of the setting out of the Works.

(ii) Carports

The Contractor shall provide on Site for the duration of the Contract, three (3) carports for the sole use of the Engineer and his staff. Each carport shall be constructed so that the vehicle parked under it is always protected against the direct rays of the sun. Each carport shall be at least 20 m² and the floor shall be covered with a layer of crushed stone to alleviate dusty and muddy conditions. The carport(s) shall be positioned so as to provide easy and convenient access to the Engineer's office.

(iii) Site meeting venue

The Contractor shall provide within his own site establishment facilities, a suitably furnished office or other venue capable of comfortably accommodating a minimum of **twenty** (20) persons at site meetings. The Engineer shall be allowed free use of such venue for conducting any other meetings concerning the Contract at all reasonable times.

(iv) Contract nameboards

The Contractor shall provide, erect and maintain four (4) Contract nameboards at such positions and locations directed by the Engineer (one at each of the four reservoir sites), which nameboards shall, unless otherwise specified elsewhere in the Contract, comply with the recommendations for the standard board of the South

African Association of Consulting Engineers, with regard to size, painting, decorating and detail, and the requirements described hereunder.

Each nameboard shall be made of tempered hardboard with a thickness of at least 12 mm, so braced on the reverse side as to prevent warping and shall be mounted on two or more, as necessary, firmly planted poles. The painting of the boards shall comply with the relevant requirements of CKS 193 and the colours of the paints shall be an acceptable match to the applicable colours given in SANS 1091.

The Contractor shall keep the Contract nameboards in good state of repair for the duration of the Contract and shall remove them on completion of the Contract.

(v) Survey equipment and assistants

- Survey equipment

The Contractor shall, for the duration of the Contract, provide the following survey equipment for the exclusive use of the Engineer and his staff:

- 1 upright reading automatic level with tripod;
- 1 metric levelling staff with protective cover bag;
- 1 x 8 meter tape measure
- 1 x 50 metre Stilon tape measure;
- 1 Laser measure (Hilti PDS or similar)
- 1 ± 2 kg hammer.
- 1 Dynamic Cone Penetration Equipment

All such survey equipment provided by the Contractor shall be in good condition, properly calibrated and fit for the purpose and shall be kept fully serviceable at all times by the Contractor at his own cost. The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Engineer's staff.

Where required by the Engineer, the Contractor shall at his own cost, promptly arrange for the recalibration of survey equipment provided.

(vi) Cellphones

The Contractor shall, on production of an itemised statement, be reimbursed only the cost of the Engineer's and his representatives cellphone calls. A Prime Cost Sum has been included in Section 1200 A of the Bill of Quantities for this purpose.

(vii) Computer

The Contractor shall provide computers and printers as specified in SANS 1200AB for the Engineer's representatives. A Prime Cost Sum has been included in Section 1200 A of the Bill of Quantities for this purpose.

The Contractor shall further provide at his own cost, all paper and black ink cartridges and other consumables reasonably required by the Engineer.

(viii) Electricity supply for the Engineer

All electricity supply to the Engineer's office(s) and laboratory (if applicable), whether provided by the Contractor by way of a reticulated supply from a local authority or other authorised electricity supply, or by way of on-site generators, shall be regulated by the Contractor to within limits such as to prevent damage due to fluctuations in the electrical current supply that may occur to any electrical plant and equipment provided by the Contractor or the Engineer.

The Contractor shall be liable for and pay to the Engineer on demand, all costs that the Engineer may incur in the repair or replacement of any electrical equipment provided by the Engineer on the Site. Reliance by the Contractor on the regulation of the electrical supply by the supplier or on current regulators fitted to generators shall not absolve the Contractor of his liabilities in terms of this Subclause and, where appropriate, the Contractor shall provide and install at his own cost, all such electrical current-regulating equipment as is necessary to prevent damage to the said equipment.

(ix) Site instruction book

The Contractor shall keep a triplicate book for site instructions on the Site at all times.

(x) Housing for Engineer's Representative

The Engineer will provide housing for the Engineer's Representative. The housing and the relevant services and local authority rates and charges shall be paid by the Contractor on the written instruction of the Engineer, from a Prime Cost Sum included in Section 1200 A of the Bill of Quantities for this purpose.

The Contractor is entitled to a percentage of the value of each payment to the Engineer to cover his expenses in this regard. (See item PSA 8.6.)

(b) Water

The Contractor shall, at his own expense, be responsible for obtaining and distributing all water as may be required for the purposes of executing the Contract, including water for both construction purposes and domestic use, as well as for making all arrangements in connection therewith. The Contractor shall further, at his own expense, be responsible for providing all necessaries for procuring, storing, transporting and applying water required for the execution of the Contract, including but not limited to all piping, valves, tanks, pumps, meters and other plant and equipment, as well as for all work and superintendence associated therewith.

The sources of all water utilised for the purposes of the Contract shall be subject to the prior approval of the Engineer, which approval shall not be unreasonably withheld.

The Contractor shall comply with all prevailing legislation in respect of drawing water from natural and other sources and shall, when required by the Engineer, produce proof of such compliance. The distribution of water shall be carried out by the Contractor strictly in accordance with the applicable laws and regulations.

All water provided by the Contractor for construction purposes shall be clean, free from undesirable concentrations of deleterious salts and other materials and shall comply with any further relevant specifications of the Contract. The Contractor shall, whenever reasonably required by the Engineer, produce test results demonstrating such compliance. Water provided by the Contractor for human consumption shall be healthy and potable to the satisfaction of the health authorities in the area of the Site.

No separate payment will be made to the Contractor for the obtainment, distribution and consumption of water, the costs of which will be deemed to be included in the Contractor’s tendered rates.

(c) Electricity

The Contractor shall, at his own expense, be responsible for obtaining and distributing all electricity as he may require for the purposes of executing the Contract, including electricity for both construction purposes and domestic use, as well as for making all arrangements in connection therewith.

The distribution of electricity shall be carried out by the Contractor strictly in accordance

with the applicable laws and regulations.

No separate payment will be made to the Contractor for the obtainment, distribution and consumption of electricity, the costs of which will be deemed to be in the Contractor's tendered rates and prices.

(d) Excrement disposal

The Contractor shall, at his own expense, be responsible for safely and hygienically dealing with and disposing of all human excrement and similar matter generated on the Site during the course of the Contract, to the satisfaction of the responsible health authorities in the area of the Site and the Engineer. All such excrement shall be removed from the Site and shall not be disposed of by the Contractor on the Site.

The Contractor shall further comply with any other requirements in this regard as may be stated in the Contract.

No separate payment will be made to the Contractor in respect of discharging his obligations in terms of this subclause and the costs thereof shall be deemed to be included within the Contractor's tendered Preliminary and General Items.

C3.4.2.3 Site usage

The site shall only be used for the construction of the works.

C3.4.2.4 Permits and wayleaves

The Employer shall be responsible to obtain all the wayleaves required for this Contract. The actual required payments for the relevant wayleaves will however be covered under this Contract. This can either be by paying the Authority directly, or by re-funding the Engineer for payments already made (as per proof provided).

C3.4.2.5 Features requiring special attention

(a) Site maintenance

During progress of the work and upon completion thereof, the Site of the Works shall be kept and left in a clean and orderly condition. The Contractor shall store materials and equipment for which he is responsible in an orderly manner and shall keep the Site free from debris and obstructions.

It should be noted that the reservoir sites are relatively small and that, for environmental reasons, no extra clear and grub, excavations or terracing (other than required for the permanent works) will be allowed at the site itself. It is therefore important to make arrangements for offices, storage facilities etc at the foot of the mountain.

(b) Testing and quality control

(i) Contractor to engage services of an independent laboratory

Notwithstanding the requirements of the Specifications pertaining to testing and quality control, the Contractor shall engage the services of an approved independent laboratory to undertake all testing of materials, the results of which are specified in, or may reasonably be inferred from, the Contract. These results will be taken into consideration by the Engineer in deciding whether the quality of materials utilised and workmanship achieved by the Contractor comply with the requirements of the Specifications. The aforegoing shall apply irrespective of whether the specifications indicate that the said testing is to be carried out by the Engineer or by the Contractor.

The Contractor shall be responsible for arranging with the independent testing laboratory for the timeous carrying out of all such testing specified in the Contract, at

not less than the frequencies and in the manner specified. The Contractor shall promptly provide the Engineer with copies of the results of all such testing carried out by the independent laboratory.

For the purposes of this clause, an "independent laboratory" shall mean an "SANAS approved laboratory" (as defined in subclause PSA 7.2) which is not under the management or control of the Contractor and in which the Contractor has no financial interest, nor which has any control or financial interest in the Contractor.

(ii) Additional testing required by the Engineer

In addition to the provisions of subclause C3.4.2.5(b)(i): Contractor to engage services of an independent laboratory, the Engineer shall be entitled at times during the Contract to require that the Contractor arrange with the independent laboratory to carry out any such tests, additional to those described in subclause C3.4.2.5(b)(i), at such times and at such locations in the Works as the Engineer shall prescribe. The Contractor shall promptly and without delay arrange with the independent laboratory for carrying out all such additional testing as required by the Engineer, and copies of the test results shall be promptly submitted to the Engineer.

(iii) Costs of testing

(a) Tests in terms of subclause C3.4.2.5(b)(i)

The costs of all testing carried out by the independent laboratory in accordance with the requirements of subclause C3.4.2.5(b)(i), above shall be borne by the Contractor and shall be deemed to be included in the tendered rates and prices for the respective items of work as listed in the Bill of Quantities and which require testing in terms of the Specifications. No separate payments will be made by the Employer to the Contractor in respect of any testing carried out in terms of subclause C3.4.2.5(b)(i).

Where, as a result of the consistency of the materials varying or as a result of failure to meet the required specifications for the work, it becomes necessary to carry out additional tests (e.g. re-tests on rectified work and/or replacement materials), the costs of such additional testing shall be for the Contractor's account.

(b) Additional tests required by the Engineer

The costs of any additional tests required by the Engineer in terms of subclause C3.4.2.5(b)(ii): Additional testing required by the Engineer, shall be reimbursed to the Contractor against substitution of the Provisional Sum allowed therefore in the Bill of Quantities; provided always that the costs of any such additional tests ordered by the Engineer, the results of which indicate that the quality of the materials utilised and/or the standard of workmanship achieved are/is not in accordance with the specifications, shall not be reimbursable to the Contractor.

(c) Contractor supplied equipment

The Contractor shall when required to supply any testing, measuring and/or survey equipment for the Engineer's use provide calibration certificates or verification certificates (as appropriate) for all equipment. This shall apply for both shared equipment as well as for equipment specified to be provided for the Engineer's use on site.

Calibration or verification, by certified authorities shall be subject to the Engineer's approval:

- prior to the delivery of any equipment to the Engineer; and
- thereafter at intervals as prescribed for the relevant equipment but not less than every twelve (12) months.

The calibration/verification certificate for each item of equipment shall be submitted to the Engineer for approval prior to its use or within seven (7) days of subsequent re-calibration/verification.

Unless otherwise provided for in the bill of quantities the cost of providing the above specified equipment.

Failure to submit certificates shall result in payment for the equipment being withheld.

(d) Subcontractors

All matters pertaining to subcontractors (including Nominated Subcontractors) and the work executed by them shall be dealt with directly between the Engineer and the Contractor in the context of all subcontract work being an integral part of the Works for which the Contractor is responsible.

The Engineer will not liaise directly with any subcontractors nor will he issue instructions concerning the subcontract works directly to any subcontractor.

All matters arising from the subcontract agreements shall be dealt with directly between the Contractor and the subcontractors and the Engineer will not become involved.

(e) Opening up and closing down of designated borrow pits

This is not applicable to this project. Only commercial sources will be used and it is the Contractor’s responsibility to identify and procure the material as specified in the contract.

(f) Access to properties

The Contractor shall organise the work to cause the least possible inconvenience to the public, land rights holders and to the property owners adjacent to or affected by the work, and except as hereunder provided, shall at all times provide and allow pedestrian and vehicular access to properties within or adjoining or affected by the area in which he is working. In this respect the Contractor's attention is drawn to Clause 8.1.2 of the Conditions of Contract.

If, as a result of restricted road reserve widths and the nature of the work, the construction of bypasses is not feasible, construction shall be carried out under traffic conditions to provide access to erven and properties.

Notwithstanding the aforegoing, the Contractor may, with the prior approval of the Engineer (which approval shall not be unreasonably withheld), make arrangements with and obtain the acceptance of the land owners and occupiers of erven and properties to close off part of a street, road, footpath or entrance temporarily, provided that the Contractor duly notifies the occupiers of the intended closure and its probable duration, and reopens the route as punctually as possible. Where possible, such streets, roads, footpaths and entrances shall be made safe and reopened to traffic overnight. Such closure shall not absolve the Contractor from his obligations under the Contract to provide access at all times. Barricades, traffic signs, drums and other safety measures appropriate to the circumstances shall be provided by the Contractor to suit the specific conditions.

The Contractor must sign an access and construction agreement with the land owner and relevant parties prior to commencement of construction activities, and comply with the terms and conditions set out in the agreement.

(g) Existing residential areas

Electricity and water supply interruptions in existing residential areas shall be kept to a minimum. The Engineer's approval shall be obtained prior to such interruptions and residents shall be notified in writing at least 24 hours but not more than 48 hours in advance. Supplies shall be normalised by 16:00 on the same day.

(j) Employment of local labour

It is the intention that this Contract should make maximum use of the local labour force that is presently underemployed. To this end the Contractor shall limit the utilisation on the Contract of non-local employees to that of key personnel only and to employ and train local labour to the extent necessary for the execution and completion of this Contract.

The Contractor shall state in Form 9 which of the personnel listed in the form is seen as Key Personnel. The data stated on the above-mentioned form will be strictly monitored during the Contract period and any deviations therefrom shall be subject to the prior approval of the Engineer, which approval shall not be unreasonably withheld.

(k) Monthly statements and payment certificates

The statement to be submitted by the Contractor in terms of Clause 6.10 of the Conditions of Contract shall be prepared by the Contractor at his own cost, strictly in accordance with the standard payment certificate prescribed by the Engineer, in digital electronic computer format. The Contractor shall, together with a copy of the digital electronic computer file of the statement, submit one (1) A4 size paper copies of the statement.

For the purposes of the Engineer’s payment certificate, the Contractor shall subsequently be responsible, at his own cost, for making such adjustments to his statement as may be required by the Engineer for the purposes of accurately reflecting the actual quantities and amounts which the Engineer deems to be due and payable to the Contractor in the payment certificate.

The Contractor shall, at his own cost, make the said adjustments to the statement and return it to the Engineer within three (3) normal workings days from the date on which the Engineer communicated to the Contractor the adjustments required. The Contractor shall submit to the Engineer one (1) set of A4 size paper copy of such adjusted statement, together with a copy of the electronic digital computer file thereof.

Any delay by the Contractor in making the said adjustments and submitting to the Engineer the requisite copies of the adjusted statement for the purposes of the Engineer’s payment certificate will be added to the times allowed to the Engineer in terms of Clause 6.10.4 of the Conditions of Contract to submit the signed payment certificate to the Employer and the Contractor. Any such delay will also be added to the period in which the Employer is required to make payment to the Contractor.

(l) Construction in restricted areas

Working space is sometimes restricted. The construction method used in these restricted areas largely depends on the Contractor's Plant. Notwithstanding, measurement and payment will be strictly according to the specified cross-sections and dimensions irrespective of the method used, and the rates and prices tendered will be deemed to include full compensation for any difficulties encountered by the Contractor while working in restricted areas. No extra payment nor any claim for payment due to these difficulties will be considered.

(m) Notices, signs, barricades and advertisements

All notices, signs and barricades, as well as advertisements, may be used only if approved by the Engineer. The Contractor shall be responsible for their supply, erection, maintenance and ultimate removal and shall make provision for this in his tendered rates.

The Engineer shall have the right to instruct the Contractor to move any sign, notice or advertisement to another position, or to remove it from the Site of the Works if in his opinion it is unsatisfactory, inconvenient or dangerous.

(n) Workmanship and quality control

The onus to produce work that conforms in quality and accuracy of detail to the requirements of the Specifications and Drawings rests with the Contractor, and the Contractor shall, at his own expense, institute a quality control system and provide suitably qualified and experienced engineers, foremen, surveyors, materials technicians, other technicians and technical staff, together with all transport, instruments and equipment to ensure adequate supervision and positive control of the Works at all times.

The cost of supervision and process control, including testing carried out by the Contractor, will be deemed to be included in the rates tendered for the related items of work.

The Contractor's attention is drawn to the provisions of the various Standardized Specifications regarding the minimum frequency of testing required. The Contractor shall, at his own discretion, increase this frequency where necessary to ensure adequate control.

On completion and submission of every part of the work to the Engineer for examination and measurement, the Contractor shall furnish the Engineer with the results of the relevant tests, measurements and levels to demonstrate the achievement of compliance with the Specifications.

(o) Setting out of Works (Sub clause 5.1.1)

The Employer shall arrange for the Contractor to be given sufficient reference pegs from which to work. The information of all bench marks shall be given in writing. The Contractor shall bear the cost of any re-survey and the cost of re-establishment or checking of any pegs, bench marks, etc. disturbed, destroyed or interfered with in any way and the cost of any survey to prove the accuracy of the setting out after any disturbance of or interference with any peg or bench mark. All surveys or re-survey shall be by Surveyors appointed by the Employer.

(p) Recording of weather

The Contractor shall erect three (3) rainfall gauges on the site (Kalkfontein, Mampuru Ext, Mampuru) and record the daily rainfall figures in a book. Such book shall be handed to the employer’s representative for his signature no later than 12 days after rain that is considered to justify an extension of time occurs.

(q) Management meetings

Site meetings will be held on monthly basis. The following parties are required to attend these meetings: The Employer’s Representative, the Engineer and/or Representative, the Contractor and/or Representative, the Community Liaison Officer, the Health and Safety Officer and the Chairperson of the Project Steering Committee.

(r) Unauthorised persons

The Contractor shall keep unauthorized persons from the works at all times Under no circumstances may any person except guards be allowed to sleep on the building site.

(s) Felling of trees

Trees which are indicated to be pruned and preserved shall not be damaged by the Contractor. A penalty of R15 000 per tree will be imposed on the Contractor for felling or damaging any such tree.

C3.4.3 PLANT AND MATERIALS

C3.4.3.1 Plant and materials supplied by the employer

The Employer shall not supply any plant or materials.

C3.4.3.2 Materials, samples and shop drawings

(a) Samples

Materials or work which do not conform to the approved samples submitted in terms of Clause 7.4.1 of the Conditions of Contract, will be rejected. The Engineer reserves the right to submit samples to tests to ensure that the material represented by the sample meets the specification requirements.

The costs of any such tests conducted by or on behalf of the Engineer, the results of which indicate that the samples provided by the Contractor do not conform to the requirements of the Contract, shall, in accordance with the provisions of Clause 7.4.4 (GCC 2015) of the Conditions of Contract, be for the Contractor's account.

C3.4.4 CONSTRUCTION EQUIPMENT

C3.4.4.1 Requirements for equipment

The four sites identified for the construction of the reservoirs, will require plant and equipment that can traverse typical off-road conditions with a gradient of between 15 and 20%. The following indicative construction equipment should therefore be considered:

- 35t Bulldozer (flywheel power of approximately 220kW) suitable for heavy ripping
- Back acting Excavator (flywheel power of 0.10kW per mm of tined bucket width)
- Grader with flywheel power of 149kW minimum (14G or equivalent)
- 4x6 / 6x6 ADT offroad tipper trucks
- 10 m^3 trucks (for importation of commercial material)
- Padfoot roller
- Smooth drum (10t) roller
- 4x6 / 6x6 Water cart / bowser
- TLB
- 4x6 / 6x6 Concrete mixer Truck (or Fiori)
- 4x6 / 6x6 Flat bed truck
- Crane
- Concrete pump (40m-50m)
- Concrete Vibrators
- Pedestrian and rammer compactors
- Generators
- Various small hand tools (Circle saws, drills, grinders etc)

It however remains the Contractor's responsibility and judgement to determine the combination of construction equipment, as well as the number of each, that needs to be established in order to deliver the project to the requirements and specifications. The programme and the sequence of activities will also have a major impact on the type and number of construction equipment required

C3.4.4.2 Equipment provided by the employer

The Employer shall not provide any equipment.

C3.4.5 EXISTING SERVICES

C3.4.5.1 Known services

The sites where the reservoirs will be constructed are greenfield sites and there are no known or expected services over the bulk of the area. There is however a possibility that services can be encountered at the start of the access roads where it links to the existing road network (at the foot of the mountain).

The Contractor needs to allow time, and provide ample warning, for the community structures and the Employer's technical division to indicate any known services, prior to the Contractor wanting to commence with work in the area of concern.

Following confirmation of the services (or lack there off), a drawing / sketch should be developed and all parties should signed off on the available information as confirmation of the agreed status.

C3.4.5.2 Treatment of existing services

Upon the detection of any services, the Contractor need to inform the relevant responsible division of the Employer or private owner, and together with them, determine the way forward. It is expected that in most cases the service will be protected and encased with soilcrete. The works will then continue. The Engineer should be kept informed as soon as such service is identified in order for the Contractor and Engineer to coordinate the required actions.

C3.4.5.3 Use of detection equipment for the location of underground services

It should also be noted that the Phase 1C contract (Bulk pipelines) will be appointing an Underground service detection service provider (PSP) and that, with proper coordination, work can be programmed in such a way that the PSP can assist with detection, prior to construction on the reservoir project.

C3.4.5.4 Damage to services

The general approach with regards to damage to services is as follows:

- When services are damaged after the Contractor being informed of the service, the repair and the cost will be for the Contractor's account.
- If there were no information available or knowledge of the service, then the cost of the damage will be for the Employer.

C3.4.5.5 Reinstatement of services and structures damaged during construction

Upon damage caused to any service, the owner of the damaged service should be informed immediately of the incident, by the Contractor. Coordination of the repairs should be agreed and implemented. The Engineer should also be informed immediately of the incident.

Should the damage of a given service cause major disruptions to the environment, community or owner, it is expected that the Contractor will do whatever he can to mitigate the consequence, irrelevant of who the responsible party is.

C3.5 MANAGEMENT OF THE WORKS

C3.5.1 SPECIFICATIONS

The following Specifications are applicable:

(i) The SANS 1200 and 2001 Standardized Specifications listed in C3.7.1;

(ii) The Variations and Additions to the SANS 1200 and 2001 Standardized Specifications given in C3.7.2;

(iii) The Particular Specifications given in C3.7.3.

C3.5.2 PLANNING AND PROGRAMME

C3.5.2.1 GENERAL

The Contractor's programme to be submitted in terms of Clause 5.6.1 of the Conditions of Contract shall take all matters that may impact the Contractor's sequence of executing the various components of the Works and the requisite rate of progress of the Works, as may be specified in or reasonably inferred from the Contract.

C3.5.2.2 FORMAT

The Construction programme to be submitted by the Contractor in accordance with the provisions of Clause 5.6.1 of the Conditions of Contract shall;

(a) Be in the form of a bar chart; and
(b) Clearly indicate the start and end dates and duration of all construction activities and identify the critical path; and
(c) Take full cognizance of all the Contractor's risks and obligations in terms of the Contract.

The said Programme and all revisions thereto shall also be provided to the Engineers in electronic digital format using the MS PROJECT software.

C3.5.2.3 FAILURE TO MAINTAIN CONSTRUCTION PROGRAMME

If the Construction programme has to be revised in terms of the Conditions of Contract, because the Contractor is falling behind in its programme, the Contractor shall submit a revised programme of how it intends to regain lost time to ensure completion of the Works before the Due Completion Date.

C3.5.2.4 SPECIFIC PROGRAMME REQUIREMENTS

The Contractor's programme shall also take full account of the matters described in the sub-clauses hereunder. No additional payments will be made to the Contractor in respect of any additional costs as it may incur in consequence of arranging or adjusting its programme to accommodate the said matters and the Contractor's various tendered rates and prices shall be deemed to fully inclusive of such costs.

No construction activities will be permitted which require the complete shut-down of existing works and operations.

The Contractor needs to take cognizance of the fact that this construction package forms part of three (3) packages which are running concurrently. The two other packages are the Pumphouse (Package 1B) and the Pipeline (Package 1C). Each package is dependent on the others for total system commissioning. It is therefor critical to programme this package (Reservoir - 1A) to inter-phase with the other two packages. The following is therefor required as part of the planning / programming for this project:

- Kalkfontein Command Reservoir to be prioritized for completion within 14 months from

the date of Commencement of Works.

- The Mampuru Reservoir to be completed within 16 months from the date of Commencement of Works.
- The site teams should be structured to achieve the above requirements.
- Cognizance must be taken of the complexity of the terrain and the implied impact this will have on construction logistics.

It is important to note that the designed concrete strips for the road, are not suitable to carry the heavy imposed axil loading expected from the construction vehicles and should therefore not be constructed prior to the completion of the "heavy" reservoir construction work. Therefore, in the programme of the Contractor, the Contractor should allow for the correct sequencing of this work, by planning as follows:

- Construct the access road earthworks (and possible layerworks – Contractor's discretion) to allow access to the reservoir site
- Construct reservoir and any work requiring heavy vehicles travelling on the access road
- Construct the concrete strips
- Sequence the construction of the rising and gravity pipe mains to suit the contractor's intended construction methodology, but avoid asserting heavy loading on the pipes at any stage post pipe construction.

Facilities to Other Contractors

Pursuant to the requirements of the Conditions of Contract, the Contractor's programme shall make allowances for the presence of such other contractors on the Site as are described below. This may involve adapting the Contractor's programme to accommodate the work of such other contractors and ensuring access to their sites along prescribed routes over the Site of this Contract.

(a) Geotechnical Engineer

The Engineer will invite the Geotechnical Engineer to site as and when required, to confirm geotechnical properties of the in-situ material as excavation progresses on site. Subsequent to these visits, changes to the design / approach could possibly be facilitated, should it be discovered that the actual in-situ material and rock formations differs from the initial indications

(b) Cathodic Protection and Alternating Current Induction Mitigation Consultant

The Employer's design engineers will visit the site at an opportune time to evaluate the in-situ soil conditions, inspect the installation of the C & ACIM infrastructure and to coordinate the interphase between the Reservoir Phase 1A project and the Pipeline Phase 1C project.

(c) Underground Service Detection

The Service providers could possibly visit the site in the initial stages to verify the presence of existing services. Coordination should take place between the two contractors of phase 1A and phase 1C in order to verify services at the start position of the reservoir project.

(d) Other Contractors

The Contractor needs to take cognizance of the fact that this construction package forms part of three (3) packages which are running concurrently. The two other packages are the Pumphouse (Package 1B) and the Pipeline (Package 1C). Coordination with these will be required to achieve complete system commissioning and provision should be made in the programme for these interphases.

C3.5.3 ENVIRONMENTAL MANAGEMENT

(a) General

The Contractor will be responsible for managing his activities so that damage to the environment is minimised, as per the approved Environmental Management Plan contained in Annexure C6.2.

C3.6 HEALTH AND SAFETY

The Occupational Health and Safety Act, Act 85 of 1993, will be applicable in all areas of the Works, except for mining areas and mine lease areas where the Mines Health and Safety Act, Act 29 of 1996, will be applicable.

C3.6.1 HEALTH AND SAFETY REQUIREMENTS AND PROCEDURES

(a) Construction Regulations, 2014

The Contractor shall be required to comply with the Occupational Health and Safety Act, 1993: Construction Regulations, 2014 (the regulations) as promulgated in Government Gazette No 37305 and Regulation Gazette No 10113 of 7 February 2014. Non-compliance with these regulations, in any way whatsoever, will be adequate reason for suspending the Works.

The proposed type of work, materials to be used and potential hazards likely to be encountered on this Contract are detailed in the Project Specifications, Bill of Quantities and Drawings, as well as in the Employers' health and safety specifications (Regulation 5(1)(b) of the Construction Regulations 2014, which are bound in the Contract document in Annexure C6.1.

The Contractor shall in terms of Regulation 7(1)(a) provide a comprehensive health and safety plan detailing his proposed compliance with the regulations, for approval by the Employer.

The Contractor shall at all times be responsible for full compliance with the approved plan as well as the Construction Regulations and no extension of time will be considered for delays due to non-compliance with the abovementioned plan or regulations.

Payment items are included in the Bill of Quantities to cover the Contractor's cost for compliance with the OHS Act and the abovementioned regulations.

C3.6.2 PROTECTION OF THE PUBLIC

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014.

C3.6.3 BARRICADES AND LIGHTING

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014.

C3.6.4 TRAFFIC CONTROL ON ROADS

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014.

C3.6.5 MEASURES AGAINST DISEASE AND EPIDEMICS

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014.

C3.6.6 AIDS AWARENESS

Refer to the Occupational Health and Safety Act, 1993 and the Construction Regulations, 2014.

C3.7 SPECIFICATIONS

C3.7.1 LIST OF APPLICABLE SPECIFICATIONS

C3.7.1.1 Applicable SANS 1200 and 2001 Standardized Specifications

The following SANS 1200 and 2001 Standardized Specifications for civil engineering construction are applicable:

SANS 1200 A	:	General (1986)
SANS 1200 AB	:	Engineer's office (1986)
SANS 1200 C	:	Site clearance (1980)
SANS 1200 D	:	Earthworks (1988)
SANS 1200 DB	:	Earthworks (pipe trenches) (1989)
SANS 1200 DK	:	Gabions and pitching (1996)
SANS 1200 DM	:	Earthworks (roads, subgrade) (1981)
SANS 1200 H	:	Structural steelwork (1990)
SANS 1200 HA	:	Structural steelwork (sundry items)
SANS 1200 L	:	Medium-pressure pipelines (1983)
SANS 1200 LB	:	Bedding (pipes) (1983)
SANS 1200 LC	:	Cable ducts (1981)
SANS 1200 LE	:	Stormwater drainage (1982)
SANS 1200 M	:	Roads (general)
SANS 1200 MM	:	Ancillary roadworks (1984)
SANS 2001CC	:	Concrete (structural)

The term "project specification" must be replaced by "scope of works" wherever it appears in these standardized specifications.

C3.7.1.2 Particular Specifications

The following Particular Specifications for work not covered by the SANS 1200 Standardized Specifications are also included hereunder:

PA	FENCING
PB	MISCELLANEOUS WORK FOR RESERVOIRS
LE01	REINFORCED CONCRETE
LE03	SLIDING FORMWORK
LE05	SURFACE FINISHES
LE06	SURFACE FINISHES
LE08	LATERAL SUPPORT ANCHORS
LE10	CONCRETE FOR AQUEOUS LIQUID RETAINING STRUCTURES
LE11	CONCRETE MINOR WORKS
LE13	BUILDING SURFACE BEDS
LE15	PROTECTION AGAINST TERMITES AND ANTS UNDER SURFACE BEDS
LE16	SOILCRETE
ME1	STRUCTURAL STEELWORK
S1	SPECIFICATION FOR LOAD BEARING MASONRY WALLS

C3.7.1.3 National and International Standards

References to these standards are included in the variations to the standard SANS 1200 and 2001 specifications and the particular specifications, if applicable.

C3.7.2 VARIATIONS AND ADDITIONS TO SANS 1200 and 2001 STANDARDIZED SPECIFICATIONS

SANS 1200 A	:	General (1986)
SANS 1200 AB	:	Engineer's office (1986)
SANS 1200 C	:	Site clearance (1980)
SANS 1200 D	:	Earthworks (1988)
SANS 1200 DB	:	Earthworks (pipe trenches) (1989)
SANS 1200 DK	:	Gabions and pitching (1996)
SANS 1200 DM	:	Earthworks (roads, subgrade) (1981)
SANS 1200 H	:	Structural steelwork (1990)
SANS 1200 HA	:	Structural steelwork (sundry items)
SANS 1200 L	:	Medium-pressure pipelines (1983)
SANS 1200 LB	:	Bedding (pipes) (1983)
SANS 1200 LC	:	Cable ducts (1981)
SANS 1200 LE	:	Stormwater drainage (1982)
SANS 1200 M	:	Roads (general)
SANS 1200 MM	:	Ancillary roadworks (1984)
SANS 2001CC1	:	Concrete (structural)

The following variations and additions to the SANS 1200 and 2001 Standardized Specifications referred to above apply to this Contract. The prefix PS indicates an amendment to SANS 1200 and 2001. The letters and numbers following these prefixes respectively indicate the relevant Standardized Specification and clause numbers in SANS 1200 and 2001 to which the variation or addition thereto applies.

PSA GENERAL

PSA 1 SCOPE

Replace the contents of subclause 1.1, including the notes, with the following:

"1.1This specification covers requirements, principles and responsibilities of a general nature which are generally applicable to civil engineering construction and building works contracts, as well as the requirements for the Contractor's establishment on the Site."

PSA 2 INTERPRETATIONS

PSA 2.3 DEFINITIONS

In the opening phrase between the words "specification" *and* "the following", *insert the words* "the definitions given in the Conditions of Contract and".

(a) General

Add the following definitions:

" 'General Conditions' and 'Conditions of Contract': The General Conditions of Contract specified for use with this Contract, together with the Contract Data as applicable.

'Specified': As specified in the Standardized Specifications, the Drawings or the Project Specifications. 'Specifications' shall have the corresponding meaning."

‘'Employers' Agent' (Clause 1.1.1.16 of Conditions of Contract) shall have the same meaning and be synonymous with Engineer throughout the Contract documentation

‘General Items’ (Clause 1.1.1.21 of Conditions of Contract) shall have the same meaning and be synonymous with Preliminary and General items.”

(c) Measurement and payment

Replace the definitions for "Fixed charge", "Time-related charge" *AND* "Value-related charge" *with the following:*

" 'Fixed charge': A charge that is not subject to adjustment on account of variations in the value of the Contract Price or the time allowed in the Contract for the completion of the work.

'Time-related charge': A charge, the amount of which varies in accordance with the Time for Completion of the Works, adjusted in accordance with the provisions of the Contract.

'Value-related charge': A charge, the amount of which varies pro rata with the final value of the measured work executed and valued in accordance with the provisions of the Contract.' "

PSA 2.4 ABBREVIATIONS

(a) Abbreviations relating to standard documents

Add the following abbreviation:

"CKS: SABS Co-ordinating Specification."

PSA 3 MATERIALS

PSA 3.1 QUALITY

Add the following at the end of subclause 3.1:

"All manufactured materials supplied shall be new materials unless the contrary is specified. All materials specified to be in accordance with SABS Specifications shall bear the SABS mark, where such a mark is available for the type of product."

PSA 4 PLANT

PSA 4.1 SILENCING OF PLANT

Replace the contents of subclause 4.1 with the following:

"The Contractor's attention is drawn to the applicable regulations pertaining to noise and hearing conservation, framed under the Occupational Health and Safety Act, 1993 (Act No 85 of 1993) as amended.

The Contractor shall at all times and at his own cost, be responsible for implementing all necessary steps to ensure full compliance with such regulations, including but not restricted to the provision and use of suitable and effective silencing devices for pneumatic tools and other plant which would otherwise cause a noise level in excess of that specified in the said regulations.

Where appropriate, the Contractor shall further, by means of temporary barriers, effectively isolate the source of such noise in order to comply with the said regulations."

PSA 4.2 CONTRACTOR'S OFFICES, STORES AND SERVICES

Add the following paragraph before the existing first paragraph in subclause 4.2:

"The Contractor's buildings, sheds and other facilities erected or utilised on the Site for the purposes of the Contract shall be fenced off and shall contain all offices, stores, workshops, testing laboratories, toilet facilities, etc. as may be required by the Contractor. The facilities shall always be kept in a neat and orderly condition.

No personnel may reside on the Site. Only night-watchmen may be on the Site after hours."

Delete "and first-aid services" *in the second paragraph of subclause 4.2 and add the following:*

"The Contractor shall provide on the Site and in close proximity to the actual locations where the work is being executed, one toilet per 10 workmen, which toilets shall be effectively screened from public view and their use enforced. Such toilets shall be relocated from time to time as the location of the work being executed changes, so as to ensure that easy access to the toilets is maintained.

The Contractor shall, where applicable, make all necessary arrangements and pay for the removal of night soil."

PSA 5 CONSTRUCTION

PSA 5.1 SURVEY

PSA 5.1.2 Preservation and replacement of survey beacons and pegs subject to the Land Survey Act

Delete the words "in the vicinity of boundaries" *in the second sentence of subclause 5.1.2 and replace the words* "under the direction of" *in the same sentence with* "in consultation and liaison with".

Add the following after the second sentence of subclause 5.1.2:

"The Contractor and the Engineer shall record on the said list, their concurrence or disagreement (as the case may be) regarding the completeness and accuracy of the details recorded therein."

Replace the third sentence of subclause 5.1.2 with the following:

"At the completion of the Contract, the Contractor shall expose all pegs that were listed at the commencement of the construction as being in order and the Contractor shall arrange with a registered Land Surveyor for the checking of the positions of all such pegs and the replacement of those that the Land Surveyor's check reveals have become disturbed or damaged. The Contractor shall, as a precedent to the issue of the Certificate of Completion, provide to the Engineer, a certificate from the registered land surveyor, certifying that all the pegs listed at the commencement of construction in accordance with the provisions of this clause, have been checked and that those found to have been disturbed, damaged or destroyed have been replaced in their correct positions, all in accordance with the provisions of the said Act.

The costs of all checking, replacement and certification as aforesaid shall be entirely for the Contractor's account. This, with the provision always that the Contractor shall not be held liable for the cost of replacement of pegs which:

(a) cannot reasonably be re-established in their original positions by reason of the finished dimensions of the permanent works, and

(b) the Contractor can prove beyond reasonable doubt to the satisfaction of the Engineer, were disturbed, damaged or destroyed by others beyond his control."

PSA 5.3 PROTECTION OF EXISTING STRUCTURES

Replace "Machinery and Occupational Safety Act, 1983 (Act No 6 of 1983)" *with* "Occupational Health and Safety Act, 1993 (Act No 85 of 1993), as amended," *and insert the following after* "(Act No 27 of 1956)": "as amended".

PSA 5.4 PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES

Replace the heading and the contents of subclause 5.4 with the following:

"PSA 5.4 LOCATION AND PROTECTION OF EXISTING SERVICES

PSA 5.4.1 Location of existing services

Before commencing with any work in an area, the Contractor shall ascertain the presence and actual position of all services which can reasonably be expected by an experienced and competent contractor to be present on, under, over or within the Site.

Without in any way limiting his liability in terms of the Conditions of Contract in relation to damage to property and interference with services, the Contractor shall, in collaboration with the Engineer, obtain the most up-to-date plans as are available, showing the positions of services existing in the area where he intends to work. Neither the Employer nor the Engineer offers any warranty as to the accuracy or completeness of such plans and because services can often not be reliably located from

plans, the Contractor shall ascertain the actual location of services depicted on such plans by means of careful inspection of the Site.

Thereafter, the Contractor shall, by the use of appropriate methodologies, carefully expose the services at such positions as are agreed to by the Engineer, for the purposes of verifying the exact location and position of the services. Where the exposure of existing services involves excavation to expose underground services, the further requirements of subclauses 4.4 and 5.1.2.2 of SANS 1200 D (as amended) shall apply.

The aforesaid procedure shall also be followed in respect of services not shown on the plans but which may reasonably be anticipated by an experienced Contractor to be present or potentially present on the site.

All services, the positions of which have been determined as aforesaid at the critical points, shall henceforth be designated as 'known services' and their positions shall be indicated by the Contractor on a separate set of drawings, a copy of which shall be furnished to the Engineer without delay.

As soon as any service which has not been identified and located as described above is encountered on, under, over or within the site, it shall henceforth be deemed to be a known service and the aforesaid provisions pertaining to locating, verifying and recording its position on the balance of the site shall apply. The Contractor shall notify the Engineer immediately when any such service is encountered or discovered on the Site.

Whilst he is in possession of the Site, the Contractor shall be liable for all loss of or damage as may occur to

(a) known services, anywhere along the entire lengths of their routes, as may reasonably be deduced from the actual locations at which their positions were verified as aforesaid, due cognizance being taken of such deviations in line and level which may reasonably be anticipated, and

(b) any other service which ought reasonably to have been a known service in accordance with the provisions of this clause.

The Contractor shall also be liable for consequential damage in regard to (a) and (b), whether caused directly by the Contractor's operations or by the lack of proper protection.

No separate payment will be made to the Contractor in respect of his costs of providing, holding available on the Site and utilising the said detecting and testing equipment, nor for any costs incurred in preparing and submitting to the Engineer the Drawings as aforesaid. These costs shall be deemed included in the Contractor's other tendered rates and prices included in the Contract.

Payment to the Contractor in respect of exposing services at the positions agreed by the Engineer and as described above will be made under the payment items (if any) as may be provided for in the respective sections of the specifications pertaining to the type of work involved.

PSA 5.4.2 Protection during construction

The Contractor shall take all reasonable precautions and arrange its operations in such a manner as to prevent damage occurring to all known services during the period which the Contractor has occupation and/or possession of the Site.

Services left exposed shall be suitably protected from damage and in such a manner as will eliminate any danger arising therefrom to the public and/or workmen, all in accordance with the requirements of the prevailing legislation and related regulations.

Unless otherwise instructed by the Engineer, no services shall be left exposed after its exact position has been determined and all excavations carried out for the purpose of exposing underground services shall be promptly backfilled and compacted. In roadways, the requirements of subclause 5.9 of SANS 1200 DB should be observed. In other areas compaction is to be to 90% modified AASHTO density.

PSA 5.4.3 Alterations and repairs to existing services

Unless the contrary is clearly specified in the Contract or ordered by the Engineer, the Contractor shall not carry out alterations to existing services. When any such alterations become necessary, the Contractor shall promptly inform the Engineer, who will either make arrangements for such work to be executed by the owner of the service, or instruct the Contractor to make such arrangements himself.

Should damage occur to any existing services, the Contractor shall immediately inform the Engineer, or when this is not possible, the relevant authority, and obtain instructions as to who should carry out repairs. In urgent cases, the Contractor shall take appropriate steps to minimise damage to and interruption of the service. No repairs of telecommunication cables or electric power lines and cables shall be attempted by the Contractor.

A list of important telephone numbers for use when services are damaged or need to be altered is provided below:

Electricity : Eskom

Contact telephone numbers:

Customer Service: 086 003 7566
Technical Support: 080 0111 652
Emergency Service: 086 0037 566

Water and Sewerage : Sekhukhune District Municipality call centre

Contact telephone numbers: 013 262 7300/1

Telkom : Customer service

To contact Telkom customer service, use one of the following methods

From Telkom fixed line phone, dial 10210
From mobile Telkom phone, dial 081180

Traffic : Fetakgomo/Tubatse Local municipality

Contact telephone numbers: 013 216 1026 / 013 237 0039

PSA 5.7 SAFETY

Replace the contents of subclause 5.7 with the following:

"The Contractor shall be required to comply with the Occupational Health and Safety Act, 1993: Construction Regulations, 2014 (the regulations) as promulgated in Government Gazette No 37305 and Regulation Gazette No 10113 of 7 February 2014. Non-compliance with these regulations, in any way whatsoever, will be adequate reason for suspending the Works.

The proposed type of work, materials to be used and potential hazards likely to be encountered on this Contract are detailed in Part C3: Scope of Works Project Specifications, Bill of Quantities and Drawings, as well as in the Employers' health and safety specifications (Regulation 5(1)(b) and baseline risk assessment (Regulation 5(1)(a) of the Construction Regulations 2014, which are bound in the Contract document/will be issued separately by the Employer.

The Contractor shall in terms of Regulation 7(1)(a) provide a comprehensive health and safety plan detailing his proposed compliance with the regulations, for approval by the Employer.

The Contractor shall at all times be responsible for full compliance with the approved plan as well as the Construction Regulations and no extension of time will be considered for delays due to non-compliance with the abovementioned plan or regulations.

The Employer or his or her agent, appointed as contemplated in sub regulations 5(5) and 5(6) of Construction Regulations, 2014 shall undertake periodic audits at intervals mutually agreed between agent and Contractor, but at least once every 30 days (sub regulation 5(1)(o)).

In addition the Employer and the Engineer shall be entitled, although not obliged, to make such inspections on the site as they shall deem appropriate, for the purpose of verifying the Contractor’s compliance with the requirements of the Act and Construction Regulations, 2014.

For these purposes, the Contractor shall grant full access to all parts of the Site, subject to any provision to grant access to the Contractor in terms of the Clause 4.8.1 of the Conditions of Contract for any portion of Site, and shall co-operate fully in such audits/inspections and shall make available for audit/inspection all such documents and records as the Employer’s and/or Engineer’s representative may reasonably require.

Where any such investigations reveal, or where it comes to the Engineer’s attention that the Contractor is in any way in breach of the requirements of the Act and Construction Regulations, 2014 or is failing to comply with the provisions of this clause, the Engineer shall, in accordance with the provisions of Clause 5.11 (GCC 2015) of the Conditions of Contract, be entitled to suspend progress on the works or any part thereof until such time as the Contractor has demonstrated to the satisfaction of the agent, that such breach has been rectified.

A payment item is included in the Bill of Quantities to cover the Contractor's cost for compliance with the OHS Act and the abovementioned regulations.

The Contractor shall have no grounds for a claim against the Employer for extension of time and/or additional costs if the progress on the works or any part thereof is suspended by the Engineer in terms of this clause, and the Contractor shall remain fully liable in respect of the payment of penalties for late completion in accordance with the provisions of Clause 5.13.1 (GCC 2015) of the Conditions of Contract should the Contractor fail to complete the Works on or before the specified due completion date in consequence of the suspension.

Persistent and repeated breach by the Contractor of the requirements of the Act, Construction Regulations, 2014 shall constitute grounds for the Engineer to act in terms of Clause 9.2.1.3.6 (GCC 2015) of the Conditions of Contract and for the Employer to cancel the Contract in accordance with the further provisions of the said Clause 9.2 (GCC 2015)."

Add the following subclauses to clause 5:

"PSA 5.9 SITE MEETINGS

The Contractor or a competent and authorised agent (Clause 4.12.2 of the Conditions of Contract (GCC 2015) will be required to attend regular site meetings, which shall normally be held once a

month on dates and at times determined by the Engineer, but in any case whenever reasonably required by the Engineer. Unless otherwise indicated in the Contract or instructed by the Engineer, such meetings shall be held at the Contractor's offices on the site. At such monthly meetings, matters such as general progress on the works, quality of work, problems, claims, payments, and safety shall be discussed, but not matters concerning the day-to-day running of the Contract.

PSA 6 TOLERANCES

Add the following subclause to clause 6:

"PSA 6.4 USE OF TOLERANCES

No guarantee is given that the full specified tolerances will be available independently of each other, and the Contractor is cautioned that the liberal or full use of any one or more of the tolerances may deprive him of the full or any use of tolerances relating to other aspects of the work.

Except where the contrary is specified, or when clearly not applicable, all quantities for measurement and payment shall be determined from the 'authorised' dimensions. These are specified dimensions or those shown on the Drawings or, if changed, as finally prescribed by the Engineer, without any allowance for the specified tolerances. Except if otherwise specified, all measurements for determining quantities for payment will be based on the 'authorised' dimensions.

If the work is constructed in accordance with the 'authorised' dimensions plus or minus the tolerances allowed, the calculation of quantities will be based on the 'authorised' dimensions, regardless of the actual dimensions to which the work has been constructed.

When the work is not constructed in accordance with the 'authorised' dimensions plus or minus the tolerances allowed, the Engineer may nevertheless, at his sole discretion, accept the work for payment. In such cases no payment shall be made for quantities of work or material in excess of those calculated for the 'authorised' dimensions, and where the actual dimensions are less than the 'authorised' dimensions minus the tolerance allowed, quantities for payment shall be calculated based on the actual dimensions as constructed."

PSA 7 TESTING

PSA 7.1 PRINCIPLES

PSA 7.2 APPROVED LABORATORIES

Replace the contents of subclause 7.2 with the following:

"Unless otherwise specified in the relevant specification or elsewhere in the Project Specifications, the following shall be deemed to be approved laboratories in which design work, or testing required in terms of a specification for the purposes of acceptance by the Engineer of the quality of materials used and/or workmanship achieved, may be carried out:

(a) Any testing laboratory certified by the South African National Accreditation Systems (SANAS) where applicable, in respect of the nature and type of testing to be undertaken for the purposes of the Contract;

(b) Any testing laboratory owned, managed or operated by the Employer or the Engineer;

(c) Any testing laboratory established and operated on the Site by or on behalf of the Employer or the Engineer.

(d) Any other laboratory that the Engineer approves in his absolute discretion."

PSA 8 MEASUREMENT AND PAYMENT

PSA 8.1 MEASUREMENT

PSA 8.1.1 Method of measurement, all sections of the Schedule

Delete the words "and South West Africa".

PSA 8.1.2 Preliminary and General item or section

PSA 8.1.2.1 Contents

Replace the last sentence of subclause 8.1.2.1(b) with the following:

"Separate items will be scheduled to cover the fixed, value-related and time-related components of the Contractor's General items (clause 1.1.1.21 of the Conditions of Contract) in respect of:

(a) Construction work period:

The number of days for reaching the Due Completion Date (Clause 1.1.1.14 of the Conditions of Contract), being the number of days for achieving Practical Completion of the Works, as specified in the Contract Data and as adjusted by such extensions of time or acceleration as may be allowed in terms of Contract.

(b) Construction Work Permit process period (if applicable):

The actual number of days that the Employer or his agent (in terms of the Construction Regulations, 2014) takes to process and issue the instruction to commence with the Works (Clause 5.3.3.2 of the Conditions of Contract, as amended) from the date of submission of the documentation referred to in Clause 5.3.1 of the Conditions of Contract.

PSA 8.1.2.2 Tendered sums

Replace the contents of this subclause with the following:

"Except only where specific provision is made in the Specifications and/or the Schedule of Quantities for separate compensation for any of these items, the Contractor's tendered sums under items PSA 8.3 and PSA 8.4 shall collectively cover all charges for:

- risks, costs and obligations in terms of the Conditions of Contract and of this standardized specification;
- head-office and site overheads and supervision;
- profit and financing costs;
- expenses of a general nature not specifically related to any item or items of the permanent or temporary work;
- providing such facilities on site as may be required by the Contractor for the proper performance of the Contract and for its personnel, including, but without limitation, providing offices, storage facilities, workshops, ablutions, services such as water, electricity, sewage and rubbish disposal, access roads and all other facilities required, as well as for the maintenance and removal on completion of the works of these facilities and cleaning-up of the site of the Contractor's establishment and reinstatement to not less than its original condition, and

PSA 8.2 PAYMENT

PSA 8.2.1 Fixed-charge and value-related items

Replace the contents of subclause PSA 8.2.1 with the following:

PSA 8.2.1.1 Fixed-charge items

"Payment of fixed charges in respect of item 8.3.1 will be made as follows:

(a) EIGHTY PER CENT (80%) of the sum tendered will be paid when the facilities have been provided and approved;

(b) The remaining TWENTY PER CENT (20%) will be paid when the works have been completed, the facilities have been removed and the site of the Contractor's establishment has been cleared and cleaned to the satisfaction of the Engineer.

No adjustment will be made to the sum tendered in respect of item 8.3.1 should the value of the works finally executed or the time for completion vary in any way from that specified in the tender.

PSA 8.2.1.2 Value-related items

Payment for the sum tendered under item PSA 8.3.2 will be made in three separate instalments as follows:

(a) The first instalment, which is 40% of the sum, will be paid when the Contractor has fulfilled all his obligations to date under this specification, the General Conditions of Contract and the Contract Data and when the value of work certified for payment, excluding materials on site and payments for preliminary and general items, is equal to not less than 5% of the total value of the work listed in the Schedule of Quantities.

(b) The second instalment, which is 40% of the sum, will be made when the amount certified for payment, including retention moneys but excluding this second instalment, exceeds 50% of the tender sum.

(c) The final payment, which is 20% of the sum, will be made when the works have been certified as completed and the Contractor has fulfilled all his obligations to date under this Specification, the General Conditions of Contract and the Contract Data.

Should the value of the measured work finally completed be more or less than the tender sum, the sum tendered under item PSA 8.3.2 will be adjusted up or down in accordance with the provisions of Clause 6.11of the Conditions of Contract, and this adjustment will be applied to the third instalment."

PSA 8.2.2 Time-related items

Replace the contents of subclause 8.2.2 with the following:

" Subject to the provisions of subclauses 8.2.3 and 8.2.4, payment under item PSA 8.4.1 (time-related preliminary and general charges) will be made as follows:

(a) Construction work period:

Payment shall be made monthly in equal amounts, calculated by dividing the sum tendered for the item by the number of days stated in Contract Data (Clause 1.1.1.14) in months.

Payment for this item shall be inclusive of the time specified in Clause 1.1.1.14 plus any Extension of Time for Practical Completion but shall exclude all days included in PSA 8.2.2(b) and PSA 8.2.2(c).

(b) Construction work permit process period (if applicable):

Payment shall be for the actual number of days it takes the Employer or his agent (in terms of the Construction Regulations, 2014) to process and obtain a construction work permit (if applicable) after the submission of documentation contemplated in Clause 5.3.1 of the Conditions of Contract. The number of days stated in the Contract Data is for tendering purposes only and shall not be used as an entitlement to substantiate any claim.

The daily rate shall be fully inclusive of all costs associated with this period (refer Programme – Scope of Works) and no claim for additional cost will be considered.

The Contractor shall note that any EoT during this period will be extended by the number of days and will be compensation for at the rate priced for in the BoQ.

Provided always that the total of the monthly amounts paid is not out of proportion to the value of the progress of the Works as a whole."

PSA 8.3 SCHEDULED FIXED-CHARGE AND VALUE-RELATED ITEMS

Replace the contents of subclause 8.3.1 with the following:

"PSA 8.3.1 Fixed preliminary and general charges Unit: sum

The sums tendered shall include full compensation for all fixed-charge preliminary and general charges as described in subclause PSA 8.1.2.2. Payment will be made as described in subclause PSA 8.2.1.1.

Add the following:

(a) De-Establishment ..... Unit: sum

(b) Re-Establishment .....Unit: sum

The sums tendered shall include full compensation for all costs the Contractor will incur to de-establish and re-establish on site.

The Employer may if for reasons beyond the Contractor's control request the Contractor to temporary de-establish form site and re-establish at a later date. If the Contractor is requested to de-establish from site, the Employer must instruct the Contractor to re-establish within a period not exceeding 90 days. If the instruction to re-establish is not given by the Employer within the 90 day period the Employer must either cancel the Contract or extend the period and reimburse the Contractor according to the provisions stated in the General Conditions of Contract.

PSA 8.3.2 Value-related preliminary and general charges Unit: sum

The sums tendered shall include full compensation for all value-related preliminary and general charges as described in subclause PSA 8.1.2.2. Payment will be made as described in subclause PSA 8.2.1.2."

PSA 8.4 SCHEDULED TIME-RELATED ITEMS

Replace the contents of subclause 8.4 with the following:

"PSA 8.4.1 Time-related preliminary and general charges Unit: sum

The sum tendered shall include full compensation for all time-related preliminary and general charges as described in subclause PSA 8.1.2.2. Payment will be made as described in subclause PSA 8.2.2.

(a) Pre-Construction period (if applicable) ..... Unit: days

(b) Construction period..... Unit: sum"

PSA 8.5 SUMS STATED PROVISIONALLY BY THE ENGINEER

Replace the contents of subclause 8.5 with the following:

"**PSA 8.5.1 Works executed by the Contractor**..... Unit: Prov sum

The Contractor will be reimbursed in substitution of the Provisional Sums (if any) allowed in the Schedule of Quantities for work to be executed by the Contractor, in the amounts determined in accordance with the provisions of Clause 6.6 of the Conditions of Contract.

PSA 8.5.2 Works executed by Nominated Subcontractors

(a) Work to be executed by a Nominated Subcontractor ..... Unit: Prov sum

(b) Overheads, charges and profit on item (a) above ..... Unit: % or sum

Subitems (a) and (b) will be provided in the Schedule of Quantities for each different Nominated Subcontract included in the Contract.

The Contractor shall be reimbursed under subitem (a), in substitution of the respective Provisional Sums (if any) allowed in the Schedule of Quantities, the amounts actually paid or payable by the Contractor to the respective Nominated Subcontractors, in accordance with the provisions of Clause 6.6of the Conditions of Contract.

The Contractor shall be paid under subitem (b), either:

(a) where the unit of measurement for subitem (b) was specified as being a percentage, the respective percentage, as stated by the Contractor in is tender, of the amount certified by the Engineer for payment under the related subitem (a), all in accordance with the provisions of Sub-Clause 13.5(b)(ii) of the Conditions of Contract, or

(b) where the unit of measurement for subitem (b) was specified as being a lump sum, an amount which is in the same proportion to the amount certified for payment under subitem (a) and the tendered lump sum is to the amount of the Provisional Sum stated under subitem (a) in accordance with the provisions of Clause 6.6.1.2.2

The percentage or sum (as applicable) paid under subitem (b) as aforesaid, shall be deemed to include for full and final compensation to the Contractor for all costs as may be incurred and all charges and profits associated with the engagement, supervision, administration and management of the Nominated Subcontractor required of him in fulfilling its obligations under the Contract as the Principal Contractor."

PSA 8.6 PRIME COST ITEMS

Replace subclause 8.6 with the following:

"PSA 8.6 PRIME COST SUMS

(a) Description of item to which Prime Cost Sum applies ..... Unit: PC sum

(b) Charge required by Contractor on subitem (a) above ..... Unit: %

Subitems (a) and (b) will be provided in the Schedule of Quantities for each different item to which a Prime Cost Sum applies.

The Contractor shall be reimbursed under subitem(s) (a) in substitution of the respective Prime Cost Sums included in the Contract, the actual price(s) paid or payable by him in respect of the goods, materials or services supplied, but excluding any charges for the Contractor's labour, profit, carriage, establishment or other charges related to such goods, services or materials.

The Contractor shall be paid under subitem (b), the respective percentage, as stated by the Contractor in his tender, of the amount certified by the Engineer for payment under the related subitem (a). The percentages tendered by the Contractor for each respective subitem (b) included in the Schedule of Quantities shall be deemed to be in full and final compensation to the Contractor in respect of any charge by the Contractor for labour, carriage profit, establishment and for any other charges related to the goods, services or materials supplied under the related subitem (a).

If the Contractor shall have omitted within his tender to insert a tendered percentage under subitem (b), or tendered a zero percentage, the Contractor's tendered rate for subitem (b) shall be deemed to be zero and the Contractor shall not be entitled to any payment under subitem (b).

Note in connection with additional tests required by the Engineer:

When a PC sum is included in the Schedule of Quantities for additional tests required by the Engineer, the Contractor shall be responsible for both the cost of normal testing and for the cost of any additional test that indicates that the specifications have not been complied with."

PSA 8.7 DAYWORK

Replace the contents of subclause 8.7 with the following:

"Measurement and payment shall be in accordance with the provisions of Clause 6.5of the Conditions of Contract."

PSA 8.8 TEMPORARY WORKS

PSA 8.8.2 Accommodation of traffic ..... Unit : Sum

Add the following:

"The tendered sum shall include full compensation for all general obligations and incidental items of cost necessary for the safe accommodation of traffic during the construction period. The tendered lump sum shall also include supply, erection and maintenance of all road signs to the satisfaction of the Engineer and the local authority and shall comply with and Traffic Signs Manual (SARTSM) - Road Note 13. No old style signs shall be permitted." and Traffic Signs Manual (SARTSM) - Road Note 13. No old style signs shall be permitted."

Replace item 8.8.4 with the following:

"PSA 8.8.4 Location and protection of existing services

Where particular items are provided in other sections of the bills the costs of detection, exposure, protection and alterations shall be covered by such particular items. Where no such particular items are provided and where there is reason to expect the presence of such a service or services, the following items will apply:

PSA 8.8.4.1 Provision of detecting devices for:

(a) Water and sewer pipes ..... Unit : Sum
(b) Electrical and other cables ..... Unit : Sum
(c) Other……..... Unit : Sum

The tendered sums shall cover the cost of providing and operating suitable equipment for as long as is necessary in order to locate all existing services likely to be affected by the construction activities. Alternatively an approved specialist firm may be employed to carry out the work.

PSA 8.8.4.2 Hand excavation necessary for locating and exposing existing services in all materials:

(a) In roadways ..... Unit : m^3
(b) In all other areas ..... Unit : m^3

The rates shall cover the cost of excavating by means of hand tools within authorised dimensions, for all precautionary measures necessary to protect the services from damage during excavation and backfilling and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 93% of modified AASHTO density.

The rate for hand excavation in roadways shall also include compensation for compacting excavated or selected backfill material to 100% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for under SANS 1200 DB.

The tendered rates shall also include for keeping excavations safe, for dealing with surface and subsurface water and for removal of surplus excavated material from the site."

Add the following items:

"PSA 8.8.7 Dealing with water

(a) Dealing with subsurface water..... Unit : Sum
(b) Dealing with surface water ..... Unit : Sum

The sum shall cover the cost for the provision, operation, maintaining and removal of all plant and materials required to deal with any water anywhere on the Site as required in terms of Subclause 5.1.3 of SANS 1200 D and Subclause 5.1.2 of SANS 1200 DB. No additional payment will be made for "Special water hazards".

The sum shall cover the cost of providing the necessary plant or materials, or both, fully erected and operative on the Site, the cost of operating and maintaining pumps, well points, sheeting, close timbering, and other equipment, as applicable, for 24 hours a day, 7 days a week, throughout the period during which the facilities are required, and the cost of removing such goods and restoring the Site to its original condition on completion of that part of the project for which the temporary works were erected.

Two equal payments will be made, one with the first and the other with the last payment certificate.

PSA 8.8.8 Protection of structures until construction in vicinity is completed:

(c) Name of existing structure stated ..... Unit : Sum
(d) Etc. for other structures

The tendered sum shall include full compensation for all the costs for protecting the existing structures until the construction in the vicinity is completed. Payment will be made in two instalments, the first when the protection measures are in place, and the second when the protection measures have been removed.

Add the following items:

PSA 8.9 WAYLEAVE ..... Unit: sum

The tendered sum shall include full compensation to the Contractor for all the costs involved in obtaining all the necessary wayleaves required on the contract.

PSA 8.10 COMPLIANCE WITH OHS ACT AND REGULATIONS (INCLUDING THE CONSTRUCTION REGULATIONS 2014) .....Unit: sum

The tendered sum shall include full compensation to the Contractor for compliance with all the requirements of the OHS Act and Regulations (including the Construction Regulations 2014) at all times for the full duration of the Contract. The successful tenderer shall provide the Engineer with a complete breakdown of this tendered sum.

This sum will be paid to the Contractor in equal monthly amounts subject to proper/substantial compliance."

PSA 8.11 CONTRACT NAMEBOARDS .....Unit: sum

The tendered sum shall include full compensation to the Contractor for all the costs involved in the supply, installation and maintaining of two contract nameboards as shown on the drawings, including the removal of the boards at the end of the contract period.

PSA 8.12 MISCELLANEOUS ITEMS

An item which, in the payment clause column of the Bill of Quantities, refers to this clause, will be measured in the unit scheduled.

The sum or rate for such item shall cover the cost of all materials, labour and plant required to execute and complete the work as specified, described in the Bill of Quantities or shown on the drawing(s).

PSA 8.13 ENVIRONMENTAL MANAGEMENT.....Unit: sum

The costs of whatever nature for complying with the obligations of the Particular Specification UW 002 (Environmental Management of Construction Projects) and the amendments to the Particular Specification UW002 and the Environmental Management Plan included in Part C4.3 will be deemed to be covered by the sums tendered for the respective items in Section A of the Bill of Quantities.

PSA 8.14 QUALITY MANAGEMENT PLAN.....Unit: sum

The costs of whatever nature for providing the Quality Management Plan as specified in Part C3 will be deemed to be covered by the sums tendered for the respective items in Section A of the Bill of Quantities.

PSA 8.15 PROVISION OF SECURITY PERSONNEL .....Unit: sum

The costs of whatever nature for providing security personnel the Contractor deems appropriate, taking cognisance of the location of the site, will be deemed to be covered by the sums tendered for the respective items in Section A of the Bill of Quantities.

PSAB ENGINEER'S OFFICE

PSAB 3 MATERIALS

PSAB 3.1 NAMEBOARDS

Replace the first sentence of subclause 3.1 of SANS 1200 AB with the following:

"The Contractor shall supply and erect at locations approved by the Engineer, the number of contract nameboards specified in the bills of quantities which, unless otherwise specified in the Contract, shall comply with the recommendations for the standard board of the South African Association of Consulting Engineers with regard to size, painting, decorating and detail, and the requirements described hereunder."

PSAB 3.2 OFFICE BUILDING(S)

Replace the words "as scheduled" *in parenthesis in the first line of subclause 3.2 of SANS 1200 AB with "*as specified in the bills of quantities.

and replace subclause 3.2(j) of SANS 1200 AB with the following:

"(j) a heater and fan or air-conditioning unit capable of both heating in summer and cooling in winter."

Add the following Subclause:

"PSAB 3.2.1 OFFICE BUILDING (S)

The Contractor shall provide, furnish and equip two offices (as scheduled) for the use of the Engineer.

The office buildings shall be painted with an approved paint after erection and the paintwork shall be maintained during the contract period.

Each door shall be provided with a lock and two keys.

The siting of all offices shall be to the approval of the Engineer's and shall be decided upon in consultation with him/her and confirmed in writing before erection.

All office buildings shall include the provision of access roads where required, fresh clean portable water and sewerage, which will be considered as part and parcel of the office building provided and will not be paid for separately.

All office buildings shall meet with the approval of the Engineer.

The offices shall comply with the following requirements.

Dimensions	Type 1 Office	Type 2 Office
Minimum floor area	12 m²	9 m²
Minimum window area	3.0 m	2.4 m²
Minimum clear height	2.4 m	2.4 m

Furniture and Equipment

Each office shall be equipped with the following:

(i) Office desk with a surface area of at least 1.5m² with at least 3 drawers one of which can be locked.

(ii) Two office chairs.

(iii) Sufficient racks and hangers for hanging contract drawings. The hangers shall be of the "Barhold" type, with one hanger to five drawings.

(iv) Double 80-watt fluorescent light fittings complete with ballast and tubes (2 per Type 1 office, 1 per Type 2 office).

(v) Air-conditioner

Add the following subclauses to clause 3:

"PSAB 3.3 CARPORT

The Contractor shall construct the number of carports specified in the bills of quantities, for the sole use of the Engineer and his staff. Each carport shall be constructed so that the vehicle parked under it is always protected against the direct rays of the sun. The carport area shall be at least 20 m² and the floor shall be covered with a layer of crushed stone to alleviate dusty and muddy conditions. The carport(s) shall be positioned so as to provide easy and convenient access to the Engineer's office."

PSAB 4 PLANT

Change the heading of clause 4.4 of SANS 1200 AB to the following:

PSAB 4.1 "COMMUNICATIONS"

Replace subclause 4.1 OF SANS 1200 AB with the following:

"The Contractor shall, subject to the availability from a suitable provider, at his own cost, arrange for the provision in the Engineer's office(s) of internet connection capable of providing Wi-Fi and wired connections, independent of the Contractor's internet service provider. The internet service shall be always available for use by the Engineer and his personnel. The upload and download speed of the internet shall be a minimum of 50 Mbps.

Add the following new subclauses to clause 4 of SANS 1200 AB:

"PSAB 4.2 COMPUTER EQUIPMENT

Where it is specified in C3.4.5.2 .5 of the Scope of Work, that the Contractor shall provide computer equipment on site for the exclusive use of the Engineer and his staff, such computer hardware and software shall comply with the specifications set out in subclauses PSAB 4.2.1 and PSAB 4.2.2 hereunder.

PSAB 4.2.1 Computer hardware

(a) Computers

- laptops
- A4/A3 laser printer

The laptops shall have the minimum specifications as listed below:

- Intel Core i5-6300U Processor Base, Integrated HD Graphics 520
- Intel Core i5-6300U (Dual Core, 2.4GHz, 3MB cache)
- 39.6cm (15.6") FHD (1920x1080) Non-Touch Anti-Glare LCD with Camera and Mic
- Smart Card Reader (Dual Pointing) Palmrest
- Non Touch WWAN HD/FHD LCD Backcover
- 8GB (1x8GB) 2133MHz DDR4 Memory
- M.2 256GB SATA Class 20 Solid State Drive
- South African Power Cord
- Primary 4-cell 62W/HR Battery
- Intel Core i5 vPro Processor Label
- E5 90W AC Adapter, 3-pin
- Intel Dual Band Wireless 8260 (802.11ac) W/ Bluetooth
- Intel Dual-Band Wireless-AC 8260 Driver for South Africa
- SSD Bracket for M2,SATA
- Internal US/International Qwerty Backlit Dual Pointing Keyboard
- Carry Case
- Dual Head Universal Swivel Lock
- Three-button mouse
- Mouse pad

All computer hardware shall be provided complete with the requisite connecting cables and all interfacing devices and software necessary for its efficient operation as an integral system.

(b) Printers

The Printers shall, unless otherwise approved by the Engineer, be Hewlett-Packard or similar approved.

PSAB 4.2.2 Computer software

The following software shall be properly installed on the computer, and the original licence agreements and disks shall be provided to the Engineer for safekeeping.
:
(a) Microsoft Windows (latest edition)

(b) MS-Office (latest edition).

PSAB 4.4 SURVEY EQUIPMENT

The Contractor shall provide survey equipment onsite and make available for the exclusive use of the Engineer and his staff, should he require it. The Engineer shall provide a list of equipment when he requests them.

All survey equipment provided by the Contractor shall be in good condition, properly calibrated and fit for the purpose.

PSAB 5 CONSTRUCTION

Change the heading of clause 5.4 of SANS 1200 AB to the following:

“PSAB 5.4 COMMUNICATION”

Replace the contents of subclause 5.4 of SANS 1200 AB with the following:

PSAB 5.4.1 Communications

The Contractor shall advise the chosen internet service provider promptly of any faults which develop in the internet service and shall, in such circumstances, arrange for the earliest possible restoration of the said service.

The Contractor shall ensure that the internet service provider account is promptly paid.

PSAB 5.8 SURVEY EQUIPMENT

All survey equipment provided by the Contractor shall be kept fully serviceable at all times by the Contractor. The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Engineer's staff.

Where required by the Engineer, the Contractor shall, at his own cost, promptly arrange for the recalibration of survey equipment provided."

Add the following new subclauses to clause 5 of SANS 1200 AB:

"PSAB 5.6 COMPUTER EQUIPMENT

All computer equipment provided shall be kept fully serviceable at all times by the Contractor. The Contractor shall have any defective equipment repaired or replaced at his own cost within 12 hours after notification by the Engineer's staff.

An uncapped data connection with a minimum speed of 50 Megabytes/second should also be provided.

The Contractor shall further provide at his own cost, all paper and black ink cartridges and other consumables reasonably required by the Engineer.

At the end of the Contract, the computer equipment and software shall revert back to the Employer."

PSC SITE CLEARANCE

PSC 3 MATERIALS

PSC 3.1 DISPOSAL OF MATERIAL

Add the following:

"The Contractor shall obtain his own dumping sites for the disposal of material and all transport costs shall be included in the rates tendered for site clearance."

PSC 5 CONSTRUCTION

PSC 5.1 AREAS TO BE CLEARED AND GRUBBED

Add the following:

"Pipeline routes shall be cleared to a distance of 5 m on both sides of the pipeline centre line. Where multiple pipes are installed in parallel along a single pipeline route or pipeline corridor the route shall be a cleared to a distance of 5 m on either side of the centre lines of the external pipelines. Route pegs or markers shall not be destroyed or damaged during clearing operations."

PSC 5.5 RECLEARING OF VEGETATION

Add the following:

"When areas have to be recleared on the written instructions of the Engineer, such reclearing shall be carried out at the Contractor's own cost and the Contractor is therefore advised not to clear the areas too soon."

PSC 8 MEASUREMENT AND PAYMENT

PSC 8.2 PAYMENT

PSC 8.2.1 Clear and grub

Replace the first line with the following:

"The area designated by the Engineer to be cleared and grubbed will be measured in square metre to the nearest square metre or, "

Replace the heading of clause 8.2.9 with the following:

PSC 8.2.10 Remove topsoil to nominal depth of 150 mm and stockpile

Replace "of 150 mm" in the item with:

"as specified in the Schedule of Quantities." Add the following items in SUBCLAUSE 8.2:

"PSC 8.2.11 Take down and re-erect existing fences..... Unit: m

The rate shall cover the cost of taking down the fences, coiling wire, sorting, stacking and guarding all materials, the cost of loading, transporting and off-loading such materials, the cost of re-erecting the fence in its original position using the dismantled material, the cost of temporary bracing of the fencing sections not taken down and the cost of appurtenant materials that may be required to restore the fence to its original condition before dismantling.

PSC 8.2.12 Remove topsoil to spoil site furnished by Contractor..... Unit: m^3

The tendered rate shall include full compensation for removing topsoil to a depth of 150 mm and for loading and transporting the material to spoil sites furnished by the Contractor."

PSD EARTHWORKS

PSD 2 INTERPRETATIONS

PSD 2.1 SUPPORTING SPECIFICATIONS

Replace subclause 2.1.2 *with the following:*

"PSD 2.1.2 Any of the other SANS 1200 specifications may form part of the Contract documents."

PSD 2.3 DEFINITIONS

Replace the word and the definition for "Borrow" *with the following:*

"**Borrow material**: Material, other than material obtained from excavations required for the works, obtained from sources such as borrow pits or the authorised widening of excavations. 'Borrow' shall have a corresponding meaning."

Replace the definition for "Specified density" *with the following:*

"**Specified density**: The specified dry density expressed as a percentage of modified AASHTO dry density."

Replace the definition for "Stockpile" *with the following:*

"**Stockpile** (verb): The process of selecting and, when necessary, loading, transporting and off-loading material in a designated area for later use for a specific purpose"

Add the following definitions:

"**Commercial source**: A source of material provided by the Contractor, not the Employer, and including any borrow pit, provided by the Contractor

Fill: An embankment or terrace constructed of material obtained from excavations or borrow pits. In roads it includes the earthworks up to the underside of the selected subgrade level.

Fill (material): Material used for the construction of an embankment or terrace

Roadbed: The natural in situ material on which the fill or, in the absence of fill, the pavement layers are constructed"

PSD 3 MATERIALS

PSD 3.1 CLASSIFICATION FOR EXCAVATION PURPOSES

PSD 3.1.1 Method of classifying

Add the following:

"The classification of material other than 'soft excavation' shall be agreed upon before excavation may commence.

The Contractor shall immediately inform the Engineer if and when the nature of the material being excavated changes to such an extent that a new classification is warranted for further excavation. Failure on the part of the Contractor to advise the Engineer in good time shall entitle the Engineer to reclassify, at his discretion, such excavated material."

PSD 3.2.3 Material suitable for backfill or fill against structures

Replace the contents of this subclause with the following:

"Material used for backfill behind structures shall generally be the material excavated, subject to the following conditions:

(a) The material shall not contain an excessive number of stones retained on a 50 mm sieve;

(b) The material shall not contain large clay lumps that do not break up under the action of the compaction equipment; and

(c) The liquid limit of the material shall not exceed 40, neither shall the PI exceed 18."

PSD 3.3 SELECTION

Add the following subclause:

"PSD 3.3.3 Selection in excavations

When the Contractor has to select excavated material for a specific purpose, it does not necessarily mean that all the material in that area is suitable for the specified purpose. What it does mean is that the area contains some suitable material. The onus shall rest on the Contractor to ensure that only material that is indeed suitable is removed and used for the specified purpose.

The Contractor shall not waste or contaminate material that has been selected for a specific purpose."

PSD 4 PLANT

PSD 4.4 DETECTORS

Replace the contents of subclause 4.4 with the following:

"The Contractor shall, for the purposes of detecting and locating underground services in accordance with the provisions of subclause 5.4 of SANS 1200 A and subclause 5.1.2 of SANS 1200 D, at his own cost, provide and use detecting equipment which is suitable for the detection of underground cables and pipes."

PSD 5 CONSTRUCTION

PSD 5.1 PRECAUTIONS

PSD 5.1.1 Safety

PSD 5.1.1.1 Barricading and lighting

Replace "Machinery and Occupational Safety Act, 1983 (Act 6 of 1983)" *with* "Occupational Health and Safety Act, 1993 (Act No 85 of 1993)".

PSD 5.1.1.2 Safeguarding of excavations

Replace "Machinery and Occupational Safety Act" *with* "Occupational Health and Safety Act, 1993 (Act No 85 of 1993)".

PSD 5.1.1.3 Explosives

Replace the contents of this subclause with the following:

"The Contractor will generally be permitted to use explosives for breaking up hard material during excavations, for demolishing existing structures, and for other purposes where explosives are normally required, subject to the following conditions:

(a) The Engineer may prohibit the use of explosives in cases where, in his opinion, the risk of injury to persons or damage to property or to adjoining structures is too high. Such action by the Engineer does not entitle the Contractor to additional payment for having to resort to less economical methods of construction.

(b) The Engineer's prior written approval shall be obtained for each and every blasting operation. This approval may be withheld if the Contractor does not use explosives responsibly and carefully.

(c) The Contractor shall comply fully with the requirements of the Explosives Act, 1997 (Act No 83 of 1997) and all other legislation and regulations as may be applicable to blasting and the use of explosives.

(d) Before blasting is undertaken, the Contractor shall satisfy the Engineer that he has established whether or not the insurers concerned require pre- and post-blasting inspections of buildings and structures within a certain radius of the proposed blasting.

Should such inspections be required, the Contractor shall, together with the Engineer and the insurer, examine and measure the buildings, houses or structures in the vicinity of the proposed blasting site and establish and record, together with the owner, lessee or occupier, the extent of any existing cracking or damage before blasting operations commence.

(e) When there is a possibility of damage to power and telephone lines or any other services or property, the Contractor shall adapt his method of blasting and the size of the charges and shall use adequate protective measures (e.g. cover-blasting) to reduce the risk of damage.

(f) All accidents, injury to persons and animals and damage to property shall be reported to the Engineer in detail and in writing as soon as is practicable.

(g) The Engineer shall be given 24 hours' notice by the Contractor before each blasting operation is carried out.

(h) When blasting to specified profiles, the Contractor shall so arrange the holes and charges that the resulting exposed surfaces are as sound as the nature of the material permits. The Contractor shall make good, at his own expense, any additional excavation necessitated by the shattering of rock in excess of any overbreak allowances specified in the Project Specifications or given on any Drawing.

Notwithstanding the Contractor’s compliance with the above provisions, the Contractor shall remain liable for any injury to persons and animals and loss of or damage to property occurring as a result of blasting operations."

PSD 5.1.2 Existing services

PSD 5.1.2.2 Detection, location and exposure

Replace the contents of subclause 5.1.2.2 with the following:

"The exposure by the Contractor of underground services, as required in terms of subclause 5.4 of SANS 1200 A (as amended) shall be carried out by careful hand excavation at such positions and to such dimensions as are agreed to by the Engineer.

Unless otherwise instructed or agreed by the Engineer, no service shall be left exposed after its exact position has been determined and all excavations carried out for the purposes of exposing underground services shall be promptly backfilled and compacted to the following densities:

(a) In roadways: 93% modified AASHTO density; and

(b) In all other areas: 90% modified AASHTO density.

Where hand excavations to expose underground services have to be carried out in roadways, the Contractor shall reinstate the road layerworks in accordance with the provisions of subclause 5.9 of SANS 1200 DB.

Payment in respect of exposing the services by means of hand excavation as described above, will be made in accordance with subclause PSD 8.3.8.1.

Payment in respect of reinstating layerworks in roadways will be made in accordance with subclause 8.3.6.1 of SANS 1200 DB (as amended)."

PSD 5.1.2.3 Protection of cables

Replace subclause 5.1.2.3 with the following:

"5.1.2.3 Protection during construction

Further to the requirements of subclause 5.4.2 of SANS 1200 A (as amended), major excavating equipment and other plant shall not be operated dangerously close to known services. Where necessary, excavation in close proximity to known services shall be carefully carried out with suitable hand tools, excluding picks wherever their use could damage the services. No additional payment will apply to such more difficult work.

Should any service not being a known service be discovered or encountered during the course of the Contract, the Contractor shall, in addition to complying with the requirements of subclause 5.4.2 of SANS 1200 A (as amended), immediately notify the Engineer thereof and implement such measures as will prevent damage of such service or, if it was damaged in the course of discovery, will prevent and minimise the occurrence of any further damage occurring."

PSD 5.1.2.4 Negligence

Delete subclause 5.1.2.4.

PSD 5.1.3 Stormwater and groundwater

Add the following:

"The Contractor shall, where applicable and at the earliest practicable opportunity, install the permanent drainage specified or shown on the Drawings and shall at his own cost provide the temporary drainage required to protect the works."

PSD 5.1.5 Reinstatement and maintenance of roads

Add the following:

"Where crossings have been made, the roads shall be reinstated in accordance with the details specified in subclause 5.9 of SANS 1200 DB."

PSD 5.1.6 Road traffic control

Delete the second sentence of subclause 5.1.6.

PSD 5.2 METHODS AND PROCEDURES

PSD 5.2.2 Excavation

PSD 5.2.2.1 Excavation for general earthworks and for structures

Add the following to paragraph (b):

"When the nature of the material precludes the above procedure, additional excavations shall be carried out to provide working space for the erection of formwork. The tendered rate for item 8.3.5 will be deemed to include the cost of a working width of 600 mm, but the Contractor may excavate a greater working width at no additional cost to the Employer."

Replace the first sentence of paragraph (e) with the following:

"Where excavations have been carried below the authorised levels, the Contractor shall backfill such excavations to the correct level with approved gravel compacted to 90% of modified AASHTO density or to the density of the surrounding material, whichever is the higher density.

Where excavations for structures have been carried out in hard material, the Engineer may direct that over-excavation be backfilled with weak concrete if there is a danger of settlement or differential settlement of the foundations.

Where the sides of excavations against which concrete is to be cast have been over-excavated or have collapsed partially, the Contractor shall retrim the excavations if necessary and, unless other remedial measures are agreed to by the Engineer, shall cast the concrete for the structure, including the additional concrete that may be required as a result of the over-excavation or partial collapse. The cost of the additional concrete or remedial measures shall be for the Contractor's account."

PSD 5.2.2.3 Disposal

Replace the second sentence with the following:

"The Contractor shall provide all necessary spoil sites for the spoiling of all surplus and unsuitable materials and shall make the necessary arrangements with the owner of the site where the material is disposed of, and pay all charges and levies as may be applicable for the use of such spoil sites.

Every spoil site provided by the Contractor shall be approved by the local authority in whose area it is located, and the spoiling shall comply with the applicable statutory and municipal regulations as well as the requirements of the owner of the spoil site.

Payment to the Contractor in respect of locating and making arrangements for suitable spoil sites and spoiling material at the such sites will be made in accordance with the provisions of subclause PSD 8.3.15."

Add the following subclause in subclause 5.2.2:

"PSD 5.2.2.4 Selection and stockpiling

Approval or designation of the material in a particular borrow pit or excavation for a particular purpose does not imply that all the material in the borrow pit or excavation is suitable for the particular purpose to which the said approval or designation relates, nor that all material in the borrow pit or source should be used for the particular purpose. The Contractor shall select suitable material from that borrow pit or source, discard unsuitable material and reserve material for other purposes as necessary.

The Contractor shall organise and carry out his operations in such a manner as will prevent the contamination of suitable embankment and backfill material with unsuitable materials. Any excavated material which becomes, in the Engineer's opinion, unsuitable for use in embankments or backfill as a result of contamination, shall be disposed of in a manner acceptable to the Engineer and shall be replaced by the Contractor with materials acceptable to the Engineer, all at the Contractor's cost.

When required, or when ordered by the Engineer, material shall be stockpiled for later use. The additional costs for stockpiling material shall be paid to the Contractor in accordance with the provisions of subclause PSD 8.3.14."

PSD 5.2.5 Transport for earthworks

Add the following new subclause to clause 5.2.5:

"PSD 5.2.5.3 Special cases relating to overhaul

(a) When material is excavated and stockpiled on the Engineer's instructions before being reloaded and transported to its point of final use, free-haul shall apply twice, firstly from the point of excavation to stockpile and secondly from stockpile to the point of final use (see subclause PSD 8.3.14).

(b) When material is to be spoiled on a site which has to be provided by the Contractor, or otherwise disposed of at the Contractor's initiative, the extra-over rate for excavation and disposal at spoil sites provided by the Contractor (see item PSD 8.3.15) shall include full compensation for all haul entailed by this operation and no overhaul shall apply."

PSD 7 TESTING

PSD 7.2 TAKING AND TESTING OF SAMPLES

Replace the contents of this subclause with the following:

"The Contractor shall arrange with the approved independent laboratory engaged by the Contractor in terms of the Project Specifications to carry out sufficient tests on a regular basis as agreed between him and the Engineer to determine whether the degree of compaction, and, where applicable, the quality of materials used, comply with the Specifications and shall submit the results of these tests to the Engineer in a form approved by him.

The compaction requirements for fills shall be deemed complied with when at least 75% of the dry-density tests on any lot show values equal to or above the specified density and when no single value is more than five percentage points below the specified value."

PSD 8 MEASUREMENT AND PAYMENT

PSD 8.3 SCHEDULED ITEMS

PSD 8.3.1 Site preparation

Replace subclauses 8.3.1.1 and 8.3.1.2 with the following:

"Where site preparation such as clearing, grubbing, the removal of large trees or the removal and stockpiling of topsoil is required, the provisions and scheduled items of SANS 1200 C shall apply."

PSD 8.3.2 Bulk excavation

Replace the contents of item with the following:

"(a) Excavate in all materials and use for embankment or backfill as ordered, from:

(1) Necessary excavations ..... Unit: m³

(2) Designated ..... Unit: m³

(3) Commercial sources ..... Unit: m³

The unit of measurement shall be the cubic metre measured in place in accordance with subclause 8.2 of SANS 1200 D.

Separate items will be scheduled for embankments and backfills for different parts of the works.

The tendered rates shall cover the cost of complying with all the precautions required in terms of subclause 5.1 of SANS 1200 D (as amended), in addition to the cost of excavating in all materials, basic selecting, loading, transporting including all haul, off-loading, spreading or backfilling, watering, compacting, final grading, complying with the requirements for tolerances, providing for testing, finishing and tidying, all in accordance with the specifications.

In addition to the aforegoing, the tendered rate for subitem (b) shall further include for the costs of royalties (if applicable), whilst the tendered rate for subitem (c) shall also include for the costs of finding a source of suitable material, for making arrangements with the owner of the source, for procuring the material, for the payment of all requisite royalties, charges or damages, and for transporting the material to the site regardless of the distance involved. No payment will be made for the removal of overburden or stockpiling at the commercial source and no extra over payment shall apply for excavating in intermediate, hard or boulder material."

(b) Excavate in all materials and dispose ..... Unit: m³

The unit of measurement shall be the cubic metre of material excavated, measured in place in accordance with subclause 8.2 of SANS 1200 D.

The tendered rates shall cover the cost of complying with all the precautions required in terms of subclause 5.1 of SANS 1200 D (as amended), in addition to the cost of excavating, basic selecting, loading, transporting including all haul, off-loading at the spoil site, maintaining and finishing the spoil site, all in accordance with the specifications.

(c) Extra over subitems PSD 8.3.2(a)(1), PSD 8.3.2(a)(2) and PSD 8.3.2(b) for:

(1) Hard rock excavation ..... Unit: m³

(2) Boulder excavation, Class A ..... Unit: m³

(3) Boulder excavation, Class B ..... Unit: m³

The rate shall cover the additional cost of the operations enumerated in subclauses 8.3.2.(a) and 8.3.2.(b) above for any portion of the excavation that is classified as intermediate, hard rock, boulder excavation class A or boulder excavation class B as applicable. (See Drawing D-2.)"

PSD 8.3.3 Restricted excavation

Replace the words "in 1 m increments" *at the end of the first sentence of subitem (a) with* "in the increments indicated in the Bill of Quantities".

Replace "in 5.2.2.1 – 5.2.2.3 (inclusive)" *at the end of subclause (a) with* "in subclauses 5.2.2.1 to 5.2.2.5 (inclusive)".

Add the following subitem:

"(c) Extra over subitem 8.3.3 (a) for hand excavation ..... Unit: m³

This item shall apply to hand excavation ordered by the Engineer or when the Engineer considers that, owing to circumstances, excavation by mechanical excavators is not practicable. It shall not apply to hand excavation for trimming or finishing an excavation made by mechanical means.

The tendered rate shall include full compensation for the additional cost of excavating by means of hand tools."

PSD 8.3.4 Importing of materials

Delete subitem (a) of 8.3.4.

PSD 8.3.6 Overhaul

Add the following:

"No overhaul shall apply to material from commercial sources or to material disposed of on sites provided by the Contractor or disposed of by other means employed by the Contractor."

PSD 8.3.8 Existing services

PSD 8.3.8.1 Location

Replace item 8.3.8.1 with the following:

"8.3.8.1 Hand excavation for locating and exposing existing services:

(a) In roadways ..... Unit: m³

(b) In all other areas ..... Unit: m³

The unit of measurement shall be the cubic metre of material excavated, measured in place according to the authorised or actual dimensions of the excavation, whichever is the lesser.

The tendered rates shall cover the cost of excavating in all materials by means of hand tools within authorised dimensions and at locations approved by the Engineer in accordance with the requirements of subclause PSA 5.4.1 for all precautionary measures necessary to protect the services from damage during excavation and backfilling, and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 90% of the modified AASHTO density.

The tendered rate for hand excavation in roadways shall include compensation for compacting excavated or selected backfill material to 93% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for in terms of SANS 1200 DB.

The tendered rates shall also include for keeping excavations safe, for dealing with surface and subsurface water, for removing surplus excavated material from the site, for transporting all material, and for supplying adequate supervision during both excavation and backfilling operations."

PSD 8.3.10 Topsoiling

Change the unit to "m³" *and replace the contents of this item with the following:*

"The unit of measurement shall be the cubic metre and the quantity shall be calculated from the authorised dimensions.

The tendered rate shall include loading of the topsoil from stockpiles, transporting it for the free-haul distance, and off-loading, spreading, shaping and lightly compacting the topsoil."

PSD 8.3.12 Road traffic signs and markings

Replace the word "Separate" in the first sentence of item 8.3.12 with the following:

"Where the Engineer requires the provision of road traffic signs and/or road markings and/or any other measures additional to those to be provided by the Contractor in accordance with subclause 5.1.6, separate …".

Add the following items in subclause 8.3:

"PSD 8.3.14 Extra over items PSD 8.3.2.(a)(1) and PSD 8.3.3 for temporary stockpiling ..... Unit: m³

The unit of measurement shall be the cubic metre of material from necessary excavations, temporarily stockpiled by the Contractor on the instructions of the Engineer, before being used in embankments or backfill. Measurements shall be taken in place in compacted embankment or backfill as the case may be.

The tendered rate shall include for the costs, additional to those provided for in PSD 8.3.2(a)(1) and PSD 8.3.3, of off-loading, forming and maintaining the stockpile for as long as is required, reloading and transporting including all haul from stockpile.

Payments to the Contractor under this item will only be made in respect of that material stockpiled on the instructions of the Engineer (which instruction shall state specifically that payments for such stockpiling will be paid for under this item) and no payments will be made to the Contractor under this item in respect of materials stockpiled by the Contractor on his own volition, nor for materials necessarily stockpiled by the Contractor in consequence of the sequence of operations adopted by him in the course of executing the works, whether such stockpiling was avoidable or otherwise."

"PSD 8.3.15 Extra over items PSD 8.3.2(b) and PSD 8.3.3 for disposing of spoil material on a site provided by the Contractor ..... Unit: m³

The unit of measurement shall be the cubic metre measured in accordance with subclause 8.2 of SANS 1200 D of surplus and/or unsuitable material disposed of, on the instruction of the Engineer, at a spoil site or spoil sites provided by the Contractor.

The tendered rate shall include full compensation for the additional cost of providing a spoil site or other means of disposing of surplus spoil material, for transporting the material regardless of the distance involved, for acceptance charges for such material and for all other incidental costs to dispose of the spoil material."

"PSD 8.3.16 Temporary works: Control ground water inflow and ground water level at Structure ..... Unit: Sum

Where this item is provided in the Bill, the tendered rate shall include all cost associated to keep the excavations dry, and the groundwater table low to prevent the structure from floating for the duration of the Contract. A drainage system form part of the construction scope and could be utilised to assist. In general the drainage system drains to a sump which shall be pumped down when the structure is at risk.

PSDB EARTHWORKS (PIPE TRENCHES)

PSDB 3 MATERIALS

PSDB 3.5 BACKFILL MATERIALS

Add the following paragraphs to subclause 3.5:

"(c) Cement-stabilized backfilling

Backfilling shall, where directed by the Engineer, be stabilized with 5% cement. The aggregate shall consist of approved soil or gravel containing stones not bigger than 38 mm and with a plasticity index not exceeding 10.

The soil or gravel shall be mixed with 5% cement and shall be compacted in layers of 100 mm thick to 90% of modified AASHTO density.

(d) Soilcrete backfilling

The aggregate for soilcrete shall be mixed with 5% cement and shall consist of approved soil or gravel containing stones not bigger than 38 mm and with a plasticity index not exceeding 10.

The soil or gravel shall be mixed in a concrete mixer with the cement and enough water to acquire a consistency that allows the mixture to be placed with vibrators to fill all voids between the pipe and the sides of the trench. Shuttering shall be used where necessary."

PSDB 3.7 SELECTION

Replace the words "if he so wishes" *in the first line of the second paragraph with the words* "at his own cost".

PSDB 5 CONSTRUCTION

PSDB 5.1 PRECAUTIONS

PSDB 5.1.3 Accommodation of traffic and access to properties

*Replace the semicolon and the word "*and" *at the end of subclause 5.1.3(a) with a full stop and replace item (b) with the following:*

"(b) Where necessary to achieve compliance by the Contractor with his obligations to provide and maintain pedestrian and vehicular access to properties affected by the works, the Contractor shall construct and maintain to the satisfaction of the Engineer, such temporary access roads around, and/or steel or timber bridges over excavations in roads, pavements, entrances or accesses to properties.

Temporary pedestrian access bridges shall be at least 1,2 m wide and temporary access bridges for vehicles shall be at least 3,6 m wide. All temporary access bridges shall be fitted with handrails as well as protective mesh fencing on both sides.

On completion of the work, the Contractor shall dismantle and remove all such temporary constructions and reinstate these areas to their former condition.

Except only where the Engineer has included in the Schedule of Quantities, particular payment items specifically therefor, the Contractor will not be paid directly for the construction and maintenance of temporary access roads and/or the provision and maintenance of bridges as aforementioned, and the costs thereof shall be deemed included in the Contractor's tendered rates for excavation."

Add the following new subclause to subclause 5.1:

"PSDB 5.1.5 Removal of existing pipelines

Where existing pipes have to be removed, they shall be carefully opened up by machine excavation to 300 mm above the pipes after which the whole pipe shall be fully exposed by means of hand excavation. The excavation width shall comply with subclause 8.2.3.

The pipes shall be removed from the trench in a manner approved by the Engineer, and brought to the surface for inspection by the Engineer.

Pipes that are declared suitable for reuse and pipes declared unfit for reuse shall be dealt with in an applicable manner described in the specifications, or on the Drawings or on the Engineer's instructions, as relevant."

PSDB 5.2 MINIMUM BASE WIDTHS

Replace paragraph (a) with the following:

"Where two pipes are placed in the same trench, they shall be 500 mm apart or as indicated on the Drawings and the specified side allowance shall still be applicable."

Add the following after paragraph (b):

"The above is not applicable to trenches for subsurface drains.

Trenches for subsurface drains shall be excavated to the dimensions and gradients shown on the Drawings or directed by the Engineer.

The specified width of trenches and the width of the excavation measured for payment shall not be less than 0,5 m, but the Contractor may reduce the actual width with the Engineer's permission."

PSDB 5.4 EXCAVATION

Add the following:

"Except where otherwise specified, trenches shall be of such a depth that the minimum cover over the pipes shall be 1000 mm except at road-crossings where the minimum cover shall be 1 200 mm."

PSDB 5.6 BACKFILL

PSDB 5.6.3 Disposal of soft excavation material

Replace the words "unless otherwise required in the project specification." *at the end of subclause 5.6.3 with:*

"… or to spoil in accordance with the requirements of subclause PSD 5.2.2.3, as instructed by the Engineer."

Add the following new subclauses in clause 5:

"PSDB 5.11 REMOVAL OF EXISTING PIPES

Where shown on the Drawings or where so instructed by the Engineer, the Contractor shall excavate, expose and remove from the ground, existing water pipelines.

If so instructed by the Engineer, the Contractor shall, before commencing with the excavation of the pipeline, expose the pipeline to be removed by means of careful hand excavation at positions agreed with the Engineer, in accordance with the requirements of subclause PSA 5.4. Measurement and payment for locating the exact positions of the pipelines where required by the Engineer shall be made in accordance with and under item PSD 8.3.8.1.

Thereafter, the existing pipelines to be removed shall be carefully opened up by machine excavation to a depth of not more than 300 mm above the pipes after which the whole pipeline shall be fully exposed by means of careful hand excavation. The excavation width shall comply with subclause 5.2.

The pipes and all specials encountered (e.g. bends, valves, valve box covers and the like) shall be removed from the trench in a manner as to avoid causing damage and as approved by the Engineer, cleaned sufficiently as to allow inspection of the pipes and specials by the Engineer and stacked in such a manner as will facilitate the inspection of each pipe and special by the Engineer.

Pipes and specials declared suitable by the Engineer for reuse shall be transported to the Employer's storeyard, where they shall be off-loaded and neatly stacked to the satisfaction of the Engineer. The

Contractor shall be responsible for obtaining a written receipt of all pipes so delivered to the Employer's storeyard.

Pipes and specials which are declared unsuitable by the Engineer for reuse shall be transported to a spoil site and covered with spoil material to a depth of not less than 300 mm.

After removal of the pipelines, the trenches shall be backfilled using the excavated material and compacted to 90% modified AASHTO density. The provisions of subclauses 5.6 and 5.7 shall apply."

PSDB 8 MEASUREMENT AND PAYMENT

PSDB 8.1 BASIC PRINCIPLES

Add the following:

"PSDB 8.1.2 In the road prism or building platform the ground surface from which depth will be measured will always (irrespective of operation sequenced) be the road bed level at centre-line."

PSDB 8.2 COMPUTATION OF QUANTITIES

Replace the contents of subclause 8.2.3 with the following:

"PSDB 8.2.3 Wherever volumetric measurement is required, the volume will be computed according to the depths indicated on the drawings, or to the bottom of the specified bedding cradle, whichever is the greater, and the width determined from the applicable side allowance set out below (see drawing DB-4) plus the nominal width of the pipe. Side allowance shall be measured from the outside of the pipe. No allowance shall be made for the extra thickness of the collars or couplings.

All Pipes Excluding Ducts		
Nominal Diameter, mm		**Side clearance on each side, mm**
From	**To**	
0	125	200
125	700	300
700	1000	400
1000	2000	500
2000	-	600

The side allowance for ducts shall be 150 mm and there shall be 300 mm between a Telkom duct and any other duct/service placed in the same trench.

Where two or more pipes/ducts are to be placed in one trench, the specified base width shall be calculated as follows:

The trench width for the deeper service shall be calculated according to above specifications. The effective trench width for the shallower service shall then be the difference between its specified base width and the overlap with the trench of the deeper service.

The trench width for subsurface drains shall be as shown on the drawings."

PSDB 8.3 SCHEDULED ITEMS

PSDB 8.3.2 Excavation

(a) Excavate in all materials, for trenches, backfill compact and dispose of surplus material

*Replace "*of 1,0 m" *in the first sentence of 8.3.2(a) with* "as specified in the Schedule of Quantities."

(b) Extra over item (a) above for:

Add the following at the end of the existing subitem 2:

"No payments will be made under subitems (1) and (2) in respect of any materials measured and paid for under subitem 3 below."

And add the following new subitems in 8.3.2(b):

"(3) Hand excavation where ordered by the Engineer in:

(a) Soft material ..... Unit: m³

(b) Hard material ..... Unit: m³

The unit of measurement shall be the cubic metre of material, measured in place according to the authorised dimensions, which was excavated by hand on the specific prior written instructions of the Engineer; provided always that the Engineer's said instruction shall have stated that measurement and payment for such hand excavation will be in accordance with this item.

The tendered rate shall include full compensation for the additional cost, effort and time resulting from excavating in the respective materials using hand methods only.

The Engineer shall not be obliged to authorise payment under this item in respect of any hand excavation carried out (whether ordered in writing or otherwise), which hand excavation was in any case necessary to achieve compliance by the Contractor with his obligations under the Contract to

(i) utilise construction appropriate to the nature of the specific parts of the works; and/or

(ii) protect existing structures and/or services; and/or

(iii) comply with all prevailing legislation and regulations.

(4) Backfill stabilized with 5% cement where directed by the Engineer ..... Unit: m³

The unit of measurement shall be the cubic metre of backfill material, measured in place after compaction according to the authorised dimensions, which was stabilized on the Engineer's instructions in accordance with subclause PSDB 3.5(c).

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing, backfilling and compacting the stabilized material to 90% of modified AASHTO density.

(5) Soilcrete backfill where directed by the Engineer ..... Unit: m³

The unit of measurement shall be the cubic metre of soilcrete placed on the Engineer's instructions in accordance with subclause PSDB 3.5(d), measured in place according to the authorised dimensions.

The tendered rate shall include full compensation for supplying the cement and for selecting, mixing and placing the soilcrete as well as for the cost of shuttering if required."

Add the following subitems in 8.3.2 after subitem 8.3.2(c):

"(d) Excavate in all materials for stormwater inlet and outlet structures and for manholes, catchpits, valve chambers and the like, irrespective of depth, and backfill around structures: ..... Unit: m³

The unit of measurement shall be the cubic metre of material excavated, measured in place according to the authorised dimensions, and excluding the volume of material excavated and paid for under subitem (a).

The tendered rate shall include for the costs of excavating in all materials, backfilling, compacting, trimming and tidying the final surface around the structure, disposing of surplus and unsuitable materials within the free-haul distance and, where applicable, selecting and keeping separate, excavated material suitable for use as backfill.

(e) Excavate open drains in all materials..... Unit: m³

The tendered rates shall include full compensation for excavating in all materials within the dimensions specified or authorised by the Engineer and to the specified lines and profiles, for the disposal of surplus and unsuitable excavated material where applicable, and in the case of item (d), for backfilling with suitable approved material compacted to 90% of modified AASHTO density around the structures.

(f) Extra over subitems (d) and (e) for excavating in:

(1) Soft material ..... Unit: m^3

(2) Hard rock material ..... Unit: m^3

Measurement and payment shall be in accordance with the provisions of 8.3.2(b) of SANS 1200 D (as amended)."

PSDB 8.3.3 Excavation ancillaries

PSDB 8.3.3.3 Compaction in road reserves

Replace the heading of this subitem with the following:

"PSDB 8.3.3.3 Compaction in road crossings"

Replace the sentence, "The volume will be measured as specified in 8.2.2, 8.2.3 and 8.3.3.1", *with the following:*

"To determine the volume in the case of gravel roads, the depth will be measured from the underside of the gravel wearing course to the top of the fill blanket, and in the case of bitumen roads, from the underside of the subbase to the top of the fill blanket.

The rest of the trench shall be backfilled as specified in clauses 5.9.3, 5.9.4 and 5.9.5, as applicable, and payment will be made under item 8.3.6.1."

PSDB 8.3.3.4 Overhaul

Replace the contents of this item with the following:

"Measurement and payment shall be in accordance with subclause PSD 5.2.5."

PSDB 8.3.7 Accommodation of traffic

Replace the heading and contents of item 8.3.7 with the following:

PSDB 8.3.7 "Accommodation of traffic .....Unit: sum

The tendered sum shall, (except where particular items are scheduled to cover particular costs) include full compensation for compliance with the requirements of 5.1.3 of SANS 1200 DB (as amended), including the construction and maintenance of bypasses and the use of existing roads as bypasses during the construction period.

It shall also include full compensation: for the provision, maintenance and removal of all traffic control measures, including temporary traffic signs, road markings, lighting, barricading, flagmen and, where necessary, communications equipment to regulate traffic; for the construction of temporary drainage works; for the maintenance of drainage works; and for arrangements for moving and subsequently reinstating services for the purposes of accommodating traffic, attending to traffic problems and complying with the requirements of the Road Traffic Ordinance and the relevant local authorities.

The tendered lump sum shall not be adjusted in the event of any extension of time for completion being granted by the Engineer in accordance with Sub-Clause 8.4 of the Conditions of Contract.

Payment shall be made in equal monthly instalments over the entire period allowed for completion, provided that where any extension of time for completion is granted, the amount which shall be payable under this item in any subsequent monthly payment certificate shall be the outstanding unpaid amount of the lump sum,

divided by the number of months remaining until the due completion date of the Contract, as revised in accordance with the Conditions of Contract."

Add the following items to subclause 8.3:

"PSDB 8.3.8 Removal of existing pipes

(a) Excavate in all materials to 300 mm above the pipelines..... Unit: m^3

The unit of measurement shall be the cubic metre of material excavated for the removal of pipelines in accordance with PSDB 5.11, measured in place according to the authorised dimensions. Depth shall be measured from the ground surface on the centreline of the pipeline to 300 mm above the pipe barrel.

The tendered rate shall include for excavating by any method in all materials and placing the excavated material alongside the trench.

(b) Excavate by hand to expose pipes ..... Unit: m

The unit of measurement shall be the linear metre of pipeline finally exposed by hand excavation methods, measured in plan view along the centreline of the pipeline, irrespective of the class of pipe. Separate items will be scheduled for each different diameter of pipe. The pipe volume as well as the volume of all associated structures such as junction boxes, manholes, valve chambers and the like shall be excluded from the volume of excavation measured.

The tendered rates shall be in full and final compensation for excavating by hand methods from a depth of 300 mm above the pipe barrel in accordance with PSDB 5.1.5 to expose the pipe to its bottom, irrespective of the type or class of pipe, as well as for excavating by hand around junction boxes, manholes, valve chambers and the like.

(c) Remove pipes from trench and stack for inspection ..... Unit: m

The unit of measurement shall be the linear metre of each type and diameter of pipe removed from the trench in accordance with subclause 5.11, measured in plan view along the centreline of the pipeline, without deduction for specials, junction boxes, manholes, valve chambers and the like as may be encountered. Separate items shall be scheduled for each different class and diameter of pipe.

The tendered rates shall be fully inclusive for uncoupling the individual pipes and specials, all additional excavation as may be necessary to facilitate the insertion of lifting slings or the utilisation of other lifting equipment, the provision and utilisation of all such lifting equipment as may be necessary (e.g. cranes), for lifting the pipes and specials out of the trench, cleaning and stacking them along the side of the trench for inspection, attending during the Engineer's inspection and recording the Engineer's decisions on each pipe/special. The tendered rate shall further include for the demolition and removal from the trench of all associated pipeline structures as may be encountered, such as junction boxes, inlet and outlet structures, valve chambers, anchor blocks and the like, and the loading and removal of the debris to spoil.

(d) Deliver pipes and specials declared reusable:

(i) Pipes..... Unit: m

The unit of measurement shall be the linear metre of pipe declared reusable by the Engineer and delivered to the address specified in subclause PSDB 5.11. Separate items will be scheduled for each different type and class of pipe. The tendered rates shall be fully inclusive for loading the pipes at the side of the trench, transporting to and off-loading at the location specified in PSDB 5.11, and carefully stacking separately according to the type, class and diameter of the pipes.

(ii) Specials ..... Unit: number

The unit of measurement shall be the number of specials declared reusable by the Engineer in accordance with subclause PSDB 5.11 above, irrespective of the type or diameter of the special, delivered to the address specified in subclause PSDB 5.11.

The tendered rate shall be fully inclusive for loading the specials at the side of the trench, transporting to and off-loading at the location specified in PSDB 5.11, and carefully stacking separately according to the type, class and diameter of the specials.

(e) Dispose of pipes and specials unsuitable for reuse:

(i) Pipes ..... Unit: m

The unit of measurement shall be the linear metre of pipe declared by the Engineer to be unsuitable for reuse and disposed of by the Contractor in accordance with the requirements of PSDB 5.11.5. Separate items will be scheduled for different types and diameters of pipe.

The tendered rates shall be fully inclusive for loading the pipes at the side of the trench, transporting to and off-loading at the spoil site and dealing with them as specified in PSDB 5.11.5.

(ii) Specials ..... Unit: number

The unit of measurement shall be the number of specials declared by the Engineer to be unsuitable for reuse and disposed of by the Contractor in accordance with the requirements of PSDB 5.11.5. Separate items will be scheduled for different types of special.

The tendered rate shall include for loading the specials at the side of the trench transporting them to and off-loading them at the spoil site, and dealing with them as specified in PSDB 5.11.5.

(f) Backfill and compact trench ..... Unit: m^3

The unit of measurement shall be the cubic metre of compacted fill, measured tight according to the authorised dimensions of the trench.

The tendered rate shall be fully inclusive for placing excavated material in the trench and compacting in accordance with subclauses 5.6 and 5.7.

(g) Make up deficiency in backfill material ..... Unit: m^3

The unit of measurement shall be the cubic metre of backfill obtained from sources other than the trench excavated for the purposes of removing the pipeline in order to make up any deficiencies in backfill material resulting from the volume previously occupied by the pipeline.

Except that the volume shall be determined as the external volume of the pipes removed together with the external volume of all ancillary structures removed along the pipeline, measurement and payment shall be in accordance with 8.3.3.1 of SANS 1200 DB.

PSDK GABIONS AND PITCHING

PSDK 3 MATERIALS

PSDK 3.2.1 Stone

Replace the contents of table 2 with the following:

"TABLE 2: SIZE AND MASS OF INDIVIDUAL STONES FOR PITCHING

1	2	3	4
Size/mass of pitching	Thickness of pitching mm, min	Least dimension mm, min	Mass kg, min
Extra heavy	600	300	180
Heavy	400	190	50
Medium	300	150	27
Light	200	110	11

"

PSDK 3.3 RIP-RAP

PSDK 3.3.1 Stone

Stone for rip-rap must be obtained from commercial sources and be approved by the Engineer. Such stone shall be clean and free of foreign matter and, blend in with the environment. The stone size shall be as shown in the table below:

STONE SIZES FOR RIP-RAP

RANGE OF STONE SIZE (IN TERMS OF D_{50} STONE SIZE)	FRACTION OF TOTAL WEIGHT SMALLER THAN THE GIVEN SIZE (%)
1.50 - 2.00 D_{50}	100
1.30 - 1.80 D_{50}	85
1.00 - 1.50 D_{50}	60
0.30 - 0.50 D_{50}	15

THE D_{50} STONE SIZE FOR RIP-RAP SHALL BE AS SPECIFIED ON THE DRAWINGS.

PSDK 3.3.2 Filter Layers

Where specified on the Drawings, or ordered by the Engineer, filter layers shall be provided between the bottom of the rip-rap layer and the surface that it is intended to protect. The filter material shall be sand, gravel or crushed stone, as appropriate to meet the grading requirements shown on the Drawings, and as approved by the Engineer."

PSDK 5 CONSTRUCTION

PSDK 5.3.3 Grouted pitching

Replace the words "(table 4)" *in the second line of the first paragraph with* "(table 2)".

Add the following new subclause to clause 5

"PSDK 5.4 RIP-RAP

PSDK 5.4.1 Placing of rip-rap

Rip-rap shall be placed in layers of the thicknesses specified on the Drawings so as to minimise the spaces between the rocks and to obtain a relatively even surface to the top of the rip-rap layer, with no rock protruding more than 150 mm above the general surface level.

PSDK 8 MEASUREMENT AND PAYMENT

PSDK 8.1 PRINCIPLES

Delete the contents of this Subclause and replace with the following:

"8.1.1 Computation of quantities for excavation

The relevant principles and computation of quantities set out in 8.1 and 8.2 of SANS 1200 DA, shall apply to excavations.

8.1.2 Tensioning frames for gabion baskets

The cost of providing tensioning frames for installing gabion baskets shall be deemed to be included in the tendered rate for gabions.

8.1.3 Installation training for gabions and mattresses

The cost of attending the compulsory on-site training session will be deemed to be included in the tendered rates supplying and installing gabions and mattresses.

8.1.4 Construction of trial gabion structure

The cost of constructing the trial gabion section will be deemed to be included in the tendered rate for supplying and installing gabions."

PSDK 8.2 SCHEDULED ITEMS

Add the following subclauses:

"PDK 8.2.11 Rip-rap ..... Unit m^3

The rate for rip-rap shall cover the cost of supplying and placing the rip-rap in a uniform layer of specified thickness to the satisfaction of the Engineer.

PSDK 8.2.12 Geotextile beneath rip-rap ..... Unit m^2

The area measured will be the area of the rip-rap layers ordered or shown on the Drawings to be underlain by geotextile. The rate shall cover the cost of supplying geotextile of the specified grade, cutting, waste, placing, joining, overlapping and fastening the geotextile in position."

PSDM EARTHWORKS (ROADS, SUBGRADE)

PSDM 3 MATERIALS

PSDM 3.2 CLASSIFICATION FOR PLACING PURPOSES

PSDM 3.2.3 Selected layer

Replace the contents of this subclause with the following:

"The following requirements shall apply in respect of the selected layer:

(a) Maximum particle size: 60% of compacted layer thickness

(b) Unstabilized selected layer

(i) Upper selected layer

Minimum CBR at 93% of modified AASHTO density: 15

Maximum PI: 12 (the Engineer has the right to alter this requirement to 3 x the grading modulus + 10)

(ii) Lower selected layer

Minimum CBR at 90% of modified AASHTO density: 7

Maximum PI: 12 (the Engineer has the right to alter this requirement to 3 x the grading modulus + 10)

(c) Stabilized selected layer

Minimum grading modulus of natural material: 0,75

UCS of stabilized material 300 kPa - 500 kPa at 93% of modified AASHTO density

Maximum PI for stabilized material: 10"

PSDM 5 CONSTRUCTION

PSDM 5.2 METHODS AND PROCEDURES

PSDM 5.2.2 Cut and borrow

PSDM 5.2.2.3 Use of material

Add the following paragraph:

"(e) Commercial sources

The provisions of subclause PSD 5.2.2.5 of SANS 1200 D as amended shall apply."

PSDM 5.2.3 Treatment of the road-bed

PSDM 5.2.3.2 Removal of unsuitable ground

Replace the second sentence of paragraph (a) with the following:

"The excavated spaces shall then be backfilled with approved imported material compacted to the required density."

Add the following sentence to paragraph (b):

"Unsuitable excavated material will be paid for as cut to spoil."

PSDM 5.2.3.3 Treatment of road-bed

Add the following paragraph:

"(c) Three-pass roller compaction

Any portion of the roadbed that is shown on the Drawings or is specified or is directed by the Engineer to be given three-pass roller compaction because of its inadequate natural density, shall be prepared by shaping where necessary and compacting with a roller, complying with the requirements specified below.

Compaction shall comprise three complete coverages by the wheels of the specified roller over every portion of the area that is being compacted. While it is not the intention that the Contractor should apply water to the roadbed for this type of compaction, and while no rigid moisture control will be exercised during compaction, the Contractor shall nevertheless satisfy the Engineer that everything is being done to take full advantage of favourable soil moisture conditions during the rainy season, and that such compaction is as far as possible carried out when the roadbed is neither excessively dry nor excessively wet.

The Engineer has the authority to decide when conditions are favourable for compaction and where such compaction is to be carried out at any particular time, and he has the right to instruct the Contractor to water the roadbed at the Contractor's expense when, in the opinion of the Engineer, the Contractor failed, neglected or refused to comply with these requirements.

The rollers to be used for roller-pass compaction shall conform to the following requirements:

Grid roller: The grid roller shall have a mass of not less than 13,5 t when ballasted, shall be loaded to this mass if required, and shall be moved at a speed of not less than 12 km/h.

Vibratory roller: The vibratory roller shall be capable of exerting a combined static and dynamic force of not less than 120 kN/m width for every metre of loose-layer thickness at an operating frequency not exceeding 25 Hz and shall move at a speed not exceeding 4 km/h."

PSDM 5.2.4 Fill

PSDM 5.2.4.3 Finishing

(e) Topsoiling

Replace the second sentence with the following:

"The thickness of the topsoil shall be as directed by the Engineer."

PSDM 5.2.5 Selected layer

Replace the contents of this subclause with the following:

"Except with regard to density, the requirements of subclause 5.2.4 shall apply. The degree of compaction shall be:

Upper selected

Selected : 93% of modified AASHTO density*

**or where only selected is specified*

Lower selected* : 90% of modified AASHTO density."

PSDM 5.2.6 Gravel surfacing

Replace the third sentence of this subclause with the following:

"The relevant requirements in subclause 5.2.4.2 shall apply, except that the material shall be compacted to 93% of modified AASHTO density."

PSDM 5.2.8 Transport

Replace the contents of this subclause with the following:

"The provisions of subclause PSD 5.2.5 of SANS 1200 D, as amended, shall apply."

PSDM 6 TOLERANCES

PSDM 6.2 DIMENSIONS, LEVELS ETC.

PSDM 6.2.2 Cut

Add the following tolerance:

"(d) Final level of all cuttings +0 mm to -50 mm."

PSDM 7 TESTING

PSDM 7.3 ROUTINE INSPECTION AND TESTING

Replace table 2 and the contents of subclause 7.3.2 with the following:

"PSDM 7.3.2 The dry density requirements for a particular lot of selected layer or wearing course shall be deemed to be satisfied if the average density and the results of individual tests meet the requirements specified in table 2 below. Refer to subclause PSD 7.2 for the requirements for fill.

TABLE 2: DENSITIES

1	2	3	4	5
Layer	Specified density (% of modified AASHTO density)	Number of tests per lot	Average density, %	Minimum density for any single test, %
Upper selected***** or selected layer***** and gravel wearing course*****	93	3 and 4 5 6	93,1 93,4 93,6	89,4 89,2 89,0
Lower selected layer*****	90	3 and 4 5 6	90,1 90,4 90,6	86,4 86,2 86,0

"

PSDM 8 MEASUREMENT AND PAYMENT

PSDM 8.2 COMPUTATION OF QUANTITIES

Replace subclauses 8.2.1 to 8.2.3 (inclusive) with the following:

"PSDM 8.2.1 The provisions of subclause 8.2.1 of SANS 1200 D shall apply.

PSDM 8.2.2 The provisions of subclause 8.2.2 of SANS 1200 D shall apply.

PSDM 8.2.3 The provisions of subclause 8.2.2 of SANS 1200 D shall apply."

PSDM 8.2.5 Verifying quantities

Replace the first sentence with the following:

"Before any earthworks are commenced but after completion of any site preparation, the Engineer will, upon a written request from the Contractor, provide cross-sections for the purpose of measurement of earthworks quantities."

PSDM 8.3 SCHEDULED ITEMS

PSDM 8.3.3 Treatment of roadbed

(a) Roadbed preparation and compaction of material to

Add the following:

"The unit of measurement shall be the cubic metre of material recompacted as specified and the volume shall be determined from levelled cross-sections on which are superimposed the levels to which the roadbed is to be constructed. When material is imported to make up the required volume, such material will be paid for as cut or borrow to fill as relevant."
Add the following:

"(c) Three-pass roller compaction:

(i) Grid roller ..... Unit: m²

(ii) Vibratory roller ..... Unit: m²

The units of measurement shall be the square metre of roadbed compacted as specified in subclause PSDM 5.2.3.3(c) for the areas designated by the Engineer.

The tendered rates shall include full compensation for shaping the areas, providing the rollers and compacting the roadbed by means of three roller passes over the entire area."

PSDM 8.3.4 Cut to fill, borrow to fill

Replace the last sentence of this item with the following:

"The unit of measurement shall be the cubic metre of fill and the volume will be calculated in accordance with the authorised dimensions of the embankment and levelled cross-sections.

The tendered rates shall include full compensation for excavating the material as if in soft material, for selecting, loading, transporting for the free-haul distance, off-loading, watering, mixing and compacting the material as specified. Borrow to fill in this item relates to material from designated borrow areas (provided by the Employer).

Where it is required that material be obtained from commercial sources, payment for procuring the material will be made under item PSDM 8.3.17."

PSDM 8.3.5 Selected layer compacted to 93% of modified AASHTO maximum density

Replace the heading and the contents of this item with the following:

"PSDM 8.3.5 Selected layer using material from designated borrow pits or excavation:

(a) Compacted to 90% of modified AASHTO density ..... Unit: m³

(b) Compacted to 93% of modified AASHTO density ..... Unit: m³

(c) Compacted to 100% of modified AASHTO density (sand) ..... Unit: m³

The unit of measurement shall be the cubic metre and the quantity will be calculated from the authorised dimensions of the compacted layer.

The tendered rates shall include full compensation for excavating the material as if in soft material for loading, transporting for the free-haul distance, off-loading, spreading, watering, mixing, breaking down and compacting the layer."

PSDM 8.3.6 Extra over items 8.3.4 and 8.3.5 for excavating and breaking down material in

Replace the heading of this item with the following:

"PSDM 8.3.6 Extra over items 8.3.4, 8.3.5 and 8.3.16 for excavating and breaking down material in"

Replace the words "items 8.3.4 and 8.3.5" *with the words* "items 8.3.4, 8.3.5 and 8.3.16".

PSDM 8.3.7Cut to spoil or stockpile from

Replace the heading with the following:

"PSDM 8.3.7 Cut to spoil from"

PSDM 8.3.12 Overhaul

Replace this item with the following:

"PSDM 8.3.12 Overhaul

Overhaul will be paid in accordance with item 8.3.6 of SANS 1200 D."

PSDM 8.3.16 Gravel surface layer

Replace the contents of this item with the following:

"The unit of measurement shall be the cubic metre of gravel surface layer and the quantity will be determined from the authorised dimensions of the compacted layer.

The tendered rate shall include full compensation for excavating the material as if in soft material, for loading and transporting the material for the free-haul distance, off-loading, spreading, breaking down, watering, mixing and compacting the material."

Add the following items:

"PSDM 8.3.17 Extra over items 8.3.4, 8.3.5 and 8.3.16 for obtaining material from commercial sources..... Unit: m^3

The tendered rate shall include full compensation for the additional cost of finding a suitable source of material, for procuring the material and paying all royalties or other charges to the owner of the source, for transporting the material to the point of use regardless of the distance hauled and for excavating in intermediate, hard or boulder material as required.

Items PSDM 8.3.6, DM 8.3.12 and PSDM 8.3.14 do not apply to material obtained from commercial sources.

PSDM 8.3.18 Final finishing and cleaning up of the site of the works Unit: sum

The tendered sum shall include full compensation for the clearing, disposal of material, finishing, tidying and all other work required to finish and clean up the Site of the works and affected areas by removing excess earth, stones, boulders, debris and other waste material, by clearing stormwater inlets and outlets and pipe barrels, by clearing the surfacing of all dirt, mud and foreign material, and by neatly finishing off all junctions, intersections and kerbing.

All material resulting from the finishing operations shall be disposed of to a spoil site furnished by the Contractor.

The tendered rate shall make provision for the reinstatement of existing driveways to their original condition where these have been affected by the works, as these items will not be measured and paid for separately.

PSDM 8.3.19 Sidewalks:

(a) Fill compacted to 90% of modified AASHTO density and obtained from:

(i) Designated borrow pits ..... Unit: m^3

(ii) Commercial sources ..... Unit: m^3

(iii) Excavations ..... Unit: m^3

(b) In-situ material scarified to a depth of 150 mm and compacted to 90% of modified AASHTO density..... Unit: m^3

(c) Excavated material removed to spoil ..... Unit: m^3

The tendered rates shall include full compensation for constructing the sidewalks to the profiles indicated either on the Drawings or by the Engineer, for working in restricted areas, for using material classified as soft material with a maximum particle size of 60 mm, and for carrying out the work in accordance with the Specifications.

PSDM 8.3.20 Existing Services *(see PSDM 5.1.3)*

Location

Where particular items are provided in other sections of the schedule (e.g. crossing services in pipe trenches), the costs of detection, exposure, protection and alterations shall be covered by such particular items. Where no such particular items are provided and where there is reason to expect the presence of services, the following items will apply:

(a) Supply of specialist equipment for detection ..... Unit : Sum

(b) Excavate by hand in soft material to expose service ..... Unit : m^3

The rates above shall cover the cost of delays and disruption of the progress of the work caused by the search for the particular service, in addition to the cost of searching for it, liaising with the local authority, excavating by hand of all material and backfilling holes that will not fall in the prism of road excavation.

PSDM 8.3.21 Temporary Protection of Services Unit : m /No

The rate for each service will cover the cost of location etc. as specified in PSDM 5.1.3.2 liaison with the relevant local authority, delays and disruptions of the progress of the work due to the existence of the service and dealing with the service during the construction period to maintain an uninterrupted continuation of the specified service. The rate must also cover the total cost of all repairs required should any of the services be damaged.

Distinction will be made between services that will be exposed during excavation for roadworks and unexposed services that will be at risk of damage during the execution of roadworks. Drawing DM3 indicates the limits in which the service must fall to qualify for payment.

Cables so grouped that the cross section containing them has a horizontal dimension not exceeding 250 mm will be regarded as one service.

PSDM 8.3.22 Scarify, mix and compact existing layerworks (top 150 mm) ..... Unit : m^3

This item applies to areas where the new road levels will be higher than the existing. The rate shall cover the cost to scarify the existing tar and base to a depth of 150 mm, mixing it with some of the new material (base or subbase), shaping it to the new levels and lines and compacting the layer to 98% of the modified AASHTO density.

PSDM 8.3.23 Extra over item 8.3.7 for benching into existing layerworks ..... Unit : m

The rate shall cover the extra cost for neatly cutting through the existing tar and benching into the existing road layers as shown on drawing no. .....

PSDM 8.3.24 Tie in with existing road edge ..... Unit : m

The tendered rate shall include full compensation for removal and disposal of existing concrete backing, protecting the existing paving when excavating the road box adjacent to it and tying the new layerworks to the existing.

PSDM 8.3.25 Raising or lowering of existing structures ..... Unit : No.

The rate shall cover the cost of locating the manholes/chambers, the necessary excavation to do the works, removing the cover and frame and the cover slab, providing materials, labour and plant for raising the manhole/chamber to the designated new level, provision of new materials in the event of any damage, setting and grouting the cover and frame to the correct level, and backfilling around the manhole to specifications.

PSDM 8.3.29 Extra over item PSDM 8.3.5 for soilcrete backfill ..... Unit : m^3

The unit of measurement shall be the cubic metre of soilcrete place where so ordered by the Engineer.

The tendered rate shall include full compensation for selecting, mixing and placing of the soilcrete as well as for the cost of shuttering that may be required all in accordance with the specifications of PSDB 3.5.

PSDM 8.3.30 Variations in the number of roller passes (applicable to subitem 8.3.3(c)):

(a) Vibratory rollers ..... Unit: m^2-pass

(b) Oscillatory rollers ..... Unit: m^2-pass

(c) Grid rollers ..... Unit: m^2-pass

(d) Tamping rollers ..... Unit: m^2-pass

(e) Impact rollers ..... Unit: m^2-pass

(f) Pneumatic-tyred rollers ..... Unit: m^2-pass

The unit of measurement shall be the square-metre coverage, and shall be computed by multiplying the number of square metres to which the changed pass efforts apply by the increased or decreased number of roller passes.

Where a change in the compaction effort is requested, the Contractor will be compensated at the tendered rates for the above items in respect of the increased number of square-metre roller passes of each type of roller required over and above that specified in the relevant standard effort. His compensation will be decreased simultaneously, at the applicable rates, by the number of square-metre roller passes of each type of roller which is either decreased or completely left out.

The tendered rate for each additional square metre-pass ordered by the Engineer over and above the specified number of passes, shall include full compensation for all supervision, labour, plant, equipment, fuel, materials, work and incidentals necessary for completing the work. The same rates shall be accepted by the Contractor during computation of a decrease in his compensation where the number of roller passes for each specific type of roller is decreased."

PSH STRUCTURAL STEELWORK

PSH 2 INTERPRETATIONS

PSH 2.3 DEFINITIONS AND ABBREVIATION

Add the following abbreviations to the end of this Subclause:

"HDG. Hot dip galvanized or hot dip galvanizing (steel), as applicable

SS. Stainless Steel

"Covered open grid flooring" and "covered grating" shall be taken to mean open grid flooring with a permanently attached solid top steel cover of the same material and finish as the grid flooring. Figure 2.3a illustrates covered open grid flooring (unbanded).

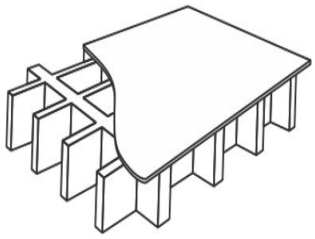


Figure 2.3a: An example of covered open grid flooring (unbanded), cover partially removed for illustration."

PSH 3 MATERIALS

PSH 3.1 STRUCTURAL STEEL

Add the following after the first sentence of Subclause 3.1.1:

"Steel shall be Grade S355JR for hot rolled steel sections. All members shall carry the Grade S355JR steel symbol to identify steel grade prior to manufacturing. Mill test certificates to be provided to the Engineer for all structural steel, prior to manufacture. Where stainless steel is specified, the grade of stainless steel shall be Grade 316L unless otherwise stated."

PSH 3.6 BOLTS, NUTS AND WASHERS

PSH 3.6.1 Bolts and nuts (other than friction-grip)

Add the following:

"All bolts, nuts and washers (i.e. fasteners) in the following categories shall be manufactured from Grade 316L stainless steel and shall have a nickel-based anti-seize compound applied along the full length of fastener threads before the nut is applied:

- Those within water-retaining structures, water-excluding structures or exposed to the rain
- Those with a diameter of 12 mm or less
- Those of any size used in conjunction with stainless steel items,
- All anchor fasteners of any size in concrete or brickwork, unless otherwise specified.

All other bolts, nuts and washers, not listed in the categories above, shall be hot-dip galvanized (HDG) to SANS 121. HDG nuts shall be tapped before galvanizing, taking into consideration the extra clearance necessary to allow for the thickness of galvanizing on the bolts. If, after installation, there is any indication that galvanising has been stripped from either the nut or the bolt, both nut and bolt shall be removed and replaced

All bolts for structural steel shall be Class 8.8 bolts"

PSH 5 CONSTRUCTION

Add the following subclauses:

PSH 5.1 DRAWINGS AND SHOP DETAILS

PSH 5.1.1 Design drawings

Add the following:

"The Contractor shall be solely responsible for the final verification of all steelwork dimensions (including confirmation of all relevant dimensions on site) before preparing his shop drawings and manufacturing any steelwork components."

PSH 5.1.2 Contractor provides shop details

Add the following:

"The Contractor shall be responsible for the preparation, in accordance with SANS 10162:2011, of shop drawings and/or details, drawn using Tekla or similar approved software. The drawings (including all applicable .IFC and .TBP files) shall be submitted for approval at least two weeks prior to commencement of fabrication. The Engineer will check the drawings for conformity with design requirements and will return the drawings with additions and corrections, if any, within ten working days of having received them. Detailed checking of shop details for dimensional accuracy and installation fit, will not be done by the Engineer."

PSH 5.2 FABRICATION

PSH 5.2.1 General

Add the following to the beginning of this Subclause:

"Before commencing with any manufacturing or construction of structural steelwork, the Contractor shall confirm all relevant dimensions on site. Any discrepancies should be brought to the attention of the Engineer immediately."

Add the following to the end of this Subclause:

"The main structural members shall be single full length."

PSH 5.2.3 Cutting

Add the following to the end of this Subclause:

"The edges of flame-cut plates shall be ground off and smoothed."

PSH 5.2.4 Holes for fasteners

Replace the contents of Subclause 5.2.4.2 with the following:

"Holes for fasteners shall be drilled."

Replace the contents of Subclause 5.2.4.5 with the following:

"Punching of holes shall only be permitted with the written approval of the Engineer."

Add the following new subclauses to clause 5.2

"PSH 5.2.7 Welding in fabrication

All welders shall be coded welders.

Welding procedures and welder's performance qualifications shall conform to the requirements of AWS D1.1 (and/or SANS 15614-1). These documents/certificates must be submitted in writing to the Engineer and approved prior to the start of welding. Welding certificates are only valid for a period of 12 months. The Contractor shall also submit, for review, an outline of the Quality Control measures that will be enforced by the Contractor to ensure that specified welding procedures are adhered to.

All welds shall be 6 mm or larger continuous fillet welds, unless otherwise specified or agreed by the

Engineer.

Welds shall be continuous on all sides of any joint. Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevices. Crevices shall not be accepted.

No staggered or intermittent welding is permitted. Approved splicing of members will be subject to non-destructive testing. In addition, the Engineer may at his discretion identify any welds for non-destructive testing. The cost of testing shall be borne by the Contractor.

No welding on site is permitted unless approved by the Engineer. Any site welder and site welding procedure will have to be re-qualified for site welding."

PSH 5.3 ASSEMBLY

PSH 5.3.4 Welding

Add the following to the end of the first sentence:

"The requirements of 5.2.7 shall apply."

PSH 5.3.9 Protective treatment

Replace the contents of this Subclause with the following:

"Corrosion protection for all structural steelwork shall be done in accordance with SANS 1200 HC."

PSH 5.5 ERECTION

Add the following new subclause to clause 5.5

PSH 5.5.6 Anchor holes

Drill bits used for creating anchor holes in concrete shall be incapable of cutting through reinforcing steel. The Contractor shall be responsible for accommodating the actual reinforcing positioning and avoiding reinforcing when drilling anchor holes. Any unused or discarded holes shall be cleaned and filled completely with the same chemical product approved for chemically anchoring the fasteners, unless an alternative product is approved. No additional payment shall be made for accommodating the reinforcing, including creating additional holes to achieve the required hole depths, filling unused holes, etc., which shall be included in the tendered price for steel items.

PSH 5.6 GROUTING OF SUPPORTS

Add the following subclause to clause 5.6

PSH 5.6.5 Holding-down bolts and grouting supports

The Contractor shall supply detailed layouts of holding-down (HD) bolts, as well as a suitable steel template of each type of HD bolt layout which can be used to accurately position the bolts.

PSH 5.7 SUNDRY ITEMS

PSH 5.7.1 Handrails

Replace the contents of this Subclause with the following:

"Handrails

5.7.1.1 The terms "handrailing", "handrails" and "guard rails" shall all be synonymous. Handrails shall be of the type and shall be purpose made in the style and shapes given in the project specification and indicated on the drawings. Steel tubing shall comply with SANS 657: Part 1. The Contractor shall ensure, by making in-situ measurements before manufacture is started, that the handrails suit the situation in which they are to be installed. Handrails shall have a vertical height of at least

1 000 mm, measured from the top of the hand rail to the floor or surface. Where handrails terminate up against a wall or other barrier, the gap between the stanchion or closure bend (as applicable) and the barrier shall be less than 100 mm, unless the rails are fixed directly to the barrier (removable handrailing may not be fixed directly to the barrier).

Handrailing shall be supplied by one manufacturer and in one fully integrated style, complete with all the necessary fasteners, connections, corrosion protection, coatings, etc. Handrailing shall, unless otherwise annotated on drawings, be continuous, uninterrupted at changes in direction or angle, i.e. rails shall not terminate and restart at changes in direction or angle but be continuously connected and joined with bends and stanchions formed to suit the changes.

Notwithstanding the above, at the interface between fixed and removable handrailing, rails and kickplates (if applicable) shall be discontinuous, with rails and kickplates ending at stanchions (rather than rails ending with closer bends/returns) and the required c/c spacing for these interfacing stanchions shall be 135mm.

Typically, the handrailing illustrated on drawings for each structure is exclusively for providing a high-level indication of where handrailing is necessary and for annotating (if applicable) the type required. The detailed handrailing requirements to be followed are provided on the general "Handrailing Details" drawing and in these specifications.

5.7.1.2 Unless otherwise indicated on the drawings or in the Bill of Quantities, the complete handrailing system (rails, stanchions, base plates, bends, kickplates, etc.) but excluding fasteners (which are specified elsewhere) shall be of stainless steel grade 304 material. The completed handrailing shall be of neat and workmanlike appearance, solidly and evenly supported, fastened in place, secure and tight under loading, true to line, level and plumb. Any gaps between stanchion base plates (stanchion feet) and concrete or brick surfaces shall be filled with non-shrink cementitious grout prior to final tightening of nuts. Where stanchion base plates are to be attached directly to metallic surfaces, Denso tape (or equivalent approved) shall be fitted under the stanchion feet to prevent direct contact.

Unless otherwise indicated, stanchions shall be top mounted (base mounted) to suit the arrangement requirements and shall be of welded construction. Stanchions which are hollow shall be self-draining. When anchoring top mounted stanchions to brickwork or concrete, they shall be installed with their centre line 100 mm (unless otherwise indicated) from the edge of the platform or centred atop upstand beams or walls (as applicable). No stanchion shall be mounted with its centre closer than 300mm to a concrete or brickwork joint.

All handrailing joints, excluding kickplate joints which shall be bolted, shall be fully welded and smoothly finished without shoulders. Handrailing shall be free from sharp corners, edges and projections which may injure persons or damage clothing. Edges shall be rounded to a radius of at least 2 mm.

5.7.1.3 Handrail stanchion spheres shall be preformed with orientation to suit the situation in and the angle at which they will be installed. Incorrectly orientated stanchion spheres will not be accepted. Stanchions shall be spaced at no greater than 1 200 mm centres for horizontal handrails and 1 000 mm centres for sloping handrails, unless otherwise indicated on the drawings or approved by the Engineer. Stanchions for a particular run shall be evenly spaced after first positioning those required at end and corners.

Railings shall be ended off with positively fixed closure bends/returns or by fixing directly to a wall or other barrier if appropriate and approved by the Engineer. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically manufactured for such a position shall be employed.

5.7.1.4 At certain positions where it shall be necessary to have infrequent access to parts of the works which shall normally be equipped with handrails, the Engineer may instruct that handrails over these short sections be omitted in favour of guard chains. A guard chain shall consist of a 6 mm diameter stainless steel grade 304 chain secured across stanchions with an M8 hook bolt on one end and an M8 eye bolt on the other. The bolts shall be fastened tightly to the stanchions and it shall only be possible to unhook the chain at one end. If alternative hook designs are approved by the Engineer, these hooks shall not be damaged nor undergo noticeable deflection when a point load of 1 500 Newtons is applied in a horizontal or downward direction to the secured guard chain.

5.7.1.5 Where kickplates are required, these shall be of the same material and receive the same coatings as the handrails (unless otherwise indicated) and provided along the full length of the handrailing system. Kickplates shall be at least 150 mm high unless otherwise indicated, and fastened securely to the guard rails with M12 U-bolt fasteners. The top corners of kickplates shall be rounded to r=16mm.

For horizontal top mounted and removable handrailing, the kickplate shall be installed on the outside face of the handrailing (face furthest from the walkway centre). For horizontal side mounted handrailing, the kickplate shall be installed on the inside face of the handrailing.

At corners, kickplates shall be bent to suit the angle of the corner. Where kickplates meet, they shall overlap by 100 mm, separated by a 150 x 100 x 1.5 mm stiff solid neoprene (or similar approved) rubber strip and fastened together with 2 x M12 fasteners. These fasteners shall be orientated such that the bolt head ends of the fasteners point towards the centre of the walkway and ends with exposed threads point away from the walkway centre.

5.7.1.6 Should HDG handrailing be specified, the galvanizing shall be done in accordance with SANS 121 and SANS 10064, and all fabrication, sizing, modifying, drilling, cutting, welding and machining shall be carried out prior to HDG. Items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising. Other corrosion protection systems or coatings specified shall comply with the general corrosion protection specification provided with the contract document.

5.7.1.7 All fasteners associated with handrailing shall be of stainless steel grade 316. Fastener threads shall project (once tightened) above the nut by at least 1 but no more than 4 threads and the exposed fastener ends shall be free of sharp edges. The diameter of anchor fasteners shall not be less than M16 and other fasteners not less than M12 unless otherwise indicated. Washers shall be provided under the bolt head (as applicable) and nut.

Anchor fasteners for anchoring handrailing to concrete or brickwork shall be chemically anchored to the substrate with anchor depth of 140 mm using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). Anchor fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated, and no cutting of these fasteners will be permitted on Site. Holes shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive and fasteners.

5.7.1.8 Unless otherwise indicated on the drawings or in the Bill of Quantities, handrailing for public spaces shall also comply with the requirements above with the exception of those indicated in 5.7.1.3, 5.7.1.4 and 5.7.1.5. In addition, handrailing for public spaces shall comply with the requirements of SANS 10104 and no opening in handrailing installed in public places shall allow the passage of a ball of 100 mm diameter.

PSH 5.7.2 Ladders

Replace the contents of this Subclause with the following:

"Ladders:

5.7.2.1 Ladders shall be manufactured in accordance with the details and general arrangements shown on the drawings. Before commencing with any manufacturing or construction, the Contractor shall confirm and accommodate the actual dimensions and details measured on Site which may differ from those provided on drawings. Unless otherwise indicated, ladders and related ancillaries (threshold plates, grab bars, etc.) but excluding fasteners, shall be of stainless steel grade 304 material. Fasteners shall be of stainless steel grade 316 regardless of the ladder material specified.

5.7.2.2 All members shall be of solid structural sections (e.g. flat bar). Hollow sections are not acceptable for any part of the ladder.

All rungs in a flight shall be uniformly spaced at 250 mm centres (unless otherwise indicated) after positioning the rung nearest the upper platform (or threshold platform, as applicable) in the

position shown on the drawings. A minimum clear space of 230 mm shall be provided behind the rungs, unless otherwise indicated on the drawings.

Anchoring supports (mounting brackets) shall be uniformly spaced at a distance not exceeding 2m. When mounted to concrete or brickwork, the gap between anchoring supports and the substrate to which they affix shall be no greater than 15 mm, and any gaps between them shall be filled with flowable non-shrink cementitious grout after the supports have been secured in place prior to final tightening of the nuts. Where ladders are mounted to steel surfaces, no gap shall be left between the surface and the anchoring support, and Denso Tape or approved equivalent shall be fitted under the anchoring support feet to completely seal the crevices between the two metallic surfaces.

Where the strings (also referred to as stringers) extend above an upper landing, they shall complement any handrailing at this level. Ladder-to-handrailing connections shall be bolted.

Generally, and unless otherwise indicated on drawings or in the BOQ, ladders of height greater than 5 m and up to 10 m shall be provided with cages. No part of the cage shall be more than 700 mm away from the plane of the rungs.

5.7.2.3 All joints shall be fully welded (leaving no crevices) and smoothly finished without shoulders. Ladders shall be free from sharp corners, edges and projections which may injure persons or damage clothing. Edges shall be rounded to a radius of at least 2 mm. Sharp edges, pits, inclusions, weld spatter, undercuts, indentations and other surface defects are not acceptable. Stainless steel ladders shall be pickled and passivated prior to installation.

If HDG ladders are specified, they shall be hot-dip galvanised after all fabrication has been completed. The unit shall be blasted and re-galvanised if it is welded, drilled or ground after galvanizing or if the zinc layer is damaged.

5.7.2.4 If a ladder as a single unit is excessively long, for ease of handling and transporting, the ladder may (at the discretion of the Engineer) be divided into practical portable lengths and reassembled on Site. Should the ladder be divided, jointing fishplates will be required (500 x 65 x 10 for the stringer joints and 500 x 45 x 8 for caging joint) and shall be located on the outside of the ladder user area with 6 No M12 countersunk bolts on the inside of the same area (3 No equally spaced on both sides of the joint). Any costs for dividing the ladder shall not be paid for separately, but shall be taken to be included in the rate tendered for the ladder.

5.7.2.5 The Contractor shall make arrangements for the Engineer to inspect the fabricated ladders for compliance prior to installation. Only ladders that comply shall be installed.

5.7.2.6 Ladders shall be supplied complete with all the necessary fasteners, etc. for fixing. All fasteners associated with ladders shall be of stainless steel grade 316. Fastener threads shall project (once tightened) above the nut by at least 1 but no more than 4 thread and the exposed fastener end shall be free of sharp edges. Unless otherwise indicated, the diameter of anchor fasteners shall not be less than M16 and other fasteners not less than M12. Washers shall be provided under bolt heads (as applicable) and nuts.

Unless otherwise indicated, fasteners for anchoring the ladder and ancillaries to concrete or brickwork shall be chemically anchored to the substrate with an anchor depth of 140 mm using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). Anchor fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated (as no cutting of these fasteners will be permitted on site). Holes shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer's instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive and fasteners.

PSH 5.7.3 Open grid floors

Replace the contents of this Subclause with the following:

"Steel Open Grid Floors

5.7.3.1 The term "grating" shall be synonymous with "grid flooring". Open grid flooring panels (whether or

not they are covered with a vastrap or similar plate) shall be manufactured by an approved firm specializing in such work. Before commencing with any manufacturing or construction, the Contractor shall confirm and accommodate the actual dimensions and details measured on Site which may differ from those provided on drawings.

5.7.3.2 The grid flooring depth as well as the thickness and pitch (spacing) of both bearer bars and transverse bars shall be as specified on the drawing. Unless otherwise indicated, bearer bars shall run parallel to shorter span (bearer bars to run between closest supports).

Grid flooring shall be manufactured with transverse bars permanently locked to bearer bars (i.e. compressive pressure locked or welded or both, unless otherwise indicated). Grid flooring panels shall be banded around all edges, including edges of cut-outs and removable or hinged access covers. These bands shall be of equal height and thickness to the bearer bars and shall be fully welded to the flooring panel (leaving no crevices at joints).

5.7.3.3 The panels shall be supplied prefabricated with cut-outs given on the details and those necessary to accommodate the Contractor's equipment. Cut-outs made to accommodate equipment shall be neat and as small as practical and gaps between equipment and grid flooring shall not exceeding 100mm in extreme cases. Panels/off-cuts may not be welded together to create larger panels.

Unless otherwise specified, cutting of grating with top covers shall be done at angles and curves to suit the equipment. For grating without top covers, cutting shall generally be done parallel or perpendicular to bearer bars (as applicable), except for cut-outs made to accommodate circular objects or pipes larger than DN 300 where the cut-out shall instead be circular to prevent excessive gaps between the object and sides of the cut-out. Unless authorized to do so, the Contractor shall not cut or weld grid floor panels on Site.

5.7.3.4 The gap between the edge of grid flooring and the support frame or abutting structure (as applicable) shall be at least 2 mm and no greater than 10 mm on each side (or no greater than 20mm on one side when the panel is shifted up against the support frame/abutting structure on the opposite side). No gaps shall be left between adjacent panels.

Grid flooring shall be mounted firm and level (unless the surrounding floor has a fall, in which case the grating shall match this fall) orientated uniformly and shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order. Adjacent floor panels shall have vertical edge alignment of within 3 mm of each other. A least four fixing clip sets of the appropriate types (depending on the location being secured) shall be used to secure each panel to the supports and adjacent panels. No perceptible movement or rocking will be acceptable. Fixing clip sets shall be stainless steel grade 316 with M8 or larger fasteners, of standard types (i.e. M-Type, F-Type, G-Type, etc.) and approved by the grid flooring manufacturer.

Individual panel lengths (measured parallel to the bearer bars) shall be no greater than 2.4m. Unless otherwise approved, individual panels which are not supported along their entire perimeter shall be no less than 1m wide at the narrowest section (where the width is measured at right angles to the bearer bars), except for the final panel in a series of panels where a smaller width may be needed to close the remaining opening. Where narrower widths are specified or approved, each unsupported panel edge shall be fixed with clip sets to the adjacent flooring panel at 350mm centre or with a minimum of 2 clip sets, whichever is greater (these over and above the four fixing clip sets aforementioned).

5.7.3.5 Where vastrap plate flooring covers are required, they shall cover the entire top of the grid flooring panel (with the edges of the vastrap plate flush with the edges of the flooring panel) and shall be welded to the panel with 20 to 30mm welds at 300mm centres. Stainless steel grade 316 countersunk bolts shall be used with clip sets to secure flooring panels which are covered with vastrap plates to supports and to each other. Suitably positioned countersunk bolt holes shall be made in the vastrap plates prior to them being HDG (if HDG is applicable). The countersunk bolts shall not protrude above the vastrap plate beyond the height of the tread pattern.

5.7.3.6 The angle supports (also referred to as frames) indicated on drawings (including added flat bars where required) are to be installed continuously along the full perimeters of openings which are to be covered with flooring panels. Notwithstanding the above, where the support frame crosses a concrete or brickwork joint, the joint is to be extended through the angle frame.

Where two different angle support types (flooring details) are specified for supporting one area of flooring, the cast-in angle support type shall be used wherever possible, with the bolt-on angle support type only used where the cast-in angle support cannot be used.

Where a structural member is to pass through a flooring panel, adequately sized bolt-on angle supports shall be installed around and fastened to the circumference of the structural member to support the flooring panel, unless otherwise directed by the Engineer. All angle supports will not be paid for separately but shall be included in the rate tendered for the relevant flooring panels.

5.7.3.7 Additional support systems which exclude angle supports and top hat sections (thus I-beams and channels, etc. are additional supports) may be specified on drawings. Each support type, complete with end plates, flat bars, fasteners, etc. will be scheduled and paid for separately under 8.3.1. The grid flooring shall be fabricated to suit the additional supports.

Unless otherwise indicated, additional supports that cross from one side of an opening to the opposite side (i.e. a straight support beam) shall be orientated such that each runs parallel to the shorter span (i.e. for a channel, they shall run between the nearest channel walls).

Where a cut-out in the flooring larger than 480mm in width or diameter (irrespective of whether the cut-out bridges more than one panel) is necessary to accommodate an object(s) passing through the flooring (which objects are not designed to structurally support the flooring, i.e. pipes and equipment), these additional supports shall first be placed as close as practical on either side of the object. The remaining supports shall be evenly spaced with appropriate centres that fall within the spacing range indicated on the drawings (or at specific centres if so specified).

Notwithstanding the above, the additional supports shall be suitably positioned to prevent more than 50% of the bearer bars of a single panel being cut in the event of multiple cut-outs being required in the same panel. Where this is unavoidable, suitable alternative support designs shall be submitted by the Contractor to the Engineer for approval.

The gap between additional support ends and the substrates to which they affix shall be no greater than 10mm, and this gap shall be neatly filled with flowable non-shrink cementitious grout after the supports have been secured in place and prior to final tightening of nuts. Additional supports shall not be mounted over or with the centreline within 200mm of a concrete or brickwork joint.

5.7.3.8 The Contractor shall submit for approval all relevant details for additional cut-outs and supports to flooring which are not specified but are required by him to accommodate his equipment. These flooring modifications and supports shall ensure that, while under design load conditions, the deflection of any bearer bars does not exceed 1/200th of the clear span, or 10 mm, whichever is the lesser. Any approved modifications shall be done prior to HDG. Cut-outs and supports required by the Contractor will not be measured or paid for separately but shall be included in the rate tendered for the relevant flooring panels.

5.7.3.9 Unless otherwise indicated, all joints to be fully welded with no crevices. All steel items, excluding fasteners, handles, hinges and clip sets, shall be HDG unless otherwise indicated. HDG shall be done in accordance with SANS 121 and SANS 10064. All fabrication, sizing, modifying, drilling, cutting, welding and machining shall be carried out prior to HDG. Items modified after HDG shall be returned to the galvaniser for stripping of the zinc coating and re-galvanising.

5.7.3.10 All fasteners shall be of stainless steel grade 316, unless otherwise specified. Fasteners shall be delivered to Site in the correct lengths and already deburred, pickled and passivated (as no cutting of these fasteners will be permitted on Site). Anchor fasteners shall be chemically anchored into concrete or brickwork using Sika Anchorfix-2+ or Hilti HIT-RE 500 (or equivalent approved). The anchor holes required shall be drilled to correct depths and cleaned in accordance with the anchor adhesive manufacturer’s instructions. The Contractor shall have all holes inspected by the Engineer after completing preparations but before installing the adhesive or fastener. SS316 washers shall be provided under both bolt head (where applicable) and nut. Unless otherwise approved, fastener threads shall project no less than 1 thread and no more than 8 threads from the head of the nuts when fixed.

"PSH 5.8 PRESSED-STEEL PANEL RESERVOIRS

A pressed-steel panel water tank (Refer to specific site drawing for tank size) shall be installed. The tank

shall be erected on reinforced-concrete foundations. All foundations shall be designed by the Engineer based on design parameters defined by the manufacturer.

The tanks shall comply with the requirements of CKS 114 (pressed-steel sectional tanks) and shall consist of 1 220 mm and 1 220 mm sectional mild steel plates for the sides and bottom and 3 mm sectional steel roof coverplates (not normal roof sheeting), complete with the necessary bracing, nuts, bolts and washers and jointing material.

The tanks shall be provided with the following (refer to site specific drawing):

(a) Lockable access manhole cover
(b) Internal and external cat ladder
(c) Water-level indicator as approved by the Engineer
(d) Ventilator
(e) Inlet and outlet connection points
(f) Scour outlet connection point
(g) Overflow
(h) A Vortex inhibitor shall be installed and shall comply in all respects with ASIB requirements.
(i) The elevated tank shall be fitted with a walkway round the tank.

All mild steel components shall be hot-dipped galvanized after manufacture to the requirements of SANS 121. This includes any pipework shown inside the tanks.

The tanks shall be tested after completion to the satisfaction of the Engineer and shall be sterilized by the builder after completion.

Water for testing shall be provided by the Contractor and he shall be responsible for providing all necessary equipment that may be required for filling the structures.

The costs of emptying a water-retaining structure which cannot be drained shall be borne by the Contractor.

The water shall be discharged in a manner approved by the Engineer and shall be such that the Employer can utilise the water if he so desires.

The water shall not be used as a medium for additives to effect remedial work or to stop leaks.

The costs of retesting the structure for watertightness shall be borne by the Contractor

The Engineer's written approval for all details of the tank, internal and external bracing, shall be obtained before manufacture. Workshop drawings shall be submitted to the Engineer timeously for his final design of the concrete footings and compilation of the bending schedules.

All flanges shall be drilled to SANS 1123 table 1000/3, unless otherwise specified.

PSH 5.9 LIGHTNING PROTECTION

The reservoirs shall be protected from the effects of lightning by the installation of a lightning-protection system which complies with the requirements of SABS Code of Practice 03.

The Contractor shall obtain the services of a firm specialising in the supply and installation of such systems. The firm which shall be approved by the Engineer, shall submit drawings of the system to the South African Bureau of Standards for approval, and work may commence only after the approved plan has been submitted to the Engineer.

PSH 5.10 STERILIZATION OF RESERVOIR

Before the reservoir is sterilized, the pipelines serving the reservoir shall have been sterilized. The reservoir shall then be thoroughly cleaned out and washed down with clean water.

The roof and walls shall thereafter be thoroughly sprayed down, using pressurised equipment, and the floors shall be scrubbed with the solution specified in subclause 5.10 of SANS 1200 L.

On completion of the sterilization, the sterilizing solution shall be run to waste before the reservoir is filled for

testing watertightness.

Should additional work be required to be done inside the reservoir after the watertightness tests have been done, the reservoir shall be resterilized at the Contractor's expense."

PSH 7 TESTING

PSH 7.1 TEST CERTIFICATES

Add the following:

"Test certificates pertaining to steel used for the various members shall be supplied by the Contractor to the Engineer when requested."

Add the following new subclause to clause 7

"PSH 7.4 WELDING TESTING

All non-destructive testing procedures, techniques and acceptance criteria shall be in accordance with AWS D1.1 (and/or SANS 15614-1) and certificates of all testing shall be submitted to the Engineer. Personnel performing non-destructive testing (other than visual) shall be qualified in accordance with the stipulations of the code. All non-destructive examinations shall be carried out in accordance with written procedures approved by the Engineer.

Full penetration butt welds are to be radio graphically tested in accordance with AWS D1.1 (and/or SANS 15614-1). A minimum of 50% of full penetration welds shall be tested. If more than 5% of the examined welds show unsatisfactory results, then additional examinations covering all welds shall be performed. Fillet welds will be inspected and tested to AWS D1.1 (and/or SANS 15614-1) at the discretion of the Engineer. Ultrasonic and radiographic examinations shall not be made within the period of 24 hours after completion of welding.

All costs (time, travelling, testing etc.) incurred by non-destructive examinations (whether due to non-conformance of specifications, any latent defects in material and welding, or as requested by the Engineer) shall be borne by the Contractor."

PSH 8 MEASUREMENT AND PAYMENT

PSH 8.1 BASIC PRINCIPLES

Add the following to the end of this Subclause:

"8.1.3 The tendered price for steel items includes for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection and finishes as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour, materials, fasteners (including holding-down bolts), etc. necessary for proper completion of structural steelwork, including casting in holding-down bolts (if applicable), fixing it to the concrete or brickwork, etc. as shown on drawings or as specified. These listed items will not be measured separately."

PSH 8.3 SCHEDULED ITEMS

Delete Subclauses 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.3.5, 8.3.6 a*nd 8.3.13 and substitute with the following*:

a) "8.3.1 Structural steel ..... Unit: t or No

The rate shall include for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection and finishes as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour, materials, fasteners (including holding-down bolts), etc. necessary for proper completion of structural steelwork, including casting in holding-down bolts (if applicable), fixing it to the concrete or brickwork, etc. as shown on drawings or as specified.

The supply and fixing of roof sheeting, cladding and rainwater goods shall be scheduled separately."

PSH 8.3.7 Handrails

Replace the contents of this Subclause with the following:

Handrail assembly complete (drawing number stated/details given):

a) Horizontal top mounted ..... Unit: m

b) Horizontal side mounted flush ..... Unit: m

c) Horizontal side mounted offset ..... Unit: m

d) Horizontal removable ..... Unit: m

e) Sloping top mounted ..... .Unit: m

f) Sloping angle mounted ..... Unit: m

g) Sloping side mounted flush ..... Unit: m

h) Step ladders top mounted ..... Unit: m

i) Step ladders side mounted flush ..... Unit: m

j) Bends ..... Unit: No.

k) End closures ..... Unit: No.

l) Sleeves for removable stanchions ..... Unit: No.

m) Kickplates ..... Unit: m

n) Handrailing for public places ..... Unit: Sum or m

o) Guard chains ..... Unit: No

The per-meter rates (a) through (i), shall be per meter of handrailing assembly complete. The per-number rates (j) through (l) shall be extra over to the relevant per meter rate (a) through (i). The rate for bends shall be 1 No. per change in handrailing direction/angle (i.e. a bend in the handrailing shall typically incorporate a bend in both the hand rail and a knee rail, which shall together be measured as 1 bend). The per-meter rate for kickplates shall be per meter of kickplate assembly complete. The rate for handrailing in public places shall be for the complete assembly as indicated, or per meter of the type indicated. The per-number rate for guard chains shall be the number of each guard chain assembly complete, separated for different guard chain details and for each width (or range of widths) between substrates (stanchions/walls/stringers, as applicable) to which the guard chain eye and hook bolts will be affixed.

The tendered rates shall include for the production of shop drawings/details (where required), all procurement costs, supply, fabrication, corrosion protection (such as galvanizing and painting) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the handrails, kickplates, guard rails, etc., including grouting in/fixing to concrete, brickwork, steel substrates, etc. as shown on drawings and as specified."

PSH 8.3.8 Ladders, complete and installed

*In the heading, replace the word "*length*" with the word "*height*".*

Replace the contents of this Subclause with the following:

"Separate items will be scheduled for ladders of different types and heights (or height ranges). The height shall be measured as the vertical distance between the two levels which the ladder provides access between (i.e. the distance between the upper and lower levels connected by the ladder).

The rate for ladders shall include for the production of shop drawings/details, all procurement costs, supply, fabrication, corrosion protection (such as galvanizing and painting) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour and materials (including fasteners) necessary for proper completion of the ladders, including fixing it to the concrete, brickwork, etc. as shown on drawings or as specified.

The rate shall also include for all ladder ancillaries shown on the ladder drawings such as threshold plates, grab bars, etc.

PSH 8.3.9 Flooring, complete and installed with frames

Replace the contents of this Subclause with the following:

The rate shall cover the cost of supplying the specified or scheduled type of flooring complete with angle supports/frames (including added flat bars where required) and top hat sections as indicated on the drawings and the cost of all fixings, installing, fixing, grouting/casting in, etc. The rate shall further include for the production of shop drawings/details (where required), all procurement costs, fabrication, cutting, welding, banding, cut-outs, corrosion protection (including galvanizing, painting, etc.) as specified, inspections as per Subclause 7.2 of SANS 1200 HC, transportation and erection, all plant, labour and materials (including

fasteners, clips, etc.) necessary for proper completion of the flooring and support frames.

Any additional supports and cut-outs not specified but which are required by the Contractor to accommodate his equipment layout shall not be paid for separately, but shall be included for in the above rate for flooring.

Additional support systems specified (i.e. specified i-beams and channel sections) will be scheduled and paid for separately under 8.3.1, which rate shall also include for the required end connections, flat bars, fasteners, etc. Additional support systems exclude angle support/frames, etc. which are already included for under the rate for flooring.

Add the following items:

"PSH 8.3.14 Manufacture, supply, erection and testing of a ..... kilolitre storage tank ..... Unit: sum

The tendered sum shall include full compensation for procuring and furnishing all materials, labour, equipment, transport, loading, off-loading, footings, assembly and erection of the tank complete with all pipework connections and accessories, filling and testing of the tank, all in accordance with the Specification and the Drawings.

Note: Excavations and footings will be measured elsewhere, as well as GMS pipework specials against stand.

PSH 8.3.15 Lightning protection for a ..... kilolitre storage tank..... Unit: sum

The tendered sum shall include full compensation for obtaining SABS approval of the drawings, and for installing and testing the lightning-protection system on the structure as specified on the approved Drawings.

PSH 8.3.16 Sterilization of a ..... kilolitre storage tank..... Unit: sum

The tendered sum shall include full compensation for sterilizing the structure as specified."

PSH 8.3.17 Miscellaneous steel items

a) Items measured by area:
Description of or drawings reference to item .....Unit: square metre (m^2)

b) Items measured by length:
Description of or drawings reference to item ..... Unit: metre (m)

c) Items measured by number:
Description of or drawings reference to item ..... Unit: No

d) Items measured by mass:
Description of or drawings reference to item .....Unit: kg or ton

The unit of measurement shall be the square metre, linear meter, number or mass as applicable to each item. The tendered rates shall include full compensation for all labour, materials, fasteners (including holding-down bolts), plant, equipment, transport, etc, manufacturing or providing and installing each item complete as scheduled and shown on the Drawings, and shall include all corrosion protection, finishes and inspections as per Subclause 7.2 of SANS 1200 HC, where applicable.

PSHA STRUCTURAL STEELWORK (SUNDRY ITEMS)

PSHA 3 MATERIALS

PSHA 3.1 STRUCTURAL STEEL

Add the following:

"Where stainless steel is to be used, the grade of stainless steel shall be grade 304L."

PSHA 5 CONSTRUCTION

PSHA 5.2 FABRICATION AND ASSEMBLY

PSHA 5.2.4 Welding

The Contractor shall submit with his shop drawings full details of welding procedures. All welds shall be continuous. Unless otherwise approved no longitudinal or overhead welding shall be carried out on site. Under no circumstances will cutting and welding of grid covers and frames be permitted on site.

Welders undertaking manual welding of permanent steelwork shall be experienced and competent artisans.

PSHA 5.2.6 Handrails

Add the following:

"Handrail stanchions shall be spaced at 1 300 mm centres unless otherwise indicated on the drawings or approved by the Engineer in writing. Handrails and stanchions shall be of the material as scheduled and all stanchion anchors shall be 12 mm diameter unless otherwise indicated on the Drawings."

PSHA 5.2.7 Ladder and step irons

Add the following:

"Ladders and step irons shall be galvanised mild steel with corrosion protection coatings as specified."

PSHA 5.2.8 Open grid floors

Add the following subitem:

"PSHA 5.2.8.3 All open grid floors and frames shall be galvanised mild steel with corrosion protection coatings as specified.

All open grid floor panels shall be open-ended as specified, except where bonding is specified on the Drawings. Cut outs shall be provided where indicated on the Drawings"

PSHA 8 MEASUREMENT AND PAYMENT

PSHA 8.3 SCHEDULED ITEMS

PSHA 8.3.1 Structural steel (type of structure indicated)

Change "Unit : t" *to* " Unit : t or No".

Add the following after the last sentence:

"Alterations to existing structural steelwork will be described in the schedule and measured in number. Rates for these items shall include full compensation for all labour tools, storing, additional steelwork, reinstallation, cleaning up, grinding, etc as described in the schedule and shown on the drawings."

PSHA 8.3.2 Handrails

Replace subitem (c)(3) *with the following:*

"(c)(3) Extra over rails for bends, end closures and accessories:

(i) (Description of item stated) ..... Unit: No.

(ii) Etc for other descriptions"

PSHA 8.3.3 Ladders, complete and installed (Drawing number or type and length stated)

Replace this item with the following:

"PSHA 8.3.3 Ladders, complete and installed (Drawing number or type and length stated)

Separate items will be scheduled for ladders
of different materials, dimensions and height ..... Unit: No.

The tendered rates shall include full compensation for the cost of supplying the specified or scheduled ladders complete, including welding where applicable."

PSHA 8.3.4 Flooring, complete and installed with frames (Drawing number stated)

Replace this item with the following:

PSHA 8.3.4 Flooring, complete and installed with frames:

(a) Open grid floors Unit : m²

(b) Floor-plate floors Unit : m² or t

(c) Frames and kerbs for flooring ..... Unit : m

Separate items will be scheduled for grid floors, floor-plate floors, frames and kerbs of different materials, dimensions, weight and different methods of fixing.

The tendered rates shall include full compensation for the cost of supplying the specified or scheduled types of flooring, frames or kerbing complete, including welding where applicable."

PSHA 8.3.6 Corrosion protection

Replace this item with the following:

"PSHA 8.3.6 Corrosion protection .....Unit : Sum

Separate items will be scheduled for different systems of corrosion protection. Separate subitems will also be scheduled for different elements to be coated/protected.

The tendered sums shall include full compensation for all material, preparation, etc, related to the specified corrosion protection system.

PSL MEDIUM-PRESSURE PIPELINES

Add the following:

This Specification shall be read in conjunction with the Particular Specification ZUT 7002 Manufacture of medium-pressure steel pipelines. Where conflict between this specification and ZUT 7002 Manufacture of medium-pressure steel pipelines occurs, the provisions of ZUT 7002 Manufacture of medium-pressure steel pipelines shall apply.

PSL 3 MATERIAL

PSL 3.1 GENERAL

Add the following paragraphs:

"Each type of pipe delivered to the Site shall be of a standard length corresponding to the standard lengths offered by the pipe manufacturer in his catalogue, with a maximum permissible variation in length of ± 2%.

A pipe that is shorter or longer than the defined standard will be rejected by the Engineer, except when such non-standard lengths are required in terms of the Contract and have been specifically manufactured or cut as such by the pipe manufacturer or supplier."

PSL 3.4 STEEL PIPES, FITTINGS AND SPECIALS

PSL 3.4.2 Pipes of nominal bore up to 150 mm

Add the following:

"The pipes shall be 'normalised' or seamless steel pipes and shall comply with SANS 62. It shall be used with malleable cast-iron fittings complying with the requirements of SANS 14 unless otherwise indicated on the Drawings.

Where flanges are required they shall comply with SANS 1123 tables. Applicable flange table to match the working pressure class of the pipe as indicated on Drawings."

PSL 3.7 OTHER TYPES OF PIPES

PSL 3.7.1 uPVC pipes

In the heading of this Subclause, replace "uPVC" with "PVC-U".

Replace the contents of this Subclause with the following:

"PVC-U (also referred to as uPVC in this spec) pipes shall comply with the requirements of SANS 966. All PVC-U pipes pressure class shall be as shown on the drawings.

Bends on PVC-U for DN 250 and smaller shall be manufactured from PVC-U. Bends on PVC pipes larger than DN 250 shall be manufactured from cast iron or ductile iron. All other specials on PVC-U pipes shall be manufactured from cast iron, ductile iron, and Grade 316L stainless steel, based on the detail of the special."

PSL 3.7.2 Polyethylene pipes

Replace the contents of this subclause with the following:

"High density polyethylene (HDPE) pipes and specials shall all be of material PE100 and comply with the requirements of SANS ISO 4427.

Where HDPE pipes and specials are not manufactured by a SAPPMA member, the approval of the manufacturer shall be obtained from the Engineer prior to ordering any pipes or specials.

The Contractor shall provide the Engineer with the batch release test results from the raw material supplier for each pipe diameter and pressure class. The following shall be considered the minimum requirements: compound density, carbon black content, volatile content, oxidation induction time and melt mass flow rate.

The Contractor shall also submit samples taken from the manufactured pipes for testing at an independent test facility where the following shall be tested as the minimum requirements: compound density, carbon black content, carbon black dispersion, volatile content, oxidation induction time, melt mass flow rate and elongation at break. Test shall be performed on each pipe diameter and pressure class applicable to the contract."

PSL 3.8 JOINTING MATERIAL

PSL 3.8.2 Flexible Couplings

Replace the contents of Subclause 3.8.2.1 with the following:

Flexible couplings for plain-ended steel pipe and adaptor couplings shall be either of the slip-on type complying with Clause 15 of BS 534 or of the slip-on type without centre register conforming to the drawings, as scheduled. Slip-on flange adaptors for steel pipes shall conform to the relevant drawings."

Add the following at the end of Subclause 3.8.2:

"3.8.2.5 All grinding off of welds shall conform accurately with the profile of the rolled section and so that no flats occur on surfaces that are supposed to be curved. The centre register (where present) shall be ground off on either side of the weld in such a manner that all sharp edges which would result in weakening of the protective coating are removed.

3.8.2.6 Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings."

PSL 3.8.4 Loose flanges

Replace the last two lines of this Subclause with the following:

"the bolt threads project no less than 1 thread and no more than 8 threads above the head of the nut.

Backing ring flanges for HDPE pipes and fittings shall be manufactured from grade 316 stainless steel, unless otherwise shown on the drawings or specified in the Bill of Quantities."

Add the following new subclauses to clause 3.8

"PSL 3.8.8 Joining pipes/fittings of the same material

HDPE pipes shall be joined by means of butt fusion welding. HDPE pipes of DN 110 and smaller can be joined with compression type fittings. Electro-fusion fittings will not be accepted unless approved by the Engineer.

PVC-U / PVC-M pipes shall use push in joints. The pipe end shall be spigot and socket with integral socket and locked-in rubber ring seal.

PSL 3.8.9 Joining pipes/fittings of different materials

a) Unless otherwise specified on the drawings or in the Bill of Quantities, when connecting HDPE pipes to pipes or fittings of other materials, they shall be bolted together. The HDPE pipe shall have a stub and steel backing ring (grade 316 stainless steel backing ring unless otherwise specified) and the adjoining pipe or fitting of other material shall be flanged. Attempting to join plain-ended HDPE pipes to pipes and fittings of other materials will not be accepted.

b) Unless otherwise specified on the drawings or in the Bill of Quantities, when connecting PVC-U/PVC-M pipes to pipes or fittings of other materials, this shall be done by means of a flange adapter. The PVC pipe shall be fitted with a ductile or cast iron flange adapter with socket end and the adjoining pipe or fitting of other material shall be flanged. An insulating flange shall be provided to prevent bi-metallic corrosion between the steel flange and the flange adaptor, and the flanges shall be bolted together.

c) **PSL 3.9 CORROSION PROTECTION**

PSL 3.9.2 Steel pipes

Replace the contents of this Subclause with the following:

"Corrosion protection shall comply with the Particular Specification ZUT 7003 Corrosion Protection."

PSL 3.9.5 Joints, bolts, nuts and washers

Replace the contents of this Subclause with the following:

"All fasteners (i.e. nuts, bolts and washers, etc.) shall be of equal or better corrosion resistance than the items being fastened, and shall under no circumstance have corrosion resistant properties less than that provided by hot dip galvanising. For example, grade 316 stainless steel or better fasteners must be used to fasten together grade 316 stainless steel flanges, HDG or better fasteners must be used to fasten together HDG flanges. Plated fasteners will not be accepted.

Washers shall be fitted under both bolt head and nut. Bolts and nuts shall be treated with nickel anti-seize paste before assembly."

PSL 3.9.6 Corrosive soil

Replace the heading of this Subclause with the following:

"Buried pipework"

Replace the contents of this Subclause with the following:

"All buried steel, cast iron and ductile iron pipework fittings, joints and valves shall be wrapped in an approved petroleum-based paste and adhesive tape ("Stopaq" or equal approved) strictly in accordance with the manufacturer's instructions."

PSL 3.10 VALVES

Replace the contents of this Subclause with the following:

"Valves shall comply with various Particular Specifications applicable to the different types of valves."

PSL 3.11 MANHOLES AND SURFACE BOXES

PSL 3.11.4 Step irons

Replace the contents of this Subclause with the following:

"Step irons shall be manufactured of copolymer polypropylene with a 12 mm diameter high tensile steel core. The step irons shall be installed in accordance with the manufacturer's specifications."

PSL 3.11.5 Manhole covers and frames

Add the following to the end of Subclause 3.11.5.1:

"All manhole covers and frames shall be manufactured from ductile iron complying with the requirements of SANS 558 and be of the SECUREX type or similar approved."

Add the following new subclauses to clause 3:

"PSL 3.12 MARKING

All pipes, specials and valves arriving on site shall be marked clearly with the item number appearing in the Bill of Quantities. Furthermore, the nuts, bolts, washers and other ancillary equipment for each individual item shall be kept separate in a bag which shall also bear the respective reference number for that item. The cost of such marking will be held to have been included in the rates tendered for the items.

PSL 3.13 PROTECTION DURING STORAGE, HANDLING AND CONSTRUCTION

The Contractor shall satisfy the Engineer that the manufacturers' recommendations for good practice for the transporting, handling, stacking, storing and installing of pipes, pipe fittings, sealing rubbers etc. are being diligently followed. The Engineer's Representative shall be given the opportunity to inspect all materials

immediately prior to installation and shall have the right to reject any materials which, in his opinion, have suffered damage which may impair the long-term durability or strength of said items.
Pipes and specials shall be protected against damage during all stages of manufacture, delivery, storage and handling.

Until required, rubber rings and couplings in which there are rubber rings shall be stored undercover in a cool, dark place, away from grease, oil and harmful chemicals. If rubber rings are tied in bundles they shall be untied at least 2 days before being required to allow the rubber rings to recover from any tie marks and indentations."

PSL 5 CONSTRUCTION

PSL 5.1 LAYING

PSL 5.1.1 General

Add the following to the end of this Subclause:

"The pipelines shall be laid to the invert levels and gradients shown on the drawings.

Horizontal and vertical angular deviations at flexible couplings shall be limited to the maximum angle specified by the pipe manufacturers.

The Contractor shall protect all buried pipe fittings, valves and joints including fasteners against corrosion by wrapping them in accordance with subclause 3.9.6.

Curving of HDPE pipes to a radius not exceeding 20 x outside diameter of the pipe, or as permitted by the pipe manufacturer, shall be permitted in lieu of bends.

PSL 5.1.2 Damage

Add the following to the end of this Subclause:

"The following shall apply with respect to surface damage to HDPE pipes:

d) All diameters: Any form of surface damage greater than 10% of the minimum wall thickness shall not be allowed.

All diameters: Any surface damage located closer than 200 mm from the pipe ends shall not be allowed.

≤ DN110: Surface damage shall not exceed 10% of the minimum wall thickness and shall not be greater than 75 mm in length. The distance between surface damages shall not be less than 300 mm and no more than two (2) defects shall be permitted per 6 metre length of pipe (reduced number of defects pro rata per length).

> DN110: Surface damage shall not exceed 5% of the minimum wall thickness and shall not be greater than 75 mm in length. The distance between surface damages shall not be less than 300 mm and no more than three (3) defects shall be permitted per 6 metre length of pipe (reduced number of defects pro rata per length).

Pipes not conforming to these criteria shall be rejected."

PSL 5.1.4 Depths and cover

Add the following to the end of Subclause 5.1.4.3:

"The minimum clearances at crossings between the barrels of proposed pipelines or between existing and proposed pipelines shall be 300 mm. The pipeline shall be laid horizontally at this level for a distance of at least 1,0 m on either side of the centreline of the service crossed. The Contractor shall inform the Engineer should he find that this minimum clearance cannot be achieved."

Add the following to the end of Subclause 5.1.4:

"5.1.4.6 The pipelines shall be laid to the invert levels and gradients shown on the drawings and so that the minimum cover to the top of the pipe barrel from finished surface level is 1.0 m unless otherwise specified."

Add the following subclause to clause 5.1

"PSL 5.1.5 Setting out

The Contractor shall clearly mark the pipeline route for the approval of the Engineer prior to commencing with and trench excavation. The requirements for marker posts in SANS 1200 A shall apply."

PSL 5.2 JOINTING METHOD

PSL 5.2.3 Welding (Steel Pipelines of Diameter 600 mm or greater)

Omit the words "of Diameter 600 mm or greater" *from the Subclause heading.*

Add following subclause to clause 5.2

"PSL 5.2.5 HDPE Welding

The HDPE pipes and specials shall be joined by means of butt fusion using approved, butt welding equipment and fully accredited, trained plastic welders in accordance with the manufacturer's code of practice. The Contractor shall undertake the following steps prior to the commencement of welding on site:

e) Provide a Welding Procedure Specification (WPS)

Provide welding tables applicable specifically to pipe diameters and pressure classes to be welded and the welding equipment used.

Provide a certificate of calibration for the welding machine to be used. The certificate shall bear the model number of the welding machine, the name and the address of the certifying agent, the date of the test and a statement as to the accuracy of the temperature and pressure gauges on the machine in question.

A certificate of calibration dated more than 12-months from the Commencement Date is not acceptable.

Provide certification that the welder/operator has successfully completed an approved training course in accordance with SANS 10269 and is qualified to weld the sizes and pressure classes of HDPE pipe to be used on this Contract. The certificate shall be issued within the previous 12 months from construction commencing on site.

A test weld, on each pipe diameter and pressure class, is to be undertaken on site in the presence of the Engineer's Representative for approval prior to the commencement of welding the pipes. The test weld(s) shall also be submitted to an approved laboratory and be tested in accordance with SANS 6269. A minimum weld factor of 1.0 is required.

Under no circumstances will welding be permitted to commence prior to the provisions of the abovementioned certificates and the weld test, and the cost of delays resulting from failure to timeously undertake the abovementioned steps shall be borne by the Contractor.

Each joint is to be uniquely numbered and a record shall be kept detailing the date, pipe details, weather, welding conditions, initial bead height, welding times and final position of joint in the ground, a copy of which shall be forwarded to the Engineer.

To remove any residual dust and other fine contaminants on the heater plate, a dummy joint shall be made at the start of each day or when changing between pipe sizes.

Unless otherwise approved, the external and/or internal beads shall be removed using suitable debeading tools. The beads and joint shall be numbered/coded using an indelible marker pen to correspond with the joint details entered into the butt fusion machine data retrieval system.

During construction, the Engineers Representative shall order the cutting out of ad hoc joints for testing in accordance with SANS 6269 at an independent testing facility. A minimum of one joint per one hundred joints, with the same welding machine, shall be tested.

If it is necessary to cut pipes, the cut ends shall be turned using a field lathe. Filing of the coupling surfaces of pipes will not be permitted."

PSL 5.5 SETTING OF VALVES, SPECIALS, AND FITTINGS

Replace the last paragraph of this Subclause with the following:

Valves requiring special adjustment after installation such as self-closing valves shall be commissioned by representatives of the valve manufacturers. Similarly, meters shall be commissioned by the respective suppliers after installation by the Contractor.

The mass of valves or water meters shall at no time be carried by the pipe, the flange or the coupling. Support stools shall be constructed as soon as practicable after the installation of valves and meters, and shall generally be constructed of steel, concrete or masonry work. Where fabricated steel stools are approved or specified, they shall comply with the requirements of SANS 10044-3 and shall be fabricated to the Engineer's

approval. Supports shall be welded to the pipe only where specified and linings of pipes and specials shall be made good after welding.

Hydrostatic testing of individual sections of the pipeline shall only be carried out when all scour valves, air valves and control valves have been installed, except where otherwise instructed by the Engineer in writing.

Should line control valves or other equipment not be delivered timeously to enable the Contractor to lay continuously and to test the pipeline, the Engineer may order the Contractor to substitute specially made temporary flanged closure pieces. Such temporary closure pieces shall be supplied and installed by the Contractor to enable laying and testing to proceed. Subsequently after installation of the control valves, etc., they shall be removed and shall become the Contractor's property. These temporary closure pipes shall have the same face to face dimensions as the line control valves and shall be fitted with a suitably reinforced control diaphragm plate for sealing of the section of pipeline where it is fitted. Wall thickness and diameter of the closure pipes shall be the same as the pipeline. A 100 mm nominal bore valve-controlled by-pass shall be fitted externally around the diaphragm plate.

PSL 5.5 ANCHOR/THRUST BLOCKS AND PEDESTALS

Add the following to the end of this Subclause:

“Thrust blocks are required for all bends where flexible joints are used. These thrust blocks are not necessarily required for pipelines that are continuously welded or where locked joints are used.

Where locked joints are used in lieu of thrust blocks, the Contractor shall submit to the Engineer the relevant calculations of the anchored lengths for all relevant bends.

The concrete in the thrust blocks shall be at least Class 25 MPa/19 mm unless otherwise specified on the drawings. The minimum cover to the steel shall be 50 mm. Where no reinforcement is shown allow 100 kg/m³ of concrete.”

PSL 5.6 VALVE AND HYDRANT CHAMBERS

PSL 5.6.1 General

Replace the words "drawing L-1" *in the second line with* "the Drawings".

PSL 5.6.2 Construction of chambers

Replace the words "drawing L-1, L-2 and L-3" *in the fourth line with* "the Drawings".

Add the following subclauses:

“PSL 5.12 MARKER BLOCKS

Type 1 and Type 2 marker blocks shall be manufactured and positioned as shown on the Drawings.

PSL 5.13 PIPELINE ROUTE MARKERS

Route markers for the various water pipelines shall be erected in the positions and shall be manufactured according to the details shown on the Drawings.

PSL 5.14 END CAPS

The Contractor shall, at the end of each day’s work, fit end caps to the open ends of the pipeline under construction. The end caps shall be manufactured in such a manner that it can be fitted to seal off the pipeline to the extent that it is totally dust and waterproof. The end cap must be able to withstand a pressure of 5 m head of water externally when fitted.

End caps shall be maintained during non-working periods.

PSL 5.15 FLEXIBLE CONNECTIONS AT STRUCTURES

In order to avoid damage to pipes due to differential movement where the pipes connect to chambers or other structures, all rigid pipes built and/or grouted into such structures shall be provided with flexible connections in accordance with SANS 1200 LD Drawing LD-2 (unless shown otherwise on the project-specific drawings).

Where PVC pipes connect to any structure a “Lyng” type PVC double socket (or where applicable, a bend) shall be fitted directly into the machined collar of the associated puddle pipe.
HDPE pipelines are considered flexible pipelines and shall connect via a restrained flanged special built into the structure.

PSL 5.16 CLEANING PIPE INTERNALS, VALVES AND FITTINGS

The Contractor shall ensure that all pipe work is installed internally free of any contaminants. All traces of dirty water, cuttings, dirt and other debris are to be removed from the inside of the pipe as it is installed.

The Contractor shall take note that flushing of the completed pipelines may not be allowed after construction has been completed and therefore clean house keeping practices will be required under all circumstances during construction. The tendered rates for pipe laying shall include for the clean house keeping practices required.
Each section of the pipeline is to be internally inspected and passed by the Engineer once construction has been completed. If the pipework is not satisfactory, the Contractor shall re-clean the pipe at his own expense until the pipe is passed clean. The Engineer reserves the right to utilize cameras or any other means to inspect inaccessible areas.

All flanges, valves, fittings and equipment are to be installed in pipe work only after they have been thoroughly cleaned. Flange faces shall be checked for damage before being incorporated into the permanent works and any damage shall be reported to the Engineer.

PSL 5.17 PREVENTION OF FLOTATION OF PIPEWORK

The Contractor will take all necessary precautions to temporarily restrain pipework until it has been successfully tested and backfilled over to prevent the potential of flotation of the pipework by rising water tables in the soil. See also Subclause 5.5 of SANS 1200 A.

Pipes to be encased in concrete shall be prevented from flotation during concreting operations. Apart from this special case during concreting operations, the Contractor shall prevent the flotation of pipe work due to storm runoff or groundwater entering the trench before backfilling has been completed.

Methods adopted to prevent flotation shall not damage coatings or linings and shall be approved by the Engineer. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it.”

PSL 7 TESTING

PSL 7.1 GENERAL

Add the following to the start of this Subclause:

“Pipelines designed for potable use shall be hydraulically tested and disinfected using potable water.

The Contractor shall submit to the Engineer a detailed method statement describing the timing, methodology and scheduling of each hydrostatic pressure test to be undertaken. No test shall proceed before approval of such method statement by the Engineer. Under no circumstances will the Contractor be allowed to carry out filling, testing and disinfecting of the pipeline without the supervision of the Engineer, neither shall the Contractor permit any other persons to carry out such said activities without the written permission of the Engineer.”

Add the following to the end of this Subclause:

“Over and above other tests specified, all pipelines shall be hydraulically tested. The pipelines shall be fitted with all valves, fittings and couplings required to complete the section before testing will be permitted. The Contractor shall construct temporary thrust blocks and provide temporary plugs, blank flanges and other isolating devices where required for testing at no extra cost to the Employer.

Before any tests are carried out, the test pressures and test points shall be confirmed with the Engineer. The Contractor shall provide all equipment required for the pressure testing of the pipeline.”

PSL 7.3 STANDARD HYDRAULIC PIPE TEST

PSL 7.3.1 Test pressure and time of test

Replace the last sentence of Subclause 7.3.1.1 with the following:

Where mixed types or classes of pipe occur, and where the pipeline traverses a wide range of altitudes, the pipeline shall be tested in reduced lengths necessary to comply with 7.3.1.2. Any temporary valves, blank flanges, thrust blocks or other isolating devices required shall be provided by the Contractor at no additional cost to the Employer.

Replace Subclause 7.3.1.2, 7.3.1.3 & 7.3.1.4 with the following:

"The field test pressure applied over any section of pipeline under test, taking differences in elevation along the pipeline into account, shall not be less than the maximum design pressure or exceed 1.25 times the maximum design pressure unless otherwise specified in the Project Specification, on the drawings or by the Engineer.

PSL 7.3.3 Permissible leakage rates

Add the following pipe materials to those listed in item b):

"HPDE, PVC-M, PVC-O"

Add the following new subclauses to clause 7.3

PSL 7.3.4 Initial filling of pipeline

Unless otherwise specified or approved in writing by the Engineer, filling of the pipeline for hydraulic testing shall be carried out at a velocity in the main pipeline not exceeding 0.5 m/s. Any damage to the pipeline caused by non-compliance with this clause shall be rectified at the Contractor's expense.

Water used for one filling of the pipeline for hydraulic testing, and in the case of potable pipelines, one filling for disinfection and one filling after draining, will be provided by the Employer to the Contractor, free of charge, at connection points stated in the Project Specification or instructed by the Engineer. Additional water supplied by the Employer owing to unsuccessful hydraulic testing and/or disinfection will be charged to the Contractor.

PSL 7.3.5 Disinfection of pipeline

Pipelines designated for potable use shall be disinfected after the hydraulic testing has been successfully completed and approved by the Engineer. Water used for the hydraulic testing shall be drained and the pipeline filled, subject to 7.3.4, using potable water with a 1.0 mg/L chlorine solution until completely full. Once completely full, the pipeline shall be allowed to stand a minimum of 3 hours for disinfection unless otherwise instructed by the Engineer and then drained completely. All valves and pipe ends shall be closed, and no drainage or leakage is permitted during the time for disinfection.

PSL 7.5 RESTRICTION ON LENGTH OF OPEN TRENCH

Unless agreed otherwise with the Engineer, pipes shall be tested in lengths not exceeding the maximum allowable length of open trench as contained SANS 1200 DB. Where additional temporary isolating devices are required for testing as a result, the Contractor shall provide these at no extra cost to the Employer.

PSL 8 MEASUREMENT AND PAYMENT

PSL 8.2 SCHEDULED ITEMS

PSL 8.2.1 Supply, lay and bed pipes complete with couplings

Delete "(See 8.2.4)" from the end of this Subclause.

Add the following to the end of this Subclause:

"The rates shall also cover the cost of any cutting and jointing (including nuts, bolts, washers, gaskets, etc.) required for temporary or permanent closure of pipes or for the creation of flexible connections at structures. The rates shall further cover the cost of marking of the items, corrosion protection as specified, wrapping of flanges and couplings with Stopaq or similar approved, supply and fitment of temporary end caps, cleaning the pipes, and all specified testing (including all cost associated with completing the tests including temporary thrust blocks, temporary isolating devices, etc.).

PSL 8.2.2 Extra-over 8.2.1 for the supplying, laying and bedding of specials complete with couplings

Add the following at the end of this Subclause:

"The contents of 8.2.3 apply."

PSL 8.2.3 Extra-over 8.2.1 for the supplying, fixing and bedding of valves

*Add "*complete with couplings*" to the end of the heading for this Subclause.*

Replace the contents of this Subclause with the following:

Specials and valves will be measured by the number of each type, class, and size.

The rates, which shall be extra-over the rates for 8.2.1, shall cover the cost of the design and provision of each special or valve, complete with specified couplings, supports, all nuts, bolts, gaskets, etc. and the cost of marking of the items, handling, inspecting, transporting, fixing, bedding, and testing of the special or valve, as applicable, and the cutting of the pipes and preparation of pipe ends.

The rates shall also cover the cost of machined collars on the specials (where shown on drawings) and the couplings/welds necessary to fit the special and valves to the associated pipeline. The rates shall further cover the cost of corrosion protection as specified, the repair of corrosion protection (as applicable), and the wrapping of flanges and couplings with Stopaq or similar approved.

No extra payment over and above the rates will be made in respect of any additional cutting, turning, and jointing of pipes required for the location of valves, specials, etc., in the positions given on the drawings.

No extra over payment will be made for bends smaller than 5° for steel pipes, 5° for PVC, 5° HDPE or 5°. GRP. The cost for bends or angular deviations at flexible couplings shall be deemed to be included in the tendered rate for 8.2.1

Unless specific provision is made in the schedule, no separate payment will be made for the supply and fitting of any additional joints and jointing materials which may be required for the connection of shortened pipe lengths.

PSL 8.2.7 Extra-over 8.2.1 for encasing joints

Delete this Subclause and its heading.

The cost of encasing joints shall be included in the rates provided under 8.2.1, 8.2.2 and 8.2.3, where the cost of the specified corrosion protection and wrapping of flanges and couplings with Stopaq (or similar approved) is included.

PSL 8.2.10 Temporary Valves, etc.

Delete this Subclause and its heading.

Payment for temporary valves, end caps, blank flanges, or other isolating devices required to complete installation and testing requirements shall be included in the rates provided under 8.2.1, 8.2.2 and 8.2.3,

PSL 8.2.11 Anchor blocks/Thrust blocks and pedestals

Add the following to the end of the 2nd last paragraph of this Subclause:

"The rates given in b) above shall also include the cost of any excavation, trimming and backfill required.

In the final line of this Subclause, replace the words "and screeding of top surfaces." *with the following*:

"Concrete, screeding of top surfaces and any backfill required. Where reinforcement is not indicated on the drawings, an amount of 100 kg of high tensile steel per cubic metre of concrete shall be included for. Temporary thrust blocks will not be paid for."

PSL 8.2.13 Valve and hydrant chambers, etc.

Replace the words "complete units." In the first sentence with the following:

"complete units, with depth increments as scheduled (if applicable). For the purpose of measurement and payment, the depth of a chamber is defined as the depth from the top of the cover to the invert level of the

chamber (where the invert level for larger chambers is that of the main floor area and not the invert of a localized recess used for draining the chamber). For bell toby valve chambers, the crown of the pipe shall be taken as the chamber invert level."

Replace the last paragraph of this Subclause with:

"The rate shall cover the cost of any additional excavation in all material (including disposal of surplus) and backfilling with suitable material (including importation of material if required). The rate shall further cover the cost of building the chambers, complete as shown on the relevant drawings, including castings, step irons, cover and frames (SANS 558 Type 2 A unless otherwise shown on the drawings), benching, vents, brickwork, concrete work, grids, other accessories, etc., and the building in of pipework and valves (but excluding supply of the main pipework and valves), along with all necessary materials, plant and labour."

PSL 8.2.14 a) Manholes, b) Extra-over for manholes of depth exceeding 1,5

At the end of the first paragraph of Subclause 8.2.14(a), replace the words "of overall depth not exceeding 1,5 m." *with the following*:

"of the incremental depths scheduled."

Add the following to the end of Subclause 8.2.14(a):

"For the purpose of measurement and payment, the depth of a manhole, inspection chamber, etc, is defined as the depth from the top of the cover to the invert level of the manhole, inspection chamber, etc.

The rate shall cover the cost of any additional excavation in all material (including disposal of surplus) and backfilling with suitable material (including importation of material if required). The rate shall further cover the cost of building the manholes, complete as shown on the relevant drawings, including castings, step irons, cover and frames (SANS 558 Type 2 A unless otherwise shown on the drawings), benching, vents, brickwork, concrete work, grids, other accessories, etc., and the building in of pipework and valves (but excluding supply of the main pipework and valves), along with all necessary materials, plant and labour."

Delete the heading and contents of Subclause 8.2.14(b).

PSL 8.2.15 Special Wrapping in Corrosive Soil

Delete this Subclause and it's heading.

The cost of wrapping shall be included in the rates provided under 8.2.1, 8.2.2 and 8.2.3, where the cost of the specified corrosion protection and wrapping of flanges and couplings with Stopaq (or similar approved) is included.

PSL 8.2.17 Marker blocks:

(a) (Give description with reference to drawing).....Unit: number

(b) Etc for other descriptions

The tendered rate shall include full compensation for all excavation and backfill, labour, equipment and materials to manufacture and install the blocks as shown on the Drawings.

PSL 8.2.18 Connection to main supply pipe and/or reservoir inlet pipework.....Unit: number

The tendered rate shall include full compensation for the cost of excavation, connection to main supply pipe or reservoir inlet pipework, removal of surplus material, all labour and equipment necessary to make the connection and all liaison with the local authorities.

Add the following subclause to clause 8.2

PSL 8.2.19 Miscellaneous

The tendered sums or rates shall cover all costs required to execute and complete the work as specified and scheduled. This shall, for example, include full compensation for the supply of all materials, delivery to site,

storage, all equipment and plant, labour, preparation, application, installation, testing, all temporary work and safety precautions, replacement of defective work, protection of completed work and clean-up after completion. Where this requires tying into an existing service, the rate shall further include managing the shutting-off/disconnection and turning-on/reconnection activities required to complete the work.

PSLB BEDDING (PIPES)

PSLB 1 SCOPE

Replace the contents of this Clause with the following:

“This specification covers the supply and installation of bedding (bedding cradle and selected fill blanket) for buried pipes carrying fluids under pressure or gravity.

Project-specific drawings (see definition) have been prepared to show the bedding details for various pipe types and installation conditions. As these project-specific drawings take precedence over the drawings which are included within the Standardised Specifications, these Standardised Specifications should be read in conjunction with the project-specific drawings.

NOTE: The standards referred to in the specification are listed in Appendix A.”

PSLB 2 INTERPRETATIONS

In the definition for “Main fill” *delete* "150 mm" *in second line and substitute* "300 mm".

Add the following at the start of the definition for “Flexible pipe”:

“A pipe made of Steel, uPVC or HDPE, and has a flexibility stiffness ratio of more than 1000 in accordance with SANS 10102, or otherwise… “

Add the following at the start of the definition for “Rigid pipe”:

“A pipe made of concrete and has a flexibility stiffness ratio of less than 10 in accordance with SANS 10102, or otherwise… “

Add the following new definitions:

“Stiffness ratio. Modulus of soil reaction of the bedding material.“

“Project-specific drawings. Drawings other than those included within the Standardised Specifications. For example, drawings LB-1 and LB-2, etc. are not project-specific drawings.“

PSLB 3 MATERIALS

PSLB 3.1 SELECTED GRANULAR MATERIAL

Add to the following to this Subclause:

“Unless otherwise specified, the selected granular material shall consist of sand and the maximum particle size shall be restricted to 5 mm (Type 1) and 13 mm (Type 2) as detailed in Subclause 3.3 below.”

PSLB 3.2 SELECTED FILL MATERIAL

Replace the contents of this Subclause with the following :

“The material for selected fill shall be selected granular as per Subclause 3.1 (and measured as such), unless indicated otherwise on the project-specific drawings.”

PSLB 3.3 BEDDING

Add to this Subclause:

“Bedding for flexible pipes:

Bedding (Type 1) (selected granular and selected fill material) for flexible pipes shall be a singularly graded fine sand or fine non-cohesive soil, carefully selected, with maximum particle size of 5 mm and which shall not cake nor form lumps when drying. Should be granular material with less than 35% fines.

Bedding (Type 2) (selected granular and selected fill material) for flexible pipes shall be fine sand or fine non-cohesive soil, carefully selected, with maximum particle size of 13 mm and which shall not cake nor form lumps when drying. Should be granular material with less than 35% fines.

Samples of bedding sand shall be submitted by the Contractor to the Engineer for approval well in advance of construction. Only after the Contractor has received written approval from the Engineer, may he/she proceed with placing sand as selected granular material.

No sharp-edged stones shall be allowed to come into contact with the flexible pipes or associated fittings. Joint holes (pockets) shall be provided in the trench bottom and bedding, at each pipe joint to facilitate inspection or welding where applicable, and no extra payment will be made for forming or filling the joint holes (pockets) with bedding sand.

The material shall be free of organic matter and shall have a compactibility factor of not more than 0,4. The material should be classified as silty to fine sand having a stiffness ratio of not less than 6,0 MPa. The origin of the materials should, preferably, be river transported since it is preferable that the larger grains be rounded and not sharp and angular.

The Contractor will be required to carry out his/her own quality control testing of the material to ensure that it meets the bedding sand requirements and complies with this specification at all times. At least one grading analysis shall be carried out for every 100 lineal metres of bedding placed. The results of these tests shall be forwarded to the Engineer within 24 hours of completion of the test. Should the material not comply with the specification, the Contractor shall remove and replace it with approved material at his/her own cost.

Depending on the actual material supplied by the Contractor, the moisture content may be critical to enable satisfactory placing and compaction and the Contractor will be deemed to have allowed in his tendered rate for any and all adjustments required to the moisture content of the bedding material at all times.

Items have been provided in the Bill of Quantities for the provision of approved bedding sand from approved Commercial or other approved off-site sources for bedding sand.

No extra payment will be made for forming or filling joint holes (pockets)."

PSLB 3.4 SELECTION

PSLB 3.4.1 Suitable material available from trench excavation

Replace the words "(but is not required)" *in the fifth line with the words* "(at his own cost)".

PSLB 5 CONSTRUCTION

PSLB 5.1 GENERAL

PSLB 5.1.2 Details of bedding

*Replace the words "*Pipes shall be bedded and protected in accordance with" with the following*:*

"Pipes shall be bedded and protected in accordance with the details shown on the project-specific drawings. Where no project-specific drawings are provided or where they do not cover certain pipe sizes or types, the pipes shall be bedded and protected in accordance with"

Add the following subclause to clause 5.1.2:

"PSLB 5.1.2.1 Stone drainage layer beneath bedding

In areas where waterlogged conditions exist or where ordered by the Engineer, special drainage may be required which consists of a single sized stone with a geofabric filter surround as specified in Subclause 5.5.2 of SANS 1200 DB as amended. The excavation for these drains will be measured in cubic metres at the contract rate applying to unsuitable excavation below the bottom of the trench. The stone filling will be paid for per cubic metre and the geofabric filter will be paid for per square metre. All measurements in this connection will be to a width equal to the base widths and depths ordered."

PLSB 5.1.4 Compacting

Replace "90%" *with* "93% (100% for sand) unless otherwise specified".

Add the following to this Subclause:

“Steps will have to be taken by the Contractor to ensure that flexible pipes do not deform excessively in cross-section during and after construction and backfilling operations. The maximum deflection which will be acceptable at any stage during or after construction shall be the minimum of 2% of the pipe diameter horizontally or vertically, or the maximum deflection permitted by the pipe manufacturer. The Contractor will be required to provide the necessary apparatus and to monitor deflection during construction.

Pipe deformations will only be maintained within the specified tolerances by correct backfilling practice. No heavy compaction equipment will be permitted for compaction of any pipe bedding, only pneumatic or hand rammers being acceptable. To this end, and to achieve the 93% (100% for sand) compaction specified it is required that the bedding material be brought up evenly on either side of the pipe. The use of complete saturation of the material as a method of achieving the specified compaction may, subject to the Engineer's approval, be used. However, in this regard, Tenderers are advised that the presence of excessive quantities of water in the pipe trench could lead to flotation of the pipe.

Prior to the commencement of pipe laying the Contractor will be required to submit, to the Engineer, for his approval, his proposed methods of placing, and compacting methods which he proposes to implement in order to ensure compliance with the specification.”

PSLB 5.1.5 Testing

All pipe joints and pipe fittings shall be left exposed with a minimum of 300 mm clearance around the bottom of the pipe during hydraulic pressure testing of the pipe to facilitate inspection.

PSLB 5.3 PLACING AND COMPACTING FLEXIBLE PIPES

PSLB 5.3.a Bedding cradle

Delete the contents of this Subclause and substitute with the following:

“The pipes shall be bedded on a minimum 100 mm thick layer of compacted granular bedding material on which a 50 mm thick layer of uncompacted granular bedding material has been placed and spread. Loose granular bedding material lying next to the pipe shall be placed into the haunch area and compacted with suitable hand tools (covered with rubber to prevent damage to the pipe coating), and additional selected granular material shall be added and compacted in layers up to the mid-point of the pipe diameter in the vertical plane. The remainder of the bedding i.e. the selected fill blanket, shall be placed in layers up the sides of the pipe, each layer being compacted until a level of 300 mm above the crown of the pipe is reached.

All joint (fox) holes shall be filled with bedding material.”

PSLB 5.3.b 200 mm Selected fill blanket

Delete "200 mm" *from title*.

PSLB 5.4 CONCRETE CASING TO PIPES

Replace the contents of this Subclause with the following:

“The requirements under this Subclause shall only be used where the encasing of pipes in concrete is scheduled under 8.2.4 Encasing of Pipes in Concrete.

Where the Engineer requires pipes to be encased in concrete, a class 25 MPa/19 mm for unreinforced, 30 MPa/19 mm for reinforced or such other class as is scheduled, shall be used. The work shall be done as follows:

a) Concrete casing shall be discontinuous at flexible couplings in the pipeline.

b) The pipe trench for the concrete encased pipeline shall be excavated to the depth below the bottom surface of the pipe, as ordered or shown on the drawings, and to sufficient width to allow for the concrete to be placed to the full specified width. The bottom of the trench shall be trimmed true to line and grade.

c) The in situ concrete bed 150 mm thick shall be cast and the pipeline laid thereon true to line and level leaving a gap nowhere less than 50 mm between the pipe and the bed. If the encasement on the drawings is shown to extend further than 200mm below the invert of the pipe, the 150mm thick concrete bed shall be increased accordingly.

d) After jointing, the pipes shall be secured to steel loops left in/anchored to the bed. Concrete shall then be punned under and around the pipes from one side only until the bottom quarter of circumference of the pipes is in contact with the concrete bed.

e) The pipe shall be tested in accordance with the applicable tests given in SANS 1200 L Clause 7, care being taken to ensure that the pipe do not move during testing.

f) After the pipeline has been tested, suitable formwork shall be erected and concrete carefully placed and vibrated in position up both sides of the pipe. The concrete level shall be raised equally on both sides of the pipe until encasement is complete and a cover over the surface of the pipe is provided that is nowhere less than that ordered or shown on the drawings.

g) No casting of subsequent concrete members or earth filling over the concrete encasing shall be commenced until the concrete encasing has achieved its 28-day compressive strength (minimum 7 days)."

PSLB 6 TOLERANCES

PSLB 6.1 MOISTURE CONTENT AND DENSITY

In this Subclause, replace "be as given below, appropriate to the particular class of work" *in the first sentence with* "be those for Degree of Accuracy II class of work, as given below"

PSLB 8 MEASUREMENT AND PAYMENT

PSLB 8.1 PRINCIPLES

PSLB 8.1.3 Volume of bedding materials

Add to this Subclause:

"(c) The volume of bedding material shall be measured net i.e. the volume of the pipe is to be deducted.
(d) No additional payment will be made for bedding material placed in joint (fox) holes.
(e) The rate for bedding and backfill material from in-situ material shall include the selection and sieving of the material."

PSLB 8.1.5 Disposal of displaced material

Replace the contents of this subclause with the following:

"Material displaced by the pipeline and by imported material from sources other than trench excavation, shall be disposed of at an approved site furnished by the Contractor. No haulage is payable for such material."

PSLB 8.1.6 Free-haul

Delete the contents of this Subclause and substitute the following:

"Subclause 5.2.5 of SANS 1200D as amended shall be applicable."

PSLB 8.2 SCHEDULED ITEMS

PSLB 8.2.1 Provision of bedding from trench excavation

Replace the "from within 0,5 km" *and* "distance of 0.5 km" *with the following*:

"From within the freehaul distance"

PSLB 8.2.2 Supply only of bedding by importation

PSL 8.2.2.1 From other necessary excavations

Delete Subclause 8.2.2.1 and substitute the following:

"8.2.2.1 From other necessary excavations, including for screening and/or other treatment:

a) Selected granular material..... Unit : m³

b) Selected fill material ..... Unit : m³

The rates shall cover the cost of acquiring, loading, transporting, offloading, screening or otherwise treating excavated material in order to produce bedding that complies with the relevant specification, delivering it to points alongside the trench spaced to suit the Contractor's methods of working and of disposing of displaced material.

NOTE: The rate for the supply and laying of pipelines covers the cost of handling the bedding material from alongside the trench, placing it under the pipeline, forming joint holes and completing the bedding around and over the pipeline."

PSLB 8.2.2.3 From commercial sources

Delete the words "of 0.5 km" *in the last line of Subclause 8.2.2.3*.

Add the following to Subclause 8.2.2.3:

"In areas where waterlogged conditions exist or where ordered by the Engineer, the Contractor shall install 19 mm crushed stone as selected granular material for concrete pipes with filter fabric as shown on the project-specific drawings.

The geotextile filter blanket shall be measured by area as:

Area = 2 x (specified stone layer thickness + minimum base width) x net length.

The rate shall include the cost of supply, placing and losses as a result of overlaps and over excavated trench widths."

PSLB 8.2.3 Concrete bedding cradle

Add the following paragraph to the Subclause:

"All concrete bedding to pipes will require formwork. The rate for concrete bedding shall include for the supply, installation and stripping of all formwork."

PSLB 8.2.4 Encasing of pipes in concrete

Replace the first sentence with the following:

Separate items will be scheduled for each size of pipe (or range of pipes), for each grade of concrete specified and whether the encasing is unreinforced or reinforced (unreinforced unless otherwise specified).

Delete the fifth and sixth lines and substitute the following:

"encasing the pipe in concrete including the cost of formwork (if any, inclusive of supply, installation and stripping), etc. and the cost of formwork to form stop ends on either side of collars, couplings, joints etc., if instructed by the Engineer.

Where encasings are specified as reinforced, the rate shall also include the cost of reinforcing (120kg of steel reinforcing per m3 of concrete encasing, unless otherwise specified). Where no encasing width or height is given on the drawings, the encasement shall extend 200 mm above and below the pipe and 200 mm on both sides of the pipe."

Add the following item:

"PSLB 8.2.6 Extra over items 8.2.1 and 8.2.2 for bedding stabilized with 5% cement..... Unit: m³

The tendered rate shall include full compensation for selecting, mixing, backfilling and compacting the stabilized material to 93% of modified AASHTO density."

Add the following

"PSLB 8.2.7 Provision of stone/geofabric to deal with water ..... Unit : m³/m²

If in the opinion of the Engineer, the Contractor complied with the requirements for dealing with water as specified in PSA 8.8.6., the Engineer may instruct the installation of crushed stone and filter fabric.

Payment for these items will only be made where instruction was given in writing by the Engineer.

The provision of crushed stone bedding material will be measured by volume based on the specified trench width and a maximum layer thickness of 300 mm unless a greater depth has been specified by the Engineer.

The unit rate shall cover the cost of supplying and laying the crushed stone.

The filter fabric will be measured separately by area based on the specified trench width, a stone bedding thickness of 300 mm and an overlap of 300 mm.

The rate shall cover the cost of the supply, delivery and laying of the filter fabric."

PSLC CABLE DUCTS

PSLC 3 MATERIALS

PSLC 3.1 DUCTS

Add the following:

PSLC 3.1.2 Split uPVC pipes

Split pipes shall only be used to provide ducts for existing services that cannot be severed and threaded through the ducts. The pipes shall be cut accurately in the middle, and opposite halves shall be matched as sawn. Split pipes shall be placed around the service, firmly bound by steel straps, and encased in concrete."

PSLC 3.4 CABLE DUCT MARKERS

Add the following:

"A cable duct marker shall consist of a 300 mm x 300 mm x 100 mm deep, class 20 MPa/19 mm concrete block, connected by means of a non-ferrous metal strip to a temporary plug to seal the end of the duct. The plug shall prevent moisture or soil from entering the duct. The metal strip shall be firmly connected to both the plug and the concrete block. The concrete block shall be positioned not further than 0,5 m horizontally from the end of the cable duct. The face of the concrete block shall be clearly marked "E" to indicate electricity cables."

PSLC 8 MEASUREMENT AND PAYMENT

PSLC 8.2 SCHEDULED ITEMS

PSLC 8.2.5 Supply, lay, bed and prove duct

Replace the payment paragraph with the following:

"Separate items are scheduled for each diameter of duct.

The rates shall cover the cost of providing all the materials and the cost of laying the ducts, installing the draw wire, jointing, bedding and providing all as specified."

PSLE STORMWATER DRAINAGE

PSLE 3 MATERIALS

PSLE 3.1 CULVERT UNITS AND PIPES

(d) Skewed ends

Add the following:

*"*Skewed ends for pipe culverts may be cut on Site."

PSLE 3.4 MANHOLES, CATCHPITS, AND ACCESSORIES

PSLE 3.4.1 Bricks

Add the following:

"Bricks shall be engineering bricks complying with the requirements of SABS 227."

Add the following subclause:

"PSLE 3.6 MATERIALS FOR SUBSURFACE DRAINS

(a) Pipes and fittings

Pipes for subsurface drains shall be normal duty, perforated or slotted uPVC pipes complying with SANS 791 unless otherwise specified. Fittings shall be heavy duty and shall also comply with SANS 791.

The size of the perforations in perforated pipes shall in all cases be 8 mm in diameter ± 1,5 mm, and the number of perforations per metre shall not be less than 26 for 100 mm pipes and 52 for 150 mm pipes. Perforations shall be spaced in two rows for 100 mm pipes and in four rows for 150 mm pipes, as shown on the Drawings.

Slotted pipes shall have a slot width of 8 mm with a tolerance of 1,5 mm in width. The arrangement of the slots is subject to the Engineer's approval, but the total slot area shall not be smaller than that specified for perforations.

(b) Crushed stone

Crushed stone shall be 19 mm single-sized and shall comply with the requirements of SANS 1083.

(c) Geotextiles

Geotextiles shall be a non-woven, spun or thermic-bonded continuous filament fabric consisting of at least 85% by mass of polypropylene, polyester or other approved material and manufactured for civil-engineering applications by a recognised manufacturer."

PSLE 5 CONSTRUCTION

PSLE 5.2 BEDDING AND LAYING

PSLE 5.2.2 Pipe culverts

Add the following:

"The class of bedding required for the various pipe culverts is shown on the Drawings."

Add the following subclause:

"PSLE 5.8 CONSTRUCTION OF SUBSURFACE DRAINS

After the completion of the excavations, the bottom portion of the trench shall be lined with geotextile sheeting as shown on the Drawings. The top edges of the vertical portions of the geotextile sheeting shall be tacked to the sides of the excavations with nails or by another suitable approved means. An overlap of at least 200 mm shall be provided at each joint. Geotextile sheeting damaged during the installation or construction shall be replaced at the Contractor's cost.

A layer of crushed stone of the thickness shown on the Drawings shall be placed on the geotextile sheeting and lightly tamped and finished to the required gradient.

Pipes of the required size shall be firmly bedded on the permeable material, true to level and grade, and coupled where required. The trench shall then be backfilled with crushed stone to the height above the pipes shown on the Drawings or as directed by the Engineer.

Crushed stone shall be placed in layers of not more than 300 mm at a time and shall be lightly compacted. Care shall be taken to prevent the contamination of crushed stone during construction of the subsurface drains and all material contaminated by soil or silt shall be removed and replaced by the Contractor at his own expense.

Perforated and slotted pipes shall be joined by couplers. Perforated pipes shall be laid with the perforations at the top or at the bottom, as directed. The higher end of subsurface drain pipes shall be sealed off with a loose concrete cap of class 20/19 concrete, as shown on the Drawings and at the lower end of the pipe shall be built into a concrete head wall providing a positive outlet, or it shall be connected to the stormwater pipes or culverts.

After all the crushed stone filter material and the protruding vertical filter material have been placed, the protruding vertical sections of the geotextile sheeting shall be folded back across the filter material so that the filter material will be completely enwrapped in the geotextile. An overlap of at least 200 mm shall be provided between the portions folded back.

The remainder of the trench shall be immediately backfilled with approved impermeable material preferably obtained from the excavations, in layers not exceeding 150 mm and compacted to 90% of modified AASHTO density, unless otherwise ordered by the Engineer. The trench shall be specially protected against the ingress of water, soil and silt until the backfilling with impermeable material has been completed.

Permeable material in subsoil drains shall not be taken to the surface but shall be discontinued at such heights as will be determined by the Engineer.

Any section of a subsurface drain constructed with pipes without perforations or slots shall be backfilled with impermeable backfill material as described above. Suitable excavated material may be used for backfilling. Payment for excavations as well as for backfilling with impermeable material will be made under SABS 1200 DB."

PSLE 8 MEASUREMENT AND PAYMENT

PSLE 8.2 SCHEDULED ITEMS

Add the following items:

"PSLE 8.2.14 Pipes in subsurface drains:

(a) Normal duty uPVC pipes complete with couplings:

(i) (Diameter and whether perforated or not, indicated) ..... Unit: m

(ii) Etc. for other diameters

(b) Heavy-duty fittings:

(i) (Type and diameter indicated) ..... Unit: number

(ii) Etc. for other types and diameters

The tendered rates per metre of pipe measured in place along its centre line including the length of fittings shall include full compensation for procuring, furnishing, laying and jointing the pipes as specified.

The tendered rates for fittings shall include full compensation for procuring, furnishing, laying and jointing the fittings as specified, irrespective of the type of fitting.

PSLE 8.2.15 Geofabric (description of type, grade, etc.) ..... Unit: m^2

The filter fabric will be measured in place after installation.

The tendered rate shall include full compensation for procuring, supplying, cutting, overlapping, jointing, placing and protecting the filter fabric as specified, as well as for wastage.

PSLE 8.2.16 Crushed stone in subsurface drains: ..... Unit: m^3

The tendered rate shall include full compensation for procuring, supplying, transporting and placing the material as specified. The quantity shall be calculated from the authorised dimensions.

Impermeable material will be paid under SANS 1200 DB.

PSM ROADS (GENERAL)

PSM 7 TESTING

PSM 7.2 PROCESS CONTROL

Add the following:

"The process control required of the Contractor shall be carried out by an independent testing laboratory approved by the Engineer."

PSMM ANCILLARY ROADWORKS

PSMM 3 MATERIALS

PSMM 3.2 ROAD SIGNS

PSMM 3.2.2 Structural steel

Delete the words "except that they shall be of D-shape cross-section" *in the first paragraph.*
Add the following:
"All steel sign supports shall be hot-dip zinc-coated (galvanized)."

PSMM 3.2.8 Paints and protective coatings

PSMM 3.2.8.1 Structural steel sign supports and sign face frames

Replace the contents of this subclause with the following:

"The sign supports and the backs of all road sign faces shall be painted grey. The colour code of the paint shall be code No D36 according to the CKS 279 classification.

Newly galvanized surfaces shall be thoroughly scrubbed down with an approved galvanized iron cleaner to remove all traces of the resinous protective coating. The surface shall be washed down and scrubbed to remove all traces of grease, oil, dirt, etc. Two coats of calcium plumbate primer shall be applied to a dry film thickness of not less than 0,028 mm. The undercoat shall follow within one week of the primer."

SANS 2001 – CC1 CONCRETE WORKS (STRUCTURAL) SPECIFICATION DATA

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CONCRETE WORKS (STRUCTURAL) (SANS 2001 – CC1)

CC1-SD1 SCOPE

This Specification Data deals with the structural use of plain, reinforced, pre-stressed and precast concrete to be used in the Works and gives amendments and additions to the South African National Standard SANS 2001, Part CC1: Concrete Works (Structural) which shall form part of the Contract.

Generally the Specification Data clauses and sub-clauses follow the same numbering system as the clauses and sub-clauses to which they refer in the Standard and to which they either amend or supplement. Where a Specification Data clause or sub-clause refers to some other clause or sub-clause in the Standard this is indicated in brackets following the heading. Where a Specification Data sub-clause is an addition and there is no appropriate clause in the Standard to which it can be linked, no clause reference is given following the heading.

Should any requirement of this Specification Data conflict with any requirement of the Standard, the requirement of this Specification Data shall prevail.

CC1-SD2 NORMATIVE REFERENCES

All the applicable national and international standards as listed in Clause 2, Normative References of SANS 2001 CC1, shall apply to this Contract where appropriate.

In particular, SANS 10100-2 (SABS 0100-2) “The structural use of concrete, Part 2: Materials and execution of work,” provides useful recommendations and information.

Applicable particular specifications:

a) LE01 – Reinforced Concrete

b) LE03 – Sliding Formwork

c) LE05 – Surface Finishes

d) LE06 – Surface finishes

e) LE08 – Lateral Support Anchors

f) LE10 – Concrete for Aqueous Liquid Retaining Structures

g) LE11 – Concrete Minor Works

h) LE13A – Building Surface Beds

i) LE15 – Protection against Termites and Ants under Surface Beds

j) LE16 – Soilcrete

k) ME1 – Structural Steelwork

l) S1 – Specification for Load Bearing Masonry Walls

Should a requirement of the project specification be inconsistent with a requirement of the said standardized specification, the requirement of the particular specification shall take precedence.

CC1-SD3 DEFINITIONS

CC1-SD3.1 GENERAL

CC1-SD3.1.1 Expansion Joint (Sub-clause 4.7.12.2)

“**Expansion Joint**” shall be a “filled joint” designed to allow for thermal or other expansive movements of the adjacent concrete.

CC1-SD3.1.2 Contraction Joint (Sub-clause 4.7.12.2)

"**Contraction Joint**" shall be an "unfilled Joint" designed to allow for thermal or other contraction movements of the adjacent concrete.

CC1-SD3.1.3 Construction Joint (Sub-clause 4.7.12.1)

"**Construction Joint**" shall be a joint required on account of constraints or convenience in the method of construction and that is not an expansion, contraction or other movement joint.

CC1-SD3.1.4 Designated Joints (Sub-clause 4.7.12)

Expansion joints, contraction joints, formed construction joints and unformed construction joints which are sealed, will be considered to be "designated joints" provided that the joints are shown on the drawings or approved as such by the Engineer prior to concreting.

Other unformed construction joints that are required by the Contractor as a result of his construction constraints or for any other reason, whether or not shown on the drawings, shall not be considered to be "designated joints".

CC1-SD3.1.5 Strength Concrete (Clause 3.4.3)

The Contractor shall be responsible for the design of strength concrete and determining the proportions of all the constituent materials in order to produce concrete that complies with the strength requirements specified on the drawings as well as the specified requirements for durability, appropriate workability, a good surface finish and all other specified requirements.

The Engineer will specify the following on the drawings and Bill of Quantities for each section of the Works:

- The required grade and strength of the concrete
- The maximum nominal size of the coarse aggregate in mm.

CC1-SD3.1.6 Notation for Grades of Strength Concrete Containing Extenders (Clauses 3.4.3 and 4.2.6)

Where a cement extender is specified, the grade of strength concrete containing the extender will be specified on the Drawings and Bill of Quantities by a compound number as follows:

A/B C (e.g. 30MPa/19mm V20)

Where

A = the 28 day characteristic strength (MPa)

B = the nominal maximum aggregate size e.g. 19 mm

C = the cement extender as a % of total cementitious material e.g.:

V20 = 20% of Fly Ash (Siliceous)

S30 = 30% of Ground Granulated Blast-furnace Slag (GGBS)

L05 = 5% of Limestone

CC1-SD4 REQUIREMENTS

CC1-SD4.1 GENERAL

CC1-SD4.1.1 Brand Name Products

In addition to the requirements of this Specification Data, the conditions and the methods specified by manufacturers of specified or approved brand name products shall be strictly adhered to. This includes such aspects as substrate preparation, the application of primers, storage and shelf life.

The Contractor shall confirm and submit to the Engineer at least 28 days prior to the commencement of any specific section of the Works, samples, specifications and performance data, as applicable to all the products he intends to use.

CC1-SD4.1.2 Plant for Concrete

Sound, modern, efficient, accurate plant shall be provided and maintained in good working order in accordance with SANS 10100-2 (SABS 0100-2) Sections 5.2 Batching plant and 5.3 Mixing plant.

CC1-SD4.1.3 Cube Moulds and Water Bath (Sub-clause 5.1.1.3)

At least nine 150 mm cube moulds and an adequately sized and covered temperature-controlled water bath with a capacity of at least 300 cubes as approved for curing concrete cubes shall be available on site at all times. The water bath shall be located under cover. Thermostatically controlled heaters/coolers shall be provided to keep the temperature of the water in the bath between 22^0C and 25^0C. The Contractor shall be responsible for providing a sufficient number of cube moulds and an adequately sized water bath to suit the size of the project and the number of cubes that will be made and cured for 7 and 28 days.

CC1-SD4.1.4 Slump Test Apparatus

Slump test apparatus as specified in SABS method 862 shall be provided in good condition.

CC1-SD4.2 MATERIALS

CC1-SD4.2.1 Cementitious Binders

CC1-SD4.2.1.1 **Cement**

Only CEM I 42,5 (Portland cement) or CEM II/A-V 42,5 (Portland fly ash cement) or CEM II/A-S 42,5 (Portland slag cement) or CEM II/B-S 42,5 (Portland slag cement) according to SANS 50197-1 (EN 197-1), may be used. The cement may not consist of more than the proportions stated in 4.2.1.3 blended with the OPC (Ordinary Portland Cement). Should the contractor wish to use any other type of cement, he shall obtain the Engineer's prior written approval.

CC1-SD4.2.1.2 Cement Extenders

Cement extenders shall only be used where specified on the drawings and scheduled in the Bill of Quantities. An approved cement extender shall only be blended with CEM I 42.5 (Portland Cement) and this shall be done in the batch plant unless otherwise approved.

Any cement extender used shall comply with SANS 1491 Parts 1, 2 or 3 as appropriate for Ground Granulated Blast-Furnace Slag (GGBS), Siliceous Fly Ash (VA) or Limestone (L) respectively, and shall carry the SANS mark, or similar approved.

CC1-SD4.2.1.3 Proportions of Cement Extenders in Concrete

Where a cement extender is specified, the proportion by mass of the extender as proportion of the total mass of cementitious material shall be as follows for different extenders unless otherwise specified:

GGBS: ≤ 30%

VA: ≤ 20%

L: ≤ 5%

CC1-SD4.2.1.4 Conformity of Cement

The test results conducted to evaluate the conformity of cement in terms of SANS 50197-1, Clause 9, shall be made available to the Engineer at least 28 days before the materials are used for concrete.

CC1-SD4.2.1.5 Storage of Cement

Cement shall not be kept in storage for more than 12 weeks without the Engineer's permission.

CC1-SD4.2.2 Water

Mixing water for concrete shall comply with the requirements of EN 1008 and shall be tested for conformation.

CC1-SD4.2.3 Aggregates

CC1-SD4.2.3.1 Source of Aggregates

Fine aggregate (sand) shall be obtained from an approved commercial source. Coarse aggregate (stone) shall be obtained by crushing rock from hard excavations on Site or from an approved commercial source.

CC1-SD4.2.3.2 Fineness of Fine Aggregate

The fineness modulus of sand delivered to the mixer shall lie between 1.7 and 2.8 and the standard deviation of fineness moduli of samples of sand that is delivered to the mixer during one shift shall be not more than 0.1.

CC1-SD4.2.3.3 Aggregate Samples

At least 28 days before commencement of concrete work the Contractor shall supply, at his own cost, full details and representative samples to the Engineer of the aggregates he intends using, together with certificates from an approved laboratory indicating that the aggregates comply with the requirements of this Standard and Specification Data. Approximately 50 kg of each sample of aggregate shall be supplied.

After approval, these samples shall be taken as the standard for the agreed aggregates to be used in the Works. If at any time during the course of the Contract there is a deviation from the approved standard or the Engineer considers that there has been a deviation, the Contractor shall submit further tested samples of the new material to the Engineer for approval.

No concrete shall be placed in the Works until the Engineer has approved the materials the Contractor intends using.

CC1-SD4.2.3.4 Tests on Aggregates (Sub-clause 4.2.3.5)

The following tests are required on aggregates to be used in the Contract:

(a) Drying shrinkage on fine and coarse aggregates;

(a) Flakiness index of the stone;

(b) Tests for alkali-aggregate reaction, in accordance with SANS 6245, shall be carried out where in the opinion of the Engineer potentially reactive aggregates to be used and where none of the cement extenders listed in SD4.2.1.3 will be used in at least the proportions given.

CC1-SD4.2.3.5 Prevention of Deleterious Alkali-Aggregate Reaction

The requirements of this clause shall not apply to concrete containing a cement extender in at least the proportions given in SD4.2.1.3.

Reference is made to “Fulton’s Concrete Technology, Chapter 10, Alkali-silica reaction.”

In accordance with this reference, the Contractor shall provide the Engineer with sufficient data to enable him to assess the degree of alkali-aggregate reactivity of the aggregates and cement to be used for concrete. For the aggregates, the type of rock and source will be required. For the cement, the percentage alkali content shall be given.

In accordance with the above reference, where potentially reactive aggregates are used for concrete, the Contractor shall ensure that the concrete is not subject to deleterious alkali-aggregate reaction by limiting the total equivalent sodium oxide content of the concrete to a maximum of 0.86 x the value given in kg/m³ in Table 10.1. (eg for Malmesbury Group, 0.86 x 2.1 = 1.8 kg/m³) This may be achieved by careful mix design and the use of cement with a low equivalent sodium oxide content or if necessary, blending with a cement extender.

For each delivery of cement the Contractor shall provide an acceptable test certificate indicating the actual equivalent sodium oxide content of the consignment.

Note 1: The equivalent sodium oxide content is measured as Na_20 + 0,658 K_20. For cement it is expressed as a percentage by mass, for concrete it is expressed in kg/m³.

The shrinkage of concrete to be cast in floor systems, shall not exceed 0,03 % tested as per SANS 6085. Three tests shall be conducted on the mix design to confirm compliance. Test results shall be made available before the concrete is used on site.

CC1-SD4.2.3.6 Storage of Aggregates

Where aggregates of differing chloride content are stockpiled on the site, strict control shall be exercised over their use for differing classes of concrete.

CC1-SD4.2.3.7 Use of Plums (Sub-clause 4.2.3.4 and 4.7.10.11)

The use of plums will not be permitted.

CC1-SD4.2.4 Admixtures, Air-entrainment Agents and Curing Agents

Admixtures are permitted, provided that the results of trial tests which demonstrate their suitability and the following are made available to the Engineer for Approval:

(a) The trade name of the admixture, its source and the manufacturer's recommended method of use;

(b) The chemical names of the main active ingredients in the admixture;

(c) Typical dosages and possible detrimental effects of under or over dosages;

(d) Whether compounds that are likely to cause corrosion of the reinforcement or deterioration of the concrete (such as those containing chloride, in any form, as an active ingredient) are present and, if so, the chloride content of the admixtures, expressed as a mass fraction of chloride ions or expressed as an equivalent mass fraction of anhydrous calcium chloride; and

(e) The average expected air content of the freshly mixed concrete containing an admixture that causes air to be entrained when the admixture is used at the manufacturer's recommended dosage.

The amounts of admixture used shall be measured to an accuracy of 2 % or better. Daily calibration and cleaning of the measuring device is imperative. Persons responsible for batching shall be fully conversant with the effects of the admixture and the consequences of over or under-dosage.

Control of admixtures shall be in accordance with SANS 10100-2 (SABS 0100-2) Section 7.2.1.2.

CC1-SD4.2.5 Reinforcement – No Specification Data applicable

CC1-SD4.2.6 Grade of Concrete – No Specification Data applicable

CC1-SD4.2.7 Grout – No Specification Data applicable

CC1-SD4.2.8 Tendons (Clause 4.2.8)

CC1-SD4.2.8.1 Characteristic Strength of the Steel (Sub-clause 4.2.8.2)

The required characteristic strength of the steel will be specified on the construction drawings.

CC1-SD4.2.9 Anchorages and couplers – No Specification Data applicable

CC1-SD4.2.10 Sheaths – No Specification Data applicable

CC1-SD4.2.11 Joint Fillers, Sealants, Waterstops, Bearings and Accessories

The following prescribed products or brand name products, or equivalent materials subject to the written approval of the Engineer, shall be used, with all specialized products to be installed by an approved applicator for certification and guarantee:

CC1-SD4.2.11.1 Joint Fillers

Joint filler material shall be “Sondor” closed cell expanded polyethylene of minimum density 35 kg/m³ “Jointex”. The required thickness and density of the filler will be specified on the drawings. Densities of up to 110 kg/m³ may be required.

Fillers shall be pre-cut to suit the application with a tear-out strip forming the specified recess for the sealant. If so required the filler shall be glued into position with approved glue.

CC1-SD4.2.11.2 Bond Breakers

The bond breaker between the blinding layer, no-fines concrete layer or soil and the underside of ground floor slabs or surface beds shall be 250 micron polyethylene sheeting that complies with SANS 952, i.e. USB Green co ex 250 ®.

The bond breaker to the face of contraction joints shall be two coats of good quality lime wash.

The bond breaker at the bottom of a joint sealing recess, where the sealant is not backed by a joint filler or bond breaking cord, shall be self-adhesive PVC tape with the same width as the joint recess.

CC1-SD4.2.11.3 Sealants (Sub-clause 4.2.11.1)

SikaFlex® Pro-3WF 1–part, moisture cured, high mechanical resistant polyurethane sealant, shall be used for all water retaining and water excluding structures including pump stations, valve chambers, and inlet and outlet structures.

SikaFlex® PRO-2HP 1-part, moisture cured, soft elastic polyurethane sealant, shall be used for building structures above ground floor level.

An approved primer fully compatible with and/or manufactured for the specified jointing and sealing material shall be applied to the prepared joint surfaces.

CC1-SD4.2.11.4 Waterstops (Sub-clauses 4.2.11.1)

Waterstops shall be “Durajoint PVC or Durajoint Rubber” as manufactured by “ABE Construction Chemicals” and to the pattern and the material and widths shown on the drawings. They shall conform to Specifications CKS 388 or 389, for natural rubber or PVC respectively.

CC1-SD4.2.11.5 Bandage Sealing Systems

(a) “Sikadur-Combiflex” Bandage System

The “Sikadur-Combiflex” bandage System is manufactured by “Sika” and consists of a flexible Hypalon sealing tape/strip and “Sikadur -31 CF” epoxy adhesive. The width and thickness of the tape/strip will be specified on the drawings.

(b) Cemflex Bandage System

The “Cemflex” bandage System is manufactured by “Sika” and consists of a strip of Cemflex fabric which must be saturated with a Cemflex slurry. The width of the strip will be specified on the drawings.

(c) Laminated Butyl Rubber or Polymer Bandage System

3 mm thick laminated butyl rubber or 2 mm thick polymer strips shall be permanently fixed to the concrete with an approved epoxy adhesive where shown on the drawings. Aluminium backing strips shall be provided where specified.

CC1-SD4.2.11.6 Swellable Joint Sealing Strips

Swellable joint sealing strips shall be “SikaSwell-P Profiles manufactured by “Sika”. The width, thickness and type of profile will be shown on the drawings.

CC1-SD4.2.11.7 Bearings (Sub-clause 4.2.11.1)

Where indicated on the Drawings, bearings shall consist of “Kilcher Bearings” of one of the following three types: “Resilient”, “Limitgliss” or “Teflon Sliding bearings”. All of these shall be supplied in a strip of expanded

polyethylene of width equal to the seating or wall width. The required capacity of the bearing strip in t/m will be shown on the drawings

Where laminated elastometric bearings or bridge type bearings are required, full details will be given on the drawings.

CC1-SD4.2.12 Epoxy-based bonding agent for screeds

Where indicated on the drawings, epoxy bonding agent for screeds shall be ABE Construction Chemicals, “epidermix 116”. All specialized products to be installed by an approved applicator for certification and guarantee.

CC1-SD4.2.13 Surface hardener for concrete floors

Where indicated on the drawings, surface hardener for concrete floors shall be “Sikafloor-3 QuartzTop ZA” natural (not coloured). This may be applied to steel floated or power floated surfaces or granolithic screeds. All specialized products to be installed by an approved applicator for certification and guarantee.

CC1-SD4.2.14 Colour Mitigation

The Contractor shall supply and apply concrete colouring at the locations as specified on the Drawings or indicated by the Engineer.

The colouring material shall be landscape varnish which shall be aqueous containing salts and iron and manganese and other trace elements including copper and zinc. The material shall be manufactured as a concentrate that can be diluted with water to achieve the desired colour intensity. The material shall contain no caustic or alkaline chemicals.

The colouring material shall be “PERMEON” or equivalent approved.

All specialized products to be installed by an approved applicator for certification and guarantee.

CC1-SD4.3 FORMWORK

CC1-SD4.3.1 General

CC1-SD4.3.1.1 Earth or Rock Cuts (Sub-clause 4.3.1.5)

Earth or rock cuts may be used as forms for vertical or sloping surfaces only if dictated by the Design and indicated on the Drawings or approved by the Engineer on Site.

Concrete used in pipe trenches for encasement may be cast against the side of the excavation.

Concrete for thrust / anchor blocks shall be cast directly against the side of the excavation as shown on the Drawings.

CC1-SD4.3.1.2 Approval by Authority (Sub-clause 4.3.1.6)

Liaison with the authority controlling the service is required before commencing with the design of formwork over an existing service i.e. pipe lines, roads, streets, railways, etc. The design shall be approved by the authority.

CC1-SD4.3.1.3 Surface Finish of Formed Surfaces (Sub-clause 4.3.1.8)

Various formed surface finishes are described in detail in Table 1.

Unless otherwise specified on the drawings, the formed surfaces of sections of the work shall be as follows:

(a) “rough” to all surfaces more than 150 mm below finished ground level or concealed from view.

(b) “smooth” to all other surfaces except where otherwise specified..

Special-smooth finish, special off-form finishes / exposed aggregate finishes shall be shown on the Drawings and, where they are required, scheduled in the Bill of Quantities.

CC1-SD4.3.1.4 Special-smooth finish

This finish is obtained by first giving the surface a smooth finish with the joints between formwork panels forming an approved regular pattern suitable for the appearance of the structure. All projections shall then be removed, irregularities repaired and the surface rubbed or otherwise treated until it is smooth with an even texture, appearance and colour.

If the finish of exposed surfaces does not comply with the requirements for uniformity of the texture and appearance, the Contractor shall, when instructed to do so by the Engineer, rub down the exposed surfaces of the entire structure or any part thereof as specified below, entirely at his own cost. All repairs must be completed before the rubbing commences.

Rubbing down shall be carried out strictly in accordance with Sub -clause 4.7.20.

CC1-SD4.3.1.5 Chamfers and Fillets

All exposed external angles in concrete work shall have 20 mm x 20 mm chamfers unless otherwise specified on the Drawings or ordered by the Engineer, but the top edge of a slab that is to receive an applied finish shall not be chamfered.

Internal corners in concrete work need not have fillets unless such fillets have been specified on the Drawings or ordered by the Engineer.

CC1-SD4.3.2 Design and Construction of Formwork and Falsework

CC1-SD4.3.2.1 Responsibility for Formwork and Falsework

The Contractor shall be entirely responsible for the design, construction, accuracy and safety of all formwork and falsework.

CC1-SD4.3.2.2 Review of Formwork Design (Sub-clause 4.3.2.1.4)

Where approval is required in terms of Sub-clause 4.3.1.6, by a controlling authority, the design and drawings for formwork and falsework shall be submitted to the Engineer for review before being submitted to the authority for approval.

CC1-SD4.3.3 Formwork Accessories

CC1-SD4.3.3.1 Formwork Ties

(a) Formwork ties for water retaining and water excluding structures

Shutter ferrules and ties shall be of the cast-in type, rust resistant, specifically designed for watertightness without forming a hole through the element with some form of positive anchorage to prevent any rotation when loosening formwork, and approved by the Engineer

(b) Formwork ties for other structures

Formwork ties for other structures shall run through a sleeve in order for the ties to be completely removed after the formwork has been struck. The outer cover width of the sleeves shall be removed by drilling or any other appropriate method leaving a clean inner surface which shall be effectively caulked with mortar by approved means in accordance with Sub-Clause 4.5.3.

(c) Formwork shall not be secured to reinforcing bars

CC1-SD4.3.4 Temporary Openings – No Specification Data applicable

CC1-SD4.3.5 Void Formers – No Specification Data applicable

CC1-SD4.3.6 Preparation of formwork – No Specification Data applicable

CC1-SD4.3.7 Reuse of formwork – No Specification Data applicable

CC1-SD4.3.8 Removal of formwork

CC1-SD4.3.8.1 Removal of Falsework and Supporting Formwork on Reinforced Concrete Structures (Sub-clause 4.3.8.3)

Where a continuously reinforced concrete structure will be constructed in stages, the Contractor shall submit to the Engineer for his review and acceptance, at least 28 days prior to the commencement of the work, full details of the manner in which the falsework and supporting frame work will be removed.

The contractor shall make provision for the continued support of beams and slabs while the formwork is being removed and/or for back-propping of beams, slabs, etc. The propping may be required simultaneously on more than one level directly underneath one another. The requirements for continuous propping and/or back-propping shall be calculated to a theoretical model that is acceptable to the Engineer, and details shall be submitted for the Engineer's acceptance. Data required for such calculations, e.g. design loads and structural dimensions, will be supplied by the Engineer on request.

CC1-SD4.3.8.2 Removal of Falsework and Supporting Formwork for Pre-stressed Concrete Structures (Sub-clause 4.3.8.4)

Where the falsework and supporting formwork in pre-stressed structures will be removed, prior to the full pre-stressing force relating to the particular stage of construction being applied, the Contractor shall submit to the Engineer for his review and approval, at least 28 days prior to the commencement of the work, full details of the manner in which the falsework and supporting framework will be removed.

CC1-SD4.4 REINFORCEMENT

CC1-SD4.4.1 Bending

CC1-SD4.4.1.1 Hot Bending (Sub-clause 4.4.1.3)

Bars shall not be bent hot.

CC1-SD4.4.2 Fixing

CC1-SD4.4.2.1 Safety of the reinforcement (Sub-clause 4.4.2.2)

The Contractor shall be responsible for the safety of the reinforcement. In addition to the chairs and spacers specified, diagonal bars, robust temporary props or whatever else is necessary shall be provided to ensure the safety of the reinforcement under all loads and particularly those due to construction activities.

CC1-SD4.4.2.2 Inspection by the Engineer

The reinforcing steel shall be inspected by the Engineer after the fixing of steel, the cleaning of shuttering and the positioning of the spacer blocks have been completed, and prior to concrete casting.

CC1-SD4.4.2.3 Welding of Bars (Sub-clause 4.4.2.2 b)

Welding of reinforcement is not permitted.

CC1-SD4.4.2.4 Spacers

Where concrete spacer blocks manufactured on Site are used, they shall be made and cured strictly in accordance with Sub-Clause 4.4.2.3 and the following NOTE. The wire ties in the blocks shall be galvanized. Concrete spacer blocks which have not been manufactured and cured strictly in accordance with these requirements or which are in any other way considered unsatisfactory by the Engineer, will be rejected and shall be removed from the Site.

CC1-SD4.4.3 Cover

CC1-SD4.4.3.1 Minimum cover

With due cognisance of Table 3, the minimum required cover of concrete over reinforcement will be specified on the reinforcement drawings for different structures and allowing for different exposure conditions in accordance with the design.

CC1-SD4.4.3.2 Minimum cover to Pipes and Ducts

The minimum distance between pipes or ducts in the concrete and reinforcement shall nowhere be less than 40 mm or 5 mm plus the maximum size of the coarse aggregate, whichever is the largest.

CC1-SD4.4.3.3 Exposure conditions (Table 3)

The various structures will not be classified in terms of exposure conditions. Instead the Engineer will specify the cover to reinforcement as per SD4.4.3.1 and durability requirements as per SD4.7.5.1.

CC1-SD4.5 HOLES, CHASES AND FIXING BLOCKS

CC1-SD4.5.1 Fixtures

Fixtures to be embedded in the concrete shall be embedded into the concrete as shown on the Drawings.

Fixing blocks and fixtures may be embedded in concrete, provided that the strength or any other desirable feature (such as the appearance of the member) is not, in the opinion of the Engineer, impaired thereby.

CC1-SD4.5.2 Ferrules (Clause 4.5.3)

Refer also to SD4.3.3.1.

CC1-SD4.6 EMBEDDED ITEMS

CC1-SD4.6.1 General

Material used for forming temporary voids (box-outs) shall be completely removed. The faces of temporary voids shall be thoroughly cleaned and prepared as for a construction joint surface. Refer to SD4.7.12.1(b)

CC1-SD4.6.2 Waterstops

CC1-SD4.6.2.1 General

Only straight lengths of waterstop may be site butt welded/vulcanised using appropriate jigs and equipment. All other intersection pieces shall be factory made by the manufacturer.

Factory-made junction pieces shall be properly corner-mitred and jointed at intersections, shall be formed in accordance with the manufacturer's instructions to approval and shall have a tensile strength across the joint of not less than 75% of that of the original material. Junction pieces shall be made so that all ribs in the original cross-section are maintained continuously and the joints are dense, homogeneous, free of all porosity and each leg of the junction having a minimum length of 300 mm. Intersections of waterstops with dissimilar pattern (i.e. "rearguard centre bulb" type, with "internal dumbbell" type) shall be made using specially-made junction pieces which accommodate the transition between patterns. On Site joints shall also comply with these requirements.

The Contractor shall test, in the presence of the Engineer, joints made in waterstops of each type of material used.

CC1-SD4.6.3 Pipes, conduits and ducts

CC1-SD4.6.3.1 Casting in of Pipes and Pipe Specials in Concrete

The Contractor shall be responsible for the installation, positioning, alignment, support and concreting in of all pipes and pipe specials regardless of whether or not these have been supplied by him and whether or not they have puddle flanges. He shall also be responsible for the watertightness of the completed structure around the pipe or special, where this is a requirement.

The Contractor shall submit to the Engineer for his review and approval, at least 28 days prior to the commencement of any specific section of the Works, a schedule indicating all the pipes and pipe specials he intends to cast in directly and the items for which he intends to provide box-outs. He shall also submit a detailed method statement describing precisely how the work will be done.

Where it is a requirement that a pipe or pipe special be anchored to resist longitudinal forces and it is provided with anchor flanges, details of the box-out and special reinforcement around the anchor flange(s) will be as

shown on the Drawings and Bending Schedules. Reinforcement shown at box-outs shall not be cut and will generally have been detailed to run through the formwork, but not through the opening itself. Reinforcement shall be added around the anchor flanges to tie in with protruding reinforcement before the pipe or pipe special is concreted in.

Where it is not a requirement that a pipe or pipe special be anchored to resist longitudinal forces, the reinforcement shall not initially be cut and will generally have been detailed to run through the formwork and through the opening itself. Reinforcement shall only be cut and/or bent out of the way at a later stage to suit the item to be cast in. After installation of the item, the remaining reinforcement shall be bent back in position as directed by the Engineer.

During the installation, positioning and concreting in of any item in an opening the Contractor shall:

(a) Remove all formwork remaining in the box-out;

(b) Make any alterations required to the position and shape of the opening;

(c) Thoroughly prepare the faces of the opening as for a construction joint surface in accordance with Sub-clause 4.7.12.1.3 and SD4.7.12.1(b) so as to obtain a satisfactory bond for the new concrete;

(d) Install, position, align and support the item to be cast in;

(e) Bend back and/or fix reinforcement around the item as directed by the Engineer or as shown on the Drawings;

(f) Install formwork as required for the concreting in operation; and

(g) Carry out final surface preparation in accordance with Sub-clause 4.7.12.1.3 before concreting.

In order to achieve the necessary watertightness and structural soundness, the following shall be considered and provided by the Contractor and shall be described in his method statement:

(a) Cast in waterstops, a bandage sealing system and/or a swellable sealing strip around the box-out;

(b) Wet-to-dry epoxy on the box-out faces;

(c) Grouting at the top of the box-out to fill any voids left;

(d) A specially designed shrinkage compensated concrete mix to fill the box-out.

CC1-SD4.7 QUALITY OF CONCRETE

CC1-SD4.7.1 General

CC1-SD4.7.1.1 Design of Strength Concrete Mixes

The concrete mix designs for strength concrete shall be prepared in an approved laboratory such that the concrete meets the strength and all other specified criteria as well as ensuring good workability and surface finish without excessive bleeding. Special attention is drawn to the fact that the concrete for water retaining/excluding structures must be very dense and impervious.

The Contractor shall submit full details of all the mixes he proposes to use to the Engineer not less than 30 days prior to the intended use of the concrete in the Works.

No concrete shall be cast until the mix designs have been accepted by the Engineer. The Engineer may call for revised mix designs at any stage during the Contract.

Once accepted by the Engineer for the use of a particular mix, the proportions of cement, extender, aggregate, water and admixtures shall not be changed without prior approval of the Engineer.

CC1-SD4.7.1.2 Trial Mixes

Trial mixes for each of the concrete grades/ mix designs to be used in the Works shall be prepared under conditions acceptable to the Engineer. Six cubes shall be made from each mix and three of each tested for compressive strength at 7 and 28 days respectively.

The results of the compressive tests on these cubes shall be submitted to the Engineer for acceptance not less than 30 days prior to the intended use of the concrete in the Works.

CC1-SD4.7.1.3 Maximum Cementitious Binder Content (Sub-clause 4.7.1.2)

The maximum content of CEM I 42.5 (Portland cement) shall be 400 kg/m³ of concrete.

The maximum cementitious content of a binder for concrete containing a cement extender shall be 450 kg/m³ of concrete.

CC1-SD4.7.2 Consistency

CC1-SD4.7.2.1 Slump

The slump of the concrete shall be as given in Table 4.

CC1-SD4.7.3 Workability

CC1-SD4.7.3.1 Pumping of Concrete (Sub-clause 4.7.3.2 and 4.7.10.15)

Pumping of concrete will be permitted.

CC1-SD4.7.4 Chloride and Sulphate Content

CC1-SD4.7.4.1 Chloride Content

The maximum chloride ion content shall be as given in Table 5; and

Efflorescence will not be acceptable on any exposed concrete surface.

CC1-SD4.7.4.2 Sulphate Content

The total water-soluble sulphate content of a concrete mix shall not exceed a mass fraction of 4% of the cementitious binder content of the mix.

CC1-SD4.7.5 Durability

CC1-SD4.7.5.1 Requirements for Durability

(a) In Water-retaining/excluding structures

Cementitious binder content in water-retaining / excluding structures will consist of cement as defined in SD 4.2.1.1 and cement extenders as defined in SD 4.2.1.2 The proportions of the various aggregates shall be such as to produce a density of at least 2 400 kg/m³.

The minimum cement content shall be 325 kg/m³. The maximum water:cement ratio shall be 0,55 for ordinary Portland cement (OPC), CEM 1 42,5 according to SANS 50197-1, and 0,50 for ordinary Portland cement blended with Siliceous Fly Ash (VA), when allowed.

The cement content shall not exceed 400 kg/m³ OPC in reinforced concrete or 500 kg/m³ OPC in prestressed concrete, or 450 kg/m³ OPC blended with VA in reinforced concrete or 550 kg/m³ OPC blended with VA in prestressed concrete.

(b) In other structures

The maximum water/cement ratio for moderate sections, general reinforced concrete, exterior portions of mass concrete, as well as for internal concrete in buildings under conditions of moderate exposure, is 0,67.

The maximum water/cement ratio for concrete slabs on the ground under very severe conditions, is 0.45.

Notwithstanding the aforementioned, the cement content may under no circumstances be less than:

- For structural concrete of ≥ 25 MPa - 265 kg/m³
- For exposed concrete, trafficable surfaces and surface beds - 280 kg/m³

CC1-SD4.7.5.2 Concrete containing entrained air

Where concrete is required to contain entrained air as indicated on the drawings, the requirements of Sub-Clauses 4.7.5.1 and 4.7.5.2 shall apply.

CC1-SD4.7.6 Prescribed-mix concrete – No Specification Data applicable

CC1-SD4.7.7 Batching – No Specification Data applicable

CC1-SD4.7.8 Mixing

CC1-SD4.7.8.1 Mixing Period for Concrete Containing an Extender (Sub-Clause 4.7.8.1.1 e)

For concrete containing an extender in the proportions given in SD4.2.1.3 the minimum periods of mixing given in Sub-Clause 4.7.8.1.1 (e) shall be increased by 2 minutes.

CC1-SD4.7.8.2 Ready-mixed Concrete

Ready-mixed concrete will be permitted and shall be mixed in accordance with the requirements of SANS 878.

CC1-SD4.7.8.3 Mortar Skim on No-fines Concrete (Sub-clause 4.7.8.4)

Where a mortar skim is specified or shown on the drawings it shall be constructed as follows: Between 24 h and 48 h after the no-fines layer has been laid it shall be covered with a 1:4 cement: sand mortar layer 10 mm thick. The mix shall be comparatively dry to ensure that it does not penetrate and block the cavities in the no-fines concrete. The surface shall be steel or power floated to form a plane surface.

Curing shall be accordance with Sub-Clause 4.7.8.4.6.

CC1-SD4.7.9 Transportation of concrete – No Specification Data applicable

CC1-SD4.7.10 Placing

CC1-SD4.7.10.1 General

The Engineer shall be given adequate notice of the intention to place concrete.

Concrete shall be placed continuously, or in layers of such thickness that no concrete will be placed on concrete that has so hardened as to cause planes of weakness.

CC1-SD4.7.10.2 Under Water (Sub-clause 4.7.10.13)

Concrete may only be placed under water if dictated by the design and indicated on the Drawings, or as and approved by the Engineer on Site.

CC1-SD4.7.11 Compaction

CC1-SD4.7.11.1 Method (Sub-clause 4.7.11.3)

Compaction shall only be achieved by means of mechanical vibration.

CC1-SD4.7.12 Joints

CC1-SD4.7.12.1 Construction Joints

(a) Location (Sub-clause 4.7.12.1.1)

Construction joints will be required and will be shown on the drawings.

The location of planned construction joints, not indicated on the Drawings, shall be submitted to the Engineer for review and approval.

Walls shall be cast in lifts of a height that permits each lift to be poured without interruption in one continuous operation during normal working hours.

(b) Preparation of Construction Joint Surfaces (Sub-clause 4.7.12.1.3 and Table 7)

Special care shall be taken in the preparation of construction joints in accordance with the requirements of Table 7 and as follows:

As soon as practical but not before 15 hours after placing, the entire area of each construction joint shall be cleaned using whatever mechanical devices are required and/or compressed air and water (green cutting). All laitance and similar deposits shall be removed and the coarse aggregate in the hardened concrete shall be exposed over the entire area of the joint. Each joint shall be inspected by the Engineer before it is rendered inaccessible by the erection of further formwork.

Where construction joint preparation is not carried out as described above, for instance on formed joint surfaces, the surface shall be wet sand blasted or scabbled after the concrete has hardened sufficiently to prevent the displacement or loosening of the coarse aggregate, followed by wire brushing and washing with high pressure air and water jets. The roughness of a scabbled or wet sand blasted surface shall be similar to that achieved by green cutting. A bush hammered surface or a surface in which the large aggregate pieces have been removed by chipping will not be considered an acceptable alternative to scabbling.

When concreting is interrupted, concrete surfaces shall be protected from the sun as specified in Sub-clause 4.7.13.2(d) or by means of hessian kept damp until concreting is resumed.

For horizontal joints in water retaining/excluding structures the mortar layer specified in method 2 in Table 7 shall be 25 mm thick. The mortar shall be protected from drying out before the fresh concrete is placed against it.

CC1-SD4.7.12.2 Expansion (Filled) and Contraction (Unfilled) Joints

Expansion and contraction joints shall be formed true to line in smooth formwork.

Joints in the joint filler material in expansion joints shall be neatly butted so as to exclude mortar from the joint. Edges of the filler strip against waterstops, concrete, formwork, projections, etc., shall also be closely fitted to exclude mortar, so that there is no resistance (other than the compression of the filler material) to the expansion movement for which the joint is designed.

Two coats of bondbreaker shall be applied to contraction joint surfaces.

CC1-SD4.7.12.3 Installation of Waterstops in Joints

Waterstops shall be so held in formwork to eliminate air pockets forming underneath. Special precautions shall be taken to the approval of the Engineer, to ensure that all flexible waterstops are in perfect contact with well compacted void free concrete. The Contractor shall provide satisfactory supervision of such vital operations.

CC1-SD4.7.12.4 Application of Joint Sealants

Rebates for sealants shall be formed to required dimensions and lines, or cut true to line and size by skilled workmen with special tools, after floating the surface and before the final set of the cement has taken place. All rebates shall be adequately protected against damage until the completion of the work. Rebates for sealants shall be grit blasted or wire brushed on all faces to remove surface laitance and thoroughly cleaned with soft brushes and/or compressed air jets, and, if necessary, dried by blow-lamp or other approved means before priming. The rebates shall be inspected by the Engineer before filling.

Sealants and primers shall be applied strictly in accordance with the manufacturer's instructions. Flow, and non-slumping grades shall be used for horizontal and vertical joints respectively.

Immediately after the sealant is applied, the joint shall be protected against damage until completion of construction.

CC1-SD4.7.12.5 Proprietary Bonding Compounds (Sub-clause 4.7.12.1.4)

Proprietary bonding compounds, including wet-to-dry epoxy, may be used between old and new concrete if approved by the Engineer. (See also SD4.2.11.8)

CC1-SD4.7.12.6 Sealing of Joints (Sub-clause 4.7.12.4)

The sealing of joints shall be undertaken in accordance with the requirements of the details as shown on the Drawings. In addition to the requirements of this Section all the conditions and methods specified by the manufacturers of the specified or approved brand name products shall be strictly adhered to.

CC1-SD4.7.13 Curing and Protection

CC1-SD4.7.13.1 Additional Curing method (Sub-clause 4.7.13.2)

Should a curing compound be allowed by the Engineer then it shall be a resin based curing compound. Curing of columns, shafts and walls shall be done by either retaining the formwork for the required period of time or covering with plastic sheeting. On lesser shafts and walls the Engineer may allow a curing compound for curing.

CC1-SD4.7.13.2 Curing Compound (Sub-clause 4.7.13.2.e)

The use of membrane curing compounds will only be considered on vertical surfaces or steeply inclined surfaces (i.e. steeper than 45° to the horizontal) of cast in situ members of a structure.

Approval of their use and the compound to be used shall be to the approval of the Engineer. Wax based curing compounds will not be permitted.

The curing compound shall be applied immediately as formwork is progressively stripped or, in the case of unformed surfaces, when the concrete has taken its initial set. The compound shall preferably be applied by spraying and the rate of application shall be strictly in accordance with manufacturer's recommendations. A method of monitoring the area to which the curing compound has been applied, and the application rate, shall be approved by the Engineer and rigidly adhered to by the Contractor.

Surfaces of joint rebates, where elastomeric sealant is to be applied, shall be protected from contamination by curing compound by the use of masking tape.

The use of membrane curing compounds on surfaces that are to be coloured will not be permitted. In this instance, effective alternative means of curing shall be used.

CC1-SD4.7.14 Adverse Weather Conditions

CC1-SD4.7.14.1 Concreting in hot weather

High temperatures and loss of moisture due to hot drying winds may cause thermal and plastic shrinkage, cracking and a reduction of strength and durability. Appropriate action is specified in Sub-clause 4.7.14.1.

CC1-SD4.7.14.2 Temperature Control for Sections thicker than 900 mm

Such sections may be considered to be "Massive concrete" in terms of SANS 10100-2 (SABS 0100-2) Section 11.

Irrespective of the ambient temperature or wind conditions, the Contractor shall take all measures necessary to ensure that the temperature of concrete at the time of placing in the Works does not exceed 26^0C and that the loss of moisture during transporting and placing is reduced to the minimum possible.

During hot weather, such measures may include but are not necessarily limited to the following:

(a) Shielding aggregates from direct sunshine.

(b) Sun shields on mixing plants and transporting equipment. This could also include lagging to moving parts kept damp to cause cooling by evaporation.

(c) Cooling the mixing water. If ice is used for this purpose it shall be in flake or hollow cylinder form. Lump ice shall not be allowed to enter the tank supplying the mixer drum.

(d) Injecting liquid nitrogen into the mixer trucks.

(e) Cooling of steel formwork and reinforcing steel by sprinkling with water.

(f) Painting all equipment and sunshields white.

(g) Blasting of chilled air through aggregate storage bays and hoppers.

(h) Spraying the coarse aggregate with water.

(i) Re-scheduling concreting to take place at night.

Areas in which concrete is to be placed shall be shielded from direct sunshine and rock or concrete surfaces shall be thoroughly wetted if instructed by the Engineer to reduce absorption of water from the concrete placed on or against them.

After concrete in any part of an area has been placed, the specified curing process shall be commenced as soon as possible. If any interval occurs between completion of placing and start of curing, the concrete shall be closely covered during the interval with polythene sheet to prevent loss of moisture.

To limit the risk of thermal cracking, the Contractor shall ensure that the temperature differential between the surface concrete and the interior concrete at any position does not exceed 20^0C at any time and that the maximum temperature of the concrete at any position does not exceed 60^0C at any time. To ensure compliance, the Contractor shall provide the necessary temperature measurement devices and take precautions appropriate to the circumstances as accepted by the Engineer which shall include the following:

(a) Limiting the size of concrete pours.

(b) Reducing the heat of hydration of the cement by use of an increased proportion of cement extender, if permitted by the Engineer.

(c) Reducing the placing temperature of the concrete to less than the 26°C specified above

(d) Insulation of exposed concrete surfaces by insulating blankets.

(e) Increasing the period before stripping of formwork. Steel forms shall be suitably insulated on the outside.

(f) Increasing the period between placing successive lifts.

(g) Preventing rapid dissipation of heat from surfaces by shielding from wind.

(h) Avoiding the use of water sprays when such use would cause rapid cooling of the surface.

(i) Shielding concrete surfaces from cold air temperatures, together with the use of heaters where appropriate.

(j) Internal cooling using cast in ducts through which cooled water is passed.

The Contractor shall obtain the Engineer's agreement of all procedures which will be applied to control concrete temperatures.

CC1-SD4.7.14.3 Prevention and Repair of Plastic Shrinkage Cracks

The Contractor shall take whatever measures are necessary to prevent plastic shrinkage cracking in the concrete. Particularly on dry windy days or hot sunny days the Contractor shall make provision for fine spraying of the concrete surface within one hour of casting, or immediately covering the concrete with black plastic sheeting. If shrinkage cracking occurs, it may be necessary to change the aggregates or the concrete mix proportions. In order to combat shrinkage cracking it may also be necessary to chance the time at which, or the manner in which, power floating in terms of SD4.7.15.6 is carried out.

If plastic shrinkage cracks occur, after screeding of the concrete, the cracks shall be closed up by re-vibrating the concrete with a poker vibrator, within about three hours of casting. Once the cracks have been closed, and after the completion of the specified or scheduled surface finish, the concrete shall be kept thoroughly wet, or covered with plastic sheeting for at least a further three hours.

CC1-SD4.7.15 Finishing of Unformed Concrete Surfaces

CC1-SD4.7.15.1 Exposed Surfaces

Exposed surfaces of concrete not cast against formwork shall be finished in accordance with Sub-clause 4.7.15.1.

CC1-SD4.7.15.2 Non-skid Surfaces

Exposed surfaces requiring a non-skid finish will be indicated on the Drawings and/or in the Bill of Quantities.

CC1-SD4.7.15.3 Screeded Finish (Sub-clause 4.7.15.1 a)

In addition to Sub-clause 4.7.15.1 (a) no mortar shall be added during the screeding operation, and noticeable surface irregularities caused by the displacement of coarse aggregate shall be made good by re-screeding after displaced aggregate has been removed or tamped.

CC1-SD4.7.15.4 Wood-floated Finish (Sub-clause 4.7.15.1 b)

Where wood-floating is specified, the surface shall first be given a finish as specified in Sub-clause 4.7.15.1 (a) and, after the concrete has hardened sufficiently, the surface shall be wood-floated, either by hand or machine, only sufficiently to produce a uniform surface free from screeding marks.

CC1-SD4.7.15.5 Steel-floated Finish (Sub-clause 4.7.15.1 c)

Where steel-floating is specified, the surface shall first be given a finish as specified in Sub-clause 4.7.15.1 (b). When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the screeded surface shall be finished through a combination of wood-floating, followed by steel floating under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.

CC1-SD4.7.15.6 Power Float Finish

Where power floating is specified, the surface shall be treated as specified in Sub-clause 4.7.15.1 (a). When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the screeded surface shall be power floated to produce a dense, smooth and uniform surface free of trowel marks. In corners and areas of restricted access the concrete surface shall be finished by steel floating in accordance with SD4.7.15.5.

The timing of power-floating is critical to its success. Power-floating shall not commence until the concrete can support the weight of a man with minimum indentation or when a footprint is barely perceptible and until the moisture sheen has disappeared. Thus several hours will have to elapse after concreting has been completed before this operation can commence. Night work may therefore be required.

CC1-SD4.7.15.7 Broom-swept Finish (Sub-clause 4.7.15.2)

Where a broom-swept finish is specified, the surface shall be wood floated as specified in Sub-clause 4.7.15.1 (b) and thereafter swept with a stiff bristle broom to produce an approved non-skid surface.

CC1-SD4.7.15.8 Preparation for and Laying of Granolithic Screeds

Before placing any granolithic screed, the base concrete shall be given a construction joint finish in accordance with SD4.7.12.1(b) and then soaked with water for at least 24 hours.

Before laying the screed, the concrete shall be thoroughly cleaned by scrubbing, and all standing water removed after soaking. A 1:2 cement / sand grout shall then be brushed on to the prepared surface, and the granolithic screed laid before the grout sets. The granolithic screed shall be of the driest feasible consistency with a slump not exceeding 50 mm and shall be formed true to profile and shape as required and shown on the Drawings. Before fresh granolithic screed is placed against existing, adjacent granolithic screed the edge of the latter shall be prepared by chipping back to firm material, wire brushing the exposed surface and brushing it with grout as for the base concrete.

Granolithic screed shall be compacted to remove all air and shall be screeded and steel trowel finished to a degree of accuracy I unless otherwise specified.

The trowelling shall be carried out in the following stages:

1st – as soon as the granolithic screed has been compacted and screeded.

2nd – after 2 hours to close the surface and remove laitance.

3rd – after a further 4 hours.

These time intervals are appropriate to normal temperature conditions and shall be varied by the Contractor according to the temperature to ensure a smooth dense finish.

Granolithic screeds shall be diamond saw cut into panels not exceeding 2 m in any direction. The saw cutting shall be carried out after an appropriate time interval to avoid cracking of the screed. Saw cut joints shall later be filled with an approved sealant.

Granolithic screed shall be cured as specified in Clause 4.7.13 but shall additionally be protected from direct sunlight and drying winds as it is being placed.

All screeding necessary to accommodate mechanical equipment shall be done under the equipment supplier's supervision and strictly in accordance with his instructions. Screeding shall commence as soon as the equipment supplier gives notice on completion of erection and shall be finished expeditiously.

The Contractor shall make good any damage to the mechanical equipment resulting from his personnel not following the supplier's instructions. Any spillage on the equipment shall be cleaned off immediately.

CC1-SD4.7.15.9 Preparation for Laying of Screeds

The interface between concrete floors and screeds shall be regarded as construction joints and the surface of the floor shall be so prepared in accordance with SD4.7.12.1(b).

CC1-SD4.7.15.10 Colour Mitigation – Application

Surfaces to be coloured shall be free of curing compounds, surface hardening or other material that may prevent direct contact with the colouring.

The colouring shall be applied directly to clean concrete surfaces at locations as specified or directed by the Engineer. Dark patches that may develop shall be controlled or avoided by custom blending of the basic technique, amending the dilution rate of the colour concentrate with water or a combination of these.

If required the Contractor shall apply the colouring to a test section to be reviewed by the Engineer. Upon approval of both the test section and application procedures by the Engineer, the Contractor may proceed using the approved application procedures.

Rock colouring material shall be applied only by licensed applicators approved by the manufacturer. Variegated patinas that develop shall be controlled by custom blending of the rock colouring material and/or varying the application techniques.

CC1-SD4.7.16 Watertight Concrete

Water retaining structures and water excluding structures will be so designated on the drawings. These will all be considered to be watertight concrete in terms of Sub-Clause 4.7.16. Special care shall be taken with all aspects of construction of these structures in order to ensure watertightness.

The tests in Sub-clauses 5.1.6.1 and 5.1.6.2 will be required for water retaining structures but not for water excluding structures.

However, should any section of the concrete Works show any sign of water leakage or penetration, irrespective of the source, that section shall be deemed to be defective and the necessary remedial work shall be carried out in accordance with Sub-clause 5.1.6.3.

CC1-SD4.7.17 Concrete in Wet Ground

Provisions for concrete in wet ground shall be as shown on the drawings and not necessarily as indicated in Clause 4.7.17.

CC1-SD4.7.18 Grouting

CC1-SD4.7.18.1 Holding-down Bolts, Column Bases and Mechanical Equipment Bedplates

The mortar grout for holding-down bolts, column bases and mechanical equipment bedplates shall be a proprietary grout ready mixed in sealed packets as supplied by the manufacturer, and mixed and placed in accordance with the manufacturer's instructions.

The following prescribed products or brand name products, or equivalent materials subject to the written approval of the Engineer, shall be used:

SikaGrout® 212, high performance cementitious grout.

CC1-SD4.7.19 Defects

CC1-SD4.7.19.1 General

Defects shall be repaired as soon as possible after formwork has been removed and the Engineer has inspected the concrete. A statement of the method and materials to be used for each repair shall be submitted to the Engineer for his approval before any work is carried out. The Engineer may prohibit the further placing of concrete in the particular structure concerned until he is satisfied that the repair has been satisfactorily executed.

An example of the methodology and materials required for an effective repair is given in ABE Construction Chemicals' data sheets "Preparation of Surfaces" and "Dura Spalling Repair". These give detailed descriptions for cleaning and surface preparation, cleaning of reinforcement, corrosion protection of reinforcement, wet-to-dry epoxy bonding agents, curing etc. Similar products are available from Sika. In making any repairs, a high level of workmanship will be required and only the very best materials shall be used.

CC1-SD4.7.19.2 Repair (plugging) of Formwork Tie Cone Recesses

Where practical, tie cone recesses shall be plugged with well rammed, dry 3:1 mortar within 48 hours of casting the concrete. The surfaces of the recesses shall first be roughened by chipping and wire brushing.

Tie cone recesses which cannot be plugged within 48 hours of casting shall be roughened by scabbling and an approved wet-to-dry epoxy shall be applied before plugging the recesses with mortar.

The mortar plugs shall be effectively cured.

CC1-SD4.7.20 Rubbing Down of Concrete Surfaces – No Specification Data applicable

CC1-SD4.7.21 The Use of Sliding Formwork – No Specification Data applicable

CC1-SD4.7.22 Records – No Specification Data applicable

CC1-SD4.7.23 Demolition and Removal of Existing Structural Concrete – No Specification Data applicable

CC1-SD4.7.24 Granolithic Screed

Granolithic screed shall consist of:

Cement: 1 part by mass

Sand: 1.25 parts by mass

Coarse aggregate: 2 parts by mass

The coarse aggregate shall consist of granite or other approved chips which shall pass a 10 mm sieve and be retained on a 5 mm sieve.

The consistency of the mix shall be as dry as practicable and the water /cement ratio shall be approximately 0.4.

CC1-SD4.8 PRECAST CONCRETE

In addition to these clauses, useful recommendations and information is given in SANS 10100-2 (SABS 0100-2) Section 13.

CC1-SD4.8.1 Casting Beds, Moulds and Formwork – No Specification Data applicable

CC1-SD4.8.2 Concrete mixers – No Specification Data applicable

CC1-SD4.8.3 Vibrating Equipment – No Specification Data applicable

CC1-SD4.8.4 Handling, Lifting and Stacking – No Specification Data applicable

CC1-SD4.8.5 Placing and Vibrating of Concrete – No Specification Data applicable

CC1-SD4.8.6 Units that have Architectural Finishes

CC1-SD4.8.6.1 Samples of Concrete

Samples of precast concrete units that have architectural finishes shall be prepared.

Samples of concrete units, not having architectural finishes shall also be prepared to establish quality before full-scale production is commenced.

CC1-SD4.8.7 Reinforcement in Precast Concrete – No Specification Data applicable

CC1-SD4.8.8 Curing of Precast Concrete Works – No Specification Data applicable

CC1-SD4.9 PRE-STRESSED CONCRETE

A tendon, when tensioned, contains a considerable amount of stored energy, which, in the event of failure of the tendon, anchorage or jack, may be released violently. All possible precautions shall be taken (both during and after tensioning) to safeguard persons from injury caused by the sudden release of this energy.

CC1-SD4.9.1 Apparatus – No Specification Data applicable

CC1-SD4.9.2 Tendons

CC1-SD4.9.2.1 Surface Condition

(a) Solvents (Sub-clause 4.9.2.1.1)

Solvents may be used for cleaning.

CC1-SD4.9.2.2 Straightness – No Specification Data applicable

CC1-SD4.9.2.3 Cutting – No Specification Data applicable

CC1-SD4.9.2.4 Positioning of Tendons and Sheaths – No Specification Data applicable

CC1-SD4.9.2.5 Tensioning Procedure

(a) Pre-stressing Force Diagram (Sub-clause 4.9.2.5.1)

Pre-stressing force diagrams will be shown on the Drawings.

(b) Order of Loading and Magnitude (Sub-clause 4.9.2.5.8)

The order of loading and magnitude of the load for each component of the tendon shall be as indicated on the Drawings.

CC1-SD4.9.3 Grouting of Sheaths

CC1-SD4.9.3.1 General

(a) Tests (Sub-clause 4.9.3.1.2)

Bleeding tests and grouting trials will be required.

CC1-SD4.9.3.2 Sheaths (Sub-clause 4.9.3.2.1)

Sheaths shall be fitted at both ends with pipes with a diameter of at least 10 mm for the injection of grout. The ends of the injection pipe shall be fitted with a clamp valve or device capable of withstanding a pressure of at least 1,5 MPa without loss of grout.

CC1-SD4.9.4 Permanent Protection and Bonding of External Tendons (Clause 4.9.4)

CC1-SD4.9.4.1 Tests (Sub-clause 4.9.4.2)

Preliminary tests shall be undertaken on the proposed encasement materials.

CC1-SD4.9.4.2 Protection (Sub-clause 4.9.4.3)

The protection and bonding of the tendons shall be effected within 7 days after final tensioning of the tendon(s).

CC1-SD4.9.5 Pre-tensioning – No Specification Data applicable

CC1-SD4.9.6 Circular Pre-stressed Concrete Reservoirs and Tanks

CC1-SD4.9.6.1 Contractor's Responsibilities

The Contractor is responsible for submitting his proposals for the pre-stressing work. He shall satisfy the Engineer with regard to all details that may be required, shall provide all plant and equipment required, shall supply all materials and shall execute and complete the pre-stressing and associated work. Accordingly, the Contractor shall comply with the requirements of SD4.9.6.2 to SD4.9.6.5 below.

CC1-SD4.9.6.2 Pre-stressing system and tendon layout

The reservoir wall is to be pre-stressed circumferentially as shown on the Engineer's drawings. The drawings show the required minimum pre-stressing force in the wall after all losses, but do not specify details of the pre-stressing system, or the sizes and arrangement of tendons.

Any proven and approved method of pre-stressing may be used, although wrapping type systems are not acceptable.

The Contractor shall determine the arrangement and sizes of tendons to provide the required pre-stressing force in accordance with the following criteria and details given on the drawings:

(a) Losses of pre-stress shall be calculated according to SANS 10100-1 (SABS 0100-1)

(b) The prestressing force, expressed as a percentage of minimum guaranteed ultimate tensile strength of the steel shall not be allowed to exceed the following values:

  (i) at any stage during the jacking process: 80%

  (ii) on completion of transfer: 70%.

The maximum vertical spacing of tendons shall be:

(a) 400 mm at the base of the wall varying uniformly to 1 200 mm at the top of the wall.

(b) All tendons shall be stressed from both ends.

CC1-SD4.9.6.3 Reinforcement

The Contractor shall design and provide the spiral bursting reinforcement to anchorages to the Engineer's approval.

CC1-SD4.9.6.4 Calculations, drawings and records

The Contractor shall, at least two months before he intends commencing with construction of the wall, submit the following to the Engineer for his approval, for the pre-stressing system adopted:

(a) A set of detailed calculations in respect of the tendon force along the length of each tendon, the expected extension and the bursting forces, using a numbering system to identify each tendon,

(b) Drawings detailing the number, layout and alignment of the tendons, the tendon supports, details of the bursting and other reinforcement, anchorage recesses, tensioning sequence, tensioning loads and extensions,

(c) Requirements for controlling the tensioning operations, and,

(d) Details of any technical data which are at variance with the information given on the Engineer's drawings.

Pre-stressing work shall not commence before the relevant calculations and drawings prepared by the Contractor have been approved by the Engineer. After this approval, no departure shall be permitted from the forces, stresses and extensions shown thereon without authorization by the Engineer.

In addition to complying with the requirements of Sub-clause 4.9.2.5.11, the Contractor shall, upon completion of the pre-stressing work, furnish a permanent record of each working drawing in the form of an A1 size drawing in electronic AutoCAD format.

CC1-SD4.9.6.5 Friction Tests

For purposes of verifying the assumed losses of pre-stressing resulting from friction between the pre-stressing tendons and the sheathing which occurs during the jacking operation, the Contractor shall carry out friction tests on the first tendon and thereafter on every fifth tendon stressed or as may be directed by the Engineer. To this end the Contractor shall provide all necessary jacking and measuring devices and all labour required for carrying out and recording the friction tests.

CC1-SD4.10 HANDLING AND ERECTION OF PRECAST CONCRETE UNITS

In addition to these clauses, useful recommendations and information is given in SANS 10100-2 (SABS 0100-2) Section 13.4.

Special care shall be taken to ensure the safety of personnel during this delicate phase.

CC1-SD4.10.1 Handling and Transportation

CC1-SD4.10.1.1 Lifting (Sub-clause 4.10.1.3)

The position of lifting and supporting points, the method of lifting, the type of equipment and the type of transport to be used shall be determined by the Contractor in liaison with the Engineer. The agreed system layout shall be submitted to the Engineer (for review, detailed design and reinforcement detailing) 28 days before the construction Drawings and Reinforcement Schedules are required by the Contractor.

CC1-SD4.10.2 Assembly and Erection

At least 28 days before commencement of the work, the Contractor shall submit to the Engineer a Method Statement including proposed methods of assembly and erection for review and approval by the Engineer.

CC1-SD4.10.3 Temporary Supports during Construction – No Specification Data applicable

CC1-SD4.10.4 Forming Structural Connections

CC1-SD4.10.4.1 Design

The design requirements for the structural connections will be indicated on the Drawings.

CC1-SD5 COMPLIANCE WITH THE REQUIREMENTS

CC1-SD5.1 TESTING

CC1-SD5.1.1 General

(a) Cube testing (Sub-clause 5.1.1.4)

Cubes shall be tested by an approved laboratory.

(b) Ready-mix Production (Sub-clause 5.1.1.7)

The tests results from a ready-mix production facility, as part of its quality control system, will not be accepted. Only concrete cubes taken and stored on site will be accepted.

(c) Alkali-aggregate Reaction (Sub-clause 5.1.1.8 and SD4.2.3.5)

The tests for potential reactivity of the aggregates shall be Petrography ASTM C 295 and Mortar-bar test SANS 6245 or ASTM C 1260 (AASHTO T 303).

CC1-SD5.1.2 Acceptance of Strength Concrete (Clause 5.1.2)

Test results obtained by a ready-mixed concrete production plant as part of its quality-control system are not acceptable for evaluation purposes in terms of sub clause 5.1.2, but test samples shall be taken from ready-mixed concrete on location.

CC1-SD5.1.2.1 Assessment (Sub-clause 5.1.2.3)

The test results will be assessed statistically.

CC1-SD5.1.3 Frequency of Sampling – No Specification Data applicable

CC1-SD5.1.4 Individual Load Tests on Precast Units and Pre-stressed Units

The following load test values will be as indicated on the Drawings:

CC1-SD5.1.4.1 Deflection (Sub-clause 5.1.4.2.1)

The maximum deflection.

CC1-SD5.1.4.2 Load (Sub-clause 5.1.4.3)

The ultimate design load.

CC1-SD5.1.4.3 Special Tests (Sub-clause 5.1.4.4)

Any special tests required.

CC1-SD5.1.5 Tests on Pre-stressed Structures

CC1-SD5.1.5.1 Tests Requirements (Sub-clause 5.1.5.1.1)

Particular requirements for pre-stressed structures will be indicated on the Drawings.

CC1-SD5.1.5.2 Acceptance Criteria (Sub-clause 5.1.5.4 and Table 10)

The acceptance criteria for pre-stressed structures in extreme exposure conditions will be indicated on the Drawings.

CC1-SD5.1.5.3 Class (Sub-clause 5.1.5.4 a)

The class of pre-stressed structures will be indicated on the Drawings.

CC1-SD5.1.5.4 Deflection (Sub-clause 5.1.5.4 c)

The deflection measured immediately after application of the test load for deflection shall not exceed the values indicated on the Drawings.

CC1-SD5.1.6 Tests for Watertightness

CC1-SD5.1.6.1 Requirements

The following requirements amplify those in Clause 5.1.6.

Water for testing shall be provided by the Contractor and he shall be responsible for providing all necessary equipment that may be required for filling the structures.

For testing liquid retention, the structure shall be cleaned and initially filled to the normal maximum level with the specified liquid (usually water) at a uniform rate not exceeding 2 m in 24h

When first filled, the liquid level shall be maintained by the addition of further liquid for a stabilizing period while absorption and autogenous healing take place. The stabilizing period may be 7 days for a maximum design-crack width of 0,1 mm or 21 days for 0,2 mm or greater.

After the stabilizing period, the level of the liquid surface shall be recorded at 24 h intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation and rainfall, shall not exceed 1/500th of the average water depth of the full tank, or 10 mm, or another specified amount.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water being recorded.

Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid to the outside faces of the liquid-retaining walls shall be assessed against the requirements of the specification. Any necessary remedial treatment of the concrete, cracks, or joints shall, where practicable, be carried out from the liquid face. When a remedial lining is applied to inhibit leakage at a crack, it shall have adequate flexibility and shall not have any reaction with the stored liquid.

Should the structure not satisfy the 7-day test, then, after the completion of the remedial work, it shall be refilled and if necessary, left for a further stabilizing period; a further test of 7 days' duration shall then be undertaken in accordance with this clause.

The roofs of liquid-retaining structures shall be watertight and shall, where practicable be tested on completion by the roof being flooded with water to a minimum depth of 25 mm for 24 h or longer if so specified. Where it is impracticable, because of roof falls or otherwise, to contain a 25 mm depth of water, the roof shall have water applied by a continuous hose or sprinkler system to provide a sheet flow of water over the entire area of the roof for not less than 6 h. In either case the roof shall be considered satisfactory if not leaks or damp patches show on the soffit. Should the roof structure not satisfy either of these tests, then, after the completion of the remedial work, it shall be retested in accordance with this clause. The roof insulation and covering shall be completed as soon as possible after satisfactory testing.

In the event of any leakage or dampness being evident at any stage of the filling or testing or in the event of the Engineer considering the final degree of watertightness to be unsatisfactory, the Contractor when ordered by the Engineer shall discontinue such filling or testing and shall, at his own expense, take approved steps immediately to rectify the leakage, until a satisfactory test is obtained, which shall prove to the Engineer that a sufficient degree of watertightness has been obtained.

The costs of emptying a water-retaining structure which cannot be drained shall be borne by the Contractor. The water shall be discharged in a manner approved by the Engineer and shall be such that the Employer can utilise the water if he so desires.

The water shall not be used as a medium for additives to effect remedial work or to stop leaks.

The costs of retesting the structure for watertightness shall be borne by the Contractor."

Water shall be used as the liquid for test purposes.

CC1-SD5.2 TOLERANCES

CC1-SD5.2.1 General

CC1-SD5.2.1.1 Degree of Accuracy

Unless otherwise specified on the drawings or directed by the Engineer, degree of Accuracy II shall apply**,** except for precast work where Degree of Accuracy I shall apply.

Every specified permissible deviation is binding in itself. No cumulative effect of permissible deviations will be considered.

None of the prescribed permissible deviations will be deemed as permission for violating the legal boundaries of properties by any part of a structure.

The above permissible deviations also apply to slip-form concrete, unless another set of permissible deviations has been accepted in writing by the Engineer beforehand. Such amended permissible deviations

shall clearly make provision for interfaces between structures erected with the aid of slip-form concrete and those erected with the aid of conventional concrete.

The maximum permissible deviation from a 3 m long straight line connecting two points on the surface of a finished floor, is 5 mm.

The Contractor shall take levels of the floor construction (suspended slabs) as part of the normal quality assurance procedure at the following positions and time intervals:

1. On every column line at quarter and mid-span in both directions of every floor panel

2. On the centrelines of quarter and mid-span lines in both directions of every floor panel

3. First set of levels to be measured after all formwork is in its final position and after the placing and fixing of reinforcement before the casting of concrete commences

4. Second set of levels to be measured immediately after the completion of power floating or other finishing of the fresh concrete surface

5. Third set of levels to be measured after final removal of all support work below each slab as well as any other supports for slabs above

6. All records of levels to be countersigned by the Engineer after it was measured

CC1-SD5.2.1.2 Tolerances for Verticality

REPLACE IN THE PERMISSIBLE DEVIATIONS FOR VERTICALITY IN TABLE 11 AS FOLLOWS:

Table 11: Accuracy in concrete work

1	2	3	4
Item	**Permissible deviation (pd) mm**		
	Degree of accuracy		
	III	**II**	**I**
Elements or component above foundations			
Verticality, per metre of height,	5	3	2
Subject to a maximum of	50	30	10

CC1-SD5.2.1.3 Tolerances not stated (Table 11)

The tolerances for bow, camber and twist in slipform / precast concrete shall be as indicated on the Drawings.

CC1-SD6 ADDITIONAL SD CLAUSES FOR WASTE WATER TREATMENT WORKS

CC1-SD6.1 AGGREGATES OF DOLOMITIC ORIGIN

Where specified on the drawings and scheduled in the Bill of Quantities, aggregates for structural concrete shall be of dolomitic origin. The quantity of insoluble matter in respect of concrete made with these aggregates, determined according to the method described in SANS 677, Appendix C, shall not be more than 15%.

CC1-SD6.2 SCREEDS FOR SETTLING TANKS

(a) Surface of floor slab below screed

As stated in SD4.7.15.9, the top surface of the floor slab shall be regarded as a construction joint and prepared as such in accordance with SD4.7.12.1(b).

All joints shall be sealed in the manner shown on the drawings. All dust, debris, etc. must be removed immediately prior to the application of the bonding agent and screed.

(b) Materials

Only CEM I 42.5 (Portland cement) shall be used.

Coarse aggregate maximum size: 10 mm

28-day cube strength: 30 MPa.

A plasticizer approved by the Engineer shall be used to reduce the water content of the mix to an absolute workable minimum. The mix design shall be submitted to the Engineer for approval.

(c) Placing of screed

All surface water shall be removed after which Fosroc Nitobond EP slowset bonding agent or similar approved shall be applied strictly according to the manufacturer's specifications. The screed shall be placed according to the recommendations and/or specifications of the manufacturer of the bonding agent.

The screed shall be placed, spread and compacted in one layer and care shall be taken to obtain maximum compaction. After the screed has been compacted and before the surface is power floated, angle irons fixed to the mechanical equipment shall be used to finish off the screed to the correct levels.

Power floating shall not commence until such time as the screed surface has lost its sheen and barely shows footprints. All laitance on the surface of the screed resulting from compaction shall be struck off prior to power floating. Too much floating causing excessive cement-water paste to surface, shall be avoided.

Curing shall commence as soon as finishing operations have been completed and shall be continued for at least 7 days. The method of curing shall be by means of a peripheral pipe directly next to the inside face of the wall with water running down the slope of the floor to the centre cone. This shall be discussed with the Engineer. Any alternative curing method must be submitted to the Engineer for approval.

(d) Joints

The joints in screeds shall be constructed according to the details shown on the drawings and must in all cases be aligned with the joints in the floor slab below.

(e) Surface finish of screeds

The finishing-off of the screed shall be done in conjunction with the mechanical contractor to ensure that the surface fits the mechanical equipment. The maximum allowable deviation of the floor from the design level is ± 3 mm.

CC1-SD6.3 COATINGS

Where indicated on the drawings, the following coatings shall be provided to structures:

CC1-SD6.3.1 Algae-resistant coating on concrete surfaces

(a) General

Concrete launder channels are attacked over a period of time by the acids generated in the purification processes. This leads to loss of cement with consequent increase in roughness by exposure of the aggregate. Phosphates in the water and the action of sunlight encourage the growth of algae. Removal of algae is a costly and continuous process, hence it is preferable to provide a smooth surface to minimise build-up of algae growth.

(b) Surface preparation

For immersion or other heavy duty applications, laitance shall be totally removed by water blast cleaning, with abrasive injection, or by mechanical scabbling of the surface, or by acid pickling, followed by very thorough washing with potable water.

For coatings of low water permeability, such as solvent borne epoxies, vinyls and chlorinated rubber, the moisture content of the concrete or plaster shall be not more than an indicated 5% when tested with an approved electrical conductivity meter, designed for use on concrete or plaster (such as the Delmhorst meter). The pins of the meter shall penetrate the concrete or plaster to a depth not less than 5 mm.

The first coat of the coating system may require thinning with the manufacturer's recommended solvent to assist penetration of the substrate.

The surface shall be dry before coatings are applied.

(c) Application

Apply epoxy tar primer such as Ivory 310P, thinned when necessary in accordance with the manufacturer's instructions to obtain adequate penetration.

Apply a suitable scraper coat such as Ivory 319TAQ to obtain a smooth finish followed by a suitable solvent-free epoxy tar coating such as Ivory 310 to give a coating thickness of 250 micrometres and finally a vinyl anti-fouling paint at the coverage recommended by the manufacturer.

NOTE: Since an anti-fouling paint functions by leaking toxic materials into the water, it has a limited effective life, dependent on flow rate. The top coat must therefore be renewed when its efficacy starts to diminish.

CC1-SD6.3.2 Abrasion-resistant coating on concrete surfaces

(a) General

Concrete structures subject to heavy abrasion and scouring action shall be coated with an abrasion-resistant coating based on solvent-free, two-component polyurethane hybrid.

For immersion or other heavy-duty applications, laitance shall be totally removed by water blast cleaning, with abrasive injection, by mechanical scabbling of the surface or by acid pickling followed by very thorough washing with potable water.

For coatings of low water permeability, such as solvent-borne epoxies, vinyls and chlorinated rubber, the moisture content of the concrete or plaster shall be not more than an indicated 5% when tested with an approved electrical conductivity meter, designed for use on concrete or plaster (such as the Delmhorst meter). The pins of the meter shall penetrate the concrete or plaster to a depth not less than 5 mm.

The first coat of the coating system may require thinning with the manufacturer's recommended solvent to assist penetration of the substrate.

The surface shall be dry to a depth of not less than 5 mm.

Alternatively, when agreed by the supplier of the material, the surface may be treated with a chemical water scavenger, supplied by the manufacturer of the coating material.

The clean, dry surface shall be primed with the manufacturer's recommended primer for concrete, applied in accordance with the manufacturer's recommendations.

Blowholes in the concrete shall be filled by application of the manufacturer's scraper coat.

(b) Materials

(i) Primer

The primer shall be a suitable primer for concrete plus scraper coat supplied by the manufacturer of the coating material and shall be applied at the manufacturer's specified thickness and shall be overcoated within the specified overcoating time.

(ii) Coating material

The coating material shall be a solvent-free, two-component polyurethane hybrid based on polyether type polyol and aromatic isocyanate. The cured coating shall comply with the following requirements:

The coating or lining thickness shall not be less than 3 mm.

Tensile strength at 3 mm thickness (ASTM D 638), not less than 15 MPa

Adhesion to correctly primed steel at 1 mm thickness (SABS Method 776), not less than 10 MPa

Impact resistance direct at 1 mm thickness (ASTM G 14), not less than 8 joules

Dielectric strength not less than 10 kV/mm

Elongation at break at 3 mm thickness, not less than 25%

Compressibility, not less than 25 MPa

Surface hardness of 5 mm thick sample, not less than 60 nor greater than 80 Shore 'D'.

Water vapour permeability at 1 mm thickness, not greater than 0,5g/24h/m²/mm

Cathodic disbonding when tested in accordance with ASTM G8 Method A, for 60 days, the disbonded area shall not exceed 500 mm².

Where it is not practical to apply the coating using a two-component spray gun, the manufacturer's brushing grade may be used, provided that the completed coating meets all the requirements of the specification.

(c) Requirements for the finished coating

The coating shall be smooth, glossy, free from bubbling, excessive orange peel or brushmarking and from excessive runs and sags.

The dry film thickness shall be not less than 3 mm.

The edge of the coated area shall be neatly finished. No overspraying or splashes shall be permitted on surfaces adjacent to the coated surface.

The coated surface shall be free from electrical insulation defects when tested with a high voltage holiday detector, earthed to the concrete substrate by wet sponge contact and operated at 15 kV potential.

(d) Application

Prepare surface as specified above.

Prime the surface with the coating manufacturer's primer for concrete.

Within the minimum and maximum overcoating time interval specified for the primer by the manufacturer apply one coat or two coats by means of an airless spray machine fitted with metering pumps that dispenses the correct mix ratio at the spray head. The machine shall be maintained in a clean condition and in good working order. The Contractor may be required to demonstrate to the Engineer that the machine is delivering components in the correct mixing ratio.

CC1-SD6.4 FLUMES

CC1-SD6.4.1 Flume structure

The structure shall be rigid and watertight and capable of withstanding flood-flow conditions without damage from outflanking or from downstream erosion. The axis shall be in line with the direction of flow in the upstream channel, and the geometry shall conform with the dimensions given on the drawings.

The surfaces of the flume, particularly those of the entrance section and throat, shall be smooth. The flume shall be constructed of concrete with a smooth cement finish and shall be surfaced with a smooth non-corrosive material. The surface finish is of particular importance within the prismatic part of the throat but the requirements may be relaxed beyond a distance along the profile 0,5 hmax upstream and downstream of the throat proper.

To minimize uncertainty in the discharge measurements, the tolerances specified under Sub-clause SD6.5.3 shall be satisfied in construction.

CC1-SD6.4.2 Mechanical devices for flumes

CC1-SD6.4.2.1 Linear scale plates and pointers

Linear scale plates to be installed at all Parshall flumes for measuring flow shall be manufactured from 2 mm thick 304L stainless steel.

All linear scale plates shall be calibrated in litres per second and shall have a width of 50 mm and a length of 1 000 mm. All numbers shall be punched onto the stainless steel plate and shall be filled with a suitable yellow paint to the satisfaction of the Engineer. The units of calibration shall be in litre/s in increments of 50 litre/s.

The linear scale plates shall be fixed into position with the aid of stainless steel chemical anchor bolts in a position as indicated on the drawings and flush with the concrete.

Mechanical pointers for elevated linear scale plates shall be manufactured from grade 304 stainless steel. They shall be robust devices which facilitate the easy and accurate reading of linear scale plates."

CC1-SD6.5 TOLERANCES

CC1-SD6.5.1 Floors

The maximum permissible deviation from a 3 m long straight line connecting two points on the surface of the finished settling tank floor is ± 3 mm.

CC1-SD7 NOT USED

CC1-SD8 MEASUREMENT AND PAYMENT

The rates tendered under this Section shall not include for the general obligations, Contractor's Plant and Equipment and work deemed to be covered by the items provided in Section A – General.

CC1-SD8.1 Measurement and Rates

CC1-SD8.1.1 Formwork

CC1-SD8.1.1.1 General Formwork

Formwork, other than formwork covered below, will be measured as the net area of the face of the concrete to be supported during the placing of concrete. No deduction will be made for fillets and chamfers of size up to 50 mm x 50 mm or for openings of diameter up to 0.7 m or of area up to 0.5 m².

CC1-SD8.1.1.2 Narrow Widths

Formwork in continuous lengths of narrow widths and of fillets or chamfers over 50 mm x 50 mm will be measured by length, the width or range of widths being stated in the Bill of Quantities.

Boxing-out, the forming of holes, and other such operations will be measured by number, basic dimensions, perimeters, or drawing references, as stated in the Bill of Quantities.

CC1-SD8.1.1.3 Separate items will be scheduled:

(a) For each class of finish required on the formed concrete.

(b) For the different angles of inclination of formwork given below:

DESCRIPTION OF FORMWORK	ANGLE OF INCLINATION FROM THE VERTICAL
Horizontal	Exceeding 85° and not exceeding 95°
Sloping	Exceeding 10° and not exceeding 85°
Battered	Not exceeding 10°
Vertical	0°

(a) For each inclination of each type of structural element, such as walls and beams, and for different prop heights for beams and slabs, and for formwork to curved (singly and double curvature), curved in plan only, arched, domical, specially moulded, and other types of work.

(b) For depths of openings required in the formed concrete, as follows:

(i) Not exceeding 0.5 m;

(ii) Exceeding 0.5 m but not exceeding 1.0 m;

(iii) Exceeding 1.0 m but not exceeding 1.5 m;

(iv) Exceeding 1.5 m but not exceeding 2.0 m;

(v) Exceeding 2.0 m;

(vi) Measured perpendicular to the surface; and

(c) For large and small voids classified as follows:

DESCRIPTION	MAXIMUM CROSS-SECTION	
	CIRCULAR VOIDS, DIAMETER, m	OTHER VOIDS, AREA, m^2
Large	Exceeding 0.35 and not exceeding 0.7	Exceeding 0.1 and not exceeding 0.5
Small	Not exceeding 0.35	Not exceeding 0.1

CC1-SD8.1.1.4 Special Smooth Finish

Where a "special-smooth" or "smooth-special" finish is specified (See SD4.3.1.4 and Table 1) and scheduled which requires more extensive operations to be carried out after striking than are specified for a smooth finish, payment for formwork will become due when the finish has been achieved as specified.

CC1-SD8.1.1.5 Special Finish

Where a special off-form finish (See Table 1) is specified and scheduled, payment for formwork will become due when the finish has been achieved as specified.

CC1-SD8.1.1.6 The Unit Rate

The unit rate shall cover the cost of all parts of formwork in contact with the concrete (including forming fillets or splays up to 50 mm x 50 mm) and the necessary ties, bearers, struts, and other supports (falsework) plus the labour and equipment necessary to erect the formwork to the required accuracy and with the specified surface finish and to strike such formwork. The unit rate shall also cover all costs associated with the design of the formwork and falsework and ensuring their safety, and for effectively plugging tie sleeves and tie cone recesses.

CC1-SD8.1.1.7 Formwork to kickers

For formwork to kickers, all additional costs for formwork to edges up to 300 mm high will be deemed to be included in the rates tendered for vertical formwork to sides of walls or columns and will not be measured separately in narrow widths.

CC1-SD8.1.1.8 Edges of Blinding/ No-fines layer

No separate payment will be made for formwork to the edge of the blinding layer, no-fines layer or divider strip. The rates tendered for concrete to the blinding layer, no-fines layer shall cover the cost of such formwork.

CC1-SD8.1.1.9 Formwork to top of sloping surfaces

Formwork to the top of sloping or conical surfaces will only be measured to surfaces of over 30° and up to 85° to the horizontal.

CC1-SD8.1.1.10 Removal of soffit formwork

Soffit formwork to top slabs of reservoirs, pump stations, valve chambers, manholes sumps etc can either be removed through the manhole cover opening or the Contractor may use permanent formwork at his own cost.

CC1-SD8.1.2 Reinforcement

CC1-SD8.1.2.1 Steel for Normal Reinforced Concrete

Steel for normal reinforced concrete will be measured net by mass of all bars, including supporting steel detailed on the reinforcement bending schedules. The mass will be computed from the nominal bar size and the nominal mass per unit length. No allowance will be made for cutting, waste, spacer devices (materials other than steel bars), or binding wire.

Separate items will be scheduled for:

(a) Mild steel bars of different sizes, which may be grouped.

(b) High tensile steel bars of different sizes, which may be grouped.

(c) Each steel section where rails or other steel sections are used; and

(d) Steel to be fixed in different parts of the Works if this could materially influence the pricing of the work.

Steel reinforcement for precast concrete units will not be measured unless so scheduled. (See SD 8.6).

Welded mesh will be measured by area shown on the Drawings, no allowance being made for cutting, waste, laps, or deduction for end cover. The areas measured will be those of the concrete floor or slab reinforced by means of mesh. In the case of continuous units partly reinforced by mesh, the area will be computed from the outside dimensions of the area covered by mesh regardless of whether additional reinforcing steel is present in the same area.

Steel off-cuts resulting from the cutting and bending of reinforcement in accordance with the bending schedule shall be deemed to be the property of the Contractor.

CC1-SD8.1.2.2 The Total Mass

The total mass of all mild and high tensile steel bars of different sizes will be scheduled.

Welded mesh will be scheduled separately for each type and mass per square metre of mesh.

CC1-SD8.1.2.3 The Unit Rates

The unit rates for steel bars shall cover the cost of supply, cutting, bending, placing in position, and fixing of the reinforcing and supporting steel scheduled, and the provision of all spacer devices and binding wire, as well as the cost of tests in terms of SANS 920.

The unit rate for welded mesh shall cover the supply, cutting, and placing of mesh, and the cost of all waste due to laps.

CC1-SD8.1.3 Concrete

CC1-SD8.1.3.1 Measurement

Concrete will be measured net to the dimensions shown on the Drawings or to the dimensions cast, whichever are the smaller. However, structural elements that are undersized will be measured for payment only if they are accepted by the Engineer.

No allowance will be made for concrete required to make up overbreak in soft excavation, but payment will be made for additional concrete or formwork, ordered in writing by the Engineer to replace unsuitable material or overbreak in hard rock or in intermediate excavation (see (d) below).

Sub-foundation carpets and blinding layers will be measured to the plan size of the concrete structure resting on the carpet. Where the concrete is scheduled by volume it will be measured on the mean thickness as cast, provided that the Engineer is satisfied that the excavation has not at any point been taken deeper or wider than necessary (see (b) above).

Where concrete is placed directly against the sides or bottoms of excavations in hard rock or in intermediate excavation, an item may be included in the schedule of quantities for any additional concrete placed in overbreak. Such additional concrete will be measured on the basis of the superficial area of the sides or bottom, or both, as applicable, of the theoretical net excavation in rock that is overbroken and in contact with the concrete.

CC1-SD8.1.3.2 Separate Items

Separate items will be scheduled, as applicable, for each type and each grade of concrete, for each type of cement and each type of aggregate, and for each unit of the Works or each element of a structure, where these could materially influence the pricing of the work and where the cost of placing concrete is affected by its position in the Works or by the conditions of placing, such as:

(a) Slabs that are sloping, conical, or horizontal, and those of different thicknesses;

(b) Concrete placed under water or between tides, the levels of demarcation being stated;

(c) Small quantities each less than 0.5 m^3 of formed concrete; and

(d) Different surface finishes (other than striking-off and levelling) such as wood-floated or steel-floated finishes and granolithic or mortar screeds.

CC1-SD8.1.3.3 The Unit Rates

The unit rates shall cover the cost of the design of the mix in the case of strength concrete, the provision of concrete, mixing, placing, compacting, unforeseen construction joints, striking-off or levelling as applicable, and curing and repairing of defects where necessary. The unit rates shall also cover the cost of the following:

(a) The design of concrete mixes by an approved laboratory, preparation of trial mixes and submission to the Engineer for approval. (see SD4.7.1.1 and SD 4.7.1.2).

(b) All costs associated with the use of a cement extender if specified, including:

  (i) Supply, storage, handling on site and mixing in of the extender.

  (ii) Increased concrete mixing time as per SD4.7.8.1.

  (iii) Increased times before formwork may be removed as per Table 2.

  (iv) Increased curing times as per Table 8.

(c) All costs associated with the use of special aggregates (e.g. Dolomitic)

(d) Temperature control for sections thicker than 900 mm as per SD4.7.14.1.

(e) Non-designated joints (see SD3.1.4).

(f) Screeded finish to unformed surfaces as specified in SD4.7.15.3 and Sub-clause 4.7.15.1 (a).

(g) All required tests (except the watertightness test).

(h) All other requirements of SANS 2001, Part CC1 and these Specification Data clauses where no payment items are provided in the Bill of Quantities.

Floor slabs, where placed on sub-foundation carpets or directly on the prepared ground surface, will be measured to the net thickness dimensioned on the Drawings.

Concrete in a column supporting a reinforced concrete beam or slab structure will be measured between the top surface of the foundation, beam, or slab on which the foot of the column is standing and the underside of the beam or slab supported by the column.

No deduction or addition will be made for nosings, bolt holes, chamfers or splays of size up to 50 mm x 50 mm, grooves or chases not exceeding 0.015 m^3 each in volume, or holding-down bolts, rails, steel sections, and reinforcement cast in the concrete.

CC1-SD8.2 SCHEDULED FORMWORK ITEMS

CC1-SD8.2.1 Rough .....Unit: square metre (m^2)

The surfaces to be so formed will be identified in the Bill of Quantities.

CC1-SD8.2.2 Smooth .....Unit: square metre (m^2)

The surfaces to be so formed will be identified in the Bill of Quantities.

CC1-SD8.2.3 Special smooth, repaired and rubbed .....Unit: square metre (m^2)

The surfaces to be so formed will be identified in the Bill of Quantities.

CC1-SD8.2.4 Special off-form .....Unit: square metre (m^2)

The surfaces to be so formed will be identified in the Bill of Quantities.

CC1-SD8.2.5 Narrow widths (up to mm wide) ..... Unit: metre (m)

The constant width, if in excess of 300 mm, or the range of widths if up to 300 mm, or width and depth in the case of grooves or chases, or the width in the case of fillets or chamfers over 50 mm wide, will be stated in the Bill of Quantities.

CC1-SD8.2.6 Box-out holes/Form voids

Items will be scheduled as set out below:

(a) Small, circular, of diameter up to and including 0.35 m:

(i) Over 0.0 m deep up to and including 0.5 m deep ..... Unit: No.

(ii) Over 0.5 m up to and including 1.0 m deep ..... Unit: No.

(iii) Over 1.0 m up to and including 1.5 m deep ..... Unit: No.

(iv) Over 1.5 m up to and including 2.0 m deep ..... Unit: No.

(v) Over 2.0 m deep ..... Unit: No.

(b) Small, other than circular, areas up to and including 0,1 m² ..... Unit: No.

Depths as in a) above

(c) Large, circular, of diameter over 0.35 m up to and including 0.7 m ..... Unit: No.

Depths as in a) above

(d) Large, other than circular, areas over 5 m² and up to and including 15 m² ..... Unit: No.

Depths as in a) above

CC1-SD8.3 SCHEDULED REINFORCEMENT ITEMS

CC1-SD8.3.1 Steel bars ..... Unit: t

The type of steel bar (mild, high-tensile, or other) will be stated and different sizes will be given. These may be grouped.

CC1-SD8.3.2 High-tensile welded mesh ..... Unit: square metre (m²)

The type reference will be stated.

CC1-SD8.3.3 Rails or other steel sections used as reinforcement ..... Unit: t

CC1-SD8.4 SCHEDULED CONCRETE ITEMS

CC1-SD8.4.1 Prescribed mix concrete ..... Unit: (m³)

The proportions and the positions or elements in the Works will be stated.

CC1-SD8.4.2 Blinding layer in Concrete ..... Unit: (m³)

Either of the following will be stated:

(a) Minimum thickness and proportions or grade ..... Unit: square metre (m²)

(b) Proportions or grade ..... Unit: (m³)

CC1-SD8.4.3 Strength concrete, grade ..... Unit: (m³)

The characteristic strength followed by the size of stone and positions or elements in the Works will be stated. Where a cement extender is specified, the type and proportion of the extender will be indicated. Where a special aggregate (e.g. Dolomitic) is specified this will be stated.

CC1-SD8.4.4 Unformed surface finishes

CC1-SD8.4.4.1 Unformed surface finishes .....Unit: square metre (m²)

Where better than a “screeded finish” (SD4.7.15.3) is required, items will be scheduled for each class or type of finish, i.e.:

(a) Wood-floated finish

(b) Steel-floated finish

(c) Power-floated finish, or

(d) Other special finish

The rate shall cover the cost of providing the specified surface finish.

CC1-SD8.4.4.2 Extra over for finishing to special accuracy .....Unit: square metre (m²)

This item is extra over sub-item (b), (c) or (d) which will be stated.

The quoted rate shall include full compensation for the additional cost of finishing the stated area to closer tolerances than per Table 11 where specified e.g. SD 6.5.2 Settling tank walls and SD6.5.3 Flume structures.

CC1-SD8.4.5 Aggregate (where measured separately) ..... Unit: (m³)

The rate shall cover the cost of supplying at the point of use and using the aggregate in the manner specified.

CC1-SD8.4.6 Cement (where measured separately) .....Unit: t

The rate shall cover the cost of supplying at the point of use and using the cement in the manner specified.

CC1-SD8.4.7 No fines concrete layer with mortar skim .....Unit: square metre (m²)

The thickness of the no-fines layer and mortar skim will be stated.

The rate shall cover all costs to construct the no-fines layer to the required thickness and where specified, providing a mortar skim. The rate shall also cover the cost of power or steel floating the mortar skim to the required accuracy as well as curing

CC1-SD8.4.8 Screeds.....Unit: square metre (m²)

The type of screed and thickness will be stated. The name of any special bonding agent will also be stated.

This item includes all concrete screeds including grano screeds and screeds to settling tanks as scheduled in the Bill of Quantities.

The rate shall cover all costs to construct the specified screed to the required thickness and accuracy. The rate shall also cover the cost of providing a construction joint surface to the concrete below in accordance with SD4.7.12.1(b), applying a bonding agent and primer where specified, floating the surface of the screed, curing and all other specified requirements.

CC1-SD8.4.9 Bond breaker below floor .....Unit: square metre (m²)

The bond breaker between the blinding/ no-fines layer and the underside of the floor slab will be measured as the total area of the floor.

The rate shall cover the cost of the supply of all materials and labour for the application of the bond breaker in accordance with SD4.2.11.2.

CC1-SD8.4.10 Casting pipes and specials in concrete ..... Unit: m or No)

The size (NB) of each pipe or special and the thickness of the concrete wall or floor through which it passes will be stated.

The rate shall cover all costs of fixing the item in position and casting it in in accordance with SD4.6.3.1, regardless of whether the Contractor chooses to fix the item into the formwork and cast it in or to box-out an opening and cast the item in later.

The pipe or special is measured elsewhere.

CC1-SD8.4.11 Miscellaneous work.....Unit: As scheduled

Separate items will be scheduled for each type of miscellaneous work.

The tendered rates shall include full compensation for providing all labour, materials and equipment required to carry out the work, for all preparatory work, for constructing the work scheduled in a workmanlike manner and for finishing off and cleaning up when the work has been completed.

CC1-SD8.5 DESIGNATED JOINTS ..... Unit: m

Only designated joints (SD3.1.4) as shown on the drawings or approved by the Engineer will be measured for payment. Non-designated joints will not be measured or paid for.

Separate items will be scheduled for different types of designated joints as shown on the drawings. These will include different types, sizes, and qualities of waterstops, bandage seals, sealants, joint fillers etc.

The unit rate shall cover the cost of all materials, labour and plant required to construct each type of joint as specified on the Drawings, including the cost of all formwork, preparation of construction joint surfaces as specified in SD4.7.12.1(b), the provision and installation of waterstops (including all joints), bandage sealing systems (including all joints), swellable sealing strips, bearings, sealants, fillers at expansion joints and sliding joints, bond breakers at contraction joints, recesses for sealants, chamfers or recesses as specified where concrete is exposed, as well as testing and repairing where necessary.

For designated joints in very thick members, it may be decided to measure the joint by area (m^3).

In this case, the various components of the joint (waterstops etc) will be measured separately by length (m) as appropriate.

CC1-SD8.6 MANUFACTURE (OR SUPPLY) AND ERECT PRECAST CONCRETE UNITS

Measurement will be any of the following: Unit: (No, m, m^2 or m^3)

(a) The total number of units

(b) The total length of units

(c) The total surface area of units

(d) The total volume of units

Separate items will be scheduled for:

(a) Different qualities of concrete

(b) Different types and sizes of units

(c) Small units not exceeding 0.5 m^3 of formed concrete

(d) Different positions of units for erection purposes

Except where separate items are scheduled for specific operations or materials, the rates shall cover all the costs of manufacture (or supply) and erection of the precast concrete units complete, in accordance with all the requirements of this Standard and Specification Data, including concrete and reinforcement and all materials, equipment and labour. The rates shall also include the cost of moulds for forming the units, special finishes, curing, transportation, handling, assembly, erecting, aligning, temporary support work, building in or fixing the units in their final position including grouting or other bedding and jointing materials, fixing dowels, and built-in metalwork and components including service ducts where applicable.

CC1-SD8.7 GROUTING

(a) Under bases (or beds)..... Unit: (m^3)

Grouting under structural steel column bases or members or under pumps, motors, or other machinery will be measured by the volume of grout (before the edges are trimmed at 45º from the bottom edges of bedplates) necessary to fill the voids and pockets between the underside of the metalwork and the top of the concrete. No deduction will be made for bolts, packers, and baseplate shear keys protruding into the grout space.

(b) HD bolts, etc. (see SD8.8) ..... Unit: (m^3)

Separate items will be scheduled for HD bolts or pockets, as applicable, of different diameters, lengths, and types, and for bearings and miscellaneous metal work of different types. The quantity will be measured by the volume of grout necessary to fill the voids in the concrete. No deduction will be made for bolts and packers protruding into the grout space.

The rates for a) and b) above shall cover the cost of scabbling, cleaning, and preparing the concrete surfaces, providing an approved proprietary grout, placing and ramming it solidly into all voids and pockets, and mitring the outside edges to a true wood-floated surface and all costs of grouting in accordance with Sub-clause 4.7.18, including the provision of formwork, if required.

CC1-SD8.8 HD BOLTS AND MISCELLANEOUS METAL WORK ..... Unit: t

Whether the item is to be supplied by the Contractor or by others will be stated. Separate items will be scheduled as specified in SD8.7 (b).

The rate shall cover the cost of supplying and delivering or taking delivery (as applicable), fixing or casting into concrete, and all cleaning, preparation, and finishing.

The cost of installing fixings for items such as handrailing, ladders and similar, shall be included in the unit rate or sum tendered for the item to be fixed.

CC1-SD8.9 COLOUR MITIGATION ..... Unit: square metre (m^2)

Measurement shall be on the plane projection along the exposed planes of the area being coloured.

The rate shall cover full compensation for all labour, materials, operation of equipment, tools, supplies and incidentals necessary to complete the work specified or as directed by the Engineer.

CC1-SD8.10 TESTS FOR WATER TIGHTNESS ..... Unit: Sum

Each water retaining structure will be stated.

The unit of measurement shall be the number of each structure successfully passing the specified watertightness tests to the satisfaction of the Engineer.

The sum shall cover all costs of testing each structure as specified, including for all water required for filling and for emptying the structure of water on completion of the test, including where the structure cannot be drained, and for measuring devices and all necessary equipment. The sum shall also include for testing of the roof of each water retaining structures as specified.

CC1-SD8.11 FILL RESERVOIR WITH WATER ..... Unit: kl

The rate shall cover all costs of sourcing, transporting, and filling the reservoir with potable water of accepted quality. This includes securing water from approved sources, logistical expenses for transport, and necessary handling during the process. The rate must also cover comprehensive testing to ensure the water meets potable standards, including chemical, biological, and physical treatments required, before being released into the pipeline or reticulation system.

C3.7.3 PARTICULAR SPECIFICATIONS

PA FENCING

PB MISCELLANEOUS WORK FOR RESERVOIRS

LE01 REINFORCED CONCRETE

LE03 SLIDING FORMWORK

LE05 SURFACE FINISHES

LE06 SURFACE FINISHES

LE08 LATERAL SUPPORT ANCHORS

LE10 CONCRETE FOR AQUEOUS LIQUID RETAINING STRUCTURES

LE11 CONCRETE MINOR WORKS

LE13 BUILDING SURFACE BEDS

LE15 PROTECTION AGAINST TERMITES AND ANTS UNDER SURFACE BEDS

LE16 SOILCRETE

ME1 STRUCTURAL STEELWORK

S1 SPECIFICATION FOR LOAD BEARING MASONRY WALLS

Should a requirement of the project specification be inconsistent with a requirement of the said standardized specification, the requirement of the particular specification shall take precedence.

PARTICULAR SPECIFICATION

PA FENCING

CONTENTS

PA 01 SCOPE
PA 02 TYPE OF FENCE
PA 03 MATERIALS
PA 04 CLEARING FENCE LINE
PA 05 CLOSING OPENINGS UNDER FENCES
PA 06 INSTALLING GATES
PA 07 GENERAL REQUIREMENTS AND TOLERANCES
PA 08 MEASUREMENT AND PAYMENT

PA 01 SCOPE

This is a Particular Specification and covers the erection of new fences.

PA 02 TYPE OF FENCE

Provide a 2200 mm (Minimum height) fence carbon hardened and galvanised steel mesh panels and support posts with security spikes on top. Security spikes to be 100 mm electro-galvanised, 2 mm thick, toughened steel. The fence should be clamber proof with see-through capabilities and have a top coat finish of baked enamel paint of synthetic coating in colours grey or black. Mesh strands to be 4 mm diameter minimum, cut resistant and with an aperture not exceeding 12 x 75 mm. The product must be manufactured and installed in accordance with the manufacturer's drawings and specifications. The fence design must be complete and inclusive of concrete footings for fence posts.

The manufacturer supplying the fence must possess a valid SABS certificate or an equivalent or higher certification. Additionally, design and compliance certificates from the approved supplier must be submitted for certification and guarantee purposes. The supplier is also required to provide shop drawings, which should be submitted to the Engineer for review and acceptance prior to the supply and installation of the fence and gate.

PA 03 MATERIALS

PA 03.1 CONCRETE

Concrete used for fencing shall comply with the requirements of SANS 2001 CC1.

PA 04 CLEARING FENCE LINE

Strip clearing for the fence shall be carried out in accordance with SANS 1200 C and will be measured and paid for under Section 1200 C of the Schedule of Quantities.

PA 05 CLOSING OPENINGS UNDER FENCES

At ditches, streams, drainage channels or other hollows where the fence cannot follow the general ground contour, the Contractor shall close the opening under the fence as shown on manufacturer's shop drawings.

PA 06 INSTALLING GATES

Gates shall be installed at the positions indicated on the drawings or pointed out on Site. The gates shall be 5m wide with similar shared specifications as he fence supplied by the same manufacturer and installed in accordance with the manufacturer's specifications and details shown on the manufacturer's shop drawings.

PA 07 GENERAL REQUIREMENTS AND TOLERANCES

The completed fences shall be plumb, taut, true to line and to the ground contour, and with all posts, and mesh panels firmly set.

The Contractor shall, on completion of each section of fence, remove all cut-offs and other loose wire or mesh so as to leave the fence with a neat and finished appearance.

PA 08 MEASUREMENT AND PAYMENT

PA.01 Supply and erection of new fence:

(a) Provide a 2200 mm (Minimum height) fence carbon hardened and galvanised steel mesh panels and support posts with security spikes on top. ..... Unit: number

The unit of measurement shall be the meters of fence installed complete as per manufacturer's shop drawings and specifications.

The tendered rates shall include full compensation for complete supply and erection of the fence as specified in PA 02 and as shown on the manufacturer's shop drawings. The tendered rate for posts shall make provision for the construction of the stays of the types shown on the drawings. The tendered rate for the fence shall make provision for concrete footings for fence posts, as well as measures to close gaps under the fence as specified in PA 05.

PA.02 New gates

(a) 5m wide gate with similar shared specifications as the fence. ..... Unit: number

The unit of measurement shall be the number of new gates erected. A pair of gates shall be measured as one.

The tendered rate shall include full compensation for gate posts, hinges, bolts, concrete, locking mechanism and straining wire, and for the erection of the gates complete as specified and as shown on the drawings. Gates shall be complete in every respect.

PA.03 Drilling and blasting holes for posts and anchors ..... Unit: number

The unit of measurement shall be the number of holes for posts and anchors made by drilling and blasting where excavation by hand-tools or pneumatic tools cannot be done economically.

The tendered rate shall include full compensation for drilling and blasting the holes and for all other expenses in connection with the provision, storage, transportation and use of explosives.

PARTICULAR SPECIFICATION

PB MISCELLANEOUS WORK FOR RESERVOIRS

CONTENTS

PB 01 SCOPE
PB 02 CRUSHED STONE ON ROOF SLAB
PB 03 LIGHTNING PROTECTION
PB 04 STERILIZATION OF RESERVOIR
PB 05 TESTING FOR WATERTIGHTNESS
PB 06 MISCELLANEOUS ITEMS
PB 07 MEASUREMENT AND PAYMENT

PB 01 SCOPE

This Particular Specification covers miscellaneous work for reservoirs not measured and specified elsewhere in the Specifications.

Items such as bearing pads, platforms, handrails, ladders, manhole covers and frames, locking devices, ventilators, rainwater downpipes, etc shall be manufactured, supplied and installed to details and in positions as shown on the Drawings. Ladders, handrails and flooring, when made of steel, shall be manufactured in accordance with SANS 1200 HA and corrosion protection thereof shall comply with the requirements of SANS 1200 HC.

PB 02 CRUSHED STONE ON ROOF SLAB

The crushed stone shall be clean and dust free and 100% of the stone shall pass through a 25 mm mesh sieve and 100% of the stone shall be retained on a 12 mm mesh sieve. The thickness of the stone layer shall be as shown on the Drawings.

The stone shall not be placed without the permission of the Engineer and not until the concrete of the roof slab has reached the design strength. The stone shall be immediately spread into position on the roof and no heaping-up of the stone will be allowed.

PB 03 LIGHTNING PROTECTION

The reservoir shall be protected from the effects of lightning by the installation of a lightning-protection system which complies with the requirements of SABS Code of Practice 03.

The Contractor shall obtain the services of a firm specialising in the supply and installation of such systems. The firm which shall be approved by the Engineer, shall submit Drawings of the system to the South African Bureau of Standards for approval, and work may commence only after the approved plan has been submitted to the Engineer. The air-termination system which shall be installed on the circumferential parapet wall on the roof shall be bonded to the steel reinforcement of the wall in the case of reinforced-concrete reservoirs, and to surface-mounted down-conductors in the case of prestressed-reinforced-concrete reservoirs, and special care shall be taken to prevent the corrosion of the reinforcement or any form of electrolysis from taking place.

Where the reinforcement is used as down-conductors, care shall be taken to ensure that, wherever such reinforcing is spliced, positive bonding between the bars forming the splice is obtained. The reinforcement shall be bonded to the earthing system at points directly below the air-terminal bonds, and the joint between the wall and ring foundation shall, for this purpose, be bridged in an approved manner.

Where surface-mounted down-conductors have to be installed on reinforced-concrete reservoirs as a result of the Contractor's failure to make the necessary provision for the wall reinforcement to be used as down-conductors, the additional costs of installing the surface conductors shall be for the Contractor's account.

PB 04 STERILIZATION OF RESERVOIR

Before a reservoir is sterilized, the roof shall have been tested for watertightness as set out in clause PB 05 below, and the pipelines serving the reservoir shall have been sterilized. The reservoir shall then be thoroughly cleaned out and washed down with clean water.

The roof, beams, columns and walls shall thereafter be thoroughly sprayed down, using pressurised equipment, and the floors shall be scrubbed with the solution specified in Subclause 5.10 of SANS 1200 L.

On completion of the sterilization, the sterilizing solution shall be run to waste before the reservoir is filled for testing watertightness.

Should additional work be required inside the reservoir after the watertightness test has been completed, the reservoir shall be resterilized at the Contractor's expense.

PB 05 TESTING FOR WATERTIGHTNESS

The structure shall be filled by water being gradually let in until the top water level has been reached. The water level will then be carefully noted and recorded by the Engineer in relation to a fixed bench mark, and the structure shall be allowed to remain filled for a period of two weeks to permit complete absorption of water by the concrete.

Any loss of water which may have occurred shall then be made up by again filling the structure to the top water level and by allowing the water to remain undisturbed for a period of not less than four days. The structure shall be considered to be watertight if the drop in level in 96 hours (less the drop caused by evaporation) does not represent more than 0,06% of the volume of the reservoir.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water being recorded.

The Contractor is free to attend the Engineer's taking of all measurements.

In the event of an appreciable leakage being evident or visible at any stage of the filling or testing, or in the event of the final degree of watertightness being unsatisfactory, the Contractor shall, when so ordered by the Engineer, discontinue such filling or testing and shall, at his own expense, take approved steps to rectify the leakage, until a test proves that a sufficient degree of watertightness has been obtained.

The watertightness of the reservoir roof shall be tested before that of the reservoir itself by continuously sprinkling water on the roof in an approved manner so as to maintain a film of water on the surface of the slab. The roof shall be considered watertight if no damp patches are visible on the underside after 48 hours of sprinkling.

Before the expiry of the period of maintenance, the Engineer shall have the right to retest the structure for watertightness; results of such further tests will be made available for the information of the Contractor. In the event of these tests indicating an unsatisfactory degree of watertightness, the Engineer will, before issuing the final certificate, again require the Contractor to rectify the leakage, at his own expense, in such a manner as will cause the least interruption of the water supply to consumers and as will ensure the soundness of the work to the satisfaction of the Engineer.

Should the failure of the reservoir to pass the first or any subsequent test for watertightness necessitate the draining of the structure, the Employer reserves the right to utilise the water by discharging it into its water-reticulation network, in which case the Contractor:

(a) shall not have to pay for the subsequent refilling of the reservoir;

(b) shall, if applicable, reimburse the Employer for any additional costs incurred to make the water fit for consumption; and

(c) shall not be entitled to claim for extra time whilst waiting for the water to be discharged into the network.

The costs of retesting the reservoir for watertightness shall be borne by the Contractor.

PB 06 MISCELLANEOUS ITEMS

Items such as internal and external access ladders, manhole covers and frames, locking devices, handrails, ventilators, rainwater outlets and downpipes, flashings, etc, for the reservoir shall be manufactured, supplied and installed to details and in positions as shown on the Drawings. Ladders and handrails, when made of steel, shall be manufactured in accordance with SANS 1200 HA.

Prior to drilling bolt holes into the concrete for the installation of any of the above items, the Contractor shall, by using a cover meter, ensure that no reinforcing steel is obstructing the proposed bolt hole positions.

PB 07 MEASUREMENT AND PAYMENT

PB.01 Lightning protection ..... Unit: sum

The tendered sum shall include full compensation for obtaining SABS approval of the Drawings, and for installing and testing the lightning-protection system on the structure as specified on the approved Drawings.

PB.02 Sterilization ..... Unit: sum

The tendered sum shall include full compensation for sterilizing the structure as specified.

PB.03 Testing for watertightness ..... Unit: sum

The tendered sum shall include full compensation for the provision of all labour, Plant and materials necessary for testing the structure for watertightness as specified, and to the satisfaction of the Engineer.

PB.04 Crushed stone on roof..... Unit: m^3

The tendered rate shall include full compensation for supplying and placing the crushed stone to the thickness as shown on the Drawings and for all labour, Plant and materials to carry out the work as specified.

PB.05 Miscellaneous items:

(a) Measured by number:

(i) (Description of item) ..... Unit: number

(ii) Etc.

(b) Measured by linear metre:

(i) (Description of item) ..... Unit: m

(ii) Etc.

(c) Measured by area:

(i) (Description of item) ..... Unit: m^2

(ii) Etc.

(d) Measured by volume:

(i) (Description of item) ..... Unit: m^3

(ii) Etc.

(e) Tendered for in a sum:

(i) (Description of item) ..... Unit: sum

(ii) Etc.

The unit of measurement shall be the number, linear metre, square metre, cubic metre or sum as applicable to each item.

The tendered rate (or sum) shall include full compensation for manufacturing or providing and installing each item complete as shown on the Drawings, and shall include all corrosion protection.

LE01 PARTICULAR SPECIFICATION FOR PLAIN AND REINFORCED CONCRETE

The South African National Standard for Construction Works (published by the South African Bureau of Standards) shall apply throughout in respect of this contract, in addition to the additions and saving the exceptions set out below:

A copy of the said specification shall be furnished by the contractor and shall be kept on the site.

PROJECT SPECIFICATION

1. Applicable standardized and particular specifications.

   For the purposes of this contract the following standardized specification shall apply

   SANS 2001 Part CC1: CONCRETE WORKS (STRUCTURAL)

   Depending on the Engineers' prescribed design and/or method of construction or deviations there from by the Contractor with the written approval of the Engineer, one or more of the following particular specifications shall apply:

   LE01 SPECIFICATION FOR PRECAST CONCRETE
   LE03 SPECIFICATION FOR SLIDING FORMWORK

   The contractor will be furnished with the above specifications that are applicable.

2. The reinforcing steel shall be inspected by the Engineer after the fixing of steel, the cleaning of shuttering and the positioning of the spacer blocks have been completed, and prior to concrete casting.

3. All beams, bands and slabs shall have the following camber, unless otherwise shown on the drawings:

   Cantilevers : span ÷ 200
   Other spans : span ÷ 500

4. Should a requirement of the project specification be inconsistent with a requirement of the said standardized specification, the requirement of the project specification shall take precedence.

5. Add the following to the relevant sub clauses of the said SANS specification 2001 Part CC1:

		SANS 2001-CC1 sub clause no
5.1	EXPLANATION OF TERMS	
	Precast concrete Concrete components of the general quality described in this specification, which have been cast and cured either elsewhere or on the site and placed in position to form an integral part of the structure.	
5.2	MATERIAL	
5.2.1	Cementitious binders	4.2.1.1
	Replace the contents of the sub clause with the following: "Only CEM I 42,5 (Portland cement) or CEM II/A-V 42,5 (Portland fly ash cement) or CEM II/A-S 42,5 (Portland slag cement) or CEM II/B-S 42,5 (Portland slag cement) according to SANS 50197-1 (EN 197-1), may be used. The cement may not consist of more than 30% extender (siliceous fly ash or granulated blast furnace slag), blended with the OPC (Ordinary Portland Cement). Should the Contractor wish to use any other type of cement, he shall obtain the Engineer's prior written approval".	
5.2.2	Storage of aggregates	4.2.3.6
	Where aggregates of differing chloride content are stockpiled on the site, strict control shall be exercised over their use for differing classes of concrete.	
5.3	FIXING	4.4.2.2
	Welding of reinforcement is not permitted.	
5.4	DURABILITY	4.7.5
	The exposure conditions for concrete are classified as "moderate" Add the following: "The maximum water/cement ratio for moderate sections, general reinforced concrete, exterior portions of mass concrete, as well as for internal concrete in buildings under conditions of moderate exposure, is 0,67. The maximum water/cement ratio for concrete slabs on the ground under very severe conditions, is 0.45".	
5.5	STRENGTH CONCRETE	4.2.3.5
	The shrinkage of concrete to be cast in floor systems, shall not exceed 0,03 % tested as per SANS 6085. Three tests shall be conducted on the mix design to confirm compliance. Test results shall be made available before the concrete is used on site.	
5.6	ACCURACY IN CONCRETE WORK	5.2
	Degree of Accuracy II shall apply**,** except for precast work where Degree of Accuracy I shall apply. Each specified permissible deviation shall be binding by itself. No cumulative effect of permissible deviations will be considered. Replace clause 5 in the section "Elements or components above foundations" with the following:	

	Permissible deviation Degree of Accuracy		
	III	II	I
	mm	mm	mm
Vertically, per metre height	5	3	2
subject to a maximum of	50	30	10

None of the prescribed permissible deviations will be deemed as permission for violating the legal boundaries of properties by any part of a structure.

The above permissible deviations also apply to slip-form concrete, unless another set of permissible deviations has been accepted in writing by the Engineer beforehand. Such amended permissible deviations shall clearly make provision for interfaces between structures erected with the aid of slip-form concrete and those erected with the aid of conventional concrete.

The maximum permissible deviation from a 3 m long straight line connecting two points on the surface of a finished floor, is 5 mm.

The **contractor shall take levels of the floor construction** (suspended slabs) as part of the normal quality assurance procedure at the following positions and time intervals:

1. On every column line at quarter and mid-span in both directions of every floor panel
2. On the centrelines of quarter and mid-span lines in both directions of every floor panel
3. First set of levels to be measured after all formwork is in its final position and after the placing and fixing of reinforcement before the casting of concrete commences
4. Second set of levels to be measured immediately after the completion of power floating or other finishing of the fresh concrete surface
5. Third set of levels to be measured after final removal of all support work below each slab as well as any other supports for slabs above
6. All records of levels to be countersigned by the Engineer after it was measured

5.7 ACCEPTANCE CRITERIA FOR STRENGTH CONCRETE — 5.1.2

Test results obtained by a ready-mixed concrete production plant as part of its quality-control system are not acceptable for evaluation purposes in terms of sub clause 5.1.2, but test samples shall be taken from ready-mixed concrete on location.

5.8 REMOVAL OF FORMWORK — 4.3.8

The contractor shall make provision for the continued support of beams and slabs while the formwork is being removed and/or for back-propping of beams, slabs, etc. The propping may be required simultaneously on more than one level directly underneath one another. The requirements for continuous propping and/or back-propping shall be calculated to a theoretical model that is acceptable to the Engineer, and details shall be submitted for the Engineer's acceptance. Data required for such calculations, e.g. design loads and structural dimensions, will be supplied by the Engineer on request.

LE03 SPECIFICATION FOR SLIDING FORMWORK

The South African National Standard for Construction Works (published by the South African Bureau of Standards) shall apply throughout in respect of this contract, in addition to the additions and saving the exceptions set out below:

A copy of the said specification shall be furnished by the contractor and shall be kept on the site.

This specification covers the design, supply and erection of sliding formwork used in the construction of permanent work.

PROJECT SPECIFICATION

1. APPROPRIATE SPECIFICATIONS

The following standardized specifications shall form part of the contract:

1.1 SANS 2001 Part CC1: CONCRETE WORKS (STRUCTURAL)

Specific reference is made to subclauses 4.3.2.2 Sliding formwork and 4.7.21 The use of sliding formwork.

1.2 LE01: Specification for Plain and Reinforced Concrete.

2. ADDITIONAL CLAUSES

2.1 MATERIALS

2.1.1 General

The materials used in the construction of formwork shall be suitable for the purpose for which they are required and shall be of a quality as will produce the standard of work specified. The type, grade and condition of the materials shall be subject to the Engineer's approval.

2.1.2 Jack rods

The jack rods, base plates and couplers shall be of sufficient strength to carry the design load under all operating conditions without buckling or becoming distorted or causing damage to the concrete. Jack rods which are to remain permanently embedded in the concrete shall comply with the requirements of clauses 4.2.5 and 4.4.3 of SANS 2001 Part CC1, where applicable. Under no circumstances shall bent rods be used in the work.

The jack rods used shall have a diameter of at least 25 mm.

2.2 GENERAL (SAFETY)

Notwithstanding the comments given by the Engineer in respect of the design and drawings prepared by the contractor for the formwork and the inspection of the formwork as constructed, the contractor shall be solely responsible for the safety and adequacy of the formwork and shall indemnify the Employer and the Engineer, and keep them indemnified, against any losses to, or claims or damages whatsoever lodged by persons, or against losses of or claims or damages whatsoever in respect of property, which may arise out of or in consequence of the design, construction, use and maintenance of the formwork and against all claims, demands, proceedings, damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

Concrete sections with dimensions smaller than 200 mm shall not be formed with sliding formwork.

2.3 CONSTRUCTION

2.3.1 Early Concrete Strength Monitoring

The acceptance criteria for strength concrete will be in accordance with SANS 2001 Part CC1: Concrete Works (Structural) subclause 5.1.2.

In addition to the above provisions, the contractor shall, before construction commences, furnish the Engineer for approval, with details of a system of monitoring early concrete strengths, not later than 72 hours after the casting of the concrete, by which the Contractor proposes to verify the expected in situ 28 day concrete strength.

Any costs incurred for developing, implementing and executing this additional monitoring system will be for the account of the contractor.

3. COSTS FOR CHECKING THE CONTRACTOR'S PROPOSAL, AND OF RE-DETAILING THE REINFORCING STEEL

The Engineer will check the proposal for sliding formwork and, where it is accepted, effect the necessary changes to the reinforcing schedules and drawings.

The costs for checking the proposal, as well as the costs related to the re-detailing of reinforcing steel, shall be paid to the Engineer by the Contractor.

LE05 SPECIFICATION FOR SMOOTH SURFACE AND EXPOSED-AGGREGATE SURFACE FINISHES

1 SCOPE

This specification describes two classes of concrete surface finishes, namely a smooth surface finish and an exposed-aggregate surface finish.

Reference is made to the applicable sections of SANS 2001 Part CC1: CONCRETE WORKS (STRUCTURAL) for Formwork; Concrete surfaces; Defects; Rubbing down of concrete surfaces; and Tolerances.

2. FORMWORK

All formwork for the two types of surface finishes shall be new and free from any matter, indentations and warps that will impart irregularities and blemishes to the concrete surface.

Except for round columns, where steel forms may be used, all formwork shall be of timber panels or boards. No differential movement between adjacent panels will be allowed.

Exposed-aggregate concrete requires quality form workmanship. Formwork must withstand the greater vibration normally associated with placing exposed- aggregate concrete.

Forms must be tight and accurately aligned at butt joints, since the slightest misalignment at form joints may be visible in the exposed surface showing up under certain lighting and shadow conditions.

The joints in formwork must be sealed or caulked to prevent the leakage of water and fines. A thin plastic adhesive tape is preferred. If joints are not sealed, a dark line will appear on the finished surface.

An important consideration in cast-in-situ exposed concrete is the treatment of form ties to prevent the rusting of the ties and the subsequent staining of the wall. Form ties can be of the type that is withdrawn from the concrete or has plastic cones so that the ties will break off no closer than 40 mm to the surface of the concrete to leave a hole not larger than 20 mm in diameter. Tie-rod holes may be left exposed in carefully predetermined patterns to eliminate patching (if stainless-steel ties are used), or must be patched immediately after the stripping of the forms.

The stripping time of formwork depends on several factors, such as safety, the resulting effect on the concrete, and the most favourable time for exposing the aggregate by way of a particular exposure technique.

3. TOLERANCES

Surface regularity relates to the shape of a surface with reference to a 3 m straight-edge (or a template in the case of curved surfaces) placed on the surface.

The tolerance on surface regularity is expressed as a distance by which the surface tested may deviate from a straight-edge or template held against the surface.

For the purposes of this specification, the distance shall not exceed 2 mm, unless otherwise allowed by the Engineer.

4. SMOOTH SURFACE FINISH

This surface finish shall be smooth and without blemish or discolouration. All projections shall be removed, irregularities repaired and the surface rubbed or treated to give a smooth finish of uniform texture, appearance and colour.

(a) General

Any remedial treatment to surfaces shall be agreed on with the Engineer following inspection immediately after removal of formwork and shall be carried out without delay. No surface may be treated before inspection by the Engineer.

(b) Repairs

Small areas of honeycombing or other imperfections, as well as isolated surface air and water bubbles, shall be filled in with a mortar consisting of the cement-and-sand portion of the concrete mix used.

For the repair of large or deep areas of honeycombing, special methods and techniques, such as pneumatically applied mortar, pressure grouting, epoxy bonding agents, etc, may be used as agreed on by the Engineer.

All patches and repairs shall be kept continuously wet for at least 5 days.

(c) Rubbing of surfaces

If the finish of exposed surfaces does not comply with the requirements for the uniformity of texture and appearance, the contractor shall, when instructed to do so by the Engineer, rub down the exposed surfaces of the entire structure or any part thereof as specified below, entirely at his own cost. Before rubbing, all repairs must be completed.

The surface shall be saturated with water for at least one hour. Initial rubbing shall be carried out with a medium coarse Carborundum stone, using a small amount of mortar on the face, in the proportions specified in (b) above. Rubbing shall be continued until all form marks, projections and irregularities have been removed and a uniform surface has been obtained.

The paste produced by the rubbing shall be kept in place. The final rubbing shall be carried out with a fine Carborundum stone and water. This rubbing shall continue until the entire surface is of a smooth, even texture and uniform in colour. Thereafter the surface shall be washed with water and a brush to remove surplus paste and powder.

5. EXPOSED-AGGREGATE SURFACE FINISH

(a) Aggregates

All coarse and fine aggregates required for the production of concrete with an exposed-aggregate surface shall be on the site before concreting commences.

Both the stockpiles of coarse and fine aggregates shall be individually mixed to obtain stockpiles that are of uniform colour throughout.

Coarse aggregate shall be of a nominal size of 20 mm. The type of rock from which it is derived will be specified in the bill of quantities.

(b) Mixing of concrete

Exposed-aggregate concrete requires good mixing, which should continue for at least one minute after all materials have been charged to the mixer. Uniformity of mixing time should be carefully controlled from batch to batch to obtain uniformity of colour.

(c) Casting and placing of concrete

Segregation must be prevented by restricting the slump to the lowest value consistent with good consolidation. The slump value of the concrete should not exceed 75 mm.

Low-slump concrete does not flow readily down a chute, and construction methods should allow the concrete to be dropped vertically in all handling operations, since the mixes can be dropped for considerable distances without segregation.

Once in the forms, the concrete can be consolidated easily by means of internal vibration but it requires ample vibration to ensure proper compaction and the elimination of honeycomb areas. The concrete should be placed in lifts not exceeding 500 mm, with the vibrator inserted into each lift at intervals not exceeding 500 mm in any direction. Vibrators should be placed in the concrete rapidly to penetrate approximately 75 mm of the previous layer, and withdrawn slowly. This will minimize the occurrence of air being entrapped between the concrete and the form, and it will blend the two layers. Insufficient vibration rather than over-vibration more often than not causes problems. The forms should therefore be designed to withstand longer periods of high-frequency vibration.

Vibrators should not be used any closer than 75 mm from the formed surface which is to be exposed. Within this limit the coarse aggregate will be driven away from the form face and will cause a mortar line on the visible surface. A small-diameter vibrator should be used in thin sections.

(d) Curing of concrete

The concrete shall be cured by established standard procedures.

(e) Exposing of aggregate

The use of surface retarders is not recommended for vertical casting. It is difficult to obtain an even effect. Deep elements cast vertically require particular care to prevent over-retarded areas from forming at the bottom and under-retarded areas at the top. The concrete can brush against the formwork during placing and carry the retarder with it to the bottom. One solution is to place plastic sheeting over the form and withdraw it as the level of the concrete rises. Also, the bleed water may carry the retarder to the top or in small channels along the surface.

If forms are exposed to sunlight too long before placing, retarder action may be nullified and large under-retarded areas may result. The same could happen if rain falls on forms treated with a retarder prior to the concrete being placed.

The retarder should be dry before the concrete is placed.

The simplest and perhaps the most inexpensive way of exposing aggregates is by washing and brushing the surface. If the operation is done before the concrete has gained much strength, it will not be necessary to use a surface retarder. A stiff brush together with flushing with water is all that is needed.

Plastic-bristle brushes are preferred because they will not soften in water. Wire brushes may be required occasionally for particularly stubborn areas.

(f) Patching of damaged surfaces

It is easier to patch exposed aggregate than plain smooth concrete elements. First, the damaged area should be chipped out and cut back to a depth slightly deeper than the maximum size of the exposed aggregate (i.e. go down 25 mm for 20 mm aggregate).

The sides of the hole should be at right angles to the surface. No undercutting is necessary. Then the area must be thoroughly soaked with water to ensure a good bond of the patch. The use of a scrubbing brush with this operation is good practice. (If a bonding agent is used, the area must be left dry.)

After the patching area is well soaked without any free water being present, a mixture of cement and water the consistency of a thick paint must be brushed in. The damaged area now is ready to receive the patching mix must be brushed.

The patching concrete must contain the same materials as those used in the concrete, minus the coarse aggregates. If the matrix was made with grey cement, a small amount of white cement or silica flour must normally be added to the patching mix because the lower water-cement ratio of the patch causes it to dry darker than the original concrete. The amount of white material to be added varies, but about 25% is average.

Trial mixes are essential for determining exact quantities. These mixes should be allowed to age for 7 to 14 days before final judgement. Small sample panels (300 mm square) should be cast during production and later broken for use as guides in matching mix colour. The patching mix must be stiff, but not so stiff that the exposed aggregates cannot be pressed into it.

The patching mix should be compacted into the hole immediately after the neat cement slurry coat has been applied, or if a bonding agent is used, any time during the agent's period of tackiness. The mix should be vigorously hand-tamped, then struck off level with the surrounding matrix.

(g) Cleaning of surface

Exposed aggregates can be cleaned after at least one week's delay by being washed with a 5% to 10% concentration of hydrochloric acid, which removes the dull cement film which has remained as a result of some exposure techniques, especially the washing and brushing. The acid is normally applied to a pre-wetted surface by brush, but it can also be sprayed.

The surface is wetted to reduce acid penetration. All traces of acid should be removed, as soon as possible before the panel dries, by flushing with plenty of clean water. The best procedure is to use two men, one applying acid while the other hoses down the surface.

6. TRIAL SURFACES

The contractor shall construct trial structures such as columns and beams with smooth surfaces and walls with exposed-aggregate surfaces to serve as samples for subsequent work.

Such trial structures and their surfaces shall be approved by the Engineer before any permanent structures may be constructed.

The number and size of each type of structure will be specified in the bill of quantities.

LE06 SPECIFICATION FOR CONCRETE SCREED

1. PREPARATION OF EXISTING SLAB

All laitance on the surface of the slab must be removed completely. Mechanized plant such as scabblers or abrasive blasters must be used.

After the mechanical cleaning of the slab surface to expose the coarse aggregate, all dust and debris must be removed, and the surface must be thoroughly wetted and kept wet for at least 12 hours before application of the screed.

2. CONCRETE SCREED

Only CEM I 42,5 (Portland cement) or CEM II/A-V 42,5 (Portland fly ash cement) or CEM II/A-S 42,5 (Portland slag cement) or CEM II/B-S 42,5 (Portland slag cement) according to SANS 50197-1 (EN 197-1), may be used. The cement may not consist of more than 20% siliceous fly ash or 30% granulated blast furnace slag, blended with the OPC (Ordinary Portland Cement).

Coarse aggregate maximum size : 10 mm
28-day cube strength : 35 MPa.

The use of an approved plasticizer is recommended to reduce the water content of the mix to the absolute workable minimum.

The mix design must be submitted to the Engineer for approval.

3. APPLICATION OF CONCRETE SCREED

Remove all surface water from the slab. Apply a grout to the slab surface which consists of a 1:1 mix of cement and clean fine sand with just enough water to provide the consistency of a slurry.

This grout is to be vigorously brushed into the scabbled surface with brooms. On completion of this operation, the surplus grout must be brushed off to leave only a thin coating.

The screed must be placed while the grout is still visibly wet.

The screed must be laid and compacted in one layer. Care must be taken to obtain the maximum compaction of the concrete screed.

4. FINISHING WITH MECHANICAL TROWEL

Power floating should not commence until such time as the concrete surface has lost its sheen and barely shows footprints.

All laitance on the surface of the fresh concrete screed resulting from the compaction of concrete must be struck off prior to mechanical trowelling.

Over-trowelling, causing an excessive cement-water paste to come to the surface, must be strictly avoided.

5. CURING

Curing should commence as soon as finishing operations have been completed and should be continued for at least 7 days. The method of curing must be approved by the Engineer.

6. JOINTS

The concrete screed should be divided into panels by joints approximately 3 m apart. The length–width ratio of the panels should be limited to 1,5:1.

The joints should be formed by cutting grooves 3 mm wide by 25 mm deep into the screed. These joints must be aligned to the joints in the structural slabs or the slabs on fill, and must be cut within 8 hours of placing the screed.

LE08 SPECIFICATION FOR GROUND AND ROCK ANCHORS AS TEMPORARY LATERAL SUPPORT

CONTENTS

1 SCOPE

2 GENERAL

3 EXCAVATIONS

4 INSTALLATIONS OF GROUND AND ROCK ANCHORS

5 CHECKING AND CONTROL

1. SCOPE

This specification covers the work in connection with the installation of ground and rock anchors as well as anchoring by means of dowels or rock bolts where anchors are not used.

2. GENERAL

(a) Method statement

All tenderers shall submit a provisional method statement as part of their tender. Once the tender has been awarded, the successful tenderer shall submit his final method statement to the Engineer for approval within one week of having received notification to proceed with the work. Until the method statement has been approved, the contractor shall not make any excavations deeper than three metres or within four metres of any boundary. Such excavations shall have sloping sides.

The contractor's final method statement shall contain the following information:

(i) A schedule of the equipment to be used for excavations, drilling, the making and pumping of grout, stressing equipment, the testing of cables and the removal of anchor heads, as well as the method of carrying out certain work, e.g. whether boreholes will be cleaned out by using air, water or foam, etc.

(ii) A list of the key personnel, in particular those with the necessary knowledge of stressing and testing operations.

(iii) A full description of the manner in which he intends placing the soldiers (rolled steel joists) accurately in position in the augured holes or holes drilled by means of pneumatic equipment, and the manner in which the position will be maintained during the casting of concrete.

(iv) A complete programme indicating at least the following activities:

Excavation, drilling, and the homing of anchors, grouting and the installation of soldiers, stressing, and the reinjection of grout, the 24-hour test, the installation of planks, guniting, 7-day test, 28-day test, further tests, and the destressing of anchors. The programme shall be such that it can be used for checking daily progress.

(v) Full information regarding the type of cable envisaged, with special reference to the guaranteed breaking strength and the cable supplier's requirements regarding the permissible percentage of breaking strength, which shall not be exceeded. Should the supplier have no recommendation in this connection, the stress caused by 110% of the prescribed cable working load shall not exceed the following:

(A) For prestressing wire, 70% of the tensile strength of steel.

(B) For steel bars, 67% of the maximum stress or 80% of 0,2% proof stress. A force/extension curve for the particular type of cable shall be attached. Based on the aforesaid permissible stresses, the contractor shall indicate the number of cables he intends using for each anchor.

(vi) A description of the anchorage system, with special reference to the stressing, anchor head, bearing plate, spacers, protection of the cables in the bond-free area, and the pressure-grouting system.

(vii) The design of the anchor length shall be indicated, but shall not be less than 6 m or 3 m for ground anchors and rock anchors respectively, or as shown on the drawings.

Test anchors are not prescribed but, should the contractor require test anchors to verify his anchor length, he shall install such anchors at his own cost. Such test anchors shall be able to withstand a force of twice the prescribed working load.

(viii) The testing procedure for determining the residual anchor force as well as checking at various times after lock-off, and the method of correction, shall be described by the contractor, but the following shall apply as minimum requirement:

(A) The anchor will be accepted if the residual anchor force is greater than 1,05 times the prescribed working load.

(B) If the residual anchor force is less than 1,05 times the prescribed working load but greater than 0,8 times the prescribed working load, the anchor shall be restressed to 1,1 times the prescribed working load.

(C) If the residual anchor force is less than 0,8 times the prescribed working load, the anchor will be regarded as an anchor which is able to withstand a working load equal to the residual anchor force, divided by 1,1.

(D) If the residual anchor force decreases a second time to a value of smaller than 1,05 times the prescribed working load, such anchor shall also be treated as described in the preceding paragraph.

(E) After an anchor has been stressed and locked off, it shall be tested to determine its residual force. This test shall be conducted after 24 hours but within 48 hours of lock-off. If this test is successful, a second test shall be conducted seven days later. If the second test is successful, a third test shall be conducted 28 days later. If the third test is successful, monthly tests shall be conducted for six months after lock-off. After one year, further tests shall be conducted at the Engineer's request.

(F) Should an anchor fail any of these tests, the process for that particular anchor shall be repeated from the beginning.

(G) The first two tests shall be conducted for all anchors, but if the anchors pass the second test, the following shall apply for further tests:

Number of anchors in the same formation (e.g. rock, weathered rock, clay, sandy soil)	Percentage to be tested
The first 50	10%
the next 50	7%
all further anchors	5%.

(ix) A description of the method for destressing anchors, after the permanent structure has been built, shall be provided.

(x) Examples of the manner in which drilling conditions, grouting, stressing, pressure grouting, testing and movement at the anchor head will be recorded.

(b) Protecting the corner pegs of the property

All corner pegs of the property will be pointed out to the contractor during the handing-over of the site. For the full duration of the contract the contractor shall, at his own cost, be responsible for the protection of these pegs or for the replacement thereof by a registered land surveyor should the pegs be disturbed.

3. EXCAVATIONS

(a) Bulk excavations

No excavation work may commence until all the survey pegs have been placed and all the indemnity certificates have been received from the owners of adjacent properties.

Bulk excavation may be undertaken in the centre part of the site, and the manner for making the excavation will not be prescribed to the contractor. The position of access ramps during excavation shall be submitted to the Engineer for approval. These accesses shall be such that minimum disruption will be caused to normal vehicle and pedestrian traffic.

Where pneumatically drilled or augered holes are required for the installation of soldiers along the perimeter of the site, the position of the holes shall be accurately determined before drilling commences. Should the Engineer wish to monitor the inflow of ground water into the drilled holes, the contractor shall ensure that the Engineer has undisturbed access to the holes for a maximum of 3 days. Thereafter the contractor shall install the steel soldiers in position in the holes and concrete them in position.

Three days after having concreted the soldiers in position, the contractor may commence excavation to the levels given on the drawings and over a sufficient length of face to enable him to complete all anchoring within 10 days of commencing the excavation at a specific anchor position. The excavation shall be done rapidly and shall not exceed the levels indicated on the drawings until the listed anchor forces have been obtained.

(b) Finishing the faces

The final finishing of the faces shall be done by hand. The boundary shall not be encroached on, and the finishing shall be such that the soldiers and shoring can bed directly against the excavation.

(c) Backfilling of over-excavation

The local collapsing of material, or blocks of material which break loose will also be regarded as over-excavation. Over-excavation shall be backfilled with material acceptable to the owner of the property on which the over-excavation has occurred. If the support of a soldier has been disturbed or removed by the excavation, a new bedding surface of class 25 MPa / 19 mm concrete shall be placed.

(d) Shoring in the case of collapse

At all times during excavation the contractor shall have sufficient emergency struts and bracing on the site to be able to support a width of 10 m without anchors. Before excavation for the second row of anchors commences, the contractor shall submit to the Engineer the design of the manner in which emergency supports shall be formed and installed. He shall provide proof that the material is on the site, and he may use the soldiers which have not as yet been installed. It shall be possible to place the emergency supports in position within 4 hours of instructions in this regard having been issued by the Engineer.

(e) Protection of services

The contractor shall at all times protect existing municipal and other services, and, should services be damaged, such services shall be repaired immediately to the satisfaction of the authority concerned and in a way as will not unnecessarily impair the excavations and anchorage systems. Only the approximate positions of services are known, and the

contractor shall make the necessary additional surveys to determine their exact positions before any anchors are installed.

Should any of the anchors shown on the drawings coincide with the positions of services as determined on the site, the contractor shall inform the Engineer thereof without delay so that revised anchor positions may be determined for such anchors.

A set of drawings showing all the existing services on the site, on the adjacent properties, in municipal servitudes and in the adjacent street reserves up to a distance of 15 m behind the excavation face or twice the excavation depth, whichever is greater, shall be obtained from the municipal and other authorities and shall be kept on the site at all times.

(f) Dealing with ground water (temporary dewatering)

The contractor shall proceed with temporary dewatering as soon as may be practicable.

The method of dewatering shall be submitted to the Engineer for approval. The Engineer may amend certain aspects of the proposed method to ensure that the temporary dewatering method is compatible with the permanent system which has been designed for dealing with ground water.

(g) Supervision of premises

For the full duration of the contract, the contractor shall place a competent guard on the site when the supervising staff are absent. It shall be possible for this guard to contact the Engineer and the contractor immediately by telephone or mobile phone in order to report any threatening collapse or abnormal occurrences. This arrangement applies specifically to nights, weekends and holiday periods and shall be in operation when excavation work commences.

(h) Requirements of the authorities

All the requirements of the authorities shall be strictly complied with, and access to the site may not be refused to the officials of such authorities.

4. INSTALLATION OF GROUND AND ROCK ANCHORS

(a) Drilling

The diameters of the holes to be drilled for the anchors shall be at least 12 mm larger than the maximum cross-sectional dimension of the assembled anchor. The holes shall be drilled at least 0,5 m deeper than is needed for the anchor length.

Drilling and pneumatic equipment shall not have a noise level of higher than 75 dBA measured at 15,0 m from the equipment.

The position of a borehole shall not deviate by more than 50 mm from its position on the wall surface as indicated on the drawing. The direction of the borehole shall not deviate by more than 1,0 m in 30,0 m from the direction as indicated on the drawings. No drilling operations shall be carried out closer than 1,0 m from a service.

(b) Grouting the holes

The grouting equipment shall be such that grout can be delivered at a pressure of up to and including 20 bar (2 000 kPa). The pump shall be equipped with a pressure gauge registering in kPa or bar. The distance from the pump to the hole to be grouted shall not exceed 150,0 m.

The design of the grout used for the grouting of holes shall be such that a compressive strength of 30 MPa will be attained at 28 days, and the water - cement ratio shall be between 0,4 and 0,45. The water - cement ratio of the grout pumped in later under pressure may be higher than 0,5. Ordinary Portland cement or rapid-hardening cement may be used. Any plasticizer added shall improve the quality of the grout and shall first be approved by the

Engineer. Grouting shall be done in the anchorage zone only but, should the hole be fully grouted, all testing results shall be adjusted accordingly.

Should grouting techniques or grouting requirements not be covered elsewhere in this document, the procedure as defined in the Manual of Grouting Techniques for Anchor Tendons, fourth edition, 1981, prepared by the Water Resources Commission, New South Wales, Australia, shall apply.

(c) Homing the anchor

After the anchor has been installed in the hole, grouting shall be done from the bottom of the hole upwards but only up to the boundary of the free-length zone as indicated on the drawings. If, however, the hole has been filled with grout, the anchor shall be driven in by moving it to and fro very slowly and pushing it deeper and deeper into the hole until the anchor has reached the specified depth.

(d) Soldiers

Soldiers in pneumatically drilled or augered holes and those placed directly against the excavation face shall be positioned to the tolerances prescribed for concrete work as they will form part of the permanent structure. If not specified on the drawings, the tolerances shall conform to degree of accuracy II as described in SANS 2001 Part CC1, Table 11 in the section “Foundations: mass and reinforced concrete”.

Soldiers placed in pre-drilled holes shall be concreted in position by filling the hole with class 15 MPa / 19 mm concrete, unless otherwise specified on the drawings. After excavation, the concrete which is not required shall be removed as indicated on the drawings.

If the rolled-steel joist has not been accurately positioned, the contractor shall correct its position at his own expense.

Soldiers placed directly against the excavation face shall be bedded properly so that the soldier will bear evenly. Cement mortar shall be used to fill gaps between the soldiers and the excavation face at least 12 hours prior to stressing.

Where soldiers bear against a base or wall, the soldier shall be bedded against the base or wall over the entire common length. The anchor cables shall be pulled through the beam or between the elements of the beam and through a hole in the bearing plate, after which the anchor head can be fitted.

The sheathing around the anchor cables shall be cut off at least 200 mm below the bearing plate.

(e) Provisional stressing of anchors

The anchors may be stressed provisionally 24 hours after the anchor has been homed, provided that the grout has attained the required compressive strength. If the anchor can withstand half the required load, no further grouting will be needed. After another 48 hours the anchor may be stressed to the full required load. When the anchor has been stressed to the full required load, normal testing and control of the anchor may commence.

(f) Reinjection of grout

If the anchorage force has not been obtained, reinjection of grout may take place. If the forming of bulbs takes place in an uncontrolled manner, reinjection must first be done at a low pressure and be maintained until no further grout is absorbed.

After another 3 days the anchor may be tested, and if the required load has been attained, normal testing and control of the anchor may commence. Should the anchor begin to slip again, the above procedure may be repeated once more. Should it again be unsuccessful, the anchor force at which creep over 24 hours does not exceed 0,055% of the free length

shall be regarded as 150% of a newly defined working load, and the normal procedure may be followed with a load of 125% of this working load.

(g) Stressing of cables

The stressing of cables in the ground anchor is controlled by means of measuring the force applied by the stressing jack and the extension of cable. The contractor shall provide all stressing jacks and associated equipment and shall maintain them in a good working order. All pressure gauges shall be calibrated before the stressing work commences. The calibration curves shall be submitted for approval. The contractor shall ensure that his stressing jacks can apply the required stressing force within an accuracy of 5%. It shall be possible to measure all extensions accurately to within 0,5 mm with the approved measuring system.

The cables shall be stressed to 125% of the working load, and the force shall be applied in not less than five equal increments, the extension being recorded at each pressure increment. This force shall be maintained for 10 minutes, and after this time the extension shall again be recorded. Should the creep be in excess of 0,055% of the anchor free length, the force shall be reduced to a value at which the creep will be within the permissible value. This force will then be regarded as 125% of a new working load for this specific anchor.

The anchors tested successfully at 125% of a working load shall be locked off with a force equal to 110% of the working load. Should it be required by the contractor, he may first stress and release the cable several times to ensure bedding. The maximum force which may be applied repeatedly shall not exceed 110% of the working load. The force may be increased only once to 125% of the working load for testing the creep.

If two out of the first three anchors stressed to 125% of the required working load slip too much and have to be stressed to a lower force, the contractor shall submit a new design and, before proceeding, he shall at his own cost prove his design with a test anchor, which shall be stressed to 200% and shall be capable of retaining the force for a period of four hours while creep is recorded. Should the creep exceed 25 mm over these four hours, the anchor will be regarded as having collapsed, and the design will not be accepted. Only after a submitted design has been proven and has been accepted by the Engineer, the Contractor may proceed.

Any rejected anchor shall be replaced at the contractor's cost. If the number of anchors cannot provide the total force, additional anchors shall be provided at the contractor's cost. Should it be not possible to attain the anchor force with less than 10 m of the total anchor length, the Engineer will increase the number of anchors with a lower working load, and the Contractor will be compensated for the installation of the amended anchors.

(h) Locking off the cables

As soon as an anchor force equal to 125% of the working load is attained, the cables shall be locked off at a force of 110% of the working load. Loss during lock-off shall be monitored by measuring the deflection at which a residual force of 40 kN still registers on the stressing-jack reading. The lock-off loss is determined with this value. The exact value can be confirmed by a hydraulic precision load cell being used or by the lift-off force being determined with the aid of the stressing jack.

(i) Planks

Planking shall be provided between the soldiers where there is a possibility of local collapse. The extent of the excavation where planking is required will be decided by the Engineer on the site. The size of the planks shall be as indicated on the drawings.

(j) Gunite

Should the Engineer require that certain open parts be protected against corrosion or desiccation, the contractor shall treat such surfaces with gunite. The gunite shall be at least 50 mm thick and a single layer of Ref No 311 mesh shall be used. The mesh shall be continuous between soldiers with a minimum lap length of 300 mm. The mesh shall be

welded to the soldiers against which the gunite butts. The gunite mixture shall have a minimum cement -aggregate ratio of 1:3, by bulk volume. The mixture of the gunite and the details of the guniting process shall be submitted by the contractor for approval.

(k) Rock reinforcement

Where a rock face is exposed, the Engineer may decide to replace ground anchors with rock bolts or dowels.

(A) Dowels

Dowels shall consist of 1,5 m and 3,0 m long, 25 mm diameter Dywidag Gewi bars of 500/550 grade steel or approved equivalent bars. The dowels shall be threaded for a minimum length of 200 mm and shall be fitted with an anchor plate, a spherical seat and a washer secured by a hexagonal nut.

The dowels shall be inserted into holes drilled in the rock. The holes shall have a minimum diameter of 36 mm and shall be not more than 100 mm longer than the installed length of the dowel.

The dowels shall be securely anchored in the holes with cement grout or an approved resin bonding agent. The grout or resin shall fill the hole completely. When the grout or resin is capable of withstanding the required tension, the nuts shall be tightened to exert a load of 50 kN.

The contractor shall proceed with the installation of the dowels as soon as may be practicable after instructions to proceed have been issued by the Engineer. The contractor may have to install the dowels as the excavation proceeds.

(B) Rock bolts

Rock bolts shall consist of 2,0 m, 3,0 m and 4,0 m long, 25 mm diameter Dywidag Gewi bars of 500/550 grade steel, or 5,0 m, 6,0 m and 7,0 m long, 26,5 mm diameter Dywidag Thread bars of 900/1100 grade steel, or approved equivalent bars. The rock bolts shall be threaded for a minimum length of 500 mm and shall be fitted with an anchor plate, a spherical seat and a washer secured by a hexagonal nut.

The rock bolts shall be inserted into holes drilled in the rock. The holes shall have a minimum diameter of 36 mm and shall be not more than 100 mm longer than the installed length of the rock bolt.

The rock bolts shall be given full permanent corrosion protection and shall be securely anchored in the holes with cement grout or an approved fast or slow-setting-resin bonding agent. When the grout or resin is capable of withstanding the load specified by the Engineer, the rock bolt shall be tensioned to that load.

5. CHECKING AND CONTROL

(a) Monitoring earth movement

A sufficient number of fixed bench marks, tied in with the survey system of the local authority, shall be installed by the contractor. These bench marks, which shall be placed at a safe distance from the proposed excavation, shall be used for interim level control during excavations. Should any one of these pegs be disturbed, it shall be replaced immediately with another peg.

All the points to be controlled are indicated on the drawings and shall be protected at all times during the contract. If such a peg is disturbed, it shall be reinstated at the contractor's cost.

These points shall be controlled in regard to height and/or position as determined on the drawings. All survey pegs shall be at least 600 mm long and 20 mm in diameter and shall be placed firmly or be cast in concrete.

If for some reason a peg cannot be placed in the required position, the contractor shall propose an alternative method. The contractor shall take the positions of pegs into consideration when placing his offices and equipment.

All surveying shall be made to an accuracy of 1 mm. Pegs shall be in position before excavation commences.

Readings shall be taken twice weekly for so long as excavations are in progress. As soon as there is no change in three consecutive readings taken for a specific point, the readings may be reduced to once per week. As soon as the readings taken once per week do not change for three consecutive weeks, readings may be reduced to once every two weeks.

If movement occurs, the rate of taking readings shall be increased to the previous rate, and if further movement occurs, the rate shall be increased to twice every week, and thereafter, at the Engineer's discretion, it may be increased to five times a week. Readings shall continue until the temporary lateral support is no longer required. If three consecutive readings differ two millimetres or less from each other, it will be regarded as "no change".

During the entire construction period, adjacent buildings and ground or road surfaces shall be inspected daily. Any new cracks or other indications of movement shall be recorded, with dates. This information shall be kept on the site for inspection by the Engineer.

During each survey the depth to which the vertical side of the excavation has been excavated and the depth of the anchors which have already been stressed shall be recorded.

All surveys shall be reduced, evaluated and submitted to the Engineer within 24 hours.

(b) Recording the anchor information

All anchors shall be numbered numerically in a horizontal direction. Additional vertical anchors shall bear a sub-number (e.g. anchor 67/1C placed next to 67C), and an additional horizontal anchor shall receive a double alphabetical number referring to the anchor (e.g. 67CC placed directly below anchor 67C).

The following information shall be recorded:

(i) Hole number

(ii) Date of excavation (ready for drilling)

(iii) Date of drilling

(iv) Depth of borehole

(v) Nature of the formation (soft, hard, rock, clay, etc)

(vi) Ground water found

(vii) Weather conditions

(viii) Date of grouting the hole

(ix) Quantity of cement and water - cement ratio

(x) Type of cables

(xi) Length of cables

(xii) Free length

(xiii) Anchor length

(xiv) Dates of any reinjections

(xv) Quantity of cement and water - cement ratio for every reinjection

(xvi) Pressure at which grouting was done

(xvii) Date of stressing of anchor (separately for the various attempts)

(xviii) 125% of working load (design working load)

(xix) Stressing force attained

(xx) Stressing force obtained as percentage of working load

(xxi) Lock-off force as percentage of working load

(xxii) Working load the locking force of which is 110% (working load achieved)

(xxiii) Date and/or time of each test load

(xxiv) Residual anchor force at each test

(xxv) Date of any restressing or insertion of shims (giving the shim size)

(xxvi) % relaxation at every test

(xxvii) % working load at every test of the residual anchor force

For the original stressing of the anchor cables the theoretical extension at 125% of the working load shall be given, as well as the permissible slip during application of the load of 125% of the working load to the anchor for 10 minutes. If a reading is taken of the stressing-jack pressure, the jack-ram area shall also be given. The calculation curve for checking the force against the extension in order to determine the lock-off force theoretically, shall be submitted for each anchor.

Any deflection of the bearing plate as well as of the soldier shall be recorded. The contractor's attention is drawn to the fact that all installation, testing and destressing of anchors shall be executed in accordance with the requirements of the appropriate laws and regulations.

(c) Destressing the anchors

As soon as the permanent support of the sides of the excavation has been completed, the anchor cables shall be destressed. The construction of the permanent support shall allow easy access should cables require to be cut off.

LE10 SPECIFICATION FOR CONCRETE FOR AQUEOUS LIQUID-RETAINING STRUCTURES

The South African National Standard for Construction Works (published by the South African Bureau of Standards) shall apply throughout in respect of this contract, in addition to the additions and saving the exceptions set out below.

A copy of this specification shall be furnished by the contractor and shall be kept on the site.

PROJECT SPECIFICATION

1. APPLICATION AND PARTICULAR SPECIFICATION:

1.1 LE01: Specification for Plain and Reinforced Concrete

2. THE FOLLOWING SUBCLAUSES OF SANS 2001 PART CC1 ARE AMENDED AS FOLLOWS:

2.1 Add the following to subclause 4.3.3.1 :

"Shutter ferrules and ties shall be of the cast-in type, rust resistant, specifically designed for watertightness without forming a hole through the element with some form of positive anchorage to prevent any rotation when loosening formwork, and approved by the Engineer."

2.2 Add the following to subclause 4.7.1.2:

"The minimum cement content shall be 325 kg/m^3. The maximum water - cement ratio shall be 0,55 for ordinary Portland cement (OPC), CEM 1 42,5 according to SANS 50197-1, and 0,50 for ordinary Portland cement blended with Siliceous Fly Ash (VA) when allowed."

"The cement content shall not exceed 400 kg/m^3 OPC in reinforced concrete or 500 kg/m^3 OPC in prestressed concrete, or 450 kg/m^3 OPC blended with VA in reinforced concrete or 550 kg/m^3 OPC blended with VA in prestressed concrete."

2.3 The following requirements amplify those in Subclause 5.1.6 :

"Water for testing shall be provided by the Contractor and he shall be responsible for providing all necessary equipment that may be required for filling the structures.

For testing liquid retention, the structure shall be cleaned and initially filled to the normal maximum level with the specified liquid (usually water) at a uniform rate not exceeding 2 m in 24h.

When first filled, the liquid level shall be maintained by the addition of further liquid for a stabilizing period while absorption and autogenous healing take place. The stabilizing period may be 7 days for a maximum design-crack width of 0,1 mm or 21 days for 0,2 mm or greater.

After the stabilizing period, the level of the liquid surface shall be recorded at 24 h intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation and rainfall, shall not exceed 1/500th of the average water depth of the full tank, or 10 mm, or another specified amount.

The evaporation shall be measured by the mean drop in level caused by the evaporation of the water in three flat containers floating in the water being recorded.

Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid to the outside faces of the liquid-retaining walls shall be assessed against the requirements of the specification. Any necessary remedial treatment of the concrete, cracks, or joints shall, where practicable, be carried out from the liquid face. When a remedial lining is applied to inhibit leakage at a crack, it shall have adequate flexibility and shall not have any reaction with the stored liquid.

Should the structure not satisfy the 7-day test, then, after the completion of the remedial work, it shall be refilled and if necessary, left for a further stabilizing period; a further test of 7 days' duration shall then be undertaken in accordance with this clause.

The roofs of liquid-retaining structures shall be watertight and shall, where practicable be tested on completion by the roof being flooded with water to a minimum depth of 25 mm for 24 h or longer if so specified. Where it is impracticable, because of roof falls or otherwise, to contain a 25 mm depth of water, the roof shall have water applied by a continuous hose or sprinkler system to provide a sheet flow of water over the entire area of the roof for not less than 6 h. In either case the roof shall be considered satisfactory if not leaks or damp patches show on the soffit. Should the roof structure not satisfy either of these tests, then, after the completion of the remedial work, it shall be retested in accordance with this clause. The roof insulation and covering shall be completed as soon as possible after satisfactory testing."

LE11 SPECIFICATION FOR STRUCTURAL CONCRETE - MINOR WORKS

1. SCOPE

This specification covers the requirements for structural concrete work (plain and reinforced) in minor civil engineering and building construction.

2. DEFINITIONS

2.1 Normal weather

Ambient temperature between 15°C and 32°C

2.2 Cold weather

Ambient temperature less than 15°C

2.3 Concrete cover

Thickness of concrete between the outside of any reinforcing steel and the face of the concrete, as cast

2.4 Smooth formwork

Formwork that leaves the concrete surface perfectly smooth when removed and where no other finish is to be applied

3. MATERIALS

3.1 All cement shall be complying with SANS 50197-1 (EN 197-1).

3.2 Cement stored on site shall be kept under cover that provides proper protection against moisture and shall not be stored for more than 8 weeks.

3.3 Fine aggregate (sand) shall comply with SANS 1083 and shall be free from dust, soft particles, clay, loam, animal or vegetable matter or other deleterious impurities.

3.4 Coarse aggregate (stone) shall comply with SANS 1083 and shall not contain flat spalls, elongated pieces or deleterious impurities. The maximum aggregate size is 19 mm.

3.5 Water shall be clean, fresh, free from injurious amounts of acids, alkalies, organic matter and other impurities.

3.6 No admixtures shall be used without the written approval of the Engineer.

3.7 Reinforcing bars shall comply with SANS 920 and welded steel fabric with SANS 1024.

4. SUPERVISION

It is essential that the foreman in charge of all concrete work shall be skilled, shall supervise the whole construction and shall pay special attention to:

- quality, testing and mixing of materials and the proper proportioning of water in the mix
- placing, vibration and curing of concrete
- construction and removal of shuttering
- sizes, positions and fixing of steel reinforcement.

5. FORMWORK

All formwork shall be designed and constructed so that the concrete may be properly placed and compacted, maintaining the required shapes and tolerances. All joints shall be sufficiently tight to prevent leakage of the liquid matrix.

The supporting struts or props shall be provided with adequate sole or bearing plates and shall have suitable jacks to allow for the adjustment of levels. Unless otherwise specified, all beams and slabs shall have a camber of 2 mm per metre length and all cantilever beams and slabs, 4 mm per metre length.

The formwork shall be constructed in such a manner that it may readily be stripped without jarring or damaging the concrete.

Formwork shall be thoroughly cleaned prior to placing concrete and shall be treated with an appropriate release agent.

Formwork shall not be removed before the concrete has sufficient strength to support its own weight and any loads imposed on it. Formwork shall remain in place at least for the appropriate minimum period indicated in Table 1.

TABLE 1: REMOVAL OF FORMWORK - MINIMUM TIME IN DAYS

ITEM	NORMAL WEATHER	COLD WEATHER
Beam sides, walls and unloaded columns	2	4
Slabs with props left underneath	4	7
Beam soffits and ribbed slabs with props left underneath	7	12
Props under slabs	10	17
Props under beams	14	28

6. REINFORCING

Reinforcing bars shall be bent cold to the dimensions shown on the drawing. At the time of the placing of the concrete the bars shall be free from loose rust, scale, oil, etc.

Reinforcing bars shall be securely bound at all laps and at intersections with 1,25 mm annealed iron wire and all stirrups shall be securely fastened to the main rods. No welding of reinforcing is permitted.

The concrete covering of the main reinforcing bars shall be as stated in Table 2. The cover shall be provided by using an adequate number of purpose-made plastic spacer blocks of adequate strength. The spacer blocks shall be placed while the reinforcement is being fastened.

TABLE 2: MINIMUM CONCRETE COVER

POSITION	COVER IN mm
Soffits of slabs	25 or equal to diameter of reinforcing, whichever is the greatest
Soffits of beams	30
Ends of beams	40
Sides of beams	25
Sides of columns	40
Foundations	50 or 75 if cast directly against excavation

7. TOLERANCES

The contractor shall construct each of the various parts of the works within the limits of the permissible deviations set out in Table 3.

TABLE 3: PERMISSIBLE DEVIATIONS FROM TRUE POSITION, SIZE OR LEVEL

ITEM	PERMISSIBLE TOLERANCE IN mm
Reinforcement	
- Spacing between bars	± 20
- Cover of reinforcement	+ 20 - 0
- Longitudinal location	± 30
Formwork shall be constructed to ensure that the position of the finished work will be as specified below:	
Foundations	
- Position	± 40
- Dimensions on plan	± 30
- Level	- 20 + 10
Elements above ground	
- Position on plan of any edge or surface	± 20
- Linear dimensions	± 20
- Level	± 10
- Verticality	5 mm per metre of height with a maximum of 30 mm

Each specified permissible deviation is binding by itself. No cumulative effect of permissible deviations will be considered.

8. CONCRETE

8.1 MIX DESIGN/CONCRETE STRENGTH

Unless otherwise specified, the mixtures and compressive strengths shall be as shown in Table 4.

TABLE 4: CONCRETE MIXES

CLASS	NOMINAL* PORTIONS	WATER/CEMENT RATIO	MINIMUM 7-DAY STRENGTH MPa	MINIMUM 28-DAY STRENGTH MPa
30	1.1½.3	0,41	20	30
25	1.2.4	0,45	15	25
15	1.3.5	0,60	10	15

* Volume of cement/sand/stone

As an alternative, 30, 25 or 15 MPa concrete from a central concrete production site may be used. SANS 878 shall apply in that case.

8.2 MIXING AND PLACING

The concrete shall be mixed for at least 1½ minutes after the mixing water has been added, in an approved mechanical batch mixer equipped with an automatic water measuring device.

The concrete shall be conveyed from the mixer to the final location as rapidly as possible by methods which prevent the separation or loss of materials. Not more than 30 minutes shall elapse between the mixing and final placing of the concrete.

The concrete shall be fully compacted by mechanical vibration. It shall be thoroughly worked against the formwork and around the reinforcement and other embedded items.

No concreting shall be carried out when the air temperature is below 5°C. Concrete shall not be exposed to temperatures below 2°C for a period of 5 days after placing.

8.3 TESTING

The slump of the concrete, measured by using a standard slump cone according to SANS 5862-1, shall not be more than 80 mm and shall not be less than 30 mm.

Two sets of three 150 mm concrete cubes shall be taken from each day's casting of each type of concrete. If more than 40 m^3 of a concrete type is cast per day, two sets of three 150 mm concrete cubes shall be taken for every 40 m^3 of cast concrete. One full set of three cubes shall be tested by an approved laboratory after 7 days and the other after 28 days.

8.4 CURING

The exposed top surface of the concrete as well as other surfaces exposed after removal of the shuttering shall be protected, as soon as practically possible, from contamination and loss of moisture. One of the following methods shall be used:

- Ponding of water on the exposed surfaces
- Covering of the concrete with sand that is kept moist
- Covering of the concrete with plastic sheeting secured in place.

The curing shall be maintained for 5 days in normal weather and for 8 days in cold weather.

9. INSPECTIONS

The Engineer shall be called to inspect the following:

- All foundation excavations prior to casting the blinding
- All reinforcing steel fixed in place.

No concrete shall be placed without the written approval of the Engineer.

The Engineer shall be given a minimum of 24 hours' notice of all inspections.

10. DEFECTS

If the concrete shows any defect after removal of the forms, the Engineer shall be informed immediately. The contractor shall not carry out remedial work or patching until authorized to do so by the Engineer.

11. RECORDS

The contractor shall maintain written records on the site to provide the following information:

- The date and time of the casting of each element of the works
- Details of cubes and other samples taken, related to the different elements of the structure as well as the laboratory results.

12. GENERAL

The applicable SANS 2001 Part CC1 shall apply in case of a dispute and/or in cases not detailed above.

LE13 SPECIFICATION FOR CONCRETE SURFACE BEDS

The South African National Standard for Construction Works (published by the South African Bureau of Standards) shall apply throughout in respect of this contract, in addition to the additions and saving the exceptions set out below:

A copy of the said specification shall be furnished by the contractor and shall be kept on the site.

PROJECT SPECIFICATION FOR CONCRETE SURFACE BEDS

1. List of applicable and particular specifications:

1.1 SANS 2001 Part CC1: CONCRETE WORKS (STRUCTURAL)

1.2 Particular Specification no LE01: Specification for Plain and Reinforced concrete

1.3 Particular Specification no LE05: Specification for Smooth Surface and exposed-aggregate surface finishes

1.4 Particular Specification no LE06: Specification for Concrete Screed

2. Should any requirement of the project specification be inconsistent with any requirement of the said standardized specification, the requirement of the project specification shall take precedence.

3. CONCRETE SURFACE BEDS, FINISHES AND JOINTS

3.1 MATERIALS

3.1.1 Air-entraining agent

Air-entraining agents shall not be used.

3.1.2 Admixtures

Admixtures will be allowed, subject to the Engineer's approval. **The admixtures shall be non-toxic and a certificate of confirmation issued by an approved laboratory shall be submitted to the Engineer.**

3.1.3 Cement

"Only CEM I 42,5 (Portland cement) or CEM II/A-V 42,5 (Portland fly ash cement) or CEM II/A-S 42,5 (Portland slag cement) or CEM II/B-S 42,5 (Portland slag cement) according to SANS 50197-1 (EN 197-1), may be used. The cement may not consist of more than 20% siliceous fly ash or 30% granulated blast furnace slag, blended with the OPC (Ordinary Portland Cement).Should the contractor wish to use any other type of cement, he shall obtain the Engineer's prior written approval".

3.1.4 Aggregates

Course aggregates shall be a maximum of 28 mm, preferably of dolomite composition and with low water absorption all in accordance with SANS 1083.

Fine aggregates shall comply with SANS 1083.

3.1.5 Off-site production of concrete

The production of concrete at a central concrete production facility or a ready-mix production facility other than on the site of construction will be permitted subject to the Engineer's approval. Concrete mix designs of all classes of concrete to be used, shall be submitted to the Engineer for acceptance prior to any production of concrete.

Concrete quality control shall be carried out by an independent testing laboratory in accordance with clause 5.1 of SANS 2001-CC1 and all test results shall be submitted to the Engineer for verification and approval. Test results obtained by a ready-mix production facility or a central concrete production facility, as part of its quality control system is not acceptable for evaluation. On site control tests shall be executed according clause 5.1 of SANS 2001-CC1.

3.1.6 Concrete floor hardeners

Concrete floor hardeners shall be applied strictly according to the manufacturer's specification and under his supervision and **the contractor shall furnish a certificate of compliance together with a written guarantee after completion.** The colour of the concrete floor hardener shall be according to the architect's finishing schedules.

Refer to sub-clauses 3.10 for material quality of natural aggregate non-ferrous concrete floor hardener.

3.2 PIPES, DUCTS, SLEEVES AND CONDUITS THROUGH CONCRETE LAYER

3.2.1 Pipes, ducts, sleeves and conduits embedded in concrete

Except with the written approval of the Engineer, no pipes, ducts, sleeves and conduits other than those shown on the drawings shall be embedded in the concrete, and the approval of the Engineer for the position of all services to be embedded shall be obtained before concreting commences. The clear space between pipes, ducts, sleeves and conduits of any kind embedded in reinforced concrete and the clear space between such pipes, ducts, sleeves and conduits and reinforcement shall not at any point be less than:

(a) 40 mm or

(b) 5 mm plus the maximum size of coarse aggregate, whichever is the greater.

3.3 WELDING OF REINFORCEMENT

No welding of reinforcement is permitted, unless instructed otherwise by the Engineer.

3.4 CURING AND PROTECTION

SANS 2001-CC1 subclause 4.7.13.

All finished exposed floor surfaces shall be cured using a non-toxic, colourless curing compound followed by 250 micron Hyperlastic or equivalent sheeting maintained in position for at least 7 days or until all construction activities are completed.

Construction traffic (dumpers, wheelbarrows, etc) and continuous foot traffic shall not get into direct contact with the finished floor surface. **The Contractor shall submit proposals for protection of concrete floors to the Engineer prior to commencement of concrete floor construction.**

Steps shall be taken by the Contractor to prevent spilling of oil, grease, etc on the finished floor surfaces.

3.5 WEATHER CONDITIONS

SANS 2001-CC1 subclause 4.7.14.

Casting of final floor finishes (screeds, etc) shall be done only after all external walls and roofs are completed. Huge door and window openings exposed to the outside, shall be covered temporarily to prevent direct sun, rain and wind draughts on and over the floors.

3.6 EXPOSURE CONDITIONS

SANS 2001-CC1 subclause 4.4.3

Exposure conditions are classified as Moderate according Table 3, of SANS 2001-CC1.

3.7 USE OF PLUMS

SANS 2001-CC1 subclause 4.7.10.11

No plums shall be permitted to be cast into the concrete.

3.8 PERMISSIBLE DEVIATIONS

SANS 2001-CC1 subclause 5.2

The degree of accuracy required on the construction of the concrete surface bed shall be Degree of Accuracy II as specified in Table 11 of SANS 2001-CC1, unless specified otherwise elsewhere.

3.9 COMPACTION

SANS 2001-CC1 subclause 4.7.11

3.9.1 Compact the concrete fully by approved means during and immediately after placing. Work it thoroughly against the formwork and reinforcement and other embedded items without causing displacement.

3.9.2 Ensure that the concrete will be free from honeycombing and planes of weakness. Work successive layers of the same pour thoroughly together to ensure a homogenous mix.

3.9.3 Achieve compaction preferably by mechanical vibration but compaction can also be achieved (if approved) by spading, rodding, tamping or forking. Avoid over-vibration causing segregation, surface laitance, or leakage, or any combination of these.

3.9.4 Insert immersion vibrators vertically into the concrete to be compacted at regular intervals not exceeding 0,6 m or 10 times the diameter of the vibrator, whichever is the lesser. Systematic spacing of insertions of the vibrator at the recommended intervals is essential to ensure that no concrete remains outside the sphere of energy released by the vibrator. The vibrator shall not be used to shape moulds of concrete down to the required slab thickness. This shall be done by shovelling or raking only.

3.9.5 Withdraw the vibrator from the concrete slowly without formation of voids as soon as water is seen to rise to the surface.

3.9.6 Ensure that the rate of concrete placing is commensurate with the available compaction equipment and that compaction by vibration is executed by skilled operators only. At least two vibrators should be used and, if the rate of casting exceeds 7,5 m^3/h, a third vibrator should be employed. Should one or more vibrators break down during concreting, reduce the rate of concreting proportionately so that the remaining equipment is capable of properly compacting all concrete placed. A spare vibrator with an independent power source shall be kept in readiness to ensure continuity of placing in the event of the breakdown of the duty vibrator.

3.9.7 Special care shall be exercised with the compaction of concrete against formwork, forming the sides and top corners of joints.

3.9.8 Placing of concrete in layers shall be avoided.

3.10 NATURAL AGGREGATE CONCRETE FLOOR HARDENER

3.10.1 Definition

The natural non-ferrous aggregate hardener for concrete floors shall be a factory prepared blend of clean properly graded and over dried natural aggregate, Portland cement and chemical additives, for monolithic application to the surface of newly placed concrete before finishing. Where required it may contain certain compatible pigments for tinted floors.

3.10.2 Compressive strength

Mixed with sufficient water to give a slump of 20 to 25 mm in a 35 x 90 x 75 mm high slump cone filled in three layers, tamping each layer with 15 strokes of a 16 mm dia rod, shall give the following minimum compressive strengths when tested in a 70 mm mortar cube, vibrated for 3 min on a vibrating table and stored in a curing room or tank at 22 - 25° C and not less than 90 % humidity.

At 7 days : 50 MPa
At 28 days : 70 MPa

3.10.3 Site Service

The successful tenderer shall be expected to include in his tender, the services of an experienced and qualified technical representative on the building site who will train the placing team in the correct application methods of the product during initial placing upon one week's notice. Circumstances may necessitate follow-up inspections.

3.10.4 Shelf life

The shelf life of the offered product shall be stated in the tender and expiry dates shall be displayed on each bag.

3.10.5 Application rates

As specified.

3.10.6 Control testing

Suppliers shall be required to provide materials from site for control testing, as and when requested by the Engineer. Payment for these tests shall be included in the contractor's rates.

3.11 CONCRETE SURFACE FINISHES

3.11.1 Power floated finish

Power floated finish to floors, etc, unless otherwise specified, shall be floated mechanically to a smooth and even surface before the concrete has set. Small surfaces and inaccessible places are to be floated by hand in a similar way. Under no circumstances shall cement mortar be added while floating the concrete. See also clause 3.11.2.1 for test panel and required surface finish. The contractor shall ensure that no dishing will occur during power floating; Particular attention should be paid to power floating at joints formed by formwork with regard to the latter.

3.11.2. Power floated finish with floor hardener

A natural aggregate or non-ferrous aggregate concrete floor hardener shall be specified on the drawings (see subclause 3.10). Refer also to clause 3.11.1 for power floated finish.

The floor hardener supplied by an approved manufacturer. The floor hardener shall be applied at the specified rate to the surface strictly according to the manufacturer's specifications.

The colour shall be light grey.

A competent and experienced supervisor from the supplier of the membrane hardener shall supervise all activities with regard to the application of the membrane hardener on a full-time basis.

The finish required shall have an especially high resistance to wear, abrasion and impact.

3.11.2.1 Application method shall be according to manufacturer’s’ specifications.

After the concrete has been spread, compacted, screeded to level, and lightly wood-floated, it shall be left undisturbed until bleeding has stopped. Subclause 3.5 shall apply and no wind draughts on or over the floor shall be allowed.

The final surface of the concrete floor shall be steel trowelled (and rolled by ripple paint texture roller if instructed) to produce a uniform textured finish free from excessive harshness and true to the grades and cross-sections on the drawings. The Engineer may require changes in the final finishing procedure as required to produce the desired final surface texture.

NB: All surfaces must be protected from wind and direct sunlight at all times. Maximum continuous slab size: 5 m x 5 m or as specified on the drawings.

3.11.2.2 Test panel

The Contractor shall prepare on Site 4 x 4 m sample panels for each type or class of finish required at a location directed by the Engineer. Samples which have been approved by the Engineer shall be retained on Site until completion of the Contract, or as directed by the Engineer. The final surface finish of all surfaces shall match that of the approved samples.

3.11.3 Hand-finished concrete surfaces

3.11.3.1 Rough surface finish

This surface finish is required on those portions of surface beds and ramps, which are to receive a concrete screed. Refer to Particular Specification no LE06 for the preparation of the surface, screed application and finishing of screed.

3.11.3.2 Hand floated surface finishes

The final surface finish of the concrete surface bed shall be affected by means of hand-operated floats eg wood or steel. The finishing of the concrete surface shall be uniform and of the same standard. The finish will be specified on the drawings. Wood floated finish shall be a smooth wood float finish unless specified otherwise on the drawings. Steel and wood float finishes shall be free from trowel marks.

Texturing the surface with hand-held brooms or combs shall be applied to those surface beds specified on the drawings. The corrugations so produced shall be approximately 1 mm deep, uniform of appearance and width. Direction of corrugations to be specified on the drawings. In order to ensure straight grooves, the broom or comb shall be operated against a straightedge placed at right angles to the concrete joints.

For non-skid surfaces the surface shall be given a broom finish. A test panel of 2 m² will be required to establish the accepted standard.

3.12 PUMPING OF CONCRETE

The pumping of concrete will not be permitted, without the permission of the Engineer.

4. JOINTS: EXPANSION, SAWN, ISOLATION AND CONSTRUCTION JOINTS

4.1 SCOPE

This section covers all work related to the forming and construction of all joints, and includes the provision and application of joint sealants where specified.

4.2 MATERIALS

4.2.1 Joint filler

Joint filler for formed joints shall be manufactured from closed cell polyethylene with collapsible strain properties and the filler strips shall be provided with a tear off cover strip. The joint filler shall be of an approved brand such as "Condor" or "Jointex" or equal and the type used shall be subject to the Engineer's approval.

4.2.2 Joint sealant

The liquid sealant in joints, subject to heavy, hard wheeled traffic, shall be a semi-rigid sealant with a shore hardness between A65 and A85. The joint sealant shall be of an approved brand subject to the Engineer's approval. Grey colour shall be used, unless specified otherwise. The joint filler should be topped up after 12 months in accordance with the manufacturer's specifications.

The initial filling of joints, not subject to heavy, hard wheeled traffic, shall be a flexible polyurethane sealant, which should be applied as soon as possible after the joints have been cut. These joints should be filled with a semi-rigid sealant, as specified above, after 12 months.

4.3 GENERAL

Joints in the concrete finishing layer shall be provided at the positions and spacing indicated on the drawings or at locations ordered by the Engineer.

The vertical faces of all joints shall be at right angles to the surface of the finishing concrete layer.

Horizontal alignment of joints shall comply with the provisions of subclause 3.8 (Degree of Accuracy II) as specified in clause 5.2 of SANS 2001-CC1.

If the joints do not comply with the requirements of the Specifications in all respects, it shall be sufficient reasons for the Engineer to stop all concreting operations on the permanent works until the Contractor can satisfy the Engineer that he will be able to perform the work in accordance with the Specifications.

4.4 EXPANSION AND ISOLATION JOINTS (MOVEMENT JOINTS)

Movement joints are made by placing fresh concrete against hardened concrete at predetermined locations separated with a 10 mm wide joint filler as specified in subclause 4.2.

The joint filler shall be accurately placed and shall be furnished for each joint in a single piece for the full depth and width required for the joint unless otherwise authorised by the Engineer. When the use of more than one piece is authorised for a joint, the abutting ends shall be fastened securely, and held accurately to shape, by stapling or other positive fastening satisfactory to the Engineer.

The joint filler together with the sealing groove shall provide complete separation of adjacent slabs and spaces between the base slab and the filler.

The sealant groove in the upper portion of the joint shall be primed and sealed with polyurethane sealant as specified in subclause 4.2.2.

Movement joints shall be formed true to line, tolerance of ± 2 mm, and shall be thoroughly cleaned of accretions of concrete or other foreign matter by scraping or other approved means. The surfaces in contact with joint sealing material shall be prepared strictly in accordance with the manufacturer's specification. A bondbreaker tape or backing shall be used to prevent the sealant bonding to the base of the joint.

4.5 SAWN JOINTS

Sawn joint shall be formed by reducing the concrete thickness at the joint by sawing a groove in the hardened concrete.

Sawing shall be carried out as specified in section 4.7 hereafter as soon as concrete can be cut without ravelling but not later than 24 hours after casting. If, however, longitudinal cracking of the concrete takes place during this time, sawing shall be completed at an earlier time to prevent future longitudinal cracking.

The nominal width of the groove shall be 3 mm or as indicated on the drawings. A width tolerance of plus or minus 0,5 mm shall be applicable. The depth of the groove shall be as specified on the drawings or one-quarter of the nominal slab thickness.

4.6 CONSTRUCTION JOINTS TO HORIZONTAL AND VERTICAL SURFACES

The surface of the old concrete shall be sandblasted or chipped with a light hammer or mechanically scabbled, swept clean and all dust removed with an industrial vacuum cleaner.

Areas contaminated with fat, oil, grease or other organic matter shall be cleaned with ABE HD Cleaner or equivalent. Alternatively, sprinkle carbonate of soda powder on contaminated areas, thoroughly clean with a water jet and let dry.

Bond new concrete to old concrete with a wet-to-dry epoxy, Epidermix 344 or equivalent. Dosing rate and application procedure shall be strictly according to manufacturer's specifications.

4.7 SAWING OF JOINTS

Sawing of joints in the slab be carried out by suitably experienced personnel only.

The Contractor's attention is drawn to the fact that aggregates obtained from crushing felsite or exceptionally tough aggregates may require the use of saw-blade specially suited to these conditions. No additional payment will be entertained for the use of special blades or any other additional measures necessary to obtain a sawn joint complying with this Specification when sawing concrete produced from such aggregates.

All joints shall be sawn by means of power-driven rotary disc saws.

Excessive spalling of the arises will not be allowed and the Contractor shall use the type of blade and equipment best suited to the hardness of the concrete being sawn.

Sufficient standby power saws shall be kept available on site by the Contractor, ready for use, at all times when concrete is being placed.

Where spalling exceeds 5 mm in depth at any point measured from the top surface of the slab, joints shall be repaired as specified in clause 5 using an approved epoxy resin mortar. Immediately after sawing the joint grooves shall be washed out with a jet of clean water to remove all fine material and the joints sealed temporarily be means of an approved paper rope.

No traffic of any kind shall be allowed on the slab until all joints have been temporarily sealed.

In cases where slight over-cutting occurs, the over-cutting shall be sealed with an approved epoxy resin.

4.8 JOINT SEALING

Every length of joint shall be approved and recorded by the Engineer before any priming or sealing is done.

The sealant of the joint shall be applied only after shrinkage and contraction of the concrete has taken

The joints shall be sealed with a polyurethane sealant as specified in clause 4.2.2. Prior to application, the joints shall be cleaned and no free water shall be present. Curing compound on joint walls shall be removed by an abrasive wheel. Dirt, dust and laitance shall be blown out of the joint with oil-free compressed air at a pressure of approximately 600 kPa immediately before the sealing operation. The primer and sealant shall be applied strictly in accordance with the manufacturer's recommendations, particularly with regard to temperature and humidity which control curing. The joints shall be sealed when temperature conditions in the building have become fairly static. The atmosphere in the building shall be free from dust during the sealing operation and for at least 24 hours thereafter. Masking tape shall be used on the sides of the joint to enable a clean neat job to be obtained.

A primer shall be used and shall be applied in accordance with the manufacturer's instructions regarding the type of primer and the maximum or minimum drying times.

A suitable applicator gun with the correctly selected nozzle shall be used and the joints shall be filled from the bottom. Large joints may require two or three runs. The sealant shall be tooled to ensure full contact with the joint faces and the sealant shall be finished off smoothly with a spatula or other suitable

instrument so as to produce a final surface which is level with the surrounding floor. A maximum concave or convex profile of 1 mm will be allowed.

The spatula should be lubricated with diluted washing-up liquid with a 10:1 dilution or by another approved method.

Finally, the masking tape shall be pulled away towards the sealant making sure the sealant is not disturbed.

All sealing work shall be completed at least two weeks in advance to allow thorough curing and inspection before any final cleaning, sterilizing and factory activities take place.

It will be required that the technical representative of the manufacturer shall supervise the installation of joint sealants until such time that the Contractor complies fully with the specifications and requirements of the manufacturer. Any cost associated with the above requirements shall be for the Contractor's account.

5. REMEDIAL WORK

The following shall apply with respect to remedial work to concrete floors:

5.1 REMOVAL OF CONCRETE

Where any section of the floor which does not comply with the specified requirements is to be removed and reconstructed, the entire portion of the slab between longitudinal and transverse joints shall be removed and reconstructed at no cost to the client.

5.2 REMOVAL OF HIGH SPOTS

Where the Engineer permits, high spots and berms may be removed by means of approved power cutters or surface planers. Generally, this shall apply to localised high spots not exceeding 3 mm. Hand -operated grinding carborundum blocks will be allowed. After individual high spots have been removed, the Contractor shall, if required, grind the surface to the nearest longitudinal and transverse joint in order that all ground areas be neat rectangular areas of uniform texture.

5.3 REPAIRING OF JOINTS

Joints along which spalls occur that exceed 5 mm in depth at any point measured from the top surface of the pavement, or any other joints which in the opinion of the Engineer are not acceptable, shall be repaired with an approved epoxy resin mortar strictly according to the manufacturer's specification. Some epoxy binder shall be used to prime the surface being repaired prior to placing the mortar mix. The mix shall be shaped to the original proper joint configuration. Refer also to subclause 4.8.

5.4 REPAIRING OF CRACKS

The Contractor shall be responsible for constructing a floor, which will not show any cracks wider than 0,1 mm except at the planned joints.

Where cracks occur in the floor which, in the opinion of the Engineer, do not warrant the removal and reconstruction of the pavement, the Contractor shall repair such cracks as specified hereinafter.

The cost of repairing cracks or of breaking up, removing and replacing existing slabs shall be borne by the Contractor. If the first cracks in any slab section between joints occur more than 90 days after casting the Contractor will be paid for repairing the cracks or replacing the slab section.

All cracks, except as otherwise provided, shall be repaired by pressure injecting the entire length of the cracks with epoxy approved by the Engineer.

Where cracks cross or are partially coincident with sawn joints, either protective measures shall be taken to prevent entry of epoxy into saw cuts sufficiently to reduce the groove depth or, at the option of the Contractor, accumulations of epoxy in saw cuts shall be removed by resawing to the specified depth prior to opening the pavement to any traffic, but not later than 72 hours after injecting the epoxy.

Epoxy injection shall be completed within ninety working days after the floor is placed.

In making epoxy injection repairs, a surface seal shall be applied to prevent the escape of epoxy and entry ports shall be placed at sufficiently close intervals to allow filling the entire length of the crack. Surface seal materials, and injection procedures, shall be such as to prevent damaging the texture and appearance of the floor surface after opening to traffic. Epoxy shall be injected using in-line-mixing equipment. Pressure pots shall not be used. Epoxy shall conform to California State Specification 731-80-27, but other epoxy adhesives and injection methods will be considered if their use can be supported by conclusive proof of satisfactory performance in concrete.

The Contractor shall provide 40 mm diameter cores of epoxied cracks at the rate of three relatively evenly spaced cores for each 10 m of epoxied crack. Cores shall extend through the entire depth of the floor and include the full depth of crack. Location of cores will be determined by the Engineer. Cracks where epoxy has penetrated to less than 80 % of the crack depth shall have additional epoxy injected until a minimum of 80 % of the crack depth has been filled. Such cracks may require additional cores for verification as determined by the Engineer.

All holes resulting from coring shall be completely filled with non-shrink epoxy of equivalent quality as the floor, but using a maximum coarse aggregate size of 6 mm.

5.5 PATCHING OF SURFACE

Should the floor be damaged and require patching at any time, the area to be patched must be chipped out in rectangular blocks at a depth of ± 40 mm, with clean vertical sides cut with an angle grinder. Apply an approved wet-to-dry epoxy before a fairly stiff mortar of the approved floor hardener. The cost of this repair work shall be for the account of the Contractor.

LE15 SPECIFICATION FOR PROTECTION AGAINST TERMITES AND ANTS UNDER SURFACE BEDS

PROTECTION AGAINST TERMITES AND ANTS

The ground under surface beds, shall be poisoned with an approved registered soil poisoning material of the chlordane or aldrin type mixed with water and applied at the rate of not less than 5 litre of solution per square metre, care being taken to apply the solution uniformly over the whole surface. The concentration of the solution shall be in accordance with the manufacturer's instructions and to the approval of the Representative / Agent. The poison and poisoning shall comply with SANS 10124.

Where the ground to be treated is of earth filling, the upper layer of filling shall be leveled by raking but shall not be rammed until after the solution is applied, and where of natural ground, it shall be dug up and well loosened to a depth of not less than 50 mm and similarly leveled, so as to enable the solution to penetrate into the soil. After the solution has been applied and allowed to soak in, the soil shall be well rammed and consolidated to 93 percent Modified AASHTO density, or as specified on the drawings.

Before applying the solution to the ground under the floors, 75 mm deep V-shaped channels shall be raked out against all walls enclosing the floors and against walls, sleeper piers, etc, under floors, and the channels flooded with poison solution. After the solution has soaked in, the channels shall be filled and rammed.

The ground at the bottom of all foundation trenches and holes shall be similarly poisoned, but without digging up and loosening the soil.

Where the concrete surface beds are laid above damp course level, the ground at damp course level shall be poisoned and a layer of clean earth filling laid on the poisoned ground to make up to underside of concrete beds, and well consolidated to 93 percent Modified AASHTO density or as specified on the drawings.

Where hard-core is to be laid over the poisoned layer a 25 mm thick protective layer of clean earth filling shall be laid on the poisoned layer before the hard-core is laid and well consolidated to 93 percent Modified AASHTO density or as specified on the drawings.

Great care shall be taken whilst laying the concrete floor beds, protective layers, filling and hard-core, to avoid rupturing the poisoned layer of soil under the floors; should the poisoned layer be ruptured at any point it shall be made good and the areas affected treated again.

NOTES:

1. The soil poison shall be delivered to the site in sealed drums, clearly labeled or stamped with the name of the product.
2. Contractors are advised that special precautions must be taken to protect the workmen whilst using the soil poison.
3. The poisoning of the ground under floors shall be done as soon as practicable, so that it may dry out before the floors are laid.
4. The treatment of the ground **must be carried out under the supervision of the Engineer.**

LE16 SPECIFICATION FOR SOILCRETE

Soilcrete shall consist of an approved soil or gravel mixed with 5 % by mass of Portland Cement and only sufficient water to give it a consistency that will permit the soilcrete to be placed, using vibrators. The material used for soilcrete shall be sandy granular material of the following specifications:

- Minimum Grading Modulus: 1,2
- Maximum Plasticity Index: 10 %
- Maximum particle size: 38 mm
- Detrimental percentages of silt and clay shall be avoided.

The soilcrete shall be mixed on site using suitable concrete mixers and the water and cement contents shall be carefully controlled. It shall be placed and thoroughly compacted by means of concrete vibrators so that all voids are filled.

ME1 SPECIFICATION FOR STRUCTURAL STEELWORK

(Note that these specifications are not exhaustive. Refer to the additional notes on the project specific drawings. If there are discrepancies between this specification and the drawing notes – then the drawing notes shall govern.)

The South African National Standard for Construction Works (published by the South African Bureau of Standards) shall apply throughout in respect of this contract, in addition to the additions and saving the exceptions set out below:

A copy of the said specification shall be furnished by the contractor and shall be kept on the site.

EQUIVALENCY OF STANDARDS

Wherever reference is made in the Contract to SANS standards and/or code requirements to be met by the goods and materials to be furnished, work performed or tested, the provisions of the latest edition or revision of the relevant SANS standards and codes in effect shall apply, unless otherwise stated in the Contract. Whenever reference is made to SANS standards and codes, other authoritative standards and codes that ensure an equal or higher quality than the relevant SANS standards and codes, will be accepted subject to the Engineer's prior review and written consent. Differences between the standards specified and the proposed alternative standards shall be fully described in writing by the Contractor and submitted to the Engineer at least twenty eight days prior to the date when the Contractor desires the Engineer's consent. In the event that the Engineer determines that such deviations are not of a high enough or better standard, the Contractor shall comply with the specified document.

A copy of the said specification shall be furnished by the Contractor and shall be kept on the site.

A list of British specifications which are deemed to be equivalent to the relevant SANS specifications are listed at the end of this specification.

PROJECT SPECIFICATION

Should a requirement of the said standardized specification be inconsistent with a requirement of the project specification, the latter shall take precedence.

1. APPLICABLE SPECIFICATIONS

SANS 2001-CS1: STRUCTURAL STEELWORK
SANS/ISO 12944: PART 1 TO 8 – CORROSION PROTECTION OF STEEL STRUCTURES BY PROTECTIVE PAINT SYSTEMS

2. THE SUBCLAUSES OF SANS 2001-CS1 ARE AMENDED AS FOLLOWS

2.1 Subsubclause 4.1.1: Structural steel

The steel shall be Grade 355JR (Equivalent to 350W) for hot rolled steel sections. All members shall carry the Grade 355JR (Equivalent to 350W) steel symbol to identify steel grade prior to manufacturing. Mill test certificates to be provided to the Engineer for all structural steel, prior to manufacture.

The thickness specified of a checker ("vastrap") floor plate, is the under-pattern thickness.

2.2 Subclause 4.2 and subsubclause 4.2.4: Contractor provides shop details

The contractor shall furnish the Engineer with shop-detail drawings within fifteen working days of having received the design drawings. Workshop drawings shall be drawn using Tekla (or similar approved software). The Engineer will check the drawings for conformity with design requirements and will return the drawings with additions and corrections, if any, within 10 working days of having received them. Detailed checking of shop details for dimensional accuracy and installation fit, will not be done by the Engineer.

2.3 Subsubclause 4.3.3: Cutting

The edges of flame-cut plates shall be ground smooth.

2.4 Subsubclause 4.6.4: Grouting responsibility

Grouting shall not be done by the steel contractor.

2.5 Subclause 4.4 & 5.2: Welding

(a) All welders shall be coded welders.

(b) The contractor shall submit welding procedures by an approved welding authority for approval and shall produce evidence acceptable to the Engineer that welding procedures and welders have been tested in accordance with the requirements of AWS D1.1 (and/or SANS 15614-1). Welding certificates are only valid for a period of 12 months.

(c) Approved splicing of members will be subject to non-destructive testing. The cost of testing shall be borne by the contractor.

(d) The Engineer may at his discretion identify welds for non-destructive testing by an approved authority the cost of which will be borne by the Contractor

(e) No staggered or intermittent welding is permitted.

(f) No welding on site is permitted unless approved by the Engineer. Any site welder and site welding procedure will have to be re-qualified for site welding.

(g) Welding procedures and welder's performance qualifications shall conform to the requirements of AWS D1.1 (and/or SANS 15614-1). These documents must be submitted in writing to the Engineer and approved prior to the start of welding.

(h) The Contractor shall submit for review an outline of the Quality Control measures that will be enforced by the Contractor to ensure that specified welding procedures are employed in all welding under this contract.

2.5.2 Weld testing

2.5.2.1 General

a. Personnel performing non-destructive testing other than visual shall be qualified in accordance with the stipulations of the code.

b. Full penetration butt welds are to be radio graphically tested in accordance with (2.5.2.2) below). A minimum of 50% of full penetration welds shall be tested. If more than 5% of the examined welds show unsatisfactory results, then additional examinations covering all welds shall be performed.

2.5.2.2 Non-destructive examination

a. Non-destructive procedures, techniques and acceptance criteria shall be as required by AWS D1.1 (and/or SAN 15614-1).

b. All non-destructive examination shall be in accordance with written procedures. The Engineer shall have the right to examine and approve the written procedures.

c. Full penetration but welds shall be radio graphically tested or ultrasonically tested to the requirements of AWS D1.1 (and/or SANS 15614-1).

d. Ultrasonic and radiographic examinations shall not be made within the period of 24 hours after completion of welding.

e. Cost of examination listed under to be borne by the Contractor.

f. All costs (time, travelling, tests) incurred by non-destructive examinations due to non-conformance of specifications and due to any latent defects in material and welding shall be borne by the Contractor.

g. Fillet welds will be inspected and tested to AWS D1.1 (and/or SANS 15614-1) at the discretion of the Engineer.

h. Certificates of non-destructive testing shall be submitted to the Engineer.

2.6 Subsubclause 7.1: Test certificates

Test certificates pertaining to the steel to be used shall be submitted to the Engineer by the contractor before fabrication commences.

The Engineer reserves the right to inspect all structural steel in the workshop before it is delivered to the site.

2.7 Subclause 5.4: Other tolerances

Degree of accuracy II shall apply unless indicated otherwise elsewhere.

3. ADDITIONAL CLAUSES

3.1 Protective treatment and painting

All structural steelwork (excluding pre-galvanized purlins) shall be painted to the specification in 3.1.3 below.

3.1.1 General

3.1.1.1 All paint shall be delivered at the workshop as well as on the site in the original containers that display the manufacturer's name and trademark as well as the SABS mark. The Engineer may, at his discretion, prescribe the manufacturer and the type of paint.

The coating system shall be from one manufacturer only. The paint manufacturer's instructions shall be strictly adhered to.

3.1.1.2 Surfaces in contact with each other after assembly or erection shall receive the primer beforehand, except for faying surfaces for friction-grip fasteners.

3.1.1.3 The application of the final coats of paint before erection will be permitted by the Engineer only in special circumstances or where specified elsewhere.

3.1.1.4 After erection of the steelwork, the specified paint system shall be reinstated in all areas where it has been damaged. All fasteners shall also be treated in accordance with the specified paint system.

3.1.1.5 No painting on the site shall be done in inclement weather or when humidity or frost is liable to cause wet or damp conditions on the surface to be painted.

3.1.1.6 No painting shall be done if the temperature falls below 7□□C.

3.1.1.7 Welded seams shall be thoroughly steel-brushed before painting. Permission shall be obtained from the Engineer before slag residue may be neutralized with acids or alkalis.

3.1.2 Surface preparation in the workshop

SIS 05 59 00 or ISO 8501 shall apply and shall be referred to in respect of this clause.

Non-galvanized steel surfaces to be painted shall first be wire brushed in accordance with SANS 12944-4 clause 6.2.2. The surface shall have an appearance equal to or better than that shown in Annexure A.

All dust and abrasion products are to be removed prior to painting. The cleaned steel surface shall not exhibit a dust class rating of not more than 2 when tested in accordance with SANS 8502-3.

Galvanized steel surfaces to be painted shall be prepared in accordance with SANS 12944-4 clause 12.

3.1.3 Paint system

The paint system shall be selected and applied in accordance with SANS 12944-5.

The desired durability range for all structural steel is Medium (5 to 15 years) in accordance with SANS 12944-1 clause 4.4. Paint application may be by brush, roller or sprayed. Red lead may not be used.

The corrosivity category for the site for internal structural steel (enclosed in the building) is classified as C2, which is equivalent to low in accordance with SANS 12944-2 clause 5. Any of the marked paint systems in Annexure A (extract from SANS 12944-5 Table A.2) is suitable for the application.

The corrosivity category for the site for external structural steel exposed to the atmosphere is classified as C3, which is medium in accordance with SANS 12944-2 clause 5. External steel is to be hot-dipped galvanized and painted to any option given in Annexure B (extract from SANS 12944-5 Table A.9).

In all cases the manufacturer's specification and requirements for any paint product must be strictly adhered to.

4. HOT-DIPPED GALVANIZING

Steelwork described as "hot-dipped galvanised" shall be galvanised after manufacturing and before delivering to site by means of the hot dipped process complying with the minimum requirements of SANS 14713-2. Structural steel members shall be given an 85 micron thick galvanised coating or such other thickness as may be specified in accordance with SANS 14713-2 (Table 1).

Damaged surfaces must be thoroughly cleaned and if welding has been carried out all slag must be removed preferably by the use of a chisel hammer.

Before galvanising all surfaces of the metalwork shall be thoroughly cleaned of all scale and rust by shot-blasting in accordance with SANS 10064 or by pickling and then fluxed ready for galvanising.

The zinc coating shall be even and continuous over all surfaces, free of bare spots, dull or rough patches, blisters or other imperfections. The zinc coating shall show no signs of peeling and shall be uniform in thickness.

All M8 and greater bolts, nuts, screws and other threaded components, shall be hot-dip galvanised to SANS 10684.

Repairing of damaged coatings

Plant repairs

Should any black spots or uncoated areas greater than 5 mm^2 (individual) or 25 mm^2 (collective) per m^2 or per m run be present after galvanizing, the coating shall be repaired. This is to be carried out using abrasive blasting following by zinc metal spray. The zinc metal spray shall be applied at least 25 % thicker than that specified and shall overlap the damaged area by 20-25 mm. The finished coating shall be wire brushed to remove any excess metal spray.

Hot patch soldering is an alternative at the plant but is seldomly used, as the method needs to be conducted while the product is still hot before quenching.

Site Repairs

Zinc metal spray as set out above.

The recommended alternative is to use a zinc rich paint provided it has at least 90 % zinc in the dry film, by mass. The paint should be a zinc rich epoxy in accordance with SANS 12944-5.

5. LIST OF SPECIFICATIONS AND CODES

All SANS specifications available from:

South African Bureau of Standards
Private Bag X191
PRETORIA
0001

Tel: + 2712 428 6666
Fax: + 2712 428 6928

ANNEXURE A

Table A.2: Paint systems for corrosivity category C2

The paint systems given in the following table are only examples. Other paint systems having the same performance are possible.
If these examples are used, it shall be ensured that the paint systems chosen comply with the indicated durability when execution of the paint work takes place as specified. See also 5.7.

Paint System No.	Surface preparation grade[1]		Priming coat(s)				Top coat(s) including intermediate coat(s)			Paint system		Expected durability (see 5.5 and ISO 12944-1)		
	St 2	Sa 2½	Binder[6]	Type of primer[2]	Number of coats	NDFT[3] µm	Binder[6]	Number of coats	NDFT[3] µm	Number of coats	Total NDFT[3] µm	Low	Medium ↓	High
S2.01	x		AK	Misc.	1	40	AK	1	40	2	80			
S2.02		x			1	40		1	40	2	80			
S2.03	x				2	80		1	40	3	120			
S2.04		x			1-2	80		1	40	2-3	120			
→ S2.05	x				2	80		1-2	80	3-4	160			
S2.06		x			1-2	80		1-2	80	2-4	160			
→ S2.07	x				1-2	80		2-3	120	3-5	200			
S2.08		x			1-2	100	–	–	–	1-2	100			
→ S2.09	x				2	80	AY, CR, PVC[4]	1-2	80	3-4	160			
S2.10		x			1-2	80		1-2	80	2-4	160			
S2.11		x			1-2	100	–	–	–	1-2	100			
S2.12		x	AY		1	80	AY	1	40	2	120			
→ S2.13	x		AY, CR, PVC		2	80	AY, CR, PVC	1-2	80	3-4	160			
S2.14		x			1-2	80		1-2	80	2-4	160			
S2.15		x	EP		1-2	80		1	40	2-3	120			
S2.16		x			1-2	80	EP, PUR[5]	1-2	80	2-4	160			
S2.17		x	EP, PUR	Zn (R)	1-2	80	–	–	–	1-2	80			
S2.18		x	ESI		1	80	–	–	–	1	80			

Binders for priming coat(s)			Paints (liquid)			Binders for top coat(s)			Paints (liquid)		
			No. of components		Water-borne possible				No. of components		Water-borne possible
			1-pack	2-pack					1-pack	2-pack	
AK	=	Alkyd	x		x	AK	=	Alkyd	x		x
CR	=	Chlorinated rubber	x			CR	=	Chlorinated rubber	x		
AY	=	Acrylic	x		x	AY	=	Acrylic	x		x
PVC	=	Polyvinyl chloride	x			PVC	=	Polyvinyl chloride	x		
EP	=	Epoxy		x	x	EP	=	Epoxy		x	x
ESI	=	Ethyl silicate	x	x		PUR	=	Polyurethane	x	x	
PUR	=	Polyurethane	x								

1) For St 2, rust grade C as defined in ISO 8501-1 is the reference grade. For Sa 2½ rust grade A, B or C as defined in ISO 8501-1 is the reference grade.
2) Zn (R) = Zinc rich primer, see 5.2, Misc. = Miscellaneous types of anticorrosive pigments.
3) NDFT = Nominal Dry Film Thickness. See 5.4 for further details.
4) It is recommended that compatibility is checked with the paint manufacturer.
5) If colour and gloss retention is required, it is recommended that the last coat should be based on aliphatic PUR.
6) For explanation of abbreviations, see foot of table.

Extract from SANS 12944-5: 1998.

ANNEXURE B

Table A.9: Paint systems for corrosivity categories C2 to C5-I and C5-M

Substrate: Hot-dip-galvanized steel [1]

The paint systems given in the following table are only examples. Other paint systems having the same performance are possible.
If these examples are used, it shall be ensured that the paint systems chosen comply with the indicated durability when execution of the paint work takes place as specified. See also 5.7.

Paint System No.	Priming coat(s)			Top coat(s) including intermediate coat(s)			Paint system		Expected durability[2] [6] (see 5.5 and ISO 12944-1)													
	Binder[5]	Number of coats	NDFT[3] µm	Binder[5]	Number of coats	NDFT[3] µm	Number of coats	Total NDFT[3] µm	C2			C3			C4			C5-I			C5-M		
									L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
S9.01	PVC	–	–	PVC	1	80	1	80															
S9.02		1	40		1	80	2	120															
S9.03		1	80		1	80	2	160															
S9.04		1	80		2	160	3	240															
S9.05	AY	–	–	AY	1	80	1	80															
S9.06		1	40		1	80	2	120															
S9.07		1	80		1	80	2	160															
S9.08		1	80		2	160	3	240															
S9.09	EP or PUR	–	–	EP or PUR[4]	1	80	1	80															
S9.10		1	40		1	80	2	120															
S9.11		1	80		1	80	2	160															
S9.12		1	80		2	160	3	240															
S9.13		1	80		2-3	240	3-4	320															

Binders for priming coat(s)	Paints (liquid)			Binders for top coat(s)	Paints (liquid)		
	No. of components		Water-borne		No. of components		Water-borne
	1-pack	2-pack	possible		1-pack	2-pack	possible
PVC = Polyvinyl chloride	x			PVC = Polyvinyl chloride	x		
AY = Acrylic	x		x	AY = Acrylic	x		x
EP = Epoxy		x	x	EP = Epoxy		x	x
PUR = Polyurethane		x		PUR = Polyurethane	x	x	

1) The mechanical or chemical surface preparation required is described in ISO 12944-4.
2) The durability is in this case related to the paint system adhesion to the hot-dip-galvanized surface.
3) NDFT = Nominal Dry Film Thickness. See 5.4 for further details.
4) If colour and gloss retention is required, it is recommended that the last coat should be based on aliphatic PUR.
5) For explanation of abbreviations, see foot of table.
6) Light grey shading indicates that the paint systems concerned would not normally be used for these corrosivity categories. They are not listed in table A.2 and/or A.3.

Extract from SANS 12944-5: 1998.

S1 SPECIFICATION FOR LOAD-BEARING MASONRY WALLS

1. APPLICABLE SPECIFICATIONS

The following standard specifications of the South African Bureau of Standards shall apply throughout in respect of this contract, in addition to the additions and saving the exceptions to the clauses set out below:

SANS 10164	The structural use of masonry. Part 1: Un-reinforced masonry walling
SANS 227	Burnt clay masonry units
SANS 1215	Concrete masonry units
SANS 1090	Aggregates from natural sources. Fine aggregates for plaster and mortar
SANS 28	Metal ties for cavity walls
SANS 10145	Concrete masonry construction
SANS 10155	Accuracy in buildings

2. ADDITIONAL CLAUSES

2.1 MATERIALS

2.1.1 Masonry units

2.1.1.1 Nominal compressive strength

Unless specified otherwise the nominal compressive strengths shall not be less than specified below:

a. Concrete masonry units: 7 MPa
b. Burnt clay masonry units:

- Face bricks: 17 MPa
- Non-facing under damp proof course, in all foundation walls and in damp conditions: 10.5 MPa
- Non-facing plastered: 7 MPa

2.1.1.2 Maximum water absorption

a. External face bricks: 12 %
b. Non facing bricks (block): 14 %

2.1.1.3 Drying shrinkage

Unless specified otherwise the average drying shrinkage of concrete masonry units shall not exceed 0.06 %.

2.1.1.4 Clay and concrete units shall not be used in combination within the same skin of brickwork.

2.1.2 Cement

Cement bearing the mandatory SANS mark and appropriate for its particular application only shall be used.

2.1.3 Mortar

Unless specified otherwise mortar class II shall be used.

2.1.4 Masonry reinforcement

Masonry reinforcing mesh shall be of hard-drawn mild steel, comprising two 2,8 mm diameter main wires spaced 50, 75, 150 or 230 mm apart, and 2,8 mm diameter cross wires spaced not more than 300 mm apart and welded to the main wires.

Ties for load-bearing cavity brick walls shall be as per specified detail.

Reinforcing wires and rods shall be cut to length as required, lapped at least 300 mm at end joints, be evenly spaced in the brick joints, with the outer wires or rods having at least a 20 mm cover from the face of the mortar. See clause 2.2.5.

2.2 CONSTRUCTION

2.2.1 Storage of material on site

Structural units delivered to the site shall be carefully unloaded by hand or crane, and placed on prepared areas free from clinker, ash or sulphate-bearing soils and in separate stacks according to strength. The stacks shall be protected from rain and arranged to allow free circulation of air.

Cement shall be stored off the ground in a dry weatherproof structure to facilitate inspection and to permit the use of materials in the order of delivery.

Sand shall be stored separately according to type and in such a way that it will not become contaminated.

2.2.2 Treatment of masonry units

Burnt clay units with an initial water absorption rate that exceeds 1,8 kg/m^2.min shall be wetted prior to laying to reduce the rate to between 0,7 and 1,8 kg/m^2.min.

Structural concrete units shall be laid without prior wetting.

2.2.3 Mortar

The mortar materials shall be mixed dry until a uniform colour is attained. Water shall then be added and the mixture turned over until the ingredients are thoroughly incorporated. The mortar shall be produced in such quantities that no setting occurs before use. (Usually less than 2 hours). When cement mortar is mixed old mortar that has already set shall be removed from the mixer or the platform as such mortar may not be incorporated in a new batch. No water shall be added afterwards to improve workability.

2.2.4 Laying of structural units

All brick units shall be laid on a full bed of mortar without furrowing. Single-frogged bricks shall be laid frog uppermost, and double-frogged bricks shall be laid with the deeper frog uppermost. All frogs shall be filled with mortar. All cross joints and collar joints shall be solidly filled and the thickness of the bed joint shall not exceed 13 mm.

Damp-proof courses and joints in fair-faced brickwork shall be strictly in accordance with the architect's specifications.

Unless specified otherwise, all masonry walling shall be built in stretcher bond. No false headers and only whole masonry units shall be used, except where legitimately required to form a bond. The walling shall be carried up in a uniform manner with no portion raised more than 1.2 m above another at any one time. The walling height built per day shall not exceed 1.3 m without prior approval.

Cutting of units shall be kept to a minimum and special units shall be used to maintain bond. Sleeves, chases and holes shall be provided during erection of the masonry. Written approval is required for the chasing of completed walls or the formation of holes. No horizontal or diagonal chases are permitted and chasing in brick columns is prohibited.

The top bearing surface of walls under concrete slabs shall be smooth and level and finished with two level, continuous layers of 3 mm tempered hardboard, smooth sides face to face or by other approved means. In cavity walls the last two brick courses below the slab shall be built solid across the cavity. Non-load-bearing walls, when constructed at the same time as the load-bearing walls, shall be finished with a layer of at least 10 mm of easily compressible material between the top of the wall and the soffit.

Where applicable, load-bearing masonry shall be fixed to adjoining structures in accordance with the specified details.

2.2.5 Masonry reinforcing

Unless specified otherwise, the minimum masonry reinforcing shall be reinforcing mesh placed in the first five courses above the wall foundations and thereafter in every fourth brick course (340 mm centres) of all walls with an additional layer in the last course. Masonry reinforcing shall also be placed in at least two courses below and above openings and has to continue at least 1 m beyond the opening corners.

Precast or reinforced brick lintels over all openings in walls shall be as specified on the drawings.

All lintels shall be supported on temporary formwork for at least 14 days. Precast lintels shall have a minimum of 230 mm support on either side.

2.2.6 Cavity walls

Return brick piers 110 mm wide and properly bonded into both brick leaves shall be constructed at the following spacings:

For 50 mm cavity walls - 3 000 mm c/c
50 to 110 mm cavity walls - 1 500 mm c/c

Vertical twist type wall ties galvanized to SANS 28 (750 g/m^2) shall also be provided at the spacing as specified in the standard specifications or on the structural drawings.

2.2.7 Protection and cleaning of masonry

Any part of masonry prone to damage or face brick staining shall be covered and protected during construction of the remaining work, and shall be made good to the satisfaction of the employer. Face-brick work shall be cleaned as the work proceeds.

During high air temperatures and strong winds newly laid brickwork shall be kept wet by an approved method for at least 24 hours.

2.2.8 Accuracy in building

Unless specified otherwise accuracy grade II shall apply as set out in SANS 10155.

C3.7.4 MECHANICAL SPECIFICATIONS

ZUT 0001 GENERAL MECHANICAL REQUIREMENTS

ZUT 0002 OPERATION AND MAINTENANCE MANUALS

ZUT 0003 CORROSION PROTECTION

ZUT 7001 STEEL SPECIALS

ZUT 7002 MEDIUM PRESSURE PIPELINES

ZUT 7003 LAYING AND JOINTING OF STEEL PIPES

ZUT 7004 VALVES FOR WATER AND WASTEWATER INSTALLATIONS

ZUT 7016 VALVE RESILIENT SEAL GATE

ZUT 7022 AIR VALVES

ZUT 7023 PIPE COUPLINGS

ZUT 7024 PIPE ANCHORS

ZUT 8009 MECHANICAL FLOW METERS

SPECIFICATION: ZUT 0001

GENERAL MECHANICAL REQUIREMENTS

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1. SCOPE

Zut 0001 specifies general technical requirements for contracts in which the Contractor is responsible for the detailed design.

2. NORMATIVE REFERENCES

The following form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Zut 0001).

- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Zut 7001: Design and Manufacture of Medium Pressure Steel Specials.
- Zut 7023: Pipe Couplings and Flange Adaptors.
- Zut 7024: Pipe Anchors.

- SANS 200
- SANS 719
- SANS 936/7
- SANS 989/992
- SANS 1034
- SANS 1062
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- SANS 10167
- SANS 10108
- SANS 10268
- SANS 12944
- SANS 15614
- SANS 15609
- SANS 15874
- SANS 50025
- SANS 60034
- SANS 61241
- SANS/ISO 4427

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- BS 1400
- BS 1452
- BS 1490
- BS 2035
- BS 2789
- BS 3100
- BS 3790
- BS 4515
- BS 4872
- BS 7854
- BS EN 681
- BS EN 1092
- BS EN 1591
- BS EN ISO 23936

- DIN 17 445

- ISO 4184
- ISO 10816

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

3. MATERIALS

3.1 GENERALLY

All materials used in the manufacture and construction of plant and equipment shall be new and unused. The Contractor shall ensure that the materials are selected in accordance with the best engineering practice to suit the working conditions and corrosive environments.

3.2 STEEL

Structural steel shall comply with the requirements of SANS 50025 for grade S 355 JR or for grade S 355 JO.

3.3 STAINLESS STEEL

3.3.1 General

The grade of stainless steel to be used shall be as specified. Rolled material shall be supplied with a matt, annealed and pickled or otherwise de-scaled surface finish.

Where grades EN Grade 1.4401 (316) and EN Grade 1.4301 (304) are specified, these shall be taken synonymously with the low carbon grades for welding.

If stainless steel is to be coated, it shall be suitably abrasive blasted to ensure adherence of the prime coat.

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3.3.2 Certification

The Contractor shall provide spectroscopic analyses of stainless steel materials. The analysis shall be undertaken by a local materials laboratory and shall be submitted to the Engineer.

Stainless steel supplied shall be clearly and permanently marked with the grade of stainless steel and cross referenced to the applicable test certificate.

3.4 3CR12

This is the titanium stabilised, 12 % chrome steel. It shall be supplied with an annealed and pickled finish.

If 3CR12 is to be coated, it shall be suitably abrasive blasted to ensure adherence of the prime coat.

3.5 PLASTICS

Thermoplastics and fibre reinforced polymers shall be UV resistant, have adequate tensile strength and high impact strength and generally suit the application.

PVC is regarded as too brittle and shall not be used unless called for in this Specification or accepted in writing by the Engineer before supply.

3.6 ELASTOMERS

The Contractor shall select elastomeric materials to be used for common duties as follows:

- Nitrile (NBR) shall be used if oil is present. PTFE or silicone shall be used if the working temperature is above 80 degrees Centigrade.
- EPDM may be used if oil is not present. PTFE or silicone shall be used if the working temperature is above 110 degrees Centigrade.

4. CASTINGS

Castings shall comply with the relevant South African or international standard for the material used, including the following:

Grey Cast Iron	SANS 1034; BS 1452
S. G. Iron	SANS 936/7; BS 2789
Steel (General Purpose)	SANS 1465; BS 3100
Aluminium	SANS 989/992; BS 1490
Stainless Steel	DIN 17 445
Copper and Copper Alloy	SANS 200; BS 1400

Castings shall be clean and sound and shall be neatly fettled and dressed. Surfaces shall be smooth and irregularities caused by mould washaways, and the presence of porosity, inclusions and sharp edges will not be tolerated. Areas under bolt heads, nuts and washers, shall be machined or spot faced to ensure a flat and smooth pressure bearing area, and sufficient space shall be provided for the use of ring or socket spanners.

All pressure retaining castings shall be hydrostatically tested to not less than 1,5 times the maximum working pressure after machining and shall be pressure tight.

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No repairs shall be undertaken to castings without the written permission of the Engineer. Cast iron castings shall not be welded.

Castings shall be heat treated to provide optimum corrosion resistance and toughness combined with reasonable machinability. In particular stainless steel castings shall be heat treated so as to ensure that all carbides are in solution, to ensure optimum grain size, and to provide maximum corrosion resistance.

The Contractor shall provide a test certificate for each casting or batch of castings, except for those made of grey cast iron, giving details of the material analysis, the heat treatment and any mechanical tests carried out.

5. FABRICATION OF CARBON STEEL & STAINLESS STEEL

5.1 GENERAL

Steelwork shall generally be constructed, fabricated and erected in accordance with the applicable requirements of SANS 1200 H.

Welding shall comply with the clause “Welding”.

Sharp edges, pits, inclusions, weld spatter, undercuts, indentations or other surface defects are not acceptable.

Edges shall be rounded to a radius of at least 2 mm.

Designs shall avoid inaccessible pockets and hollows.

Sharp edges on items fabricated from thin sheets will not be acceptable and sharp edges shall preferably be avoided by good design.

Inspection of fabrications shall generally be done after fabrication is complete.

5.2 CARBON STEELS

Structural steelwork shall be of grade S 355 JR or of grade S 355 JO in accordance with SANS 50025.

The requirements of the Hot Dip Galvaniser’s Association of South Africa shall be complied with if the item is to be hot-dip galvanised. Designs shall provide proper access for safe and complete entry of the molten zinc into open spaces so that subsequent drilling at the galvaniser’s yard is avoided.

Surfaces to be coated shall be accessible by blast and spray equipment. Inaccessible pockets, such as bad weld profile as well as hollow structures, are unacceptable and the angle of impact of blast material and sprayed coatings shall not be less than 45 degrees. Edges shall be rounded for safety reasons and also to be suitable for the coating system to be applied.

5.3 AUSTENITIC STAINLESS STEELS

Fabrication of austenitic stainless steels shall comply with the recommendations in the "Pocket Guide" issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steel fabricators shall use permanently dedicated storage and fabrication areas and shall use machines, tools and handling equipment which are suited and permanently dedicated to this type of material.

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Fabrications shall be pickled and passivated over their full surface to achieve an even colour. If grinding is required before pickling, the final grinding shall be done with a fine disc in order to remove coarse grinding marks.

5.4 3CR12

Fabrication of 3CR12 shall comply with the requirements for austenitic stainless steels except that the recommendations for Utility Ferritics in the “Pocket Guide" issued by Columbus Stainless shall be used. Compliance with publications from equivalent authorities will be acceptable.

5.5 HIGHLY ALLOYED STAINLESS STEELS

Fabrication of duplex, super austenitic and other highly alloyed stainless steels shall follow the metal producer’s own guidelines.

Welding of duplex stainless steel pipework shall be in accordance with BS 4515 Part 2 or equivalent.

6. WELDING

6.1 STANDARDS

Welding shall be in accordance with SANS 15614-1 or with other equivalent standards acceptable to the SAIW.

Welders shall be experienced artisans approved in accordance with BS 4872 or equivalent.

The Contractor shall ensure that all structural welding, including all welding of pipework, is done in accordance with a welding procedure specification (WPS). The welding supervisor shall ensure compliance with the WPS. The document shall be available for scrutiny at all times.

6.2 PREPARATION

Wire brush and de-grease both surfaces to at least 30 mm from the weld.

Cleaning of stainless steel shall utilise non-chlorinated fluids only.

6.3 CONTINUOUS WELDING AND ELIMINATION OF CREVICES

Welding shall be continuous on all sides of any joint. Designs which do not allow this shall be re-designed.

Crevices, including those arising from welding on one side only, shall be eliminated. This requirement applies to the welding of all metals and welding procedure shall be designed to prevent unacceptable deformation.

Welds which are only accessible from one side shall be prepared so that the root run provides an acceptable profile and prevents the formation of crevices. Pipework shall be designed so that such welds can be inspected and, where applicable, pickled and passivated.

In special cases only, non-continuous welding might be accepted in writing by the Engineer. The resulting crevices shall be sealed with a two part solvent free epoxy which can be applied at thicknesses of up to 600 µm and above such as Sigmaline 523 or Corrocoat Zip E or Sigmacover 1000 or equivalent.

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6.4 WELD APPEARANCE

Welding shall be free of blowholes, projections, pinholes, splatter and undercuts and all welding flux, weld spatter and other sharp imperfections shall be removed. Weld beads with a surface irregularity exceeding 3 mm or with sharp crests having a radius under 2 mm shall be ground.

6.5 SITE WELDING

Site welding shall be kept to a minimum and shall only be undertaken with the acceptance of the Engineer.

6.6 WELDING OF STAINLESS STEEL AND 3CR12 – ADDITIONAL REQUIREMENTS

Fabrication of austenitic stainless steels and 3CR12 shall comply with good practice and as described in the recommendations in the publications issued by Columbus Stainless. Compliance with publications from equivalent authorities will be acceptable.

Stainless steels to be welded shall be of the low carbon grade; e.g. 1.4306 rather than 1.4301 and 1.4404 rather than 1.4401.

The welding rods used shall be the most suitable for the metal and purpose.

Only welders experienced with welding stainless materials shall be used.

Welds which are accessible from only one side shall be executed in a manner to prevent heat tint or shall be post-weld treated in order to remove all traces of heat tint.

Type 309 stainless steel welding rods shall be used for welding 3CR12 unless otherwise accepted in writing. 3CR12 shall be welded as recommended by Columbus Stainless.

All possible steps shall be taken to ensure maximum corrosion resistance and strength of the welds and welded material. Special care shall be taken to avoid prolonged heating. Welds shall be passivated. Discolouration and steel contamination must be removed by pickling or electro cleaning as accepted by the Engineer but should rather be avoided by taking the appropriate measures.

6.7 INSPECTIONS

The Contractor shall arrange for all fabrications to be inspected by the Engineer prior to transport from the fabrication workshop.

7. CORROSION PROTECTION

7.1 GENERAL

Unless stated otherwise in the contract document, corrosion protection shall be suitable for the high corrosivity category (C4 of SANS 12944-2).

Corrosion protection shall comply with Zut 0003.

Corrosion protection systems used shall be suitable for an expected item life of at least 30 years in the environment for which they are designed. Corrosion protection for items which are buried or cast into concrete shall be designed for a life of 70 years.

7.2 SYSTEMS

The Contractor shall propose corrosion protection systems to the Engineer for review.

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The preferred system for structural steelwork and gantries is hot-dip galvanised carbon steel.

The preferred system for cranes is hot metal zinc spray and seal.

The preferred system for pipework internals is a solids containing barrier coating with a dry film thickness of not less than 800 microns.

The preferred system for guard rails, grid flooring, trench covers, stairways and ladders is hot-dip galvanised carbon steel (unless stainless steel is called for in the project specifications).

The preferred system for clarifier bridges and other carbon steel structures above water bodies is epoxy coated 3CR12 or hot-dip galvanised and painted carbon steel or hot metal zinc sprayed and sealed carbon steel.

Hot-dip galvanised surfaces to be painted shall be sweep blasted with air pressure less than 2,5 bar and a nozzle distance of at least 500 mm.

7.3 STAINLESS STEEL

Where specified, stainless steel pipework which is in contact with pipework or valves of other materials shall be provided with an internal coat to provide an electrical barrier between the stainless steel and the fluid. Stainless steel valves, strainers and other items of equipment shall be similarly coated if specified.

The surface shall be blasted in order to achieve an acceptable profile for the coating material.

A coating such as 70 microns of Sigmacover 280 or equivalent is acceptable. The coat shall extend over flange faces.

8. INSTALLATION

8.1 GENERAL

The Works shall comply with the following:

a) When erected and installed, the plant and equipment shall be of neat and workmanlike appearance, solidly and evenly supported, true to line, level, plumb and in proper working order.

b) There shall be no visible movement of static components.

c) The Contractor shall provide all anchor bolts, supports, hangers, brackets, etc. required for the support and fixing of equipment.

d) The Contractor is responsible for grouting work associated with the equipment and pipework to be provided in terms of the Contract.

e) No more than three shims at each position shall be used in the alignment of equipment. Machined spacers shall be prepared where necessary. Shims and spacers shall be of a corrosion resistant material such as stainless steel.

f) Corrosion protection requirements shall be carefully attended to and the requirements of Zut 0003 must be noted. All mating faces must be coated before and sealed after assembly.

g) A small amount of a nickel based, anti-seize compound shall be applied along the full length of fastener threads before the nut is threaded on.

h) Crevices which are formed by bolting between two metal surfaces shall, prior to final fastening, be filled with a suitable formable packing, Denso tape or equivalent, or with a suitable mastic or sealant.

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8.2 ALIGNMENT OF SHAFTS

Shafts for drives with an output above 150 kW shall be aligned to the driven shaft as follows:

a) Final alignment shall be done after installation and before commissioning and shall be checked in the presence of and to the approval of the Engineer. Alignment shall be sufficiently accurate to ensure that no pre-load is placed on the shaft coupling.

b) Each motor shall be aligned to its pump by alignment specialists using laser aligning equipment with real time computer display. This shall be done after the pipework is bolted to the pump.

9. CIVIL AND BUILDING WORKS

9.1 GENERAL DUTIES

The Contractor shall be responsible for grouting pipework required to pass through walls, for all equipment grouting work, anchoring of equipment and closing of apertures associated with equipment to be provided in terms of this Contract.

The Contractor's Documents shall indicate the civil and building details required to accommodate the equipment installation; subject to and in accordance with any details shown on the drawings provided by the Employer. These details shall include plinths, foundation blocks, rebates, pockets, sleeve ducts, holes, thrust blocks, anchor fasteners and openings/box-outs for pipework passing through walls.

The Contractor shall inspect and check the related structures constructed by others for accuracy and suitability of construction and for conformance with the Contractor's documents before commencing installation and construction. No payments shall be allowed for additional costs to the Contractor resulting from a failure to check such works timeously or a failure to provide the related information in Contractor's Documents timeously.

9.2 CIVIL CONTRACTOR'S WORK

The main civil and building works will be completed by others and will be mostly completed when the Contractor is granted access to the Site.

9.3 PUDDLE PIPES

The Contractor shall install the puddle pipes required by the design into concrete structures. For this purpose, the Contractor shall provide the details of box-outs required in the structure to the Engineer. Puddle flanges shall be of the same dimensions as standard flanges and the box-out shall be designed accordingly and with allowance for civil tolerances of $\pm$ 40 mm.

Concrete structures will generally be constructed by others and, if required, it will be tested for water tightness by the Engineer before handover to the Contractor by temporary closure of the box-outs.

Upon receiving access to the Site, the Contractor shall install the pipework and shall grout the puddle pipes into the structure using a suitable non-shrink grout to the approval of the Engineer. The Contractor shall provide a water tight installation and shall be responsible for rectifying any leakage at the puddle pipe.

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9.4 BASEFRAMES, PIPE ANCHORS, ETC.

The design requirements for baseframes and pipework anchors are specified elsewhere in Zut 0001.

The Contractor shall be responsible for grouting of baseframes, pipe anchors, plinths, etc. required for installation of the equipment and this includes any metallic structure which is mounted onto a concrete surface.

The method proposed for anchoring baseframes and for securing pipe anchors, etc., to concrete shall be submitted to the Engineer for approval and shall incorporate the details of the grout proposed. The material used for the primary grouting of the anchors shall be a non-shrink, cementitious grout such as ABE Duragrout 1000, or equivalent. ABE Epidermix 324, or equivalent, is acceptable if an epoxy grout is required.

The secondary grout shall be applied only after each anchor fastener has been tested for integrity. The design and grouting shall eliminate collection points for water or dirt.

If called for by the Engineer, the initial grouting shall be overseen by the grout supplier's technical representative.

10. PUMP SUCTION & DISCHARGE PIPEWORK

10.1 PUMP SUCTION PIPEWORK

Pump suction pipework shall comply with good hydraulic design so that the flow at each pump inlet has a steady, uniform pattern.

Suction side pipework shall have a pressure rating which is greater than the operating pressure of the pumping system.

Air leaks shall be prevented.

Two mechanical couplings shall be provided on each pump’s suction pipework. A single rubber tyre type coupling is acceptable for pump inlets of DN 100 and smaller.

The pipe connected to the pump inlet shall be a straight pipe of the same diameter as the pump inlet and shall have a length of at least five times its diameter. The remainder of the pipework shall preferably be sized so that the flow speed is no higher than 1,5 m/s.

The configuration of the suction manifold shall ensure equal flow to each pump, regardless of the number of pumps operating. The speed of flow in the suction manifold and into each pump branch shall be as low as feasible. Suction manifold tee offs shall be of swept tee formation if the nominal speed of flow in the pump’s branch pipe is 0,7 metres per second or higher. The suction manifold tee offs may be a normal tee formation for lower flow speeds.

Pipework shall be level or shall slope upwards toward the pump. High points shall be avoided where the flow speed is below one metre per second.

The Contractor shall provide bell mouths for pump suction pipework drawing water from open sumps. The bell mouth shall be flanged on one end and shall be of glass reinforced plastic, EN Grade 1.4401 (316) stainless steel or of cast iron. Bell mouth openings shall be mounted between 0,3D and 0,5D above the sump floor (“D” is the pipe diameter). All bell mouths in a single sump shall be mounted at the same height. The flow speed through the pipe shall be approximately 1,7 metres per second.

An access hatch shall be provided upstream of each screen and/or flow straightener. The hatch shall incorporate an inner surface which is streamlined to match the pipe curvature.

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10.2 PUMP DISCHARGE PIPEWORK

Two mechanical couplings or one rubber tyre type coupling shall be provided on each pump's discharge pipework.

11. PIPEWORK FOR FLOW METER CHAMBER

One flange adaptor shall be provided upstream of the flow meter and one flange adaptor shall be provided downstream of the meter.

The pipework shall also make allowance for one isolation valve upstream of the flow meter.

12. STEEL PIPEWORK

12.1 INTRODUCTION

This clause specifies requirements for carbon steel and stainless steel pipework.

12.2 INSPECTION AND TESTING

Prior to the start of welding, the Contractor shall perform the following:

a) Obtain acceptance of quality control documentation from the Employer's Representative.

b) Provide certification of the chemical composition of the pipe steel; including heat treatment.

c) Confirm that the welder(s) has passed the qualification tests as specified in Clauses 6.1 to 6.7 of API Standard 1104. An equivalent standard, such as SANS 9606, is acceptable.

d) Provide the welding procedure specification (WPS); which shall comply with SANS 15609.

Quality of welding shall comply with SANS 3834. Where dispute arises regarding acceptance of welds, the requirements of SANS 10167 shall be used. All failures shall be reported to the Engineer who shall determine the rectification procedure.

The Contractor shall perform the following:

a) Visually inspect pipework.

b) 100 % dye penetrant testing of all welds.

c) X-Ray test the first five butt welds by any individual welder.

d) X-Ray 10 % of welds. This percentage might be reduced by the Engineer if welds are found to be in order during initial testing. On discovery of defective welds, however, the Engineer may call for X-Ray examination of all welds until it is shown that the necessary standard is being maintained. Repairs of welded joints will be permitted and the repair procedure and performance of repairs shall be in accordance with Section 10 of API Specification 5L.

e) Arrange for the Engineer to inspect the pipework after fabrication but before any corrosion protection.

f) Measure paint thickness.

g) Pressure test pipelines.

h) Provide inspection and test reports

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12.3 CONSTRUCTION, MATERIALS AND CONFIGURATION

12.3.1 Overall Configuration

Steel pipework shall be joined using bolted flanges. Steel pipework smaller than DN 150 may be of threaded rather than of flanged construction.

Pipework shall be anchored to withstand forces. It shall be supported above floor level on pipe anchors or shall be wall mounted and shall not be installed at the floor level.

Gravity lines shall have a minimum downward slope in the direction of flow of one percent.

Pipework shall be configured and shall be provided with couplings and/or bends to allow easy dismantling and disassembly without damage to the pipework or pipe anchors.

The Contractor's design shall accommodate thermal and structural movement and shall isolate structures from vibration.

Provision shall be made for draining all sections of pipework and for venting high points. Stainless steel ball valves shall be provided at each point.

Bends shall preferably be of the long radius type. 90 degree "lobster back bends" shall have a minimum of five segments and the pipe welded to each flange shall be perpendicular to its flange.

Convergences shall preferably be of swept tee configuration.

The full internal surface of welds shall be accessible for inspection and this might require that bends, tees and bifurcations are short.

Pipework shall be sized so that the speed of flow of fluids containing solids which could settle does not drop below 0,8 metres per second during operation.

12.3.2 Pipe

Carbon steel pipework shall be fabricated from welded carbon steel pipes complying with SANS 719.

Austenitic stainless steel and 3CR12 pipes shall be to ASTM A312, ANSI B36.19 or ANSI B36.10 or equivalent. Duplex stainless steel pipes shall be fabricated in an automated production pipe facility using mechanised welding procedures; i.e. they shall not be fabricated by the Contractor from plate.

12.3.3 Flanges

Flanges shall comply with SANS 1123 or BS EN 1092. Flange sizes and pressure ranges greater than provided in these standards shall be designed in accordance with an equivalent flange in ASME B16.47 and shall meet the jointing requirements of BS EN 1591. Flanges which are required to match existing flanges may deviate from these requirements.

Pipework of PN 25 and above shall have raised face flanges.

Flange drilling shall be "off centre" unless required to match an existing flange which is drilled otherwise.

The jointing material used on flange joints shall be of a suitable rubber or compressed mineral fibre at least 3 mm thick complying with BS EN 681 or BS EN ISO 23936, as applicable. Gaskets shall be full face. Properly designed O-ring seals are also acceptable.

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Carbon steel flanges shall be chamfered on their outside edges, on their inside edges and on both sides of each bolt hole in order to provide a suitable surface for the corrosion protection coating to be applied. Stainless steel flanges shall be chamfered on their outside edges.

12.3.4 Manufacture

The manufacture of pipe specials shall comply with Zut 7001.

Welding shall be in accordance with SANS 15614-1. Welding shall achieve full penetration. Crevices are not acceptable. Both internal and external weld surfaces shall have a neat profile.

Fabrication shall comply with the quality requirements for fabrications specified elsewhere in Zut 0001.

12.3.5 Corrosion Protection

Corrosion protection shall comply with Zut 0003.

12.3.6 Pipe Couplings, Alignment & Flexibility

Pipe couplings shall be provided where misalignment or dismantling must be allowed for and also for possible pipe movement from settlement or other cause. The coupling shall have the same or higher pressure rating than the pipework in which it is installed.

Thrust restraints on couplings shall only be provided where these are essential.

Pipe couplings shall comply with Zut 7023.

12.3.7 Reducers

Reducers shall have a maximum total angle of divergence of 10 degrees.

The tapered pipe shall not be welded directly to the flanges; i.e. a short, perpendicular, cylindrical length of pipe shall be provided between the tapered pipe and each flange.

12.3.8 Nozzles/Sockets

Nozzles shall be provided for the installation of gauges, transmitters, drain pipes, cooling water take-offs, air release valves, etc.

In carbon steel pipework, nozzles shall be designed so that the pipework corrosion prevention system can be correctly applied. A nozzle shall consist of a flanged, welded tee-off of at least 100 mm diameter, coated internally and provided with a non-corrosive blank flange, e.g. EN Grade 1.4401 (316) stainless steel. The blank flange shall be provided with tapped holes, or similar, suitable for the installation.

Stainless steel pipework shall be provided with stainless steel sockets which are welded into the pipework with no crevices either externally or internally.

Nozzles on the suction side of pumps shall be designed and positioned to cause minimum interference to the flow.

Nozzles for pressure gauges and sensors shall be positioned for steady, uniform flow.

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12.3.9 Flow Velocity

Air flow speeds in pipework smaller than DN 150 shall be approximately 10 m/s and shall not exceed 20 m/s. Air flow speeds in larger pipework shall be approximately 20 m/s and shall not exceed 25 m/s.

Where the pipe diameter is not specified elsewhere, the design flow velocities for water shall be as follows:

DESIGN FLOW VELOCITY [m/s]				
	flow = 0 - 2,5 ℓ/s	*flow = 2,5 - 15 ℓ/s*	*flow = 15 - 100 ℓ/s*	*flow = 100 - 500 ℓ/s*
grit free	< 0,75	< 1,25	< 1,5	< 2
solids containing	0,8 – 1,5	0,8 – 1,5	1 – 1,75	1 – 2

12.3.10 Site Work

Pipework shall be neatly installed, straight to line and level and adequately supported.

The Contractor shall make allowance for the misalignment of pipework to which the Contractor's pipework is to be connected.

12.3.11 Sludge Pipework

Sludge pipework shall be provided with a rodding eye, or similar, at bends to provide access for cleaning.

Sludge discharge pipework shall have a minimum slope of one percent downwards in the direction of flow.

12.3.12 Puddle Pipework

Puddle pipes to be cast into concrete shall be of EN Grade 1.4401 (316) stainless steel or shall be of a grade of stainless steel with a higher Pitting Resistance Equivalence Number than EN Grade 1.4401 (316).

Puddle pipes shall be a straight length, flanged both ends and with a puddle flange. Puddle pipe length shall be as short as feasible but adequate clearance shall be provided for inserting flange bolts and for valve handwheels and/or actuators.

The puddle flange shall be of the same diameter as a normal flange and shall be positioned in the central plane of the concrete. It shall be of the same material as the puddle pipe. Puddle flanges shall have a plate thickness of at least half the thickness of the standard flange but with a minimum of 10 mm. They shall be fully welded on both sides.

External surfaces which are not encased in concrete shall receive the full corrosion protection system. The coating shall extend about 50 mm into the concrete but the area in contact with the concrete shall otherwise be uncoated. This uncoated area shall be abrasive blasted to promote bonding with the concrete.

The Contractor shall submit a method statement for the grouting process and shall not cast the puddle pipe into the concrete structure until the Engineer has accepted this statement.

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12.3.13 Marine Pipework

Pipework containing sea water or brine shall comply with the following:

a) Shall be of EN Grade 1.4410 (2507) super duplex stainless steel.

b) One bolted hatch shall be provided upstream of each valve. The hatch shall be DN 150 or larger.

13. PLASTIC PIPEWORK

Polyethylene or Polypropylene pipes shall comply with SANS/ISO 4427 and SANS 15874 respectively and shall carry the SABS mark.

PVC pipework is not acceptable for applications involving vibration or shock, including hydraulic shock.

An operating life of 50 years shall be designed for and appropriate de-rating factors shall be applied to suit the application. The class of pipe selected shall be suitable for at least 1,5 times the actual maximum operating pressure.

Plastic pipework installed externally shall be provided with protection against ultraviolet light.

Tappings, for example for gauges, shall be provided with welded, external doubler plates. The plates shall have a thickness at least equal to the wall thickness of the pipe.

Welding of thermoplastic pipework shall comply with SANS 10268.

14. CAST IRON PIPEWORK

Cast iron pipes and fittings shall comply with BS 2035 (Class D) and shall be pressure tested in accordance with Clause 12 of that Standard. The requirements of the Standard's Clause 6 regarding freedom from defects and casting appearance and Clauses 8, 9 and 10 regarding casting accuracy will be strictly applied.

Cast iron pipework shall comply with the requirements of the clause “Castings".

15. PIPEWORK ANCHORS

Anchors for steel pipework and for plastic pipework shall comply with Zut 7024.

16. ELECTRIC MOTORS SMALLER THAN 30 KW

16.1 PREAMBLE

Induction motors smaller than 30 kW shall comply with this clause.

16.2 GENERAL REQUIREMENTS

Motors shall be rated for operation on a 3-phase, 4-wire, 400/230 Volt, 50 Hz, AC supply.

Motors shall be squirrel cage motors in accordance with SANS 60034. Cooling shall be IC 0141 (similar to “tefc”) and the motors shall be suitable for a damp environment. Ingress protection shall be IP 55 or higher.

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Motors shall be suitable for both "continuous running duty", Duty Class S1, and "intermittent periodic duty", Duty Class S3. Windings shall be insulated with Class F material (100 ºC rise capability) with a designed Class B temperature rise (80 ºC). The motors shall be suitable for 6 starts per hour, two of which shall be consecutive.

A stainless steel rating plate shall be secured to the frame with stainless steel fasteners. This shall include the motor's lubrication details. If the manufacturer's nameplate does not comply with these requirements, the Contractor shall provide additional nameplates.

Motors above 30 kg shall be provided with lifting eyes or lugs.

16.3 PERFORMANCE REQUIREMENTS

Motors shall perform in accordance with the requirements of the specified mechanical equipment but the rated power of the motor shall, nevertheless, not be less than 20 % in excess of the designed power requirement of the driven equipment (the Engineer might waive this latter requirement if the motor forms part of a factory packaged unit).

Motors shall be designed to provide their rated power output at an ambient temperature of up to 40 ºC and at an altitude of at least 1 500 masl.

16.4 OPERATION AND CONTROL

Protection against both starting overload and running overload shall be provided.

16.5 VFC DRIVEN MOTORS

The Contractor shall submit correspondence from the motor manufacturer/designer which confirms that the motor is designed for supply from the particular make and model of variable frequency converter to be provided in the application without shortening of the motor's lifespan.

Unless of the submersible or immersible type, VFC driven motors shall be cooled by a separate, constant speed fan (this requirement will be waived if the Contractor provides documentation confirming that the drive and motor design can operate in the application, with shaft-mounted fan, without exceeding its designed temperature rise).

Motors shall incorporate protection against damage to the bearings from induced currents.

16.6 BEARINGS

Bearings shall be of the rolling element type (i.e. ball or roller) and may be either oil or grease lubricated.

Grease lubricated bearings shall be re-greasable during motor operation. They shall be provided with stainless steel grease nipples and shall be suited for external applications. A port for relief against over-greasing shall be provided. Greasing points shall be provided with stainless steel extension tubes where access is restricted.

L-10 design life shall not be less than 100 000 hours.

Bearings shall comply with the clause "Bearings" in Zut 0001.

16.7 CORROSION PROTECTION

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

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The fan cowl shall preferably be of cast iron or of stainless steel. For internal applications, plastic fan cowls are acceptable. Carbon steel cowls are acceptable if hot-dip galvanised. Painted carbon steel cowls are not acceptable.

16.8 HAZARDOUS LOCATIONS

If the specification calls for a motor to suit a hazardous location in terms of SANS 10108, then suitable motors complying with SANS 60034-5 or SANS 61241, as appropriate, shall be supplied.

The relevant SANS certificates, clearly indicating the location classification in which the machine may be operated, shall be submitted to the Engineer before delivery of the motors.

Each motor shall be clearly and permanently marked with the applicable certificate number.

16.9 SAFETY

Rotating parts shall be guarded as required by legislation.

17. ELECTRIC MOTORS OF 30 KW AND LARGER

17.1 PREAMBLE

Cage and slipring induction motors of 30 kW and above, with the exception of 3,3 kV, 6,6 kV, 11 kV and 15 kV motors, shall comply with this clause.

3,3 kV, 6,6 kV, 11 kV and 15 kV motors shall comply with the specification for MV motors.

17.2 GENERAL REQUIREMENTS

Motors shall be in accordance with SANS 60034.

The type of motor and starter to be provided by the Contractor shall be determined by the requirements of the application specified and by any starting limitations specified. In the absence of such specifications, a squirrel cage motor shall be provided. If a special motor is required to obtain special starting characteristics and/or variable speed, this shall be to a standard at least equal to this specification and shall incorporate all aspects of electrical protection.

Motors with a rating below 1 000 kW shall be squirrel cage motors with cooling to IC 0141 (similar to “tefc”). Ingress protection shall be IP 55 or higher.

Motors with a rating above 1 000 kW shall be squirrel cage motors of CACA configuration with an ingress protection rating of at least IP 55 and shall be provided with oil lubricated sleeve bearings.

Motors shall be suitable for both "continuous running duty", Duty Class S1, and "intermittent periodic duty", Duty Class S3. Windings shall be insulated with Class F material (100 ºC rise capability) with a designed Class B temperature rise (80 ºC). The motors shall be suitable for 6 starts per hour, two of which shall be consecutive.

Wound rotor motors shall have a separate enclosure for the slip-ring assembly to ensure that dust from the slip ring followers does not enter the motor. The enclosure shall have the same ingress protection as the main motor enclosure but shall have covers for direct access. The rings shall preferably be of stainless steel.

Motors shall be structurally suitable for DOL starting regardless of the specified starting system.

The frame and end covers shall locate on a spigotted register to ensure concentricity and parallelism.

Motors shall be provided with lifting eyes or lugs.

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An earth terminal shall be provided on the frame.

Access shall be provided to the winding neutral point.

All monitored motor parameters; e.g. bearing temperature, winding temperature, current, etc.; shall be appropriately indicated.

Motors shall be of the reduced noise level type.

At least one internal cooling circuit fan shall be provided for frame sizes 355 and larger.

Motors of size 75 kW and above shall be fitted with "pocket" heaters. These shall be arranged to switch on when the motor stops operating and switch off when the motor starts operating.

A stainless steel rating plate shall be secured to the frame with stainless steel fasteners. This shall include the machine's lubrication details. If the manufacturer's nameplate does not comply with these requirements, the Contractor shall provide additional nameplates.

Measured vibration severity at the bearings shall meet the requirements of Zone A or Zone B of ISO 10816.

When motors are transported, care shall be taken to prevent damage to bearings.

17.3 PERFORMANCE REQUIREMENTS

Motors shall perform in accordance with the requirements of the specified mechanical equipment but the rated power of the motor shall, nevertheless, not be less than 15 % in excess of the designed power requirement of the driven equipment.

Motors shall be designed to provide this rated power output at an ambient temperature of up to 40 ºC and at an altitude of at least 1 500 masl.

Motors shall reach full operating speed within 5 seconds unless driven by electronic soft start or variable speed drive.

Protection against both starting and running overload shall be provided.

17.4 400 VOLT MOTORS

400 Volt motors shall be designed to operate on a 3-phase, 4-wire, 400/230 volt, 50 Hz, AC supply.

17.5 TEFC MOTORS

The fan cowl shall preferably be of cast iron or of stainless steel. For internal applications, plastic fan cowls are acceptable. Carbon steel cowls are acceptable if hot-dip galvanised. Painted carbon steel cowls are not acceptable.

If it is specified that the motor shall produce low sound output, the fan cowl shall be provided with internal damping.

17.6 CACA MOTORS

The heat exchanger shall be provided with lifting eyes or lugs.

Silencers shall be provided for cooling air inlets and outlets.

Rotors shall be dynamically balanced.

Ports shall be provided for air gap measurement at the drive end and at the non-drive end.

Vertical jacking shall be provided at each holding down point.

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17.7 VFC DRIVEN MOTORS

Motors fed by frequency converters shall comply with the following:

- Motors shall be rated to allow for additional harmonic losses in accordance with SANS 60034-17. The voltage stress withstand capability of the motor shall be checked against the converter supplier's specification. The stress due to converter operation shall be lower than the repetitive voltage stress withstand capability of the motor winding insulation system.
- Motors shall incorporate an insulated bearing and an earthing brush (or other approved protection against damage to the bearings from induced currents).
- Motors, unless submersible or immersible, shall be cooled by auxiliary constant speed motor driven fans.

The Contractor shall submit the following to the Engineer.

- Confirmation that the motors comply with the requirements of SANS 60034-25 for the application.
- Motor manufacturer's written confirmation that the motor is suitable for drive by the VFC make and model to be provided, including confirmation that the motor's voltage withstand capability is sufficient for the voltage stresses that will occur at the motor terminals.
- Guaranteed VFC harmonic performance including sample output wave forms with harmonic distortion levels at 40, 45 and 50 Hz for the VFC for the load.
- Guaranteed VFC dip ride through capability curve.
- Copy of VFC type test certificate (this is required if type tests have been carried out on the model).

17.8 BEARINGS

Bearings shall comply with the clause "Bearings" in Zut 0001.

Grease lubricated rolling element bearings shall be re-greasable during motor operation. They shall be provided with stainless steel grease nipples and shall be suitable for external applications. A port for relief against over-greasing shall be provided. Greasing points shall be provided with stainless steel extension tubes where access is restricted.

Bearings for motors of 250 kW and above shall be provided with temperature measurement, indication and alarm.

Bearings for motors in belt drive applications shall be of the rolling element type; i.e. shall not be slide bearings.

17.9 INSTRUMENTATION

Motors of 30 kW and up to (but not including) 150 kW shall be provided with thermistors embedded in the windings of each phase. The thermistor tails shall be "brought out" to separate terminals mounted near the motor winding terminal block.

Motors rated at 150 kW and above shall be provided with PT 100 type RTDs. Two RTDs shall be provided per phase winding. All six shall be incorporated into the control system; three to provide monitoring and three to provide high temperature trip functions.

17.10 CORROSION PROTECTION

Motors shall be provided with a corrosion protection system which is suitable for the high corrosivity category, C4, of SANS 12944-2.

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17.11 HAZARDOUS LOCATIONS

If the specification calls for a motor tor suit a hazardous location in terms of SANS 10108, then suitable motors complying with SANS 60034-5 or SANS 61241, as appropriate, shall be supplied.

The relevant SANS certificates, clearly indicating the location classification in which the machine may be operated, shall be submitted to the Engineer before delivery of the motors.

Each motor shall be clearly and permanently marked with the applicable certificate number.

17.12 SAFETY

Rotating parts shall be guarded as required by legislation.

18. PLINTHS & BASEFRAMES - PERMANENTLY MOUNTED EQUIPMENT

18.1 GENERAL

Permanently mounted rotating equipment shall be mounted on a metal baseframe and shall not be mounted directly onto concrete plinths.

The Contractor shall provide the baseframe, anchor fasteners, grouting, chemical anchor, etc. and is responsible for all installation work, including anchoring of the baseframe to the plinth.

The concrete plinth shall be designed by the Contractor for the application.

Equipment up to 1 000 kW shall be mounted on common baseframes. Separate baseframes may be provided for equipment above 1 000 kW and such base frames shall be grouted within (encapsulated in) their concrete plinths.

Equipment shall be secured to baseframes with both flat washers and spring washers (or another locking mechanism) of adequate size. Through bolts shall be used; i.e. a nut shall be used to secure the bolt.

The Contractor shall submit the baseframe workshop drawings to the Engineer for acceptance.

18.2 PLINTHS

The Contractor shall take into account all dynamic and static forces in the design of the reinforced concrete plinth and shall submit the design calculations and drawings to the Engineer for acceptance. The calculations shall confirm that the equipment's enforcing vibration will cause no resonant condition. If the plinth rests directly on soil, the calculations shall demonstrate that the design is suitable for the ground conditions. The design shall ensure that all forces, including the motor breakdown torque (or equivalent force if the driver is not a motor) and the torque experienced at power failure, will be properly withstood.

Plinths shall comply with all of the following:

- Plinth shall be of reinforced concrete.
- Plinth mass shall be greater than 4,5 times the sum of the masses of the driver and the driven equipment.
- Width of plinth shall be greater than the height between the shaft centreline and the bottom of the plinth.
- Height of plinth shall be greater than one fifth of the width.
- Height of plinth shall be greater than one tenth of the length.

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- Plinths for rotating equipment above 130 kW shall be isolated from the surrounding floor and other machinery plinths (this requirement does not apply to machinery which is isolated from the floor by proprietary anti-vibration mounts).

18.3 SOLEPLATES

Sole plates; i.e. plate supports for equipment feet which are individually anchored into the concrete plinth; are acceptable as baseframes for equipment above 1 000 kW. They shall be grouted within (encapsulated in) their concrete plinths.

The soleplates to a depth of 50 mm within the concrete plinth/grout shall be of EN Grade 1.4401 (316) stainless steel or better for corrosion resistance. Carbon steel is acceptable for portions of the soleplates with concrete cover of 50 mm or more.

The soleplate's structure shall be designed so that air will not be captured under it during grouting.

18.4 BASEFRAMES

18.4.1 Dimensions

Baseframes shall have dimensions which comply with the larger of the following:

- The main frame members shall have a height of at least 0,095 times the length of the baseframe.
- The main frame members shall have a height of at least 0,18 times the width of the baseframe.

Baseframes fabricated from members which are cold formed from plate shall also comply with the following:

- The plate thickness shall have a thickness greater than 0.0037 times the length of the baseframe (but with a minimum of 4,5 mm).

18.4.2 Materials

Baseframes shall be fabricated from carbon steels complying with SANS 50025 for grade S 355 JR or S 355 JO or from 3CR12 or from EN Grade 1.4162 (LDX 2101) stainless steel.

18.4.3 Mounting Pads

The baseframe shall incorporate machined mounting pads for each equipment foot. The thickness of the mounting pads before machining shall be at least 1,25 times the diameter of the holding down bolts. The pads shall be drilled for inserting through-bolts (i.e. not machine screws in threaded holes) and access to the underside shall be provided.

Machining of the top surfaces of mounting pads shall be done after fabrication, stress relieving and hot-dip galvanizing, if applicable, are complete. In the period between machining and installation of the equipment, the machined surface shall be protected against corrosion by a removable coating. After installation, a non-hardening compound, Valvoline Tectyl Multipurpose 506 or equivalent, shall be liberally applied to exposed machined surfaces and to the crevices formed at the foot of the equipment.

18.4.4 Jacking Points

Baseframes shall be provided with robust jacking points for alignment of the motor to the driven equipment.

Jacking screws shall be hot dip galvanised.

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18.4.5 Fabrication

Fabrication and welding shall comply with the requirements elsewhere in Zut 0001.

The Contractor shall arrange for the Engineer to inspect the fabrication of the baseframe before corrosion protection.

18.4.6 Corrosion Protection

18.4.6.1 General

The design of the baseplate shall take into account all practical aspects of the corrosion protection system; for example:

- accessibility for surface preparation and coating.
- hidden surfaces are not acceptable.
- inaccessible pockets and hollow spaces which cannot be accessed by blast and spray equipment shall be avoided or shall be welded closed;.
- structures to be hot dip galvanised shall provide proper access for safe and complete entry and exit of the molten zinc.

Baseframe designs shall prevent pooling of water. They shall be grout filled and/or shall be provided with large drain holes in all side members (before corrosion protection).

Holes in the baseframe and welded lugs for mounting of conduits, etc. are acceptable on condition that these are provided prior to galvanising or prior to pickling and passivation, whichever is applicable. They shall preferably be positioned near the neutral axis of steel sections.

18.4.6.2 Carbon Steel Baseframes

Carbon steel baseframes shall be hot-dip galvanized in accordance with Zut 0003.

Baseframes which are drilled, welded or ground after galvanising will be rejected. Machine milling of mounting pads, with subsequent protection against corrosion as specified, is acceptable.

18.4.6.3 Stainless Steel and 3CR12 Baseframes

3CR12 shall be coated with a suitable system complying with Zut 0003.

EN Grade 1.4162 (LDX 2101) stainless steel and other stainless steels need not be coated.

18.4.7 Anchor Fasteners

18.4.7.1 Requirements for All Baseframes

Baseframe anchor fasteners shall be of EN Grade 1.4401 (316), or better.

Fasteners shall comply with the requirements for fasteners elsewhere in this specification.

The baseframe and plinth shall form a structural unit (i.e. the baseframe and plinth shall vibrate as a unit) and, to achieve this, the baseframe anchors must transfer force into the concrete (i.e. it is not acceptable to provide a levelling nut below the baseframe as the anchor will not be properly pre-stressed into the plinth).

Anchor fasteners shall be provided with both a lock washer and a flat washer of adequate size.

18.4.7.2 Additional Requirements for Pump Baseframes

Baseframe anchor fastener size for pump installations shall be in accordance with the table below.

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Pump Inlet Size	Minimum Fastener Size
DN 50	M10
DN 100	M12
DN 200	M12
DN 300	M16
DN 400	M20
DN 500	M24
DN 600 and larger	M30

The number of baseframe anchors for pump installations shall be in accordance with the table below.

Pump Inlet Size	Minimum Fasteners (No.)
DN 50	6
DN 50 to DN 150	8
Above DN 150	10, or more.

18.4.8 Installation

Not more than three shims may be used at any point and these shall be of a corrosion resistant material.

Concrete surfaces under baseframes shall be scabbled before the baseframe is placed and shall be clean. Dust shall be removed from the surface by compresed air immediately before grouting.

Baseframes shall be grouted in a manner which will eliminate collection points for water or dirt.

The material used for grouting shall be a non-shrink, cementitious grout (ABE Duragrout 1000, or equivalent).

Final equipment alignment shall be done after grouting has been completed.

19. SKID MOUNTED EQUIPMENT

Skid baseframes shall comply with the design requirements for anchored baseframes. They shall be single fabricated units.

The baseframe shall be provided with four jacking points and four lifting points.

Equipment shall be secured to the baseframe on anti-vibration mounts.

Skid baseframes shall be placed on anti-vibration rubber mats, “Tico pad” or equivalent. These shall provide a gap between the skid and the concrete in order to prevent pooling of liquids (in addition to vibration isolation). The elastomeric materials shall be resistant to oil.

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20. MACHINE GUARDS

Guards shall comply in all respects with the Occupational Health and Safety Act of 1993 as amended.

Guards are required to cover all moving or revolving components of machinery and shall prevent a person from touching any moving protrusion. Guards which do not adequately cover moving protrusions such as keys, lock nuts, lock washers, setscrews, etc., or irregularities such as keyways, will under no circumstances be accepted.

Guards shall be neatly and rigidly constructed and fixed and shall not vibrate or cause noise during operation.

Where expanded metal or similar mesh is used, the mesh opening shall not permit a circular object 10 mm or larger to penetrate. Mesh shall not be used for chain guards but on belt drives the side of the guard most conveniently sited for inspection shall be constructed of expanded metal or similar. Mesh should similarly be used in other situations where inspection or ventilation is required.

Allowance must be made for adjustment where adjustment will be required such as on belt guards.

It shall be possible to remove guards easily for maintenance purposes.

Guards shall preferably be fabricated of EN Grade 1.4401 (316) stainless steel (uncoated) but may also be hot-dip galvanized, hot metal zinc-sprayed or hot metal aluminium-sprayed carbon steel, coated to Specification in all these cases. Fasteners shall be M10 or larger and shall be of EN Grade 1.4401 (316) stainless steel.

21. SHAFT COUPLINGS

Shaft couplings shall be selected to reduce transmission of misalignment forces and of torsional oscillations between the driving and the driven machine. The service factor for electric motor drives shall be at least 1,5; for electric motors on variable frequency converter drives shall be at least 2 and for internal combustion engine drives shall be at least 2,5.

Couplings shall preferably be of the rubber tyre or rubber compression type, keyed to the shafts. Elastomeric elements shall be urethane based.

The design shall respect the requirements of the machine bearings in order to counter thrust forces and limit axial movement.

Flexible metallic elements shall be of stainless steel. Couplings shall not require lubrication.

Spacer couplings shall be used where required for disassembly of the equipment. It shall be possible to dismantle the coupling without having to move either the driver or the driven equipment.

Coupling guards shall comply with the requirements of the OHS Act and shall be to the approval of the Engineer.

After installation, shaft alignment shall be checked by the Contractor in the presence of the Engineer or a person delegated by him. Alignment shall be accurate and to the approval of the Engineer.

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22. BELT DRIVES

Belt drives shall be designed to suit the power rating of the motor using service factors appropriate to the driving and driven machinery. Drives shall be designed, manufactured and installed in accordance with BS 3790 and ISO 4184 or equivalent, utilizing taperlock pulleys with taperlocks keyed to the shaft.

Where alternative pulley diameters can be selected, preference must be given to the larger pulley diameters to minimize the belt loading on bearings.

The bearing arrangements of driving and driven machinery shall be designed to cope with the loads imposed by belt drives. Rolling element bearings shall be designed for an L-10 life exceeding 100 000 hours.

Belt drives shall incorporate lay shafts where necessary. Lay shafts shall be supported by bearings mounted in bearing housings which are adequately sealed and fitted with grease nipples. Bearing units incorporating open, shielded bearings are not acceptable.

Belt driven machinery shall be equipped with rolling element bearings; i.e. shall not be equipped with slide bearings.

23. DRIVEN GEARBOXES

23.1 GENERAL

Driven gearboxes shall be supplied with environmental protection to IP 55 or higher.

The gearbox ratings shall be provided for an ambient temperature of 40 degrees Centigrade.

Gearboxes shall have an efficiency of not less than 96 % on two stage reduction and 95 % on three stage reduction.

23.2 SERVICE FACTOR

23.2.1 Motor Driven Gearboxes

The service factor to be used for the design of gearboxes in uniform load duty shall be at least 1,25 for electric motor driven applications. A minimum service factor of 1,5 shall be used for moderate shock applications and a minimum service factor of 2 shall be used for heavy shock applications.

23.2.2 Engine driven gearboxes

The service factor to be used for engine driven gearboxes shall not be less than 2.

23.3 DESIGN REQUIREMENTS

Gears shall be case hardened, profile ground and lapped, helical and spiral bevel gears.

The gearbox housing shall be of rigid cast construction preferably split in the horizontal plane.

Unless close coupled, each gearbox shall be mounted on machined sole plates fitted with jacking screws to assist with alignment.

Rolling element bearings shall be designed for an L-10 life in excess of 100 000 hours.

A breather designed to prevent moisture from entering shall be fitted.

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23.4 LUBRICATION

Oil-bath gearboxes shall have suitable oil level indicators or dipsticks which indicate the allowable levels. Inaccessible oil drain points shall be provided with extensions so that the oil can be easily drained. The drain line shall be of EN Grade 1.4401 (316) stainless steel and shall be fitted with a ball valve and square head plug.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

23.5 OIL CHANGE

The Contractor shall drain and replace oil in all gearboxes during the Defects Notification Period.

23.6 CORROSION PROTECTION

Gearbox external surfaces shall be provided with a coating suitable for the high corrosivity category (C4 of SANS 12944-2) and the dry film thickness shall not be less than 200 micron.

24. MANUAL GEARBOXES

An over-torque limiting device shall be incorporated.

Grease lubrication points shall be easily accessible. Grease nipples shall be of stainless steel.

A breather designed to prevent moisture from entering shall be fitted.

25. BEARINGS

25.1 BEARING CHOICE

Bearing design shall suit the requirements of the equipment and the installation.

Greased lubricated bearings are acceptable for units with power ratings up to 100 kW but oil lubricated bearings are preferred for larger machines.

Units with power ratings above 1 000 kW shall be provided with slide bearings (oil film type). Slide bearings are also preferred for units with high speed shafts and for high temperature applications.

25.2 OPERATIONAL REQUIREMENTS

Bearing designs shall ensure safe shut down without damage following electrical supply failure.

Bearing designs for variable speed drive applications shall be suitable for the full expected speed range.

25.3 SEALS

Bearings shall be provided with seals to prevent the ingress of water and solids.

25.4 ROLLING ELEMENT BEARINGS

For shaft sizes above 50 mm, the bearing shall be selected for an L-10 bearing life of at least 100 000 hours. This may be reduced if the equipment is expected to operate for less than 3 000 hours in a normal year.

Grease lubricated rolling element bearings shall be provided with relief against over greasing.

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Oil lubricated rolling element bearings shall be provided with an oil ring.

25.5 SLIDE BEARINGS

Slide bearings ("plain bearings", "oil-film bearings" or "sleeve bearings") which are oil lubricated shall have lubrication by oil ring, by rotating dish or by pumped feed or by a combination of these.

Lubrication shall be active during normal run down and during power failure and the design shall ensure that the bearing is not damaged.

Loss of pressure in pumped lubrication systems shall lead to shut down of the machinery.

Small diameter bushes shall preferably be self-lubricated sintered metal or of engineering polymer with suitable lubrication.

25.6 MOTOR BEARINGS

Motor bearings shall be provided with protection against stray currents which cause damage to the bearing.

25.7 THERMAL ALARMS

Thermal alarms on bearing systems shall be set in accordance with the equipment manufacturer's instructions.

Alarm settings done on Site shall be set after at least 24 hours of operation have occurred.

If high temperature protection is specified for a bearing, the Contractor shall note the equilibrium temperature reached after 30 minutes of normal operation and shall also note the ambient temperature. The high level trip temperature shall then be calculated as follows:

$T_{trip} = T_{equilibrium} + (40^{o}C - T_{ambient}) + 10^{o}C$.

(This assumes that the bearing is operating correctly.)

25.8 BELT DRIVEN EQUIPMENT

Belt driven machinery and belt drive motors shall be equipped with rolling element bearings; i.e. shall not be equipped with slide bearings.

26. LUBRICATION

26.1 TYPE

Grease lubrication is generally acceptable where design parameters are not severe. Oil lubrication shall be provided where the design parameters are more severe.

Lubrication systems shall be designed to exclude dirt and moisture. Air vents on the oil reservoir shall incorporate filters. Drain facilities shall always be provided.

26.2 GREASE LUBRICATION

Where a grease point is not easily accessible, a grease line shall be piped to an easily accessible position for manual greasing. Each grease point shall be provided with its own grease point and pipework.

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A distributor shall be provided where motorised lubrication is provided to more than one destination. The distributor shall be a positive displacement device which ensures equal, successive lubrication to all destinations. Only one distributor shall be used for each lubrication pump; i.e. distributors shall not be cascaded.

Pipework for grease distribution shall be of stainless steel.

26.3 OIL LUBRICATION

Where oil lubrication is provided, the Contractor is responsible for the initial oil fill and the first oil change, including flushing, draining and filling, after an initial run in period not exceeding 3 months

Oil level indicators shall be provided for visual checking. Drain valves, including EN Grade 1.4401 (316) fittings where necessary to permit convenient draining, and plugged at the end, shall be provided for oil reservoirs exceeding 1,5 litre capacity. Drains shall be from the lowest point and syphon type drains are unacceptable.

26.4 SUBMERGED BEARING HOUSINGS

Submerged bearing housings shall be grease lubricated by motorised lubrication. The seals shall be arranged to avoid overgreasing of the bearing. These requirements apply to the bottom bearings of equipment such as Archimedes screw pumps but do not apply to equipment such as submersible pumps in which the bearing housing is contained within the pumpset housing.

27. GAUGES

27.1 CONSTRUCTION

Gauges shall be of industrial construction. The case and bezel shall be of stainless steel unless this material is unsuitable for the application.

Pressure, vacuum or compound gauges shall comply with SANS 1062 and shall bear the Standards mark. Gauges shall be of Accuracy class 1.6 and Durability grade A.

The gauge reading shall indicate gauge pressure unless absolute pressure measurement has been called for.

Gauges shall have a scale diameter of not less than 100 mm.

Calibration shall be in mWC (metres Water Column). The units of measurement shall be clearly marked on the dial.

The scale shall be chosen so that the operating pressure is not less than half full scale reading. In addition, the full scale reading for a gauge on the discharge of a centrifugal pump shall be higher than the pump's shut-off head.

Wherever applicable, gauges shall be clearly strip marked in green to indicate the normal operating range and in red to indicate the non-permissible range of values.

Gauges shall be suitable for continuous operation and shall be glycerine filled on all pump applications and where fluctuations in pressure may cause damage.

Scale markings shall be radial, plain, straight, black lines on a white background and shall be spaced so that one scale division represents approximately 1,5 % of the maximum scale value in values of 1, 2 or 5 multiplied by any power of 10 to suit the maximum operating rating. On circular gauges the scale shall be concentric and the maximum and minimum scale values shall be near the bottom of the gauge, with the scale symmetrically disposed about the vertical centre line of

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the gauge. The tip of the pointer shall be of the knife edge type extending across the scale divisions and shall be as close as practical to the dial.

27.2 INSTALLATION

Gauges shall not be mounted directly on equipment subject to vibration.

Gauges for pipework larger than DN 250 shall be remotely mounted and isolating valves shall be provided at each end of the connecting pipework.

Gauges shall be mounted vertically and in such a position that they can be easily read from floor level.

Nozzles/sockets for gauges shall be provided in accordance with the clause “Steel Pipework; DN 150 and Larger”.

Pressure gauges shall be fitted with an isolating and an air bleed valve. Valves shall be stainless steel ball valves with stainless steel operating levers.

Gauges for sludges and other liquids which contain solids shall have their nozzles on the side of the parent pipe. The configuration shall allow easy cleaning of the passageways.

Gauges used on wastewater, sludge, chemical, solids conveying or other applications where blockage or corrosion of the gauge is possible shall be fitted with a diaphragm type chemical seal, both being liquid filled. The portion of the seal in contact with the process liquid shall be of a suitable non-corroding material.

When used on steam lines a siphon shall be fitted between the steam line and the gauge which shall be filled with water before it is put into service.

27.3 CALIBRATION

The Contractor shall calibrate all instrumentation prior to commissioning and shall submit the calibration certificates to the Engineer.

28. ELECTRONIC INSTRUMENTATION

Environmental protection of electronic instrumentation shall be as follows:

a) Instrumentation and associated displays and transmitters which are either located inside or located outside and above ground level shall have IP 55, or higher, rating.

b) Instrumentation and associated displays and transmitters which are located in underground chambers shall have IP 68 environmental protection. The instrument shall be mounted in an enclosure which shall provide physical protection and shall be self-draining.

c) Instruments and associated displays and transmitters which are located outside buildings shall be mounted in enclosures. Enclosures shall be of polycarbonate construction with transparent front, Fibox EK or equivalent. The complete enclosure installation shall have an IP 55 rating or higher. The enclosure size shall be chosen to provide a clearance of at least 100 mm all around the instrument.

Instruments and their cabling shall be protected so that electromagnetic interference does not affect their operation and signal transmission.

Instruments shall have permanently affixed nameplates.

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The Contractor shall calibrate all instrumentation prior to commissioning and shall submit the calibration certificates to the Engineer. Calibration certificates shall be included in the Manual.

29. GUARD RAILS

29.1 GENERAL

Legislated requirements call for guard railing to be provided in positions where the vertical change in level is 1 000 mm or greater.

Guard railing shall comply with SANS 10104 and shall be designed for access for maintenance purposes.

29.2 OPERATIONAL REQUIREMENTS

Guard railing shall be designed to resist, without any damage and without excessive deflection, the loadings in Category E in Table 7 in Clause 9.4 of SANS 10160 2:2011, Edition 1.1, namely:

a) a force of 1 000 Newtons in any direction (concentrated over a length of 100 mm).

b) a distributed horizontal force of 1 000 Newtons per metre applied along the top rail.

29.3 DESIGN REQUIREMENTS

Guard railing shall be designed to resist the loadings set out in SANS 10160.

Hand and knee rails shall have an outside diameter of not less than 33 mm and a wall thickness of not less than 2,5 mm and a maximum span of 1 500 mm (greater spans will be acceptable if heavier tube dimensions are used).

Tubular stanchions shall have a wall thickness of at least 3,0 mm.

On platforms, walkways, landings or around dangerous areas the vertical height, measured from the top of the hand rail to the floor or surface, shall be at least 1 000 mm.

On stairways and fixed ladders the rails shall be parallel to the strings, and the vertical height, measured from the top of the hand rail to the nosing of the tread, shall be at least 900 mm.

No opening between rails shall allow the passage of a ball of diameter 600 mm.

Stanchions and rails shall be smoothly finished and free from sharp corners, edges and projections which may injure persons or damage clothing. Stanchion bases shall have the corners rounded or sheared off.

Welded guard rail installations are preferred. Installations which incorporate bolted sections shall be secure and tight under loading. “Pop” rivetted installations will not be acceptable. Joints shall be smoothly finished, without shoulders.

Railings shall be ended off with positively fixed closure bends. At corners, short radius bends with stanchions on both ends shall be employed or, alternatively, stanchions specifically designed for such a position shall be employed. No sharp ends will be permitted.

Stanchions shall generally be base-mounted to suit the arrangement requirements and shall be of solid or welded construction.

Stanchions which are hollow shall be self-draining.

Stanchion feet which are attached to metallic surfaces shall have minimum dimensions of 150 mm X 60 mm X 8 mm. Two fasteners, of minimum size M16, shall be used to secure each

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foot. Neatly fitting packing, Denso tape or equivalent, shall be fitted under stanchion feet to prevent the formation of crevices.

Stanchion feet which are attached to non-metallic surfaces shall have minimum dimensions of 150 mm X 150 mm X 10 mm. In instances where the horizontal surface to which the foot is to be fastened is less than 150 mm wide, the foot shall be designed to be seated on at least two surfaces. Four fasteners, of minimum size M16, shall be used to anchor the foot. Non-shrink, cementitious grout shall be applied under the foot prior to final tightening of nuts.

Toe plates shall be provided. These shall extend to 150 mm above the walkway level.

29.4 ADDITIONAL DESIGN REQUIREMENTS FOR GUARD RAILING IN PUBLIC PLACES

The requirements for guard railing at equipment installations shall also apply for guard railing for public places. The following specific requirements shall also be complied with:

a) The structural design shall be done in accordance with the requirements of SANS 10104.

b) No opening in guard railing installed in public places shall allow the passage of a ball of 100 mm diameter.

29.5 CARBON STEEL GUARD RAILS

Fabrication and welding shall comply with the clauses “Fabrication of Carbon Steel and Stainless Steel” and “Welding”.

The guard rails shall be hot-dip galvanised. Designs shall provide proper access for safe and complete entry of the zinc into open spaces so that subsequent drilling at the galvaniser’s yard is avoided.

If the guard rails are welded or cut after hot-dip galvanising, they shall be returned to the galvaniser for re-galvanising.

29.6 STAINLESS STEEL AND 3CR12 GUARD RAILS

Fabrication and welding shall comply with the clauses “Fabrication of Carbon Steel and Stainless Steel” and “Welding”.

29.7 FASTENERS

All anchor fasteners, including nuts and washers shall be of EN Grade 1.4401 (316) stainless steel.

Fastener diameter shall not be less than M12.

30. GRID FLOORING

The depth of bearer bars in metal grid flooring shall not be less than 30 mm with a bearer bar pitch of not greater than 40 mm.

The bearer bars shall be across the shorter span.

Panels shall be set level and fixed to angle frames to prevent rocking.

Cut-outs in grid flooring for pipes, valve spindles, etc. are to be fully banded. The edges of removable grid access covers must also be fully banded. Corrosion protection shall only be done after welding of banding has been completed.

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Unless another material such as stainless steel is specified, grid flooring and frames shall be of carbon steel, hot-dip galvanized after fabrication. If hot-dip galvanising is not suitable, a glass flake resin, such as Power Blast's Vitaglass or equivalent which is applied by dipping the flooring in catalysed resin, is acceptable. Painted coatings are not acceptable as corrosion protection.

Where grid flooring rests on painted surfaces, strips of rubber insertion material shall be secured under the grid to protect the paint.

The fixing clip set (saddle clamp and locking plate) shall be of hot-dip galvanised steel or stainless steel. Fasteners shall be of EN Grade 1.4401 (316), or better.

GRP grid flooring is not acceptable.

31. FASTENERS

31.1 STANDARDS

Bolts and nuts shall be hexagon head type complying with SANS 1700 with threads of the coarse pitch series.

31.2 LOADING/STRESS

Fasteners shall be loaded in accordance with their design and shall not be loaded as columns and/or in bending. In particular, anchor fasteners shall only be loaded in tension and sideways forces shall be transferred to the concrete structure in which they are anchored.

31.3 MATERIALS

M12 fasteners and smaller shall be of EN Grade 1.4401 (316) or better.

Fasteners in corrosive areas shall be of EN Grade 1.4401 (316) or better. Corrosive areas shall be taken to include any moist or wet area such as in and above settling tanks, in or in the vicinity of open channels, where a continuous spray can be expected and all areas in the vicinity of a wastewater treatment works or wastewater sump.

Fasteners larger than M12 which are in non-corrosive areas shall, except when specified otherwise, be hot-dip galvanized.

Plated fasteners are not acceptable.

31.4 HIGH TENSILE BOLTS

Where high tensile bolts are required by the design, they shall be hot-dip galvanized and painted. The bolt holes and crevices shall be filled and sealed prior to painting.

31.5 ANCHOR FASTENERS

Anchor fasteners shall be of EN Grade 1.4401 (316), or better.

Anchor fasteners for water retaining structures and for brickwork shall be of the chemical anchor fastening type. Other anchors may be of the expanding type or chemical anchor type.

Where hook bolts are used, these shall be supplied and grouted by the Contractor into pockets which will be provided in the concrete structure in accordance with the information to be supplied by the Contractor. The grouting products shall be used strictly in accordance with the manufacturer's instructions.

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Where machinery is anchored by studs or bolts which extend through the supporting structure and is therefore fastened down with the use of nuts from both sides, the studs or bolts, together with associated washers and brackets, shall also be of EN Grade 1.4401 (316), or better.

Anchors shall be tensioned when their nuts are tightened; i.e. it is not acceptable to use a second nut below the baseplate to position it; and the holding down force shall be loaded into the concrete structure rather than the baseplate being held between two nuts.

Submerged anchors shall be secured with chemical anchor designed for submersion.

31.6 MATERIAL COMPATIBILITY

Fastener material shall always be of equal or better corrosion resistance than the items being fastened, e.g. EN Grade 1.4401 (316) bolts must be used to fasten together EN Grade 1.4401 stainless steel flanges and fabrications.

31.7 WASHERS

Flat washers shall be provided under nuts and setscrew heads.

Flat washers shall be provided under bolt heads on painted surfaces.

Flat washers shall be provided under bolt heads where the bolt is positioned in a slot.

Spring washers shall be used on fasteners subject to vibration (other approved locking arrangements will also be acceptable on proprietary equipment).

Anchor bolts for machinery shall each be provided with a flat washer and a spring washer (other locking arrangements are not acceptable).

Washers shall be of the same material as the fasteners.

Flat washers exhibiting visual deformation shall be replaced by thicker washers.

31.8 ANTI-SEIZE COMPOUND

Before assembly, stainless steel threads shall be treated with a nickel-based, anti-seize/corrosion protection compound such as Chesterton 725 : Nickel Anti-Seize Compound, or equivalent. Copper based compounds are not acceptable.

A small amount of the compound shall be applied along the full length of the exposed thread before fastening. Excessive compound visible on the thread after the nut has been applied is unacceptable and indicates that the compound has not been used correctly.

31.9 THREAD PROJECTION

Bolt threads shall project no less than 1 thread and no more than 8 threads from the head of the nuts when fixed. Longer projections will only be allowed if the Contractor can show that bolts of a more suitable length are not manufactured.

31.10 CORROSION PROTECTION

After installation, the exposed surfaces of fasteners not of stainless steel shall be coated as for the items being fastened.

“Self-tapping” fasteners are not acceptable.

If the use of Allen head or similar fasteners has been accepted by the Engineer, the recessed heads shall be filled with a suitable non-hardening sealing compound.

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32. MACHINE VIBRATION

The mechanical vibration of machines measured at all important points such as bearings shall be lower than that specified as "good" for that class of machine in BS 7854 (ISO 10816).

Reciprocating machines shall be designed and installed so that the machine vibrations are isolated from the floor structure. Vibration isolation mountings which will eliminate not less than 90 % of the vibrations transmitted by the equipment shall be provided between the baseframe and the concrete plinth. When mounted on the vibration isolators, distortion of the baseframe shall be negligible in comparison with the permissible and acceptable misalignment of the equipment mounted thereon.

Shafts shall be designed so that the critical speed is outside the operating speed range.

33. NOISE CONTROL

33.1 GENERAL

Noise emitted by equipment shall be kept to a minimum and shall not exceed the noise levels specified in these documents.

33.2 NOISE LEVELS

The sound power of any equipment shall not exceed 89 dB(A) (referred to 10^{-12} Watts) unless specifically accepted by the Engineer. This is approximately equivalent to a sound pressure level of 81 dB(A) at a radius of one metre from the acoustical centre assuming uniform hemispherical propagation in a free field on a hard floor. In certain instances, a lower noise level may be called for.

Where the Contractor is unable to restrict the noise level of the machines to the maximum specified by the appropriate selection of suitable equipment; e.g. by selecting slow speed or silent type machines, quiet type cooling fans, suitable silencers, etc.; the Contractor shall inform the Engineer so that appropriate steps can be taken to counteract the effects of noise.

33.3 ACOUSTIC TREATMENT

Standard acoustic enclosures shall be provided where called for.

Acoustic treatment of high noise sources shall be provided where this can be done without greatly interfering with operation or maintenance.

If acoustic lagging of pipework or ducting is specified, this shall consist of pre-formed rockwool encapsulated in stainless steel sheet metal. Alternatively, a 100 mm thick layer of rockwool having a density of 60 kg/m^3, suitably fixed in place and reinforced to prevent collapse, and covered with 25 mm thick asbestos free plaster having a density of 1 000 kg/m^3 (I.P. Insultex AF720, or equivalent). The outer surface shall be finished off with scrim cloth before being painted.

It is not normally necessary to lag flow meters and cast iron valves on acoustically lagged pipelines.

Components which can move, such as those associated with expansion bellows or mechanical couplings, shall be enclosed by an effective acoustic enclosure designed to prevent sound transmission but able to cope with movement without damage.

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33.4 MEASUREMENT

Noise levels will be verified by taking impulse weighted Leq readings in dBA over ten minutes at the specified positions. Readings so achieved shall not exceed the specified level by more than 2 dBA. Should the noise exceed the specified level or should the level be in dispute, the Contractor will be responsible for obtaining certified sound pressure levels across the full octave band mid-frequency range in order to establish the precise A weighted level.

34. THERMAL LAGGING

Thermal insulation shall only be carried out after successful pressure testing of the equipment.

The efficiency of the insulation system shall exceed 90 % and the insulation cold face temperature shall not exceed 40 ºC.

Pipe insulation shall consist of pre formed insulation material having a thermal conductivity of approximately 0,040 W/m ºK at 60 ºC. The insulation material shall not have any corrosive effect on the pipework and, in particular, it must be noted that fibreglass may not be used on stainless steel.

Inside buildings, or in other protected areas, pipe insulation shall be supplied with a canvas covering having a 50 mm lap at one end and along the longitudinal seam. The laps shall be sealed using a suitable lagging adhesive. On bends the insulation material shall be neatly mitred and covered with canvas. At all flanges the insulation shall be closed off. Flanges, couplings, tees and valves shall be insulated using a removable canvas blanket or jacket fastened in place with brass hooks and eyes.

All insulation shall be coated with a suitable sealer and then painted in accordance with the colour code. The manufacturer shall advise regarding the paint types and system to be used.

Outside buildings or in other exposed areas pipe insulation shall be fixed in position using three bands per section or a suitable adhesive and then clad with aluminium. All longitudinal and circumferential joints shall incorporate a 50 mm lap with each edge grooved. The longitudinal joints shall be positioned in the "twenty past" position with the lap and groove downwards. All ends next to couplings or flanges shall be closed off and sealed before fitting muff type insulation and cladding over the couplings and flanges. All bends, tees and other fittings shall also be insulated and clad but valves need not be insulated. All joints shall be primed and sealed using a silicone or other appropriate sealer and the contractor shall generally ensure that the lagging is weatherproof with particular attention being paid to all joints and pipework anchor points.

With large exposed items such as vessels mounted outside, a suitable system incorporating a 20 mm thick, smooth layer of weatherproof, reinforced plaster covered with a scrim cloth and overcoated with at least two coats of fibre reinforced resin sealer shall be acceptable.

35. SPARES

Spares which are specified as part of the Works shall be packed individually in wooden boxes with the lids unattached. Each box shall be labelled with the Contract number, manufacturer, contents, relevant part/model numbers and the supplier’s address. The boxes shall be brought to Site and the lids shall be secured to the boxes immediately after the Engineer has accepted the spares and the packaging.

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36. SIGNAGE

36.1 GENERAL

All signs as specified below shall be installed prior to commissioning.

36.2 OPERATING INSTRUCTIONS

Operating instructions shall be framed and shall be attached to the wall in the control room using brass screws. The frame shall be of wood or aluminium with a glass front and hardboard backing. They shall include the following:

a) Start up, Shut down and Operating instructions shall be comprehensive and shall indicate actions to be taken in the case of all alarm conditions. These shall be written from the point of view of the plant operator.

b) A layout drawing of the equipment installation.

c) A process flow diagram.

d) A P&ID.

36.3 SAFETY

Safety signs shall be suitably framed or encapsulated. Symbolic signs shall comply with SANS 1186. The wording of the signs shall be accepted by the Engineer prior to final printing. They shall be provided by the Contractor in appropriate places on the walls of the plant room and shall include the following:

a) All statutory and special safety warning instructions.

b) Course of action during/after electrical shock.

c) Any operating restrictions for equipment.

d) Operating instructions in cases of plant trip and electrical supply failure.

e) Spares list.

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SPECIFICATION: ZUT 0002

OPERATING AND MAINTENANCE MANUAL

CONTENTS LIST

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2. SUBMISSION OF MANUAL 2
3. GENERAL REQUIREMENTS 2
4. FORMAT AND CONTENTS 2

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1. INTRODUCTION

Zut 0002 specifies the requirements for the Operating and Maintenance Manual to be provided by the Contractor.

2. SUBMISSION OF MANUAL

The Contractor shall submit the Manual to the Engineer for acceptance. If the Manual does not comply with this specification and/or is incorrect, the Contractor shall correct it and re-submit it for acceptance until the Engineer accepts it. At each submission, the Contractor shall provide a duplicate copy for the Employer.

Six copies of the final version of the Manual, as accepted by the Engineer, shall be provided prior to the issue of the Taking Over Certificate by the Engineer and the start of the Defects Notification Period.

3. GENERAL REQUIREMENTS

The Manual shall be for the complete Works.

The Manual shall be in English and shall be practically and neatly presented.

One Manual shall contain original documents and this set shall be marked "Original". The other 5 Manuals shall contain all the information in the original and shall be marked "Copy 2" to “Copy 6".

Binders shall have hard, plastic protected covers utilising four-ring, spring-clip holders. Each binder shall not be more than two-thirds full. A title label shall be affixed to the spine of each binder. This shall indicate the Employer, the Contract number, title, Contractor's name, Site/Plant name and volume number.

Sections and sub-sections shall be titled, uniquely numbered and provided with separator sheets.

Manufacturer’s printed matter shall be marked to identify the model provided.

Drawings shall be to a scale which makes details clear. Large drawings shall be held in plastic envelopes in the Manual. A4 and A3 drawings may be bound as normal pages. Drawings shall also be provided on electronic data storage in Autocad, or equivalent, format.

Cross-referencing within the Manual is acceptable if this will avoid duplication.

Three copies of the complete Manual shall be provided in pdf format, on flash drives.

4. FORMAT AND CONTENTS

The Manual shall comply with the following format:

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NO	HEADING	CONTENT
1	**General**	
1.1	Contents List	Contents list for complete Manual.
1.2	Description of the Works	Description of the equipment installation with reference to layout drawings and process flow diagrams. Process description and performance parameters for the Works.
1.3	Equipment List	Single list of the make, model, operating range and hazardous zoning of every item of mechanical, electrical, instrumentation and control equipment.
1.4	Drawing List	List of the Contractor's drawings.
2	**Operation**	
2.1	Training Manual	Basic operating instructions (5 page maximum plus Contents List, Layout drawing and Process flow diagram). Include **S**tart-up, adjustment, operating and shut-down procedures for manual and automatic operation - **E**mergency operating procedures - **P**rocess verification - **S**ettings, setpoints, protection, alarms and trips. A paper copy of this document shall be provided to each trainee.
2.2	Commissioning	Trainee attendance registers & Commissioning results.
3	**Maintenance Schedule**	
		Schedule of routine maintenance for all **mechanical**, **electrical**, **instrumentation** and **control** equipment, broken down into daily, weekly, monthly and annual periods. The schedule shall be all-inclusive but may refer to manufacturer's standard manuals in other parts of the Manual. The schedule shall include **all** lubrication periods, lubricants and capacities.
4	**Mechanical Equipment**	
4.1	Equipment item 1 (e.g. pumps)	- The make, model, serial number, description, size, design range, performance data, motor and drive details and supplier's details of the item. - Dimensioned drawing. - A photograph of the nameplate. - Manufacturer's operating and maintenance manual. - Operating curves, test results, etc. - Specified certification; e.g. lifting and pressure equipment inspection and testing.
4.2	Equipment item 2 (e.g. mixers)	ditto
4.3	etc.	ditto
5	**Electrical Equipment**	
5.1	Equipment item 1 (e.g. transformer)	As for 4.1 above; *PLUS:* **C**ontrol and electrical details, including logic sequence, circuit diagrams and software, as applicable - **E**lectrical reticulation drawings - **E**quipment overall dimensions - **W**iring diagrams - **S**witchboard layout drawings - **S**LDs.
5.2	Equip. item 2 (e.g. VFCs)	ditto
5.3	etc.	ditto
6	**Instrumentation Equipment**	
6.1	Instrumentation Equip. Item 1 (e.g. Magflo)	As for 4.1 above; *PLUS:* **C**ircuit diagrams of instrumentation systems and of individual instruments - **I**nstallation arrangement - **N**ormal operating range – Pressure relief valve certificates -Calibration certificates.
6.2	Equip. Item 2 (e.g. level)	ditto
7	**Control**	
7.1	Identifying Information	Make and model of PLCs, transmitters, HMIs, computers, etc.; copied from the Equipment List.
7.2	I/O List	Cross-referenced listing of all I/Os used.
7.3	SCADA	Colour prints of SCADA mimic screens, control faceplates, sequences and trend screens. Schedule of alarm messages and TAG lists. File structures, lists and naming conventions.
7.4	Program	An annotated program listing. CDs containing all software. Loop and logic diagrams for each PLC. System control diagram and logic sequence chart.
7.5	Documents	Schedule of cable terminals. Copy of SCADA hardware diagnostic mimic.
8	**Documents**	
8.1	Drawings	As-built drawings, including GAs, MFDs, P&IDs, electrical panel construction drawings, etc. These shall also be provided electronically.
8.2	Cable Schedule	Cable schedule for power, data, control and instrumentation cables. This shall include the cable construction, conductor material, insulation, protection, voltage rating, start and finish points, route length, duty, load, voltage drop, core area, no. of cores, no. of cores used and gland size. For cable voltages above 400 Volts, the schedule shall also include the purchase details, specification and date of manufacture.
8.3	Other	**C**ertificate of electrical compliance - **C**orrosion protection systems used - **C**oating supplier's data sheets and coating repair procedures - **P**rotection relay settings and test certificates - **L**ist of spares provided – Pressure relief valve test certificates.

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SPECIFICATION: ZUT 0003

(Version: August 2014)

General Corrosion Protection for Pipelines, Water and Waste Water Works

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1 SCOPE

This Specification covers the painting and corrosion protection of plant, equipment in pump stations and water and wastewater treatment works and pipelines exposed to environments with variable corrosive tendencies.

Interpretations and variations of this Specification are set out in the Amendments of this Specification.

2 NORMATIVE REFERENCES

2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

a) Amendments to this Specification;

Equipment, materials and operational methods shall comply with the latest edition of the relevant SANS, ISO, AS, BS, DIN or equivalent American Standard as shown in Annexure A.

3 DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

In this Specification the following shall have the meaning given:

a) **Coat:** A single uniform film of corrosion protection material applied to a substrate for corrosion protection purposes.

b) **Layer:** A uniform protective film of corrosion protection material applied to plant, equipment and piping in a specified manner consisting out of multiple coats.

c) **System:** A corrosion protection coating or lining consisting of multiple coats and/or layers, the type of coat, the number of coats and their thickness, the method of application and the requirements of the complete system.

d) **Coating:** A system on the outside of plant, equipment and pipework. However, certain international specifications referred to in this specification (e.g. AWWA specifications) use the term ‘coating’ to refer also to internal pipe protection and where these specifications are being referred to their terminology is used.

e) **Lining:** A system on the inside of plant, equipment and piping.

f) **Dis-bonded area:** An area of coating or lining that initially did adhere to the steel substrate after application, but which subsequently became loose from the substrate as a result of mechanical, chemical or other action.

g) **Un-bonded area:** An area of coating or lining which at no stage adhered to the steel substrate.

h) **Water path:** The shortest distance along the surface of an object embedded in concrete but exposed to water measured along the concrete interface.

i) **Holiday:** A discontinuity in a coating or lining which exhibits electrical conductivity when exposed to a specific voltage.

j) **Abrasive blast cleaning**: The process of projecting a stream of abrasive particles at high velocity towards a surface for the purpose of removing contaminants from that surface and to produce a textured surface which will increase the surface area and thus increase adhesion of the coating.

k) **Dry film thickness (DFT)**: The thickness of a coating or lining after it is hard dry.

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l) **Electrical insulation defect (EID)**: Defects in a coating or lining that impair the protective properties of the coating or lining and that are detected instrumentally by either:

i) a low-voltage, wet-sponge detector, or

ii) a high-voltage, sparking detector,

operated in each case within the parameters specified.

Note: EID's include such defects as steel projections from the substrate, conductive particles embedded in the coatings or linings, voids and those defects commonly known as pinholes and holidays.

m) **Fusion bonded epoxy (FBE)**: A thermoset epoxy powder coat. (The powder is normally applied by electrostatic spray to a preheated surface. The powder normally melts, fuses and cures at a temperature of 220ºC to 250ºC.)

n) **Inspector**: A person authorised by the Engineer to act as his representative in examining the work and materials and drawing such samples and carrying out such tests as may be necessary to ensure compliance with the specification.

o) **Lot**: A number of similar or related items submitted for inspection at one time by the Contractor and of such size that the inspector can reasonably be expected to examine adequately in not more than one working day.

p) **Paint**: A liquid material that, when applied as a thin film to a suitably prepared surface by an appropriate method, undergoes a physical or chemical change (or both) that converts it to a solid coating or lining bonded to the surface to which it is applied.

q) **Pinhole**: An electric insulation defect detected by the use of a wet sponge detector (see EID).

r) **Pot life**: The period, after the contents of the packs of a two-pack paint have been mixed together, during which the paint remains suitable for use without the addition of further solvent.

s) **Powder coat**: A material in the form of a dry, free flowing powder that, when applied to a suitably prepared steel surface by an appropriate method, can be fused by application of heat and subsequent cooling to form a continuous coating or lining that is bonded to the surface. A powder coat is classified as thermoplastic when the applied coat may be re-melted by heating, or as thermoset when it cannot be re-melted by heat. Low or medium density polyethylene powder is thermoplastic whilst FBE is a thermoset material.

t) **Significant surface**: The part of the article covered or to be covered by the coating or lining and for which the coating or lining is essential for serviceability and/or appearance.

u) **Steel**: This term embraces carbon steels, 3CR12 and all grades of stainless steels.

v) **Water break free**: A surface which, when wetted all over with plain potable water, maintains a continuously wet surface and the water does not break up into islands surrounded by unwetted surfaces.

w) **Wet film thickness (WFT)**: The thickness of a coating or lining immediately after application and before any volatile matter has evaporated.

x) **Quality control**: The operational techniques and activities that are employed by the Contractor to sustain the required quality of a product, process or service.

y) **SAHDGA**: South African Hot Dip Galvanisers Association.

z) **Sa**: Followed by a number refers to a photographic illustration of the standard of blast cleaning required, as shown in ISO 8501-1

aa) **St**: Followed by a number refers to a photographic illustration of the standard of mechanical cleaning required, as shown in ISO 8501-1.

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3.2 ABBREVIATIONS

The following abbreviations shall have the meaning assigned to them:

µm	:	Micrometre
3CR12	:	A 12% chromium-containing corrosion resistant steel
3LPE	:	Three layer high density polyethylene
ABS	:	Acrylnitrile-butadiene-styrene
Al	:	Aluminium
CI	:	Cast iron
CS	:	Cast steel
DCA	:	Die cast aluminium
DFT	:	Dry film thickness
EID	:	Electrical insulation defect
FBE	:	Fusion-bonded Epoxy
FBP	:	Fusion-bonded Polyester
FBPE	:	Fusion-bonded Polyethylene
GRP	:	Glass fibre reinforced Polyester
HDG	:	Hot-dip galvanized
HDPE	:	High Density Polyethylene
MIO	:	Micaceous Iron Oxide
MS	:	Mild steel
PC	:	Polycarbonate
PVC	:	Polyvinylchloride
QCP	:	Quality Control Plan
SG	:	Spheroidal graphite cast iron
SS	:	Stainless steel – grades 304, 304L, 316 and 316L
UV	:	Ultra Violet
WFT	:	Wet film thickness

4 REQUIREMENTS

4.1 CONTRACTOR'S OBLIGATION

The requirements, material, surface preparation and corrosion protection systems prescribed in this Specification is regarded as a minimum requirement for the specific application. No deviation from this Specification shall be allowed without the written approval of the Engineer.

The Contractor is responsible for the design of the corrosion protection system and shall submit to the Engineer details of the material selection, surface preparation method and corrosion protection system he

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intends using as part of his design, including the Manufacturer's Instructions for each product and shall only proceed with the purchase of the corrosion protection materials/paints upon receipt of conformation from the Engineer.

The Contractor shall obtain a written evidence from the chosen material manufacturer/supplier that the proposed materials, surface preparation method and corrosion protection system comply with the specified requirements and are suitable for the intended purposes under the specified Environmental Conditions (refer to Clause 4.3). The Contractor shall also obtain the Manufacturer's Instructions (refer to Clause 4.2). The written evidence and Manufacturer's Instructions shall be submitted to the Engineer for comment before commencement of the work.

In the event that no corrosion protection is specified for any Plant, equipment or pipes within the Specifications or Drawings, this Specification shall be used as a basis to agree on a corrosion protection system for the specific application.

4.2 MANUFACTURER'S INSTRUCTIONS

The manufacturer's instructions shall be regarded as the recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead.

The following details shall be made available to the Engineer and the applicator:

- Brand and type of corrosion protection material;
- Mixing and thinning instructions;
- Recommended type and quantity of solvent required for thinning during application;
- Pot life of mixed product;
- Minimum and maximum recommended dry film thickness per coat;
- Minimum and maximum recommended dry film thickness per layer;
- Recommended time intervals between coats;
- Recommended minimum and maximum steel surface temperatures during application;
- Time for complete drying and curing on applicable surfaces;
- Substrate surface preparation requirements;
- Recommended primers for substrate;
- Recommended method of coating and lining application;
- Repair procedures for damaged coatings and/or linings and field joints on pipelines;
- Toxicity if in contact with water, and
- All relevant information the Supplier wishes to submit on his product.

Verbal instructions by the manufacturer's representative will not be accepted unless confirmed in writing by the Contractor.

4.3 ENVIRONMENTAL CONDITIONS

Environmental conditions shall be classified according to SANS 10120-3 HC. The corrosion protection system design and applied by the Contractor shall be suitable for the Environmental Conditions specified.

Unless otherwise specified in the Amendment of this Specification the Environmental Conditions shall be classified as follows:

- Mildly-corrosive: Dry, indoor/internal, above ground and ventilated conditions, not within 5km from the coastline or polluted industrial area. Relative humidity below 70%.
- Severely corrosive: Submerged, splash-zone, underground, very moist conditions, or within 5km from coastline or polluted industrial area, or in waste water works, or close to electrical power lines. Relative humidity above 85%.

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- Medium Corrosive: All other conditions not included in the abovementioned definitions.

Notwithstanding the abovementioned information the Contractor shall satisfy himself of the environmental conditions on Site and design the final corrosion protection systems accordingly.

4.4 WORKMANSHIP

A high standard of workmanship is required. Only experienced personnel shall be used to carry out corrosion protection work. All work shall be carried out under the constant supervision of a qualified supervisor.

Similarly all repair work at Site shall be done by competent personnel under the supervision of a qualified supervisor.

4.5 COMPATIBILITY OF MATERIALS

4.5.1 Design Precautions

All equipment shall be designed to suppress corrosion in an exposed environment with special reference to galvanic corrosion.

The Contractor shall ensure that dissimilar metals or alloys alongside each other are compatible or are adequately protected if, in the galvanic series, there is more than a 0,3 volt difference in the galvanic potential.

4.5.2 Galvanic Corrosion Prevention

The Contractor shall ensure that the following steps are taken to minimise corrosion:

(1) If dissimilar metals are used: Coat all surfaces of the whole assembly including the more noble member of the galvanic series.

(2) If the noble member of the assembly cannot be entirely covered:
   (a) Keep the anode/cathode ratio as large as possible in the particular component.
   (b) Use electrical insulators between two metals. Insulation must be complete, a bolt requires a sleeve as well as washers of an insulating material.

(3) Joints and crevices between metals shall be sealed.

(4) Where fastening is unavoidable, the fasteners shall be more noble (cathodic) than the base material. Fasteners shall be coated where possible and/or adequately electrically insulated between fasteners and the base material.

4.6 HANDLING OF CLEAN ITEMS

After cleaning, surface shall not be contaminated in any way. Operators shall wear clean gloves and all surfaces shall be clean and free from oil, grease, grit, dirt and other contamination.

4.7 MACHINED AND MATCHING SURFACES

Mating surfaces of joints shall be coated with primer (where specified) or first coat only. The coating or lining shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joints shall be fully coated.

4.8 SPECIAL AREAS

Areas that are inaccessible after assembly shall be prepared and fully coated with the specified system to the specified requirements before assembly. The coats shall be fully cured before assembly.

Steel edges to be welded after coating shall not be coated for a distance of 50 mm from the welding edge. The unlined strip of grit blasted surface shall be temporarily protected with a coat of (red or a different colour to the lining/coating) weldable primer between coating and/or lining application and installation.

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Friction grip areas shall be left un-coated unless otherwise specified.

4.9 SUPPORTS

During coating and/or lining application, the items shall be so supported to prevent damage to the wet coatings or linings until the coatings or linings have hardened adequately. Items shall remain supported during curing, storing and handling.

4.10 WATER RETENTION AREAS

Pockets, recesses and crevices in which water and dirt may collect shall be avoided. Water retention areas shall be properly drained by holes as large as possible.

Surfaces of corrodible metals, such as the insides of tanks or hollow Specifications that cannot be protected by any method (e.g. painting or dipping), shall be avoided, or where not possible, be fully sealed against ingress of air and moisture.

4.11 STRIPE COATS AND CREVICES

All complex surfaces including metal edges, up stands, welds, bolts and nuts shall be adequately coated to ensure complete corrosion protection. Additional stripe coats shall be applied after initial priming, if required or ordered by the Engineer.

Special attention shall be given to crevices and edges to ensure complete coverage and uniform paint thickness.

4.12 REPAIR OF DAMAGED COATS

Repair procedures shall be approved by the Engineer and repairs will be subject to inspections as set out in Clause 11.2. Where the damage is extensive the particular remedial procedures for each such instance shall be agreed with the Engineer in writing.

All repairs shall comply with the requirements of the repair-product Manufacturer's Instructions. The Engineer may at his discretion request that repaired areas undergo adhesion tests.

Any damage occurring during transit from the Contractor's premises to the Site shall be the responsibility of the Contractor. The Contractor shall repair any damage occurring on Site during handling, assembly, storage, transport and erection.

A repaired area shall be tested in accordance with Sub-Clauses 5.4 and 5.9 of SANS 1217 for compliance with the relevant requirements for thickness and electrical insulation defects respectively.

Any item showing electrical insulation defects exceeding an average of five per square metre (a cluster of pinholes within a radius of 25 mm being regarded as a single defective area), or flaking or other signs of loss of adhesion, shall not be repaired. The item shall be blast cleaned and re-coated in accordance with the relevant requirements of this Specification.

Paint surfaces which become streaky because paint has run, will be rejected.

Touching up of damage to the final paint coat will NOT be permitted. If final paint coat is damaged the item shall completely repainted with the finishing coat in accordance with the specifications.

4.12.1 Repair Methods for Minor Defects

The repair of areas showing electrical insulation defects or low film thickness shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 7.4.1.
- Thoroughly abrade the area, including an adjacent surrounding area of at least 25 mm wide, with a medium grade 220 abrasive paper.

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- Vacuum-clean the surface to remove dust and debris in accordance with Clause 7.2 to achieve a dust quantity rating 1 and a dust size class 0 in terms of ISO 8502-3.
- Wipe the abraded paint surface with methyl ethyl ketone and allow to dry.
- Apply as many coats of repair material as necessary to achieve the specified electrical insulation thickness and finish as to conform to the adjoining corrosion protection system's requirements.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

4.12.2 Repair Methods for Major Defects

The repair of areas showing damage down to the steel surface shall, if approved by the Engineer, be carried out as follows:

- Degrease in accordance with Clause 7.4.1.
- Blast-clean area to Sa 3 (ISO 8501-1).
- Feather the surrounding paint for a distance of 25 mm beyond the damaged areas with a medium grade 220 abrasive paper.
- Vacuum-clean the surface to remove dust and debris in accordance with Clause to achieve a dust quantity rating 1 and a dust size class 0 in terms of ISO 8502-3.
- Wipe only the abraded paint surface with methyl ethyl ketone and allow to dry.
- Apply as many coats of repair material as necessary to conform to the specified adjoining corrosion protection system's requirements.
- Apply a final top coat over the repaired area to achieve a pleasing, uniform finish of the item.

4.13 QUALITY CONTROL

This clause and its sub-clauses shall be read in conjunction with Specification AUR 0005 - Quality Control.

4.13.1 Submission for approval

The Contractor shall submit the following to the Engineer, including data sheets where applicable, for approval:

4.13.1.1 Corrosion Protection

- A programme;
- The Quality Control Plan (QCP) for corrosion protection indicating hold points;
- Process Method Statement;
- Blast material;
- Proposed corrosion protection systems; and
- Proposed pickling and passivating products.

4.13.1.2 Manufacture and Corrosion Protection Programmes

The manufacture and corrosion protection programmes shall state the time and place when the following will be conducted:

- Inspection of material;
- Hydrostatic testing of uncoated castings, pipes and fittings;
- Manufacture of components;
- Fettling or dressing;
- Degreasing;

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- Water soluble salts test;
- Blast cleaning and application of the first coat;
- Application of intermediate and final coats; and
- The commencement of Site repairs.

4.14 HEALTH & SAFETY REQUIREMENTS

4.14.1 Control of Major Classes of Risk

(1) Health risks, these include:
  (a) Gases/vapours;
  (b) Volatile liquids in the paint; and
  (c) Powders/dust.
(2) Fire or explosion risks, these include:
  (a) Fire risk during storage/transport; and
  (b) Explosion hazard during application.

4.14.2 General Aspects of Explosion Hazards

The essential precaution to be taken is, inter alia that sufficient ventilation air shall be provided to maintain the ratio of vapour/air to no more than 10% of the lower explosive limit.

4.14.3 General Aspects of Toxic Hazard

Measures shall be taken by the Contractor to ensure that the following are prevented:

- Inhalation of dust/fumes;
- Skin contact with paint;
- Ingestion of paint; and
- Eye contact/penetration of paint.

Operators shall be provided with the necessary Personal Protective Equipment (PPE), such as masks/hoods, barrier creams and protective clothing to minimize the chances of the above occurring.

Emergency procedure shall be in place and First Aid kit provided to deal adequately with any of the above occurrences.

The Contractor shall ensure that in terms of Clause 6(2) of the Construction Regulations of the OH&S Act 85 of 1993, an assistant construction supervisor is specifically appointed for the application or repairs of linings inside enclosed or semi-enclosed areas e.g. pipe linings, prior to the execution of any such work.

4.15 SPECIFIC REQUIREMENTS FOR PIPES AND SPECIALS

4.15.1 Cut Back of Coated Pipes

The blast cleaned surface shall be stopped off or cut back by suitable masking which shall not contaminate the cleaned surface. Cut-backs shall comply with the requirements as set out in Table 4.1 below:

Table 4.1: Cut-back of Coatings

PIPE END	CUT-BACK (mm)	COMMENT

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Pipe ends prepared for field butt welding	100	All coatings to be mitred or feathered to prevent air entrapment in the joint coating system
Pipe ends prepared for flexible joint couplings	Various	The coating shall be cut back a sufficient distance to accommodate a standard coupling for the particular diameter of pipe
"Bell and spigot" pipe ends prepared for first welding	100	The cut back shall be measured from either side of the (field) external fillet weld position when the spigot is fully inserted into the "bell"

4.15.1.1 Protection of Pipe Ends on Pipes with Cut-Back

Before delivery cut backs of each pipe for field welds shall be coated with an approved rust inhibitor. This inhibitor shall provide corrosion protection for up to 6 months and shall enable good cutting and welding properties (Sigmaweld 120, Plascon etching primer or equivalent approved). Plain ended pipes (to be joined by flexible couplings) are to be coated with an approved rust inhibitor for a distance of 100mm from the pipe ends on the inside and the outside of each pipe. Careful attention must be paid to ensuring the pipe ends are also completely covered. The inhibitor used must be compatible with both the lining and the coating.

4.15.2 Pipe Ends

4.15.2.1 Extension of Lining

For flanged pipes or specials and pipes or specials intended for joining with flexible couplings or for Site welding by means of double sleeve weld-on couplings, the lining shall extend to the ends of pipes and specials including edges and shall overlap by at least 300 mm on the outside of the pipe. Coatings shall overlap surfaces on the outside by at least 25 mm.

4.15.2.2 Butt Weld Edges

For pipes and specials intended for Site butt-welding, lining and coating shall extend up to a distance of 50 mm from pipe ends. The unlined circumferential strip of grit blasted surface shall be temporarily protected between the Works and Site with a coat of weldable primer (of a different colour to the lining/coating).

4.15.3 Field Joints

No welding whatsoever shall be performed on any pipe or special on which the lining or coating has been completed, unless otherwise approved by the Engineer in writing.

The materials used for the repairs to field joints, linings and coatings shall be the same as that used for the pipes, unless otherwise approved by the Engineer in writing.

The linings and coatings of butt welded steel pipes or continuously welded steel cylinder type prestressed concrete pipes, shall be made continuous over joints as soon as possible after approval and acceptance by the Engineer of the welded joint. At no time shall field joints, lining and coating repairs/remedial work lag more than 250 metres behind the last pipe laid.

Flexible couplings shall be provided with external protection as soon as the pipeline has been hydrostatically tested and electrically bonded, where applicable.

4.15.4 Supports

When pipes are installed or mounted on concrete supports, rubber insertion shall be used to insulate the pipe from the support. The thickness of the rubber insertion shall not be less than 10 mm and protrude not less than 20 mm all round.

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4.15.5 Sealing

Pipes that enter or exit concrete shall be sealed on their circumference with a continuous polyurethane or polysulphide flexible sealer, in a 25 mm square recess.

4.15.6 Spare Pipes

Corrosion protection of spare pipes shall where applicable be supplied with a top coat of Re-coatable Polyurethane to a DFT of 30 – 50 µm, colour white or silver, for storage and above ground installation.

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5 MATERIALS

The material requirements for each corrosion protections system is specified in the relevant clauses of Clause 10 and shall be read in conjunction with this clause.

5.1 GENERAL

All materials in a corrosion protection system shall be purchased from the same manufacturer unless approved by the Engineer.

Materials offered and subsequently approved shall not be changed without written approval of the Engineer.

All corrosion protection materials shall be delivered in the manufacturer's original containers clearly marked with the following:

- Manufacturer's name;
- Product Brand and Reference Number;
- Batch Number which may incorporate the date of manufacture;
- Abbreviated instructions for storage and use of material, which shall include mixing ratios of the components of multi-component materials, minimum and maximum temperature of application and the method of application; and
- The SANS mark where applicable.

Any conflict between the manufacturer's data sheet and the specification shall be referred to the Engineer for adjudication.

5.2 TOXICITY OF LINING MATERIAL

Materials used for the lining of equipment that will be in contact with water shall be non-toxic and shall not impart any odour, taste, or colour to the water.

5.3 STORAGE

All corrosion protection materials shall be kept in an approved dry and enclosed store. The temperature shall not drop below 0°C nor exceed 40°C.

Usage of materials shall be on a first in, first out basis and no materials shall be used that have exceeded the shelf life recommended by the manufacturer.

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6 CONTRACTOR'S EQUIPMENT

6.1 HANDLING AND TRANSPORTATION

The plant and equipment used by the Contractor for handling of pipes, valves, pumps and other equipment, for the purpose of corrosion protection shall be such that no pipe shell, valve or pump casing or any other piece of equipment is over stressed during any operations covered by this Specification.

6.2 SURFACE PREPARATION EQUIPMENT

The Contractor shall provide all the equipment required for abrasive blast cleaning, preparation and cleaning of all surfaces to be coated.

6.3 COMPRESSOR

Compressors used for abrasive blast cleaning shall be fitted with an after cooler and oil and water traps such that the air delivered at the nozzle is completely free from oil and water. The volume displacement of the compressors shall be adequate for the number and bore of blast nozzles, the spray equipment and flame spray equipment that may be necessary to carry out the specified coating operations.

6.4 APPLICATION EQUIPMENT

The Contractor shall provide all the equipment required for airless spray painting, two component hot airless spray painting, electrostatic powder coating, fluidised bed powder coating, or any other approved method of applying the corrosion protection system in the shop or required for site application and repairs to coats. All equipment shall be thoroughly cleaned on completion of each day's work and maintained in clean working order.

6.5 INSPECTION OF EQUIPMENT

All facilities and equipment shall be subject to inspection by the Engineer or the independent inspectorate and defects in the equipment shall be rectified when so required.

6.6 INSPECTION EQUIPMENT

The Contractor shall supply all facilities and equipment for inspecting and testing the specified preparation and corrosion protection of all items supplied under the Contract. Recent calibration certificates shall be available for all equipment requiring calibration. This equipment shall be made available to the Engineer or his independent inspectorate for the purpose of testing the specified corrosion protection systems and verifying the accuracy of the test equipment.

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7 PREPARATION OF SURFACES TO BE COATED

The surfaces of all items to be coated and/or lined, irrespective of the corrosion protection system used, shall be prepared in accordance with the relevant following requirements.

7.1 STANDARDS

Reference is made to the latest issues of the following Standards:

SANS 1344	Medium duty solvent detergent.
SANS 10064	The preparation of steel surfaces for coating.
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 8502-3	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
ISO 8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
SANS 5770	Cleanliness of blast-cleaned steel surfaces for painting (freedom of soluble salts).
SANS 5772	Profile of blast-cleaned steel surfaces for painting (profile gauge).
ISO 11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.
ISO 11127	Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives.

7.2 SURFACE CONDITION

Before surface preparation all items to receive a coating or lining shall be in rust condition A to C of ISO 8501-1. Items in rust condition D will be rejected.

Prepared surfaces shall conform to Table 7.1 below. If only surface cleanliness to ISO 8501-1 is specified in the Specifications then the corresponding values of Table 7.1 for degreasing, surface profile and soluble salts shall apply.

Table 7.1: Surface Condition

Cleanliness to ISO 8501-1 (min)	Sa 3	Sa 2½	St 2
Residual dust quantity rating and size class (ISO 8502-3)	1 / 0	1 / 1	1 / 1
Oil, grease and perspiration	Nil	Nil	Nil
Surface Profile(min) Layers up to 200 µm (max)	30 µm 50 µm	30 µm 50 µm	n/a
Surface Profile (min)	50 µm	50 µm	n/a

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Cleanliness to ISO 8501-1 (min)	Sa 3	Sa 2½	St 2
Layers > 200 and up to 300 µm (max)	80 µm	80 µm	
Surface Profile (min) Layers > 300 and up to 500 µm (max)	60 µm 100 µm	60 µm 100 µm	n/a
Water soluble salts:			
Maximum at any point.	100 mg/m^2	400 mg/m^2	500 mg/m^2
Average of any 250 cm of Pipe length.	100 mg/m^2	100 mg/m^2	100 mg/m^2

Note: The maximum surface profile shall be less than ⅓ of the coat thickness.

Unless otherwise specified in the Amendments to this Specifications the surface condition shall conform to the following requirements:

- Sa 3 for the environmental condition classified as severely corrosive,
- St 2 for Tape Wrapping, and
- for all other environmental conditions the surface condition shall be Sa 2½.

7.3 PREPARATION OF ITEMS

Prior to the application of any coat, each item shall comply with the following:

- Weld splatter shall have been removed by chipping or grinding to a smooth surface flush with the surrounding steel.
- Weld seams shall have a smooth contour, free from sharp edges, protrusions and undercuts.
- Sharp edges and protrusions shall have been removed by grinding to a smooth radius. The radius shall be a minimum of 3 mm for steel of thickness 6 mm or greater, or a minimum of 50% of the steel thickness for steel of thickness less than 6 mm.
- Laminations, scabs or occluded scale shall be ground out. If such grinding penetrates deeper than 3.5% of the metal thickness, the area shall be repaired by welding or the metal shall be rejected at the discretion of the Engineer.
- Articles for hot-dip galvanizing shall not have any overlapping joints. Closed sections shall be suitably vented.

7.4 CLEANING OF ITEMS

7.4.1 Degreasing

All surfaces to be coated shall be tested for oil and grease contamination by the water break free test.

In the event that degreasing is required, items shall be degreased by the use of a water based solvent degreaser such as that complying with SANS 1344 or, for use in enclosed systems, with SANS 1365.

Items shall be thoroughly washed with clean potable water to remove all residues. The items shall then be allowed to dry. The washed surfaces shall be tested after degreasing to show that no oil, grease and chemical contamination are present.

Care shall be taken to avoid entrapment of cleaning agents in recesses or other retention areas.

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7.4.2 Blast Cleaning

Blast-cleaning shall be done in accordance with the code of practice SANS 10064. Any abrasive used for blast cleaning shall composed of clean, non-recycled, sound hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter, water soluble salts and foreign metals.

The surface of the items to be coated or lined shall be blast cleaned by centrifugal or air blast cleaning methods, then vacuum cleaned or blown off to achieve the following requirements:

- The surface condition shall be in accordance with ISO 8501-1 as stipulated in Clause 4.2 and specified in the Amendments and Additions of the Specification, when tested in accordance with SANS 5772.
- Any laminations revealed by blast cleaning shall be ground out and re-blast cleaned to meet the above requirements. If grinding penetrates the steel to a depth greater than 3.5% of the nominal wall thickness, the item will be rejected.
- The time interval between abrasive blast cleaning and paint application shall not exceed those given in Clause 9.2.6.2.

7.4.3 Mechanical Surface Preparation

Cleaning by hand or by means of power tools (e.g. wire brushing) shall be carried out in accordance with the methods described in SANS 10064 to the standards specified in the Amendments of this Specifications and as shown in ISO 8501-1 and Clause 7.2.

7.5 PICKLING AND PASSIVATION

Where specified the following areas shall be pickled and passivated:

- All un-coated areas;
- Ground and sheared edges; and
- Heat affected zones caused by welding or cutting.

Where possible, pickling and passivation shall be done by the dipping process.

Proprietary pickling and passivation chemicals (as supplied by approved suppliers) shall only be used in accordance with the manufacturer's recommendations. Pickling formulations made up of 15 to 20% nitric acid (HNO_3) and 1 to 2% hydrofluoric acid (HF) by volume with potable water are considered suitable. Care shall be taken not to exceed the maximum contact time recommended.

After pickling and passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. Repeat the process, if necessary to remove all discolouration. Surfaces shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer.

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8 SURFACE PREPARATION METHODS

The requirements as specified below shall be read in conjunction with the requirements of Clause 7: Preparation of Surfaces to be Coated. Each preparation method specified below shall also conform to the relevant requirements of Clause 7 and its sub-clauses. Where in in conflict with Clause 7 and its sub-clauses the requirements hereunder shall take precedence.

Unless otherwise specified in the Amendments of this Specifications and subject to the approval of the Engineer, the surfaces of all items to be coated and/or lined shall be prepared in accordance with one or more of the following methods.

8.1 MILD STEEL

Components manufactured from mild steel shall be degreased and blast clean before the corrosion protection system is applied. Oil and grease contamination, when present, shall be removed to a water break free surface by degreasing (Refer to Clause 7.4.1) before blast cleaning (refer to Clause 7.4.2).

Steel items less than 2 mm thick may distort when blast cleaned. Sheet steel items less than 2 mm in thickness shall be degreased, acid pickled and phosphated with an approved proprietary 7 or 9 stage process to produce a fine grain zinc phosphate surface complying with SANS 10064 Table 1 Lightweight or by a proprietary process approved by the Engineer for the standard of cleaning specified.

All surfaces of steel 2 mm or more in thickness shall be abrasive blast cleaned in accordance with SANS 10064 Section 5.3 and cleaned to achieve the requirements given in Table 4.1 for the standard of abrasive blast cleaning specified.

8.2 CAST IRON AND CAST ALLOYS

Cast iron shall be abrasive blast cleaned until all sand particles, residual burnt-on sand and casting skin have been completely removed. Cast iron surfaces shall be abrasive blast cleaned in accordance with SANS 10064 Section 5.3 to achieve the requirements given in Clause 7.2 for the standard of abrasive blast cleaning specified.

Blowholes and omegas in cast surfaces shall be opened up where necessary and filled with a two component solvent free epoxy filler. When the filler has set hard, the surface shall be abraded to be flush with the surrounding metal.

8.3 STAINLESS AND CORROSION-RESISTANT STEEL

Components manufactured from stainless or corrosion-resistant steel shall be supplied in the fully passivated condition. Sheared edges, welds or surfaces subjected to any form of heat treatment or contamination with iron or mild steel, shall be pickled and passivated in terms of Clause 7.5.

Surfaces shall thereafter be thoroughly degreased in terms of Clause 7.4.1, then rinsed with potable water to obtain a water-break-free surface.

When it is required to paint stainless steel exceeding 2 mm thickness, the surface shall be blast cleaned in accordance with the parameters given in Clause 7.2, using non-metallic abrasives such as iron slag, copper slag or platinum slag. The use of steel shot, steel grit or cast-iron grit is strictly prohibited. Any contamination with iron or mild steel is prohibited.

Where blasting is impractical, the surface shall be cleaned with detergent solution and roughened manually by the use of non-metallic abrasive pads, followed by washing with clean potable water to a water-break-free surface. If a water-break-free surface is not obtained, detergent cleaning shall be repeated until the surface is water-break-free. Allow the surface to dry before coating.

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8.4 ALUMINIUM

Generally, aluminium surfaces will be anodized or powder coated and will require no further treatment. Where painting is required, the aluminium surface shall be thoroughly degreased then rinsed with clean potable water. If the surface is not water break free, repeat the degreasing process until a water-break-free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 micrometres dry film thickness) of wash primer, mixed and applied in accordance with the manufacturer's instructions. Note that the “wash primer” is an adhesion promoter and does not replace the primer specified in the paint system.

8.5 HOT-DIP GALVANIZED SURFACES

Hot-dip galvanized surfaces shall be thoroughly degreased by scrubbing with water rinsable solvent degreaser, followed by thorough washing with clean, potable water. If the water breaks up into islands of non-wetted surface, the degreasing shall be repeated until a water break free surface is obtained. Small areas may be abraded with a non-metallic abrasive paper prior to painting. Large surfaces may be sweep blast cleaned, using ultra-fine abrasive (particle size 0,2 to 0,8 mm) and a nozzle pressure not exceeding 300 kPa. A uniform matt surface shall be obtained. Loss of zinc thickness shall not exceed 10 µm. Cracking and flaking of the galvanized layer is indicative of excessive blast cleaning by using too coarse abrasive or too high blast pressure. Such surfaces will be rejected. The article shall then be stripped and re-galvanized.

8.6 PAINTED SURFACES

8.6.1 Primer Only

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.

The succeeding coats shall be compatible with the primer. Where the type of primer is unknown, a test patch shall be applied. There shall be not loss of adhesion or other defects of the primer or between primer and undercoat. If defects or adhesion loss occur, the primer shall be completely removed, feather blasted and replaced by a primer which is compatible with the specified system.

8.6.2 Recoatable Materials

Surfaces painted with recoatable paints shall be abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried to remove dust and deposits before overcoating.

8.6.3 Fully Cured Non-Recoatable Materials

Surfaces painted with fully cured non-recoatable paints that have exceeded their overcoating time shall be thoroughly abraded with abrasive paper grade 220 to a uniform matt finish, washed and dried before overcoating. The edges of any damage shall be smoothly feathered into the sound paint. Repairs to damaged areas shall extend 25 mm beyond the damage.

8.6.4 Two Component Paints within their Overcoating Time

Surfaces painted with two component paints where the paint is still within the overcoating time specified by the manufacturer shall be recoated without special surface preparation. Where the surface has become contaminated, it shall be cleaned.

8.7 PLASTIC SURFACES SUCH AS PVC AND GRP

Where the surface has been contaminated it shall be washed and dried to remove dust and deposits before overcoating.

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8.8 CONCRETE AND PLASTER SURFACES

Concrete and plaster surfaces to be painted shall be clean, dry and free from laitance, dust or similar friable surface layers and from mould oil or similar contaminants that will interfere with the adhesion of the coating or lining.

Mould oil shall be removed by the use of a water-based detergent followed by high pressure water washing. When all contaminants have been removed, the surface shall be allowed to dry either to a damp condition or to a completely dry condition, depending on the coating or lining to be applied.

For immersion or other heavy duty applications, laitance shall be totally removed by water blast cleaning, with abrasive injection, or by mechanical scabbling of the surface, or by acid pickling, followed by very thorough washing with potable water.

Off shutter concrete usually shows surface blowholes or omegas. Omegas shall be drilled or chipped open to the full hole diameter. Blowholes and opened omegas shall be filled with a suitable filler such as acrylic or solvent-free epoxy. The use of gypsum or cellulose-based fillers is not permitted for underwater or humid conditions. Shutter kicks and similar projections shall be removed by grinding to a smooth surface.

For coatings or linings of low water permeability, such as solvent-borne epoxies, vinyls and chlorinated rubber, the moisture content of the concrete or plaster shall be not more than an indicated 5% when tested with an approved electrical conductivity meter, designed for use on concrete or plaster (such as the Delmhorst meter). The pins of the meter shall penetrate the concrete or plaster to a depth of not less than 5 mm.

The first coat of the coating or lining system may require thinning with the manufacturer's recommended solvent to assist in penetration of the substrate.

9 APPLICATION OF CORROSION PROTECTION SYSTEM

All coatings and/or linings, irrespective of the surface preparation method or corrosion protection system used, shall be applied in accordance with the relevant following requirements.

9.1 CONDITIONS DURING APPLICATION

If in the opinion of the Engineer adverse weather conditions are such as to interfere with the successful application of an efficient corrosion protective system, he shall order a stoppage of work. The Contractor will be deemed to have accepted this risk and made provision for it in his rates.

9.1.1 Dusty Conditions

Coats shall not be applied in dusty or contaminated conditions.

9.1.2 Surface Temperature

Coats shall not be applied if the surface temperature of the base metal is less than 3°C above dew point or outside the range 5 - 40°C, unless otherwise recommended in the manufacturer’s instructions.

9.1.3 Ambient Temperature

Coats shall not be applied when the ambient temperature is less than the minimum or greater than the maximum recommended by the manufacturer’s instructions of the corrosion protection material.

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9.1.4 Relative Humidity and Time Interval

The time interval between abrasive blast cleaning and paint application shall not exceed those given in Table 9.1

Table 9.1 - Maximum time interval - Between blast cleaning and coating

Ambient Relative Humidity	Maximum Time (hours)
Below 50%	6
50% - 70%	4
70% - 85%	2
Over 85%	Coating not permitted - Reblast and coat when rel. humidity below 85%

Should immediate lining/coating not be possible, or should any atmospheric oxidisation take place between the completion of blast cleaning and commencement of lining/coating, such oxidisation shall be removed by flash blasting to restore the specified surface finish.

9.2 PAINTS

9.2.1 Application method

The recommendations of the paint manufacturer as per the manufacturer's instruction (refer to Clause 4.2) as shown on his data sheets or given in writing shall be followed.

Apart from touch up, all liquid paints applied in the shop shall be applied by means of airless spray machines. Before use all paints shall be thoroughly stirred so as to be completely homogeneous. Two component paints shall be thoroughly mixed in the correct proportions as specified in the manufacturer's data sheet.

Painting on site shall be carried out to the Engineer's written approval. Significant surfaces to be painted on site shall be those specified in the Specification or shown on the drawings. Site application methods shall comply with the paint manufacturer's recommendations.

9.2.2 Colour

Successive coats shall have distinctively different shades to facilitate coverage of each coat. Unless otherwise specified in the Amendments to this Specification, or directed by the Engineer, the final paint colour shall be that given in Appendix B of this specification and shall be a commercial match to the appropriate colour in SANS 1091 - National Colour Standards for Paint.

9.2.3 Wet film thickness

The Contractor shall regularly and frequently monitor wet film thickness and shall calculate the dry film thickness from the volume solids of the paint.

9.2.4 Mixing

All paint components, particularly two- or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.

9.2.5 Degree of Cure

The degree of cure of paint will vary with time, temperature and ventilation and shall be assessed by solvent wiping in accordance with the method given in SANS 1217 (Methyl Ethyl Ketone Resistance Test).

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9.2.6 Overcoating

9.2.6.1 Compatibility of Coats

All primer, intermediate, finishing coats and layers shall be mutually compatible and recoatable paints shall be used where applicable. There shall be not loss of adhesion between the consecutive coats or other defects.

9.2.6.2 Overcoating intervals

The minimum and maximum overcoating intervals provided in the manufacturer's data instructions shall be strictly observed. Times and dates of application shall be recorded for each separate item and coat in the quality control records.

Since overcoating times are frequently quoted at 20 °C or 25 °C, longer overcoating times shall be allowed at lower temperatures. As a rough guide, increase time by 50% for a 5° decrease (or by 100% for a 10° decrease) in the ambient temperature below the temperature quoted in the data sheet.

9.2.6.3 Thickness of Consecutive Coats

Generally a corrosion protection system will be build-up with multiple coats. The thickness of all coats, primer, intermediate or finish coats shall be strictly according to the manufacturer's instructions. For solvent-base paints it is imperative that the applicator does not exceed the maximum film thickness per coat applied in order to prevent entrapment of the solvent and the formation of pinholes.

9.3 DUPLEX OR MULTI-LAYER SYSTEMS

Duplex or Multi-layer systems consist of more than one corrosion protection system applied consecutively e.g. a Hot-Dip Galvanizing and Polyurethane system

The specifications for each of the corrosion protection systems shall be strictly followed. Special attention shall be given to adhesion between the systems.

9.4 FINISHING ON SITE

Repairs, finish painting and cleaning on the site are regarded as inherent parts of the installation. On completion of erection, all pipework, control gear and indicating gear shall be thoroughly cleaned.

After erection, paint work shall be washed down, using nylon brushes and detergent to remove all adhering contamination. It shall then be washed with clean water to remove all traces of detergent and allowed to dry. The finishing coat shall then be applied as specified in the Amendments to this Specification.

All surfaces which cannot be painted after erection shall be painted as specified before erection. The painting system so applied shall be allowed to become fully hard dry (for at least two weeks for epoxy type paints) before erection.

For coatings such as epoxies, having a limited overcoating interval as specified in the manufacturer's data sheets, the surface shall be washed and thoroughly abraded to a matt finish before application of the finishing coats in accordance with the manufacturer's instructions.

9.5 TOLERANCES

9.5.1 Individual Coats Film Thickness

At least 90% of all thicknesses measured shall comply with the minimum thickness of the system specification. Up to 10% of all readings may be below the specific minimum thickness, but no reading shall be less than 70% of the specified minimum thickness.

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9.5.2 Total Dry Film Thickness

Not more than 10% of readings shall be less than the minimum specified and no reading shall be less than 90% of the specified minimum. For severely corrosive conditions no reading shall exceed the specified thickness by greater than 60% of the minimum.

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10 CORROSION PROTECTION SYSTEMS

The requirements as specified below shall be read in conjunction with the requirements of Clause 9: Application of Corrosion Protection Systems. Each system specified below shall also conform to the relevant requirements of Clause 9 and its sub-clauses. Where the requirements of this clause is in conflict with Clause 9 and its sub-clauses the requirements hereunder shall take precedence.

10.1 RECOMMENDED CORROSION PROTECTION SYSTEM

Unless otherwise specified in the Amendments to this Specification and subject to the approval by the Engineer, Plant, equipment and pipework in pump stations and water and wastewater treatment works and pipelines shall be corrosion protected with one or more of the corrosion protection systems described in the following paragraphs of this Specification.

10.2 SYSTEM 1: ALKYD RESIN BASED

Alkyd systems are intended for use in environments of low corrosivity, where a good decorative finish is required. Materials shall therefore be applied with due cognisance of appearance and protection. Defects such as runs, sags, curtaining, shrivelling or wrinkling will not be permitted.

10.2.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 630: Decorative high gloss enamel paints.

SANS 681: Undercoats for paints

SANS 1319: Zinc phosphate primer for steel

10.2.2 Material

Alkyd zinc phosphate primer for steel shall comply with the requirements of SANS 1319.

General purpose alkyd undercoat shall comply with the requirements of SANS 681 Type 2.

Alkyd enamel shall comply with the requirements of SANS 630.

10.2.3 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7.1 and the applicable Method as specified in Clause 8.

10.2.4 Application

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification.

10.2.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in Clause 4.12.

10.2.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

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10.3 SYSTEM 2: VINYL RESIN BASED

Vinyl copolymer (PVC) paints are a single component vinyl resin-based paints have excellent resistance to water, chemicals, dilute acids and hypochlorites. Their resistance to heat is poor and they must never be used on surfaces continually subjected to a temperature of 70 °C or higher. They are not resistant to solvents and should not be used where there may be contact with oils, grease, kerosene, petrol etc.

The main advantage of vinyls is their easy maintainability. Whereas epoxies are difficult to recoat after about one month's exposure, vinyls may be recoated after any period of time.

Vinyls are recommended for use above water and for interior and exterior use where and could be subject to chemical fumes, as in chlorination rooms.

10.3.1 Material

Vinyl copolymer (PVC) paints shall have a solids content of 50% by mass and 32% by volume with a viscosity of 4,5 poise +_ 0,5 poise. The paint shall be stabilised against UV radiation.

10.3.2 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7.1.

10.3.3 Application

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification.

10.3.4 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in Clause 4.5.

10.3.5 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.4 SYSTEM 3: THERMAL SPRAY METAL

Thermally sprayed metal coatings shall consist of the metal spray plus the application of a suitable sealant and a suitable coating.

10.4.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 2063: Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys

10.4.2 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Table 7.1.

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10.4.3 Application

Thermally sprayed metal coatings shall consist of the metal spray plus the application of a suitable sealant and a suitable coating.

The minimum coating thickness for both aluminium and zinc shall be 150 µm. Greater thicknesses may be specified for particular applications.

Termal spray metal paints shall be continuously agitated in a pressure pot to ensure dispersion of the zinc particles in the liquid components.

The time between surface preparation and coating shall be shortened from 4 hours to 2 hours at any application area closer than 10 km from the coast.

10.4.4 Repair of Damaged Coats

The requirements of Clause 10 shall apply.

10.4.5 Testing

The thickness shall be checked on every surface plane at points not more than 300 mm apart for small articles and 500 mm for large articles. Angles shall be checked along all 4 surfaces, channels along all 6 surfaces, pipes in 4 planes. The minus tolerance on thickness in isolated areas shall also not exceed –10 % and such low areas shall not be larger than 50 mm in diameter.

10.5 SYSTEM 4: POWDER COATS

10.5.1 Standards

Reference is made to the latest issues of the following Standards:

BS 5493: Protective coating of iron and steel structures against corrosion.

10.5.2 Material

Material used shall conform to SA*N*S 1217, Type 2, powder coating.

10.5.3 Surface Preparation

The substrate surface preparation shall conform to the Manufacturer's Instructions or as specified in the Amendments of this Specification as approved by the Engineer. In the event of it being omitted the surface preparation shall confirm to the requirements Sa 2½ (ISO 8501-1) and the corresponding requirements as specified in Clause 7.2 and Table 4.1.

10.5.4 Application

10.5.4.1 Coating Thicknesses

Coating thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification

10.5.4.2 Coating Application

Powder shall be applied in the shop by electrostatic spray or by fluidised bed as applicable. Items for powder coating shall after surface preparation, be pre heated to the required temperature, usually in the range 200 to 250ºC, coated by electrostatic spray or by fluidised bed, then post cured if necessary to obtain complete fusion and cure. For surfaces to be immersed the applied coating shall be tested for defects by high voltage spark testing. No defects will be permitted. Thermoset materials such as FBE shall be fully cured.

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10.5.5 Repair of Damaged Coats

No repairs of damaged coatings will be accepted.

10.5.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.6 SYSTEM 5: TWO PACK EPOXY

This corrosion protection system is suitable for large steel items subject to medium corrosive and severely corrosive environmental conditions such as valves, pipes, etc.

10.6.1 Standards

Reference is made to the latest issues of the following Standard Specifications:

SANS 1217: Internal and external organic coating protection for buried steel pipelines.

ISO 2808: Paints and varnishes - Determination of film thickness.

BS 5493: Protective coating of iron and steel structures against corrosion.

10.6.2 Material

The material used for two component (two pack) high build polyamide epoxies shall be based on epoxy-polyamide resins and shall comply with the requirements of SABS 1217. Epoxies shall be of the high build, modified aluminium epoxy mastic type, containing at least 90% solids.

Solvent free epoxies in accordance with SANS 1217 Type 1B is preferred. Type 1A (solvent-borne chemically cured paint material) will only be approved by the Engineer for specific application conditions.

The epoxies shall be non toxic and non tainting when it will be in contact with potable water.

10.6.3 Surface Preparation

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements Clause 7.2.

10.6.4 Application

10.6.4.1 Dry Film Thicknesses

Dry film thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification.

10.6.4.2 Mixing

In the case of two-pack materials, each component containing pigments shall be thoroughly mixed.

The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. For two pack materials, the use of part of the contents (split packs) is strictly forbidden.

In the case of solvent based Epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period, as recommended by the manufacturer, before use.

During application, paint materials shall be agitated regularly to keep the solids in suspension.

The preparation time, induction time and pot life of these materials shall be closely adhered to.

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10.6.4.3 Curing

Adequate ventilation (and heating if required), shall be provided for the proper curing of the epoxy coating or lining in all circumstances with special reference remedial work, repairs and to field joints of pipelines.

10.6.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and in terms of Clause 4.12.

10.6.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.6.7 Pipe Field Joints for Epoxy Linings

The internal corrosion protection System of welded field joints, for pipes with epoxy linings, shall be the same as that used for the adjacent pipes.

The surface preparation of the field joint area shall be the same as for the repair of major defects as specified in Clause 4.12.2.

10.7 SYSTEM 6: FUSION BONDED EPOXY (HEAVY DUTY)

This corrosion protection system is suitable for large steel items subject to medium corrosive and severly corrosive environmental conditions such as valves, pipes, etc.

10.7.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1217: Internal and external organic coating protection for buried steel pipelines.

ISO 12944: Paints and varnishes – Corrosion protection of steel structures by protective paint systems.

10.7.2 Material

Material used shall conform to SANS 1217, Type 2, powder coating.

10.7.3 Surface Preparation

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements Clause 7.2.

10.7.4 Application

10.7.4.1 Dry Film Thicknesses

Dry film thicknesses shall be at least 250 µm unless otherwise specified in the Amendments of this Specification

10.7.4.2 Coat Application

Items shall be heated to a temperature of 200°C (only applicable to heavy items) and coated with Fusion-bonded Epoxy by means of an electrostatic powder gun.

The normal procedures pertaining to powder application shall apply.

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On completion of the coating or lining, items shall be cured for 60 minutes at 200°C (mean temperature).

10.7.5 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and conform to the requirements of Clause 4.12. with an approved repair kit.

10.7.6 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.8 SYSTEM 7: HOT-DIP GALVANIZING (HEAVY DUTY)

This corrosion protection system is suitable for steel items subject to mildly corrosive and medium corrosive environmental conditions such as handrails, covers, small diameter pipework, etc.

10.8.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 32:	*See EN 10240.*
SANS 121:	Hot-dip galvanized coatings on fabricated iron and steel articles.
SANS 1344:	Medium duty solvent detergent.
SANS 2063:	Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys.
SANS 5772:	Profile of blast-cleaned steel surfaces for painting.
ISO 752:	Zinc ingots.
ISO 2808:	Paints and varnishes - Determination of film thickness.
ISO 14713:	Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines.
EN 1179:	Zinc and zinc alloys – primary zinc.
EN 10240:	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic Plants

10.8.2 Material

Impurities in the molten zinc, as defined in ISO 752 and EN 1179, shall not exceed a total of 1.5%.

Steel to be hot-dip galvanized shall be as listed below. In both cases material certification shall be supplied:

- For aesthetic appearance:
  - Aluminium killed steel, or
  - Silicon-killed steel with a Silicon content not exceeding 0.04% and a Phosphorus content not exceeding 0.02%.
- For general corrosion protection:
  - Aluminium killed steel, or
  - Silicon killed steel with a Silicon content not exceeding 0.25% and a Phosphorus content not exceeding 0.02%.

The condition of articles to be hot-dip galvanized shall comply with Clause 7.3 of SANS 121.

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The condition of tubes to be hot-dip galvanized on a continuous line shall comply with “Annexure A” of EN 10240.

10.8.3 Surface Preparation

Unless otherwise specified in the Amendments of this Specification the surface preparation shall confirm to the requirements Clause 7.2.

10.8.4 Application

Galvanizing shall only be done by members of the Hot Dip Galvanizers Association of Southern Africa (HDGASA) in accordance with SANS 121 and EN 10240.

The coating of lining thickness shall comply with the values specified for General Applications or Heavy Duty Applications as specified in this Specification.

Galvanized surfaces which are to be painted shall NOT be passivated by the galvanizer.

10.8.5 Special Requirements

10.8.5.1 Steel Specials

(1) Surface

Surfaces shall be free from nodules, blisters, roughness and sharp points. Un-coated areas, flux residues, lumps and zinc ash will not be permitted.

Notwithstanding Clause 6.1 of SANS 121, in the case of handrails etc. a high quality surface finish is required and a bright smooth surface shall be achieved. Double dipping shall not be allowed.

(2) Thickness

The thickness of hot-dip galvanizing shall comply with the requirements of the Table 10.1 below.

Table 10.1: System 7 - Minimum Coat Thickness on Items that are not Centrifuged

ARTICLES AND ITS THICKNESS	HEAVY DUTY	LIGHT DUTY	
	Thickness µm (min)	Local Thickness µm (min)	Mean Thickness µm (min)
Steel ≥ 6 mm	105	70	85
3.0 mm ≤ Steel < 6.0 mm	80	55	70
1.5 mm ≤ Steel < 3.0 mm	65	45	55
Steel < 1.5 mm	55	35	45
Castings ≥ 6.0 mm	105	70	80
Castings < 6.0 mm	-	60	70

Heavy duty coats are required except in the following cases:

- Where a high surface finish is required; and
- Where otherwise specified in the Amendments of this Specification.

10.8.5.2 Steel Tubes

Steel tubes shall be in accordance with Clause 7 of EN 10240.

(3) Surface

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The surface of the coat shall be continuous, smooth and free from flux residues.

(4) Thickness

The thickness shall comply with the requirements of the coat quality A1, in accordance with Clause 8, Table 1 of EN 10240, as specified below.

Table 10.2: System 7 - Minimum Local Coat Thickness Requirements for Coat Quality A1

REQUIREMENTS	QUALITY A1
Minimum local coat thickness on the inside surface except at the weld bead	55 µm
Minimum local coat thickness on the inside surface at the weld bead	28 µm
Minimum local coat thickness on the outside surface	55 µm

(5) Adhesion

The coat shall show no evidence of flaking or cracking when tested in accordance with

Clause 11.4 of EN 10240.

(6) Qualities

Coat qualities shall be A1 for water installations – see Sub-Clause 8.2 of EN 10240.

The surface of the coat on the inside shall be as smooth as can be achieved by steam blowing.

10.8.6 Testing

This clause and its sub-clauses shall be read in conjunction with Clause 4.13 and Clause 11.1 of this Specification.

10.8.6.1 Steel Items

(7) Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

(8) Thickness

Thicknesses shall be in accordance with Clause 10.8.5 and shall be tested in accordance with Sub-Clause 6.2 of SANS 121.

10.8.6.2 Steel Tubes

(9) Visual Examination

Where a superior aesthetic appearance of hot-dip galvanizing is requested, a bright mirror surface finish shall be achieved by the galvanizer.

(10) Thickness

Shall be tested in accordance with Sub-Clause 11.3 of EN 10240 (SANS 32).

(11) Adhesion

Shall be tested in accordance with Sub-Clause 11.4 of EN 10240 (SANS 32).

10.8.6.3 Chemical Analysis

Items shall be tested in accordance with Sub-Clause 11.5 of EN 10240 (SANS 32).

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10.8.7 Repair of Damaged Coats

10.8.7.1 General

Repairs to damaged galvanizing shall be carried out in accordance with the procedures specified in SANS 121 by hot metallic zinc spraying unless the use of an appropriate solder is approved. Conventional solder shall NOT be used. Solder composition shall have been approved in writing by the SANS (Metallurgy Division) or by the SAHDGA.

10.8.7.2 Steel Items

The total un-coated areas for renovation by the galvanizer shall not exceed 0.5% of the total surface area of a component. Each un-coated area for renovation shall not exceed 400 mm². If un-coated areas are larger, the item containing such areas shall be re-galvanized.

The repair method shall be approved by the Engineer before repairs are initiated.

Repairs shall be by zinc thermal spray in accordance with SANS 2063 or three component zinc solvent free Epoxy repair system. The repair shall include removal of any scale, cleaning and any necessary pre-treatment to ensure adhesion – refer to Clause 7

The coat thickness on the renovated areas shall be a minimum of 30 µm more than the local coat thickness specified in Clause 10.8.5 for the relevant hot-dip galvanized coat unless otherwise specified by the Engineer. The coat on the renovated areas shall be capable of giving sacrificial protection to the steel to which it is applied.

10.8.7.3 Steel Tubes

Repairs shall not be allowed on internal surfaces of tubes. Where repairs are required, tubes shall be re-galvanized. Repairs on external surfaces shall be in accordance with Clause 10.8.7.1.

10.9 SYSTEM 8: ELASTOPLASTIC POLYURETHANE

This part of the Specification applies to two component solvent free elastoplastic polyurethane. This system shall only be used in limited approved applications.

10.9.1 Standards

Reference is made to the latest issues of the following Standards:

SANS1217: Internal and external organic coating protection for buried steel pipelines.

10.9.2 Material

The paint material shall be a solvent free two-component polyurethane hybrid based on a polyester type polyol and aromatic isocyanate. The cured paint shall comply with the following requirements:

- Tensile strength at 3 mm thickness - ASTM D638 - not less than 15 MPa.
- Adhesion to primed steel - SANS Method 776 - not less than 10 MPa.
- Impact resistance (direct) - ASTM G14 - not less than 9 Joules.
- Dielectric Strength - not less than 10 kV/mm.
- Elongation at break - not less than 25%.
- Compressibility - not less than 25 MPa.
- Surface hardness of 5 mm thick sample - not less than 60 nor greater than 80 Shore 'D'.
- Water Vapour Permeability - not greater than 0.5 g/24 h/m²/mm².

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- Cathodic disbonding - when tested in accordance with ASTM G8 Method A, for 60 days, the disbonded area shall not exceed 500 mm².

10.9.2.1 Adhesive

Adhesive shall be a two component polyurethane adhesive designed to maximise adhesion between used polyurethane and freshly mixed polyurethane.

10.9.3 Application

10.9.3.1 Dry Film Thicknesses

Dry film thicknesses shall be at least as follows unless otherwise specified in the Amendments of this Specification

- Overcoating as duplex system
  - The dry film thickness shall be 40 µm minimum.
- For corrosive/abrasive environmental conditions:
  - The dry film thickness shall be 1.0 mm minimum.
- For highly corrosive/abrasive environmental conditions:
  - The dry film thickness shall be 3.0 mm minimum.

10.9.4 Repair of Damaged Coats

Repair procedures shall be approved by the Engineer and conform to the requirements of Clause 4.12.

10.9.5 Testing

Testing shall conform to the requirements of Clause 11 and SANS 1217.

10.10 SYSTEM 9: TAPE WRAPPING

The tape wrapping system is intended to be used in areas where special protection is required due to handling of items e.g. pipelines at road crossings etc. or where it is highly likely that the paint system can be damaged e.g. at specials and addition precaution is required to protect the pipeline. It is also often used to repair field joints of pipelines. It is suitable for severely corrosive environments.

10.10.1 Standards

Reference is made to the latest issues of the following Standards:

SANS 1117: Plastic wrappings for the protection of steel pipelines.

SANS 10129: Plastics tape wrapping of steel pipelines.

10.10.2 Material

Polyethylene pressure-sensitive tape or polyethylene laminated to an elastomeric layer of butyl rubber tapes shall conform to SANS 1117, types A, B or C.

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10.10.3 Application

10.10.3.1 General

Steel pipes, fittings and specials, protected by means of tapes, shall be wrapped in accordance with SANS 10129 as amended and supplemented by this Specification. All pipes shall be wrapped outside the trench in accordance with acceptable factory applications. Tape wrapping may be carried out in an "over the trench" operation for pipe diameters up to 450 mm.

10.10.3.2 Surface Preparation

Steel pipe surface preparation shall conform to Clause 3.2 of SANS 10129.

10.10.3.3 Priming

Immediately after surface preparation but not later than 4 hours after cleaning, provided the pipe surfaces are kept dry and free from dust, a primer shall be applied according to Clause 4.2.1 of SANS 10129.

10.10.3.4 Normal Wrapping

Tape wrapping shall be applied with sufficient pre-tensioning immediately after priming, in accordance with Clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects at temperatures up to 65°C.

For normal wrapping, tape shall be applied in two layers with a minimum overlap of 50 mm on both the inner and outer wraps.

Tape joints and repairs shall be done in accordance with Clause 4.2.3 of SANS 10129.

Hand wrapping shall only be allowed for short lengths that are inaccessible to a wrapping machine, specials, joints, small diameter pipes and small repairs – refer Clause 10.10.6

10.10.3.5 Armouring

Where armour wrapping is specified, two layers of tape wrapping shall first be applied with sufficient pre-tensioning immediately after priming, in accordance with Clause 4.2.2 of SANS 10129, and shall ensure a smooth wrap free from wrinkles, blisters, frayed or torn edges, cracks or other defects even at temperatures up to 65°C.

The first layer of wrap shall overlap by half the tape width plus 25 mm and the second wrap shall overlap by not less than 50 mm.

The above-mentioned layers of tape shall be armoured by the application of a third layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50%.

Armoured wrappings shall generally be applied at the following positions:

- All road crossings through sleeves and culverts;
- All railway crossings through sleeves or culverts; and
- Wherever the Engineer may consider that special conditions warrant such measures.

10.10.3.6 Wrapping of Specials

In the case of specials or pipe lengths where length and/or shape preclude the application of a protective wrapping system by any means, the protection shall be carried out either by bitumen-fibre glass or epoxy corrosion protection system in accordance with the requirements of the applicable corrosion protection system. In the case of access, scour, air valve and farmers off-take tees the special shall be deemed to incorporate at least two (2) diameter lengths either side of the main tee barrel.

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10.10.3.7 Armour Wrapping of Coated Pipes

Where armour wrapping of coated pipes is specified, a single layer of pressure-sensitive polyethylene tape with a carrier thickness of 750 micrometres and a minimum overlap of 50% shall be applied.

10.10.4 Tolerances

10.10.4.1 Pressure Sensitive Tape Wrapping

The minimum thickness of the inner low-density polyethylene tape carrier component shall be 300 µm and the maximum thickness of the outer high-density tape carrier shall be 1000 µm. Total minimum polyethylene thickness of 1450 µm.

The adhesive part of the inner layer shall be a minimum thickness of 1.5 times the polyethylene tape carrier thickness. For the outer layer the adhesive layer shall be at least equal to the thickness of the polyethylene tape carrier thickness.

10.10.4.2 Butyl Rubber Laminates

The minimum thickness of the completed wrapping shall be 750 µm. The inner layer shall be a butyl rubber laminate of 450 µm minimum thickness of which the butyl rubber film shall not be less than 200 µm thick and the polyethylene film shall not be less than 200 µm thick.

The outer layer shall be high density pressure tape of 300 µm minimum thickness.

10.10.5 Testing

This clause and its sub-clauses shall be read in conjunction with Clause 4.13 and Clause 11.1 of this Specification.

10.10.5.1 Visual Inspection

The wrapping shall have a smooth appearance, free from wrinkles, blisters, bridging across weld beads, frayed edges, cracks, dis-bonding and any signs of physical damage.

10.10.5.2 Non-Destructive Testing

(12) Electrical Insulation Defect (Holiday) Testing

The entire wrapping of the pipeline shall be tested to ASTM G62 with an approved Holiday Detector equipped with a rolling ring detector around the pipe by the Contractor to the Engineer's satisfaction. The ring shall be in close contact with the surface of the wrapping along the pipe circumference. The test shall be carried out immediately prior to lowering the pipe into the trench. The wrapping on specials or short pipe lengths shall be tested with an approved Holiday Detector fitted with a copper bristle brush detector of suitable form. The wrapping shall exhibit no Holidays when tested with an effective voltage of 12 kV at a nominal pulse frequency of not less than 30 Hz.

The Engineer may instruct any length of pipe or any number of specials to be re-tested using a Holiday Detector with a copper bristle brush detector.

(13) Insulation Test

The Engineer shall carry out a conductance test on the wrapping over any section of pipeline between valves when the pipeline has been wrapped and installed in the trench with padding and back filling completed. The test shall be conducted as per NACE TM0102 with the valves temporarily removed from the line, at the Contractor's expense, to ensure complete isolation of the pipeline section under test or between gaps left for tie-ins.

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The length of the section of pipeline under test shall be carefully measured and the conductance over the section tested shall not exceed 180 micro-Siemens per square metre of pipe surface under all conditions of test. If the results of the test for the section of pipeline tested are not satisfactory, two sections immediately adjacent to the testing section will be tested. If the results on one or both of these sections tested are not satisfactory, all sections of wrapped pipeline shall be tested.

10.10.5.3 Destructive Testing

The Engineer may from time to time collect samples of 10 m of each type of tape and one litre of primer for testing, for compliance with the Specification, by any independent laboratory appointed by the Engineer. The supply of samples shall be for the Contractor's account. The Engineer reserves the right to reject the whole batch of materials from which unsatisfactory samples were obtained.

10.10.5.4 Repair of Damaged Coats

The Contractor shall be required to locate areas of faulty protection on all sections on which unsatisfactory results are obtained and to affect the necessary repairs. The cost of this work and all additional materials provided or supplied, including the reinstatement of the trench and the retest shall be for the Contractor's account.

10.10.6 Repair Methods

Where damage to the wrapping on a pipeline has occurred and where there are creases, wrinkles and folds in the wrapping, proceed as follows:

10.10.6.1 Small Damaged Areas

If the width of the tape being used exceeds by at least 100 mm the length of the section affected, cut the area of damaged wrapping away to bare metal leaving no raised edges or protrusions.

Clean and prime the exposed area in accordance with Clauses 10.10.3.2 and 10.10.3.3 and apply a patch of tape, ensuring an overlap of not less than 50 mm on all sides onto the surrounding wrap.

Apply by hand-wrapping with a 55% overlap, a further layer of tape commencing two turns before and continuing for two turns beyond the patch.

10.10.6.2 Large Damaged Areas

Where the extent of damaged or faulty wrapping is such that the tape cannot span the affected area and provide a 50 mm overlap on all sides it must be completely removed from the pipe over the affected section. The area shall be cleaned and primed in accordance with Clauses 10.10.3.2 and 10.10.3.3. The pipe must be re-wrapped with a 55% overlap, commencing two turns before and finishing two turns beyond the bared section.

10.10.6.3 Damage on Double Wrap

Where damage or a defect has occurred in a section that has been double wrapped and in the case of small Holidays, the outer wrap shall be removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area.

The appropriate procedure given in Clauses 10.10.6 shall be used to affect the repair of the inner wrap.

The outer wrap shall be re-instated in accordance with Clause 10.10.3.5.

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10.10.6.4 Outer Wrap Damage

Where damage extends through an outer wrap / rockshield (see Section 6 of SANS 10129), this shall be carefully removed for a distance equal to three (3) times the width of the inner wrap tape on each side of the damaged area without damaging the inner wrapping.

The repair shall be carried out by the appropriate method given in Clauses 10.10.6 and the outer wrap / rockshield re-instated in accordance with Clause 10.10.3.5.

10.11 SYSTEM 10: PETROLATUM WRAPPING

Profiling mastic and mastic blankets are used for corrosion protection of couplings and flanges in chambers with high humidity and buried in soil.

10.11.1 Standards

Reference is made to the latest issues of the following Standards:

ISO 8501-1: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after removal of previous coatings.

SANS 10129: Plastics tape wrapping of steel pipelines.

10.11.2 Surface Preparation

Mechanically clean and wire brush the joint to remove all loose rust, scale, old coating or lining and foreign matter to St 2 (ISO 8501-1).

Areas subjected to chemical attack, salt spray, fungus or bacteria shall be neutralized, rinsed with clean potable water and mechanically cleaned as specified above.

10.11.3 Priming

Brush priming solution well over the entire joint area, leaving a thin film (at a nominal coverage rate of 0.8 m²/litre). Apply a liberal amount around the bolt threads, narrow cavities and crevices.

Paste shall be used where excessive surface corrosion has occurred and under high humidity or submerged conditions.

10.11.4 Application

Use profiling mastic and/or strips to fill all voids, crevices and sharp or irregular contours.

Apply mastic tape circumferentially over the area to be coated with a 25 mm overlap on either side of the mastic with a 75 mm end overlap.

Pre-formed petrolatum mastic blanket system (10 mm thick), supported by a coated tape backing, is available to provide a quick and easy method to apply this system.

Eliminate all air pockets, wrinkles and creases.

10.11.5 Top Coat

10.11.5.1 Buried Conditions

Two complete turns of the polyethylene sheeting shall be applied circumferentially. The ends are secured to the pipe barrels with 48 mm wide bands of PVC adhesive tape, which is also applied to the outside diameter of the bolted joint.

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10.11.5.2 High Humidity Conditions

Overcoat with a synthetic coat mixed with a cementitious filler to give a tough, flexible coat. The base coat may be over-coated with water based Acrylics or Epoxies.

NOTE:

- Detail of application shall be in accordance with the manufacturer's data sheets and approved by the Engineer.

10.12 SYSTEM PC1: SOLVENT FREE POLYURETHANE COATING

This corrosion protection system covers the application of Solvent Free Polyurethane as a coating to steel pipes. Generally the coating is to be applied in accordance with ANSI/AWWA C222-99 'Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings'. Where in conflict with ANSI/AWWA C222-99, the amendments hereunder shall take precedence.

10.12.1 Section Numbers of ANSI/AWWA C222-99

The section (clause) and sub-section numbers in this clause refer to the same numbered sections and subsections in ANSI/AWWA C222-99.

10.12.1.1 ANSI Section 4.2 Test Requirements

Replace 'Table 1 Requirements' with the new Table 1 below.

New Table 1: Physical and Performance Requirements

Property	Polyurethane Coating Material	Test Method Sub-Section
Adhesion, MPa min (laboratory)	15 MPa	ASTM D 4541
Impact resistance Kg m, min	1.6 kg m	ASTM D 2794 Intrusion
Water absorption %, max	max 3%	ASTM D 570 long term
Dielectric strength kV/mm thick min	7.5 kV/mm thick min	SANS 1217 clause 5.9
Resistance to abrasion, mg max	max 100/1000 rev	ASTM D 4090 CS17 1 kg 1000 cycles
Cathodic disbondment	max 12 mm radius	ASTM G 95 at 23 deg C
Durometer Hardness	min 65 Shore D	ASTM D2240
Chemical Resistance 10% sulphuric acid 30% NaCl 30% NaOH Diesel fuel	max 5% in mass, length or width max 5% in mass, length or width max 5% in mass, length or width max 5% in mass, length or width	ASTM D543

10.12.1.2 ANSI Section 4.3 Coating Thickness

ANSI Sub-Section 4.3.1

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The minimum dry film thickness of coating is to be 2000 microns within a tolerance of -100 microns and +1000 microns.

10.12.1.3 ANSI Section 4.4 Surface Preparation

The requirements of section 4.4 of ANSI/AWWA C222-99 will apply and will take precedence over Clause 3.2 above.

10.12.1.4 ANSI Section 4.7 Welded Field Joints

ANSI Sub-Section 4.7

The hold backs (cut-backs) are to comply with Clause 4.15.1 of this Specification.

10.12.1.5 ANSI Section 5.3 Coating Tests

ANSI Sub-Section 5.3.1

The basis of acceptance of proposed coating material shall be as per method (1).

10.12.1.6 ANSI Section 5.5 Coated Pipe Inspection

ANSI Sub-Section 5.5.4

Electrical continuity inspection shall be conducted on all pipes as per Clause 5.9 ‘Dielectric strength’ of SABS 1217.

10.12.1.7 ANSI Sub-Section 5.5.3

The adhesion is to be tested in accordance with ANSI/ASTM D4541.

10.12.1.8 ANSI Section 6.5 Affidavit of Compliance

The manufacturer is to submit with his/her first request for payment an affidavit that all material and work has been conducted in accordance with the requirements of this standard.

10.13 SYSTEM PC2: FUSION-BONDED MEDIUM DENSITY POLYETHYLENE

This coating system shall comply with the Australian Standard Specification AS 4321-1955 entitled “Fusion bonded medium density polyethylene coating and lining for pipes and fittings” except as modified hereunder.

10.13.1 Modifications to Specification AS 4321-1955

10.13.1.1 Preparation of Surface

Delete Clause 5.1 of AS 4321-1955 and replace with Section 3 “SURFACE PREPARATION FOR PIPES TO BE COATED AND LINED” of this specification.

10.13.1.2 Repairs

Delete the last sentence of Clause 8.1 of AS4321-1995 and replace with ”Damaged areas that pass the continuity test need not be repaired provided that the coating or lining thickness is equal to or greater than the thickness specified in Table 1 of AS 4321-1995. Generally no more than 3 repairs will be allowed per 9m length of pipe and the area of a single repair is not to exceed 0.01 square m. If the area of a single repair does exceed 0.01 square m the pipe will be rejected. Repairs may be undertaken in accordance with Clause 8 of AS 4321 for the following methods of repair:- Fusion bond; Heat shrink sleeve or Hot gas welding. A wrapping system may also be used if applied as detailed hereunder.

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10.13.1.2.1 Repairs with Tape

When repairs are permissible the repairs shall be made using a repair system comprising (1) a polymer bitumen primer (Denso Primer D or equivalent approved), (2) an inner seal of modified rubber bitumen sealing tape (Denso Mastic Sealing Tape or equivalent approved) and (3) an outer protective layer of acrylic coated/modified bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape. The outer protective tape is to be wrapped around the entire pipe.

(14) Pinholes

At each pinhole detected by the electrical test, the surrounding area shall be abraded to at least a minimum area of 175mm by 175mm around the hole. The abrasion shall be carried out (with clean emery paper of 80 to 100 mesh) around the repair so as to provide a suitable rough surface profile without causing the removal or excessive amounts of coating material. The repair area is to be feathered into the surrounding sound coating. Debris and other deleterious matter are to be removed by means of a clean rag moistened with Cleaning Solvent. The primer is applied and once it has dried the prepared surface is covered with a patch of modified rubber bitumen sealing tape (Denso Mastic Sealing Tape or equivalent approved) of size 150mm by 150mm. The bond is to be free of air bubbles and smoothed out by hand or using an aluminium fluted roller. Finally, acrylic bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape.

(15) Larger Damaged Areas

The edges of the damaged coating must be chamfered back to remove all potential void areas. The primer and modified bitumen rubber are applied as for pinholes but the modified bitumen rubber tape is pre-cut and applied with 55% overlap Finally acrylic bitumen adhesive pipeline tape (Denso Acrylic Pipeline Tape or equivalent approved) is to be applied with a 50% overlap, ensuring that it is placed 50mm wider all round than the inner repair tape. Weld beads are repaired with suitable lengths of the above size tapes. When covering weld beads, the centre portion of the square must make contact first. Smooth the tape out with an outward direction to remove all entrapped air.

10.13.1.3 Storage, Handling, Transport and Marking

Add to Clause 11 of AS 4321-1955, Clause 1.5 entitled “Plant and Rigging for the handling and delivery of Pipe and Specials” of this specification.

10.14 SYSTEM PC3: THREE LAYER SYSTEM

The three layer corrosion protection system consists of a powdered epoxy primer, a polymeric adhesive and a polyethylene outer sheath which shall be applied in accordance with Canadian Standards Association Specification (CSA) Z245.20-06 and Z245.21-06.

The application is to be in accordance with, inter alia, the following sections of the Canadian specifications listed below.

10.14.1 Z245.20 External Fusion Bond Epoxy Coating for Steel Pipe

a) General Requirements

b) Materials

The following Fusion Bonded Epoxy primers are approved for use.

Akzo Nobel PCL 331

Jotun CORRO-COAT EP-F 1003HW

Should the Supplier wish to use any other make of primer, samples must be left with the Employer or his/her agent for testing. Delays in approval will not be accepted as a reason for late delivery.

c) Coating Application

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d) Inspection and Testing

e) Repair of Coated Pipes

f) Markings

g) Handling and Storage

h) Test Reports and Certificates of Compliance

i) Test Procedures

10.14.2 Z245.21 External Polyethylene Coating for Pipe

a) General Requirements

The Polyethylene outer sheath is to comply with System B1

b) Materials

The following adhesives are approved for use:-

Borealis Borcoat ME0420

Industrie Polieco M.P.B. SRL COESIVE L8.92.8

The following HDPE Outer Sheath materials are approved for use:-

Borealis Borcoat HE3450

Industrie Polieco M.P.B. SRL HDPE 2050

Should the Supplier wish to use any other make of adhesive or outer sheath materials, samples must be left with the Employer or his/her agent for testing. Delays in approval will not be accepted as a reason for late delivery.

c) Coating Application

d) Inspection and Testing

e) Repair of Coated Pipes

f) Markings

g) Handling and Storage

h) Test Reports and Certificates of Compliance

i) Test Procedure

10.15 SYSTEM PC4: BITUMEN FIBRE COATING

10.15.1 General

Where bitumen fibre coating of steel pipes is specified, the method of coating is generally to comply with SABS 1178 ‘The production of lined and coated steel pipes using bitumen or coal tar enamel’. The lining is to consist of a hot-applied bitumen with a double wrap of glass fibre reinforcing material to a thickness of 5mm. There shall not be less than 1mm of bitumen between the pipe surface and the inner wrapping and also between the inner and outer wrappings. Where in conflict with SABS 1178, the amendments hereunder shall take precedence.

10.15.2 Amendments to SABS 1178

The following details are to be noted. The clause and sub-clause numbers hereunder refer to the same numbered clauses and sub-clauses in SABS 1178.

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10.15.2.1 SANS Sub-Clause 3.1.1 Primers

Before the application of external protections, pipes and specials shall be primed with primer type (a) a cold applied bitumen primer complying with SABS 1136 or a synthetic primer for bitumen, complying with SABS 1140.

10.15.2.2 SANS Sub-Clause 3.1.2.1 Bitumen

The bitumen used is to conform to SABS 1137.

10.15.2.3 SANS Sub-Clause 3.1.3 Reinforcement Wrappings

Glass fibre material is to be used as the reinforcement wrapping and is to conform to SANS 1130.

10.15.2.4 SANS Sub-Clause 3.1.4 Reflective Finish

A non-stick, reflective covering shall be applied to the coating. This shall consist of a lime wash based on a dolomitic type lime suitable for non-porous surfaces mixed with water to a slurry and further mixed with boiled linseed oil to improve its water resistance.

10.15.2.5 SANS Sub-Clause 3.2.2 Coating and Table 1

The coating type is to be CB6A as per Table 1. However, the inner wrap may conform to type 1 or type 3 of SABS 1130 and the outer wrap may conform to type 1, type 2 or type 3 glass fibre reinforcing material. The minimum coating thickness excluding the weld seam is to be 5mm. The thickness tolerance shall be +2mm,-0mm.

10.15.2.6 SANS Sub-Clause 3.7.7 Disbonded Areas

Holidays are not to be repaired unless authority to do so is given by Umgeni Water's authorized Quality Inspector.

10.15.2.7 SANS Sub-Clause 3.7.8 Holidays

The coating shall be free from holidays and tested in accordance with Clause 7.2.2 of SABS 1178 at 15Kv.

10.15.2.8 SANS Clause 6 Markings

Refer to Clause 7 of Sub-Clause 2.2 of this specification.

10.15.2.9 SANS Sub-Clause 7.1 Inspection

Add the following sentence –

Before leaving the shop the coating of every pipe and special shall be inspected visually for all defects including, but not restricted to:- tears, holes, mechanical damage and cracking.

10.15.2.10 SANS Sub-Clause 7.2.2 Holiday Detection

A metallic brush or a jointed spiral ring type of scanning electrode is to be used on the variable voltage detector.

10.15.2.11 SANS Sub-Clause 7.3 Destructive Tests

Sufficient coating material shall be removed from the ends of at least one pipe of each day's production for

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the purpose of carrying out destructive tests as detailed under Clause 7.3 of SABS 1178.

10.16 SYSTEM PC5: POLYMER MODIFIED BITUMEN COATING

This corrosion protection system is suitable for large pipes items subject to medium corrosive and severely corrosive environmental conditions.

This specification relates to factory applied pipe coating operations based on hot applied polymer modified bitumen.

10.16.1 Standards

This standard makes reference to the documents listed below. Unless otherwise specified the latest editions of these documents, including all addenda and revisions, shall apply.

British Standards

BS 410	Specification for test sieves.
BS 1796	Methods using test sieves of woven wire cloth and perforated metal plate.
BS 2000	Methods of test for petroleum and its products.
BS 3900	Methods of test for paints:
	Part A 6 (replaced by EN 535) – Determination of flow time of paints.
	Part B 2 (replaced by ISO/DR 1515) – Determination of volatile matter and non-volatile matter.
BS 4147	Bitumen-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.
BS 7079	(Replaced by ISO 8501-8504) – Preparation of steel substrates before application of paints and related products.

Swedish Standard

SIS OS 5900	Pictorial surface preparation standards for painting steel surfaces.

American Standard

ASTM D 113-86	Ductility of bituminous materials.
ANSII AWWA C203-91	Coal-tar Protective Coatings and linings for steel water pipelines – enamel and tape-hot applied.

South African Standard

SANS Method 772	Blast profile.

10.16.2 Materials

10.16.2.1 Primer

The primer shall be of synthetic composition, designed to be used with a specific polymer modified bitumen.

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The drying rate of the primer shall be suited to the application conditions. The primer shall be supplied in new sealed steel drums.

The primer shall have the characteristics shown in Table 3. In addition, when stored in original sealed containers at ambient temperature, the primer shall retain the properties as set out in Table 3 for not less than 6 months from the date of delivery.

Table 3:Characteristics of Primer

CHARACTERISTIC	**REQUIREMENTS**	**METHOD OF TEST**
Viscosity at 23°C	35-60 seconds	Flow cup No 4
		BS3900: Part A6 = EN 535
Volatile matter	75	BS3900: Part B2 = ISO/DR
(max. % loss by mass)		1515 (105^{0}C for 3 hours)

10.16.2.2 Polymer Modified Bitumen

10.16.2.2.1 Composition

The polymer modified bitumen shall consist of a uniform mixture of the following:

- A formulated blend of polymer modified bitumen, as specified in (c) and (d) below.
- A proportion of approved filler (limestone or asbestos shall not be used).
- Characteristics of the filler shall be as specified in (b) below.

10.16.2.2.2 Filler Grading

Method of test to BS 1796 modified to use the metric sieves specified in BS 410.

Passing 90 microns – not less than 93%.

Passing 250 microns – not less than 99%.

10.16.2.2.3 Characteristics of the Polymer Modified Bitumen

The material shall conform to the requirements given in Table 4 when tested in accordance with the methods specified.

10.16.2.2.4 Performance Tests of the Polymer Modified Bitumen System

The polymer modified bitumen shall be of thermoplastic rubber/bitumen modification.

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The polymer modified bitumen containing mineral filler with the characteristics detailed in 10.16.5.1.2 shall pass the performance test specified in Table 4.

Table 4:Characteristics and Performance Test for Polymer Modified Bitumen

PROPERTIES	**METHOD**	**UNIT**	**REQUIREMENTS**
Softening Point	ASTM D36	^{o}C	115-130
Penetration @ 25°C	ASTM D5	1/10 mm	15-30
Density @ 25°C	BS 4147	g/cm^3	1.1-1.4
Viscosity @ 170°C	Brookfield	Cp	7000-12000
Viscosity @ 190°C	Brookfield	Cp	3000-6000
Filler Content	BS 4147	%	20-30
Impact @ -10°C	BS 4147	mm^2	Max. 6500
Peel Initial / Delayed	BS 4147	mm	Max:
Sag @ 25°C	BS 4147	mm	3,0/3,0
Sag @ 40°C	BS 4147	mm	3,0/3,0
Sag @ 50°C	BS 4147	mm	3,0/3,0
Sag @ 60°C	BS 4147	mm	3,0/3,0
Sag @ 80°C	BS 4147	mm	Max. 1.5
Aging Test @ 190°C	Phoenix	hours	Min. 72
Bend	BS 4147	mm	Min. 15

NOTES:

- The test plates shall be cleaned by abrasive blasting to grade Sa 2½ of SIS OS 5900 (BS 7079 and ISO 8501 – 8504) and with a profile of 50 – 75 microns (SANS Method 772). They shall be coated with primer at a rate of 100g per m^2.
- For the impact test a plate 12.7 mm thick shall be used and a single impact made in each quarter of the plate. The average of the four areas disbanded shall not exceed the permitted

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value shown in Table 4.

- The peel test at 25°C is equivalent to / replaces the preliminary adhesion test in the original Specification.

10.16.2.3 Outerwrap

a) The outerwrap consists of a combination of polyester and glass fibres to ensure the required strength and elasticity. This is combined with a glass fabric of uniform quality and amount to control the best application and the required amount of bleed through, in order for the outerwrap to provide maximum protection.

b) The outerwrap shall be impregnated with the polymer modified bitumen compatible material to fulfil the characteristics shown in Table 5.

c) The characteristics of the outerwrap shall comply with the requirements of Table 5 and shall be determined in accordance with the test procedure.

Table 5:Characteristics of Outerwrap Saturant

CHARACTERISTIC	**REQUIREMENT**	**METHOD OF TEST**
Softening Point	Min 100°C	BS 2000
Penetration @ 25°C	60-85 1/10 mm	BS 2000
Saturant	Polymer Modified Bitumen	

Table 6:Physical Characteristics of Outerwrap

CHARACTERISTIC	**TYPE A**	**TYPE B**	**METHOD OF TEST**
Minimum Thickness (mm)	0.6	0.6	AWWA C203-91
Weight (g) per m^2	500 – 700	500 – 700	AWWA C203-91
Tensile strength (N/50 mm)			
Longitudinal	> 800	> 400	AWWA C203-91
Transverse	> 800	> 200	AWWA C203-91

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10.16.3 Application

10.16.3.1 Care of Wrapping Materials

All wrapping materials consigned to the coating yard or factory shall be properly stored to prevent damage or deterioration.

10.16.3.2 Care of Pipe

Throughout the wrapping process pipe and coating materials shall be kept clean and away from all foreign matter.

10.16.3.3 Marking

Any pipe manufacturer's identifying marks shall be removed before the start of the wrapping process and shall be permanently marked on the side of each pipe at both ends with a weatherproof paint. Metallic dye stamping shall only be permitted using approved stamps and only on the pipe bevel.

10.16.3.4 Blast Cleaning

In preparation for the application of primer all grease or heavy soil shall be removed without spreading over the surface with a volatile solvent, e.g. xylene (or approved equivalent) and thereafter the external surface of the pipes shall be cleaned by abrasive blasting to at least Sa 2½ grade SIS O5 009 (BS 7079 and ISO 8501-8504) SANS 772 and surface profile amplitude 75 µm. DWS 9900 C1 for detailed description of surface preparation process.

10.16.3.5 Priming

d) Following blast cleaning and within 2 hours, the pipe exterior shall be coated with the primer applied at a controlled rate to the manufacturer's recommendations. Pipes shall be coated within 24 hours of being primed.

e) The primer shall be applied to a dry, clean and dust free pipe and thereafter the primed pipe shall be kept free from moisture, dust or any other contaminant. The primed pipe shall be uniform and free from runs, drips, flooded or bare areas. Particular care shall be taken to ensure complete coverage of weld areas.

f) The primer should be applied at a pipe temperature of 10°C (or above) or 3°C above the dew point. If the pipe temperature is lower than this level or if moisture is present on the pipe, heating of the pipe may be required.

g) Deteriorated or contaminated primer shall not be applied to the pipe. Primer that has deteriorated or become contaminated after its application shall be removed to the satisfaction of the Employer or his representative, at the Contractor's expense. The cleaned area shall then be re-primed.

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10.16.3.6 External Coating and Wrapping Application

h) The pipe, after priming and when the primer is no longer tacky, shall be passed through coating facilities of a type approved by the Engineer. The machine shall coat the pipe weld (longitudinal or spiral) with a 50 mm wide strip of extruded polymer modified bitumen and thereafter the entire pipe with an extruded coating of polymer modified bitumen and shall simultaneously apply the outerwrap.

i) All primed surfaces shall be clean and dust free immediately prior to coating.

j) The coating shall have an average thickness of not less than 4 mm, with an absolute minimum thickness of 3 mm. The coating shall be reinforced by a spirally-wound layer of outerwrap pulled into the polymer modified bitumen with an overlap of 20 mm, such that the outerwrap is wetted by the polymer modified bitumen. Particular attention shall be paid to the location of the reinforcement and thickness of the wrapping over the weld. The average thickness shall be determined in the following manner: At least four thickness measurements at approximately the pipe quarter points per lineal metre of pipe length shall be taken. At least 25% of the measurements shall be taken at the weld bead. The average thickness shall be the arithmetic average of all measurements.

k) The completed coating shall be well bonded to the pipe metal; uniform, smooth and free from Holidays, laminations, voids or other defects.

l) The wrapping shall be carefully trimmed off 100 mm from the ends of each pipe and bevelled throughout its thickness over a minimum length of ±5 mm, unless otherwise specified by the Employer or his representative.

m) Solar protection paint shall be applied to the coated pipe while the coating is still warm. It shall be white in colour, water resistant, continuous and shall cover the wrapping sufficiently to form an effective barrier to solar radiation. The solar protection shall be terminated approximately 100 mm from each end of the wrapping (i.e. 200 mm from each end of the pipe).

10.16.4 Inspection and Testing

The Contractor shall be responsible for, and shall bear the cost of a system of inspection and repair of the wrapped pipe approved by the Engineer. The system shall meet all relevant requirements in this Section and in addition the following requirements:

n) Monitoring of grit size and the finish of blast cleaned pipe.

o) Viscosity measurement (see Table 3) and control of film thickness of external primer at least once for every batch of primer, in addition to visual checks of the applied prime coating.

p) Adequate temperature control the polymer modified bitumen at the application head. In order to ensure that the polymer modified bitumen applied to the pipe has the characteristics specified in Table 4, samples of the polymer modified bitumen shall then be taken from the application head and subjected to the following test and frequency of testing shown in Table 7.

q) Visual checks on the outer wrap and the appearance of the final wrap.

r) Holiday detection of 100% of the surface area of every wrapped pipe with approved equipment operating at a minimum 15 kV, maximum 25 kV with regular calibration of the equipment to the satisfaction of Quality Assurance.

s) Test of bond strength and thickness of the wrapping including removal of samples of the wrapping for inspection.

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t) Adequate and proper repair of any defects to ensure compliance with this Section. A need to repair more than 1 defect per m^2 of pipe coating shall be sufficient grounds to reject the pipe and cause the Contractor to adjust his process to reduce the number of defects to an acceptable level.

Any necessary repairs of tested pipes shall be carried out by the Contractor at no additional cost to the Employer.

One pipe from every day's production shall be held back for examination on the following day. This examination shall include bond testing, thickness testing and examination for laminations, voids or any other defects.

If, in the opinion of the Engineer, there are a signification number of defects on the test pipe, then a back check procedure will be invoked. This will involve checking the ten pipes immediately preceding and the ten pipes immediately following the faulty test pipe (the pipe numbers shall be available from the final inspection). These twenty pipes shall be subjected to an examination similar to that carried out on the test pipe. Should the number of defects detected be, in the opinion of the Engineer, significant, then the entire production for that week shall be quarantined and jointly investigated by the Contractor and the Engineer.

Should tests in any production batch show a defect rate of more than 10%, the Engineer may reject the whole batch. In such cases the Contractor shall conduct an investigation to establish the cause of the defects.

Table 7:'In Plant Testing'

TEST		**FREQUENCY OF TESTING**
1.	Softening Point	Twice per working shift
2.	Penetration at 25°C	Twice per working shift
3.	Bond test for coated pipes	One pipe per working shift

These tests should be conducted at the coating Plant by the Contractor and monitored by the Approved Inspection Authority (AIA), who would be trained in the procedures by the coating material supplier.

At least once during the Contract or when the method of surface preparation is changed, a sample wrapped pipe shall be tested for resistance to cathodic disbonding.

When tested, the wrapping shall not be disbanded from the pre-damaged area by more than a 5 mm radius after exposure for 28 days at the specified potential, i.e. -1500 mV (BS 3900:F1 1).

The inspection activities shall be coordinated with the Contractor's operations so as to delay or interfere with the operations as little as possible. The Contractor's methods shall, nevertheless, always permit inspection to be made and allow adequate repair of imperfections.

Prior to dispatch from his Plant, the Contractor shall ensure that the wrapped pipe is correctly marked on the internal painted surface of the pipe at each end with approved paint, with sufficient information to enable subsequent identification of the pipe to be made. Documentation shall be supplied to the Engineer to enable the history of the processing of each pipe to be traced.

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10.16.5 Methods of Testing

10.16.5.1 Testing of Wrap Characteristics

10.16.5.1.1 General

The procedures given below are reference methods of test, which shall be used to establish conformity to the Specification in cases of dispute. Other similar methods, however, may be used by manufacturers for routine quality control purposes with the approval of the Engineer.

10.16.5.1.2 Thickness

The thickness shall be determined by means of a suitable instrument fitted with a micrometre dial gauge, a cylindrical brass block 57 mm in diameter and giving a nominal loading of 3.45kN/m^2 and a surface plate.

The thickness shall be measured by interposing the outer wrap between the cylinder and the surface plate. Measurements shall be made by marking 75 mm square across the effective width of the mat and making a measurement within each square. No single reading across the width of the mat shall be less than the specified minimum thickness.

10.16.5.1.3 Weight per m2

The weight per square metre shall be determined by cutting representative samples from the effective width of the outer wrap. The samples shall be of such a size, that the weight per square metre may be determined to an accuracy of ± 2%.

10.16.5.1.4 Tensile Strength

The tensile strength shall be measured with approved equipment. The size of the samples cut from the roll shall be 520 mm long and shall have the required width. (See Table 4 for the minimum tensile strength).

When mounted in the equipment, the distance between the jaws shall be 320 mm. The constant rate of separation of the jaws shall be in the range of 100 mm to 610 mm/minute and the tensile strength at breaking point shall be determined. For reference purposes the rate of separation of the jaws shall be 200 mm/minute. At least four samples shall be tested and an average figure obtained. The test may be carried out on narrower samples if required, provided that at least two of the reinforcing strands are included in the specimen. Sealing of the ends is recommended.

The value for tensile strength obtained from a narrower sample shall be extrapolated to 150 mm width.

10.16.5.2 Bond Test for Coated Pipes

u) Measure the temperature of the coating with a surface thermometer.

v) If the temperature of the coating is not between 10°C and 25°C, cool or warm the pipe in the test area to bring the temperature within this range.

w) Using a knife, heated if necessary, make two parallel cuts, through the coating down to the pipe surface. The cuts shall be 100 mm long and 30 mm apart.

x) With a stiff flat blade, loosen the coating the full width between the two cuts and lift the wrap upward in a direction at right angles to the pipe surface.

y) The bond shall be considered satisfactory if the coating does not peel cleanly from the primer or the pipe surface but is removed with difficulty.

z) This bond test should be carried out at the start of each shift or change in production and thereafter at a frequency approved by the Engineer.

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10.16.6 Handling

At all times the pipe, unwrapped as well as wrapped, shall be handled with the aid of slings, lifting yokes and protected hooks to the approval of the Engineer.

At all times the coated pipe shall be handled and stacked in such a manner as to prevent damage to the coating. Particular care shall be taken immediately after coating to avoid damage while the enamel is above ambient temperature. No stacking or loading shall be undertaken until the coating has cooled sufficiently to avoid marking.

The coated pipe shall be stored at all times clear of the ground and in such a way that either water or mud cannot accumulate on the inside or outside of the pipe. Storage shall be effected by the use of wooden bearers, suitably covered, or mounds of gravel-free sand, covered with polyethylene sheets.

The pipe shall only be stacked to a height such that no flattening of the wrapping occurs.

The pipes shall be separated from each other with approved polyethylene covered pads.

10.16.7 Repairs

Although the polymer modified bitumen has excellent self-healing properties, damage caused by transportation or laying of the coated pipe may occur. This shall be quickly repaired using torch-on membrane.

Damage shall be repaired by removing the existing coating to at least 10 mm beyond the area of damage. The repair area shall then be cleaned of all deleterious matter to 100 mm beyond the proposed repair area. Exposed metal shall be re-primed in accordance with this Section. The repair patch, which shall lap at least 50 mm onto sound coating, shall be applied by gently heating with a gas torch and applying it to the pipe in a manner, which prevents the entrapment of air bubbles. All air bubbles shall be removed using a wooden roller or by other means and the perimeter of the repair patch shall be neatly finished off. The patched area shall then be Holiday tested in accordance with the Specification.

10.17 SYSTEM PL1: CEMENT MORTAR LINING

This corrosion protection system covers the application of Cement Mortar as a steel pipe lining. The pipes will be used to convey potable water.

10.17.1 Standards

Reference is made to the latest issues of the following Standards:

AS 1281-2001: Cement mortar lining of steel pipes and fittings

10.17.2 Material

All materials for the cement mortar lining of pipes shall be in accordance with AS 1281-2001.

10.17.3 Application

10.17.3.1 Mixing of mortar

Components of the mix shall be accurately weighed. Each batch shall be identical. Mixing shall be carried out in a suitable mechanical mixer. Aggregate and cement shall be measured in correct proportions, then dry mixed in the mixer. When homogeneous, water shall be added from a measuring vessel to achieve the correct consistency but shall not exceed the amount stated previously. When correctly mixed, the material shall be used as soon as possible and not later than 1 hour after the first addition of water. Re tempering of the mix by further addition of water or other material shall not be permitted.

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From a random batch of each days production prepare three 150 mm test cubes, in accordance with SANS 5863. After 28 days curing, the compressive strength shall not be less than 30 MPa.

10.17.3.2 Placing of cement mortar

Cement mortar shall be placed to the specified thickness by spin casting (preferred method) or by mechanical drag trowel. In either case, sufficient centrifugal force shall be used to ensure optimum bonding to the pipe wall and optimum compaction of the cement mortar, with minimum segregation of different sizes of aggregate. The finished lining shall be smooth and uniform. Hand application is not permitted except on specials or by prior agreement of the Engineer.

10.17.3.3 Curing of lining

After completion of placing, spinning, trowelling an end finish, the lining shall not be disturbed until set. The pipe ends shall be closed with waterproof end covers or caps and the pipe shall be left undisturbed for at least 40 hours. After 48 hours the lining shall be sprayed with a fine mist of water and the covers and caps replaced or shall be steam cured by an approved method. The lining shall be kept wet for not less than 7 days. Pipes shall not be transported within 21 days from the date of applying the lining.

During placing of the cement mortar and the whole of the curing period, the pipes shall be kept constantly in the shade or under cover. Pipes shall not be exposed to direct sunlight.

Some of the pipes are likely to be stored on site for periods in excess of 3 months before being laid.

10.17.4 Testing

The Quality Control Plan and Procedure referred to in Clause 4.13 above will detail the means of demonstrating compliance with AS 1281-2001 and will be based on Appendix B of AS 1281-2001.

10.18 SYSTEM PL2: SOLVENT-FREE EPOXY LINING

This system is specific design to be used as a lining system for pipelines conveying potable water and raw water.

10.18.1 General

This corrosion protection system covers the application of Solvent Free Liquid-epoxy as a steel pipe lining. Generally the lining is to be applied in accordance with AWWA C210-97 ‘Liquid-epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines’. Where in conflict with ANSI/AWWA C210-97, the amendments hereunder shall take precedence. The full cost of all the testing is to be included in the rates for coating unless it is itemised separately in the Schedule of Quantities.

10.18.2 Amendments to AWWA C210-97

The section and sub-section numbers in this clause refer to the same section and sub-section numbers in AWWA C210-97.

10.18.2.1 AWWA C210 SECTION 1.1 SCOPE

ANSI Sub-Section 1.1.2 Coating and Lining Systems

> The lining system is to be type (3), a single coat of a two part, chemically cured epoxy coating. In the event of the thickness being less than the minimum specified the coating shall be removed and the pipe length shall be re-blasted and re-lined to comply with the specification.

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10.18.2.2 AWWA C210 SECTION 4.2 QUALITY AND SAFETY

Details of all quality related controls and tests are to be included in the QCP&P referred to in Clause 4.13 of the Employer's specification above.

AWWA C210 Sub-Section 4.2.2 Certification

Copies of the certification of the products used, as required by this section, are to be submitted with the tender documents.

10.18.2.3 AWWA C210 SECTION 4.3 COATING SYSTEMS

AWWA C210 Sub-Section 4.3.1 Liquid-Epoxy Coatings.

Add the following:-

The following products have been approved by Umgeni Water: - Sigma Line 523, Carboline 891 and Denso ST100. Should the Manufacturer/ Supplier wish to offer an alternative product it will be necessary to get the approval of the client. Only solvent free epoxies which have been certified non-toxic and non-tainting and suitable for use with potable water will be permitted. Any delays in approval will not be accepted as a reason for late delivery.

AWWA C210 Sub-Section 4.3.2 Coating Thickness

The pipes shall be lined to a dry film thickness of a minimum of 406 and a maximum of 1000 microns, and shall be free from sags and runs.

AWWA C210 Sub-Section 4.3.4 Physical Requirements

Replace Table 1 with the following new Table 1

Tests 1 through 3 in the new TABLE 1 new shall be conducted on every pipe.

Tests 4 and 5(a) and 5(b) in the new TABLE 1 below shall be applied to at least one pipe selected at random from the first day's production or from each new batch of liquid epoxy, whichever is more frequent.

Tests 6, 7 and 8 in the new TABLE 1 below shall be applied to at least one pipe selected at random from the first day's production of each item.

Should the Manufacturer experience difficulties in achieving this specification, additional tests may be required by the Purchaser until the problem(s) has been identified and rectified. Such additional tests shall be to the Purchaser's account.

No	PROPERTY	REQUIREMENT	TEST METHOD
1	Visual	Smooth glossy or semi-glossy finish, free from excessive runs, sags, orange peel, occlusions or other visible defects	Use an experienced observer
2	Coating Thickness	Min 406 microns Max 600 microns	ISO 2808. Take a minimum of 2 readings per m² of surface up to 300 mm nominal bore, or 12 per m² over 300 mm
3	Electrical Insulation Defects	Nil defects at 90 Volts, 10 Mega-ohm	SABS 1217, Section 5.10
4	Impact Resistance	No defect at 1 Joules	SABS 1217, Section 5.6 but modified as given in Note 1

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5a	Degree of cure: • Static Test	No softening or discolouration when fully cured	SABS 1217, Section 5.8. Cure time shall be in accordance with the manufacturer's data
5b	• Dynamic Test	No softening or discolouration when fully cured	50 Double rubs with cotton wool swab soaked in MEK. Cure time shall be in accordance with the manufacturer's data
6	Adhesion (Hot water soak)	Not more than 15 mm disbonding from point of V	Immerse in water at 75ºC for 48 hrs. Make V cut at 30º angle. Test adhesion when panel has cooled to 25ºC
7	Cathodic Disbonding	Total disbonded area not to exceed 40 mm diameter after 30 days. Current flow not to exceed 5mA	ASTM G8 Method B – Magnesium Anode - 20ºC – 7 mm holiday
8	Cathodic Disbonding	Total disbonded area (including holiday) not to exceed 20 mm diameter	Impressed current -3, 5 volts potential at 75ºC for 48 hours 3 mm artificial holiday

NOTE: Impact resistance shall be carried out on a sample of production pipe firmly clamped and choked (to be rebound free) to a rigid base. No electrical insulation defects shall be detected at the point of impact when tested at 1 Joule.

NEW TABLE 1

10.18.2.4 AWWA C210 SECTION 4.4 COATING APPLICATION

AWWA C210 Sub-Section 4.4.1 General

Application by airless spray is required.

AWWA C210 Sub-Section 4.4.2 Pipe Preparation

The requirements of section 4.4.2 of AWWA C210-97 will apply and will take precedence over the Purchaser's Clause 3.2 above.

AWWA C210 Sub-Section 4.4.3.2 Hold-Back for Field Welds

The hold backs (cut backs) are to comply with the Clause 4.15.1 of this Specification.

AWWA C210 Sub-Section 4.4.3.4 Application Temperature

Add the following:-

The cure rate of liquid epoxy coating is very dependent upon temperature, with the rate of cure being very slow below 10ºC and the reaction generally ceasing below 5ºC. Manufacturer's tendering for this type of lining are therefore expected to have a heated shop or warm air blowers with suitable heat insulating tunnels to enable the temperature of the coating to be maintained at not less than 15ºC from the time of application until full cure has taken place. Adverse weather conditions will not be accepted as a reason for delay in supply.

10.18.2.5 ANSI SECTION 4.5 COATING REPAIR

AWWA C210 Sub-Section 4.5.1 Defective Coating

Add the following at the beginning of the Clause:

Repairs of electrical insulation defects may be carried out provided that the number of repairs necessary does not exceed 3 per pipe. A cluster of pinholes within a radius of 25mm shall be regarded as one defect. Any pipe needing repairs in excess of this number or where the lining shows any sign of flaking

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or loss of adhesion shall not be repaired. The lining shall be removed and the pipe length shall be re-blasted, cleaned and re-coated to comply with the requirements of the specification.

AWWA C210 Sub-Section 4.5.1.1

Delete this sub-section and replace with the following:-

Repairs with Epoxy

When repairs with epoxy are permissible, the following method shall be used :-

- Abrade an area at least 25mm diameter around and beyond the defective area. The abrasive paper shall not be coarser than 220 mesh and shall be preferably 400 mesh. It shall be used preferably wet to avoid excessive removal of coating.

  The repair area shall be smoothly feathered into the surrounding sound area. The repair area shall be abraded to a matt finish, free from deep scratches and excessive removal of coating. After abrasion, the area shall be wiped clean with M.E.K. or other suitable approved clean solvent and allowed to dry.
- All repairs shall be undertaken using a repair product recommended by the material manufacturer.
- Repair material shall be mixed in the proportions supplied by the manufacturer. No splitting of packs shall be permitted unless the material is supplied in self metering packs.

  The mixed repair material shall be applied to the clean, dry, abraded repair area so as to cover the defect and extend to within 1 or 2mm of the edge of the abraded area. A “halo” of abraded area shall be visible around the repair material.
- After curing, the repair and at least 250mm surrounding area shall be tested for electrical insulation defects as specified in the contract. There shall be no electrical insulation defects.

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11 COMPLIANCE WITH REQUIREMENTS

11.1 TESTING

Tests, instruments, methods and criteria shall be as specified below or in the Amendments of this Specification.

The requirements of Clauses 4.13 shall apply.

11.1.1 Visual Inspection

All surfaces shall be inspected visually and shall be free from tears, runs, sags, wrinkles, blisters, change in colour or gloss, orange peel, dirt, visible pinholes, dust or fluff occlusions or any other visible defects.

11.1.2 Holiday Inspection

100% of all coated surfaces shall be tested and there shall be no electrical insulation defects on any area inspected.

For films exceeding 500 µm thickness, a high voltage, electrical insulation defects detector shall be used in accordance with SABS 1217.

Except on system containing conductive pigment (Zn, Al), low-voltage wet sponge electrical insulation defects inspection shall be carried out in accordance with SANS 1217 for coatings and linings of thickness not exceeding 500 µm.

For systems exceeding 500 µm thickness, the high voltage, sparking electrical insulation defects detector shall be used in accordance with SANS 1217.

During the inspection procedure the Contractor shall ensure that sufficient moisture is present at all times on the surfaces to be tested.

11.1.3 Dry Film Thickness

The dry film thickness (DFT) shall also conform to the requirements of Clause 9.5

(a) Measurements shall be taken in accordance with ISO 2808.

(b) 100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.

(c) Film thickness in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the system is demonstrated to be sound in all respects.

(d) The method used to measure film thickness, and the significance of the readings for each particular project, shall be agreed upon by all parties prior to commencement of the work.

11.1.4 Degree of Cure of Fusion-Bonded Materials

The degree of cure of corrosion protection material shall be assessed by solvent wiping in accordance with the method given in SABS 1217 (methyl ethyl ketone resistance test)

11.1.5 Free of Oil and Grease

11.1.5.1 Wetting with Water

All surfaces cleaned of oil and grease shall be tested using the “water-break-free” method. The surface shall be wetted with water and the entire surface shall be covered by an unbroken film.

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11.1.5.2 Solvent-Wiping

Where water soluble lubricants may be present the surface shall be further tested by wiping with a clean cotton wool swab soaked in solvent. No stain shall be evident on the swab after solvent-wiping.

11.1.6 Water Soluble Salt Contaminants

Substrate surfaces shall be tested for the presence of water soluble salt contaminants in accordance with SANS 5770 or by means of the Weber Reilly Test.

11.1.7 Standard of Mechanical Surface Preparation

Mechanical surface preparation shall be visually compared to the standard shown in SABS ISO 8501-1.

11.1.8 Blast Profile

The blast profile of the substrate surfaces shall be determined in accordance with SANS 5772.

11.1.9 Residual Dust and Debris

Substrate surfaces shall be tested for the presence of residual dust and debris in accordance with ISO 8502-3.

11.1.10 Blasting Material

All blasting-materials shall be approved by the Engineer.

11.1.10.1 Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11125 for particle size, hardness, density, foreign matter and moisture.

11.1.10.2 Non-Metallic Abrasive

Abrasive shall be tested in accordance with ISO 11127 for particle size, hardness, density, moisture and water soluble contaminants.

11.2 PIPE AND SPECIALS SPECIFIC TESTING

11.2.1 Dry Film Thickness (DFT)

Measurements shall be taken in accordance with ISO 2808.

100% of all system thicknesses measured shall comply with the minimum requirements of this Specification.

In the case of coats applied after the erection of steel work on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of the Engineer, and may be dictated by accessibility.

DFT in excess of the prescribed maxima shall not necessarily constitute reason for rejection if the paint film is demonstrated to be sound in all respects.

DFT shall be tested within 7 days of application.

The method used to measure DFT, and the significance of the readings for each particular item, shall be agreed upon by all parties prior to commencement of the coating work.

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11.2.1.1 Automated Shop Applied Lining and Coating

The film thickness on the first pipe of a production run and thereafter on at least one pipe selected at random from every day's production, but not less than one pipe out of every ten pipes, shall be measured non-destructively by an approved eddy current instrument. At least four readings at equally spaced intervals around the circumference, approximately 300 mm from each end of the pipe, shall be taken. The first reading shall be over the weld bead. When practicable an additional four readings at equally spaced intervals around the circumference in the centre of the pipe shall be taken. The thickness shall not be less than the minimum specified over 100% of the area including weld beads. The Engineer may at his discretion supplement the above test by checking wet film thickness on any or all pipes during application of the coats.

11.2.1.2 Hand and In-situ Applied Lining and Coating

All the hand applied lining and coating thicknesses shall be tested by means of an approved eddy current or magnetic instrument. At least four readings shall be taken at equally spaced intervals around the pipe circumference at any test point. The first reading shall be over the weld bead. The thickness shall not be less than the minimum specified over 100% of the area including weld beads.

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12 MEASUREMENT AND PAYMENT

12.1 GENERAL

The rates tendered under this Specification shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the Items provided in Specification.

Payment for the requirements of this Specification will be included in the payment item for the particular item supplied including painting or corrosion protection. No separate payment shall be made for painting and corrosion protection unless specifically allowed for in the Bill of Quantities.

12.2 SCHEDULED ITEMS

12.2.1 QCP and documentation — Unit: lump sum (Sum)

Separate Items are provided in the Bill of Quantities for the submission of the Quality Control Plan (QCP) and all other pre-manufacture documentation.

The rate shall include full compensation for the preparation and submission of the QCP and the submission of all pre-manufacture documentation in compliance with the Specification.

Payment will only be made after the QCP and all documentation has been approved by the Engineer."

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ANNEXURE A: APPLICABLE STANDARDS

The following Standards and Codes of Practice are referred to in this Specification:

Standards Australia

AS 1281-2001	Cement mortar lining of steel pipes and fittings
AS 4321-2001	Fusion-bonded medium-density polyethylene coating and lining for pipes and fittings

American National Standards Institute

ANSI B31.3	Standards of pressure piping

American Petroleum Institute

API 5L	Specification for line pipe
API 1104	Standard for welding pipelines and related facilities

American Society of Mechanical Engineers

ASME BPVC-IX	Boiler and Pressure Vessel Code – Section IX, Welding and Brazing Qualifications

American Society for Testing of Materials

ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A312	Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes
ASTM D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM D2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

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ASTM D4090	
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM G8	Standard Test Methods for Cathodic Disbonding of Pipeline Coatings
ASTM G14	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
ASTM G62	Standard Test Methods for Holiday Detection in Pipeline Coatings
ASTM G95	Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)

American Water Works Association

AWWA M11	Steel pipe – A guide for design and installation (3rd edition)
AWWA: C207 - 1994	Steel pipe flanges 4” through 144”.
AWWA: C208 - 1996	Dimensions for fabricated steel water pipe fittings.
AWWA C210-97	Liquid epoxy coating systems for the interior and exterior of steel water pipelines
AWWA C222-99	Polyurethane coatings for the interior & exterior of steel water pipe & fittings

British Standards Institution

BS 970	Specification for wrought steels
BS 2494	Materials for elastomeric joint rings for pipe work and pipelines
BS 2633	Class I arc welding of ferritic steel pipe work for carrying fluids

Canadian Standards Association

CSA Z245.20	External Fusion Bond Epoxy Coating for Steel Pipe
CSA Z245.21	External Polyethylene Coating for Pipe

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European Standards

EN 1179	Zinc and zinc alloys – Primary zinc
EN 10240	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic Plants

International Organization for Standards

ISO 544	Welding consumables - Technical delivery conditions for welding filler materials - Type of product, dimensions, tolerances and markings
ISO 752	Zinc ingots
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of un-coated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 8502-3	Preparation of steel substrates before application of paint and related products - Tests for the assessment of surface cleanliness Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
ISO 8504-2	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning.
ISO 11125	Preparation of steel substrates before application of paints – Metallic blast-cleaning abrasives.
ISO 11127	Preparation of steel substrates before application of paints – Non-metallic blast–cleaning abrasives.

NACE International

NACE TM0102	Measurement of Protective Coating Electrical Conductance on Underground Pipelines

South African Bureau of Standards

SANS 32	*See EN 10240*
SANS 62-1	Steel pipes Part 1

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SANS 121 (ISO 1461)	Hot-dip galvanised coatings on fabricated iron and steel articles
SANS 630	Decorative high gloss enamel paints
SANS 681	Undercoats for paints
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (large bore)
SANS 1091	National colour standard
SANS 1117	Plastics wrappings for the protection of steel pipelines
SANS 1130	Fibre reinforcing material for pipe wrapping
SANS 1178	The production of lined and coated steel pipes using bitumen or coal tar enamel
SANS 1200 L	Standardized specification for civil engineering construction Section L: Medium-pressure pipe lines
SANS 1217	Internal and external organic coating protection for buried steel pipelines
SANS 1274	Coatings applied by the powder-coating process
SANS 1319	Zinc phosphate primer for steel
SANS 1344	Medium duty solvent detergent
SANS 1365	Solvent degreasers that contain chlorinated hydrocarbons
SANS 1700	Fastners
SANS 2063	Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys
SANS 5770	Preparation of steel substrates before the application of paints and related products - Test for the assessment of cleanliness of blast-cleaned steel surfaces - Freedom from certain soluble salts
SANS 5772	Preparation of steel substrates before the application of paints and related products - Surface roughness characteristics of blast-cleaned steel surfaces - Profile of blast-cleaned surfaces determined by a micrometre profile gauge
SANS 10044	Welding
SANS 10064	The preparation of steel surfaces for coating
SANS 10120-3 HC	Code of practice for use with standardized specifications for civil engineering construction and contract documents Part 3: Guidance for design Section HC: Corrosion protection of structural steelwork

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SANS 10129	Plastics tape wrapping of steel pipelines
SANS ISO 14713	Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines

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ANNEXURE B: PAINT COLOUR CODING

MECHANICAL AND GENERAL

ITEMS	COLOUR	SANS 1091 CODE
Structural steel, Gates	Light grey	G29
Hydraulic power Pack	Strong blue	F11
Hydraulic oil	Salmon pink	A40
Hazardous objects/areas (restricted headroom, crane hook etc.)	Golden yellow with black chevron	B49*
Handwheels and levers	Golden yellow	B49
Handrails: vertical	Black	
- horizontal	Golden yellow	G49
Handrails on dam walls	Un-coated	
- Aluminium	Un-coated	
- Stainless steel	Light grey	G29
- Galvanized		
Floors:		E14
- safe and walking areas	Emerald green	B49*
- restricted areas	Golden yellow	
- open flooring (gratings) – MS galvanized	Un-coated	
3Cr12	Un-coated	
Stainless steel	Un-coated	
Fire protection Plant	Signal red	A11*
Control panels	Eau de nil	H43

PUMP STATION

ITEMS	COLOUR	SANS 1091 CODE
Electric motors	Light beige	C57
Pumps/control valves: for raw water	Apple green	H29
for chem-treated water	Middle blue	F07
Fan and coupling guards	Signal red	A11*
Base plates	Black	
Overhead traveling cranes	Golden yellow	B49
Isolating valves: for raw water	Brilliant green	H10

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ITEMS		COLOUR	SANS 1091 CODE
	for chem-treated water	Arctic blue	F28

ELECTRICAL

ITEMS		COLOUR	SANS 1091 CODE
Low voltage panels:	Indoor	Light orange	B26*
	Outdoor	Light orange	B26
Medium voltage panels:	Indoor	Admiral grey	G12
	Outdoor	Admiral grey	G12
Panel accessories (gland plates, back plates, interior)		White	
UPS Plant items		Light orange	B26
Transformers		Light stone	C37
LV distribution kiosks, mini subs		Light stone	C37
Standby electrical Plant items(Permanently powered)		Signal red	A11*
General outdoor		Light grey green	H40
All Plant– interior		White	

WATER TREATMENT PLANT

ITEMS	COLOUR	SANS 1091 CODE
Plant	Same colour of respective pipe work	
Handwheels (remote valves)	Same colour of respective pipe work	
PIPE WORK		
Raw water	Brilliant green	H10
Chemical treated raw water	Verdigris green	E22
Clarified raw water	Eau de nil	H43
Filtered water	Pale blue	E39
Chlorinated filtered water	Arctic blue	F28
Backwash water	Cornflower blue	F29
Air saturated water	Turquoise blue	E18
Wash water recovery	Middle buff	B33

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SEWAGE PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Raw sewage	Dark earth	B11
Settled sewage effluent	Brilliant green	H10
Biologically treated sewage effluent	Verdigris green	E22
Final/chlorinated effluent	Eau de nil	H43
Digested sewage sludge	Middle brown	B07
Raw sewage sludge	Dark brown	B03
Humus sludge	Golden brown	B13
Return activated sludge	Golden brown	B13
Waste activated sludge	Middle brown	B15
Supernatants/underflows returning to head of works	Middle buff	B33

DOSING/CONTROL PIPE WORK

ITEMS	COLOUR	SANS 1091 CODE
Poly-electrolyte	Pinotage	A08
Alum/Ferric chloride	Jacaranda	F18
Chlorine solution	Primrose	C67
Chlorine gas	Lemon	C54
Chlorine liquid	Light orange	B26
Lime slurry	Biscuit	B64
Lime hydrated	Biscuit	B64
Lime saturated water	Biscuit	B64
Air/compressed air	White	
Steam	Pastel grey	G54

NOTE: Colours marked thus ***** are restricted for specified Plant only.

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SPECIFICATION: ZUT 7001

Design and manufacture of medium-pressure steel specials

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1. SCOPE

This Specification covers the design, manufacture and delivery to site of electrically welded low carbon steel specials of outside diameter up to 2 280 mm, for transporting water and sewage at ambient temperatures and under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with SANS 1200 L. Where conflict between this specification and SANS 1200 L occurs, the provisions of this specification shall apply.

Interpretations and variations of this specification are set out in the Amendments preceding this Specification.

2. NORMATIVE REFERENCES

2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

a) Amendments;

b) SANS 1200 Series of Standardized Specifications;

i. SANS 1200 L: Medium-pressure pipelines (see 1. above)

c) Specification ZUT 7002 : Manufacture of medium-pressure steel pipes

d) Specification ZUT 0003 : Painting and corrosion protection for water and wastewater works

e) Specification ZUT 7003 : Laying, jointing and testing of medium-pressure steel pipes and specials

The latest issues of the specifications listed in Appendix A shall be deemed to apply to the design and manufacture of welded steel specials manufactured using approved welding techniques.

3. DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

For the purposes of this Specification the definitions and abbreviations given in the applicable clauses of the specifications listed in 2.1 and the following definitions shall apply:

Cut-and-shut bend : A bend formed by cutting out one or more V-shaped sections equally disposed about a line at right angles to the axis of the pipe, preparing the cut-out edges for welding; bending the pipe to form the bend and welding the pipe shut along the prepared edges to complete the bend (see BS 2633, Fig 25)

Fitting :
a) A special or valve.
b) Any process of jointing (except welding) straight pipes to one another and to specials and valves.

Flexible pipe : A pipe of which the diameter is reduced by more than 1% under an external radial force before the appearance of cracks.

"H" : The cross-sectional shape of a weld at a skelp.

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Manual shielded electric arc process welding	:	Electric arc welding done by hand using a filler electrode coated with a material that gasifies at the point of arc and excludes oxygen from the weld, thus improving the metallurgical quality of the completed weld.
Mitre welds	:	Welds which join two lengths of pipe at an angle point in such a manner that the axis of both lengths of pipe proceed in a straight line to the point of intersection.
Nominal diameter (size)	:	A numerical designation of diameter which is common to all components in the piping system other than components designated by OD or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.
Nominal pressure	:	A numerical designation which is a convenient round number for reference purposes. All equipment of the same DN designated by the same PN number shall have compatible mating dimensions.
Pinhole	:	A very small hole indicating a flaw in the weld.
Pipe end bevel	:	A bevel cut made on the end of a pipe to afford a groove between abutting joints in order to receive weld metal.
Pipework	:	Includes all pipes, joints, specials, fittings and valves.
Skelp	:	The jointing edges of steel coils used in the manufacture of spiral welded pipe.
Special	:	Any pipe other than a straight pipe. Note: Under this definition shall be included all sizes of specials of shapes such as bends, tees, crosses, angle branches, reducers, tapers and flexible couplings with or without centre registers.
Straight pipe	:	A straight pipe of uniform bore and of standard or non-standard length.
Welding icicles	:	Congested droplets of metal which extend through the weld to the interior of the pipe, caused by excessive heat or improper welding technique.

3.2 ABBREVIATIONS

The following abbreviations (additional to those referred to in 3.1) shall have the meanings given:

AISI	:	American Iron and Steel Institute
DN	:	Nominal diameter (e.g. DN 200 = 200 mm nominal diameter)
DS-AW	:	Double submerged-arc welded
FBE	:	Flanged both ends
FOE	:	Flanged one end
ID	:	Internal diameter
MS	:	Mild Steel

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OD : Outside diameter, which shall mean the internal diameter + 2x(lining thickness + pipe wall thickness)

p.e. : Plain ended.

PN : Nominal working pressure (eg. PN 10 = 1 000 kPa)

Scab : Unbonded piece of plate in tight contact with the plate

SS : Stainless Steel

t : Wall thickness of pipes

TP : Test pressure

WP : Weld preparation

4. REQUIREMENTS

4.1 MATERIALS

4.1.1 General

Specials and fittings shall be of the types shown on drawings or billed and, unless otherwise required in terms of the Amendments, they and their couplings shall be capable of withstanding the applicable test pressure. All specials and fittings shall be supplied complete with couplings and jointing material.

4.1.2 Types of steel

Unless otherwise billed or shown on drawings, specials and fittings shall be manufactured from the following materials:

4.1.2.1 Nominal diameter equal to or less than 150 mm

Medium or heavy class steel, complying with the applicable requirements of SANS 62.

4.1.2.2 Mild steel

Steel grade	Minimum Yield Stress (MPa)	Chemical Composition and Physical Properties
B	241	SANS 719, Table 1
300WA	300	SANS 1431
X42	289	API 5L Table 3.1 & 4.1
X46	317	API 5L Table 3.1 & 4.1
X52	358	API 5L Table 3.1 & 4.1
X56	386	API 5L Table 3.1 & 4.1
X60	413	API 5L Table 3.1 & 4.1
X65	450	API 5L Table 3.1 & 4.1

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4.1.2.3 3CR12 Corrosion resistant steel

3CR12 corrosion resistant steel plate shall have a No.1 finish and shall be supplied ex-factory ready pickled and passivated.

4.1.2.4 Stainless steel

Stainless steel shall be either EN Grade 1.4301 (304L stainless steel) or EN Grade 1.4401 (316L stainless steel).

4.1.2.5 Super duplex stainless steel

Duplex stainless steel shall be either EN Grade 1.4162 (2101) or EN Grade 1.4462 (2205). Super Duplex stainless steel shall be EN Grade 1.4410 (2507).

4.1.3 Flanges

Flanges on pipe ends, where applicable, shall be manufactured from the same material as the pipe, unless otherwise specified in the Amendments.

Where mild steel flanges are specified, flanges shall be manufactured from steel plate conforming to BS 4360 or SANS 1431 Grade 300W for working pressures up to PN 25. Flanges rated more than PN 25 and up to PN 60 shall be made from steel manufactured in accordance with BS EN 10222 Grade 460 or as approved. Flanges for pressures exceeding PN 60 and up to PN 250 shall be special flanges and gaskets manufactured by Hydro Power Engineering or equal approved.

4.1.4 Certification

The Contractor shall submit to the Engineer the steel maker's certificates covering all steel used in the manufacture of the specials as required in Clause 4.4 of SANS 719. In addition, all information relevant to pipework fabrication shall be made available to the Engineer during the course of the manufacturing process.

4.2 DESIGN

4.2.1 General

The Contractor shall be responsible for the design of all specials in accordance with the general arrangement shown on the drawings and/or described in the Bill of Quantities and in conformity to BS 534.. He shall submit his design calculations and shop drawings to the Engineer for approval before manufacturing commences. The design of saddle type reinforcement shall be in accordance with AWWA M11.

Specials shall be fabricated by welding from pipes which have been tested to SANS 719 and that conform to the requirements applicable to the Manufacture of medium-pressure steel pipes.

Lifting eyes (lugs) shall be welded to all unwieldy specials and to all specials of DN 600 and larger to facilitate handling and minimise damage to the protective coating.

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4.2.2 Wall thickness

Specials shall be designed so that 50% of the minimum yield stress of the steel is not exceeded under maximum working pressure and so that 75% of the minimum yield stress of the steel is not exceeded under maximum surge pressure.

An OD/t ratio of more than 100 will not be permitted unless specifically indicated otherwise on the drawings or in the Bill of Quantities.

For all branch connections (tees) the plate thickness of the barrel and branch shall be such that the maximum stress shall not be greater than that for an uncut pipe of the theoretical required minimum thickness. Where it is more economical to provide external reinforcement in the form of collar type rings or crotch plates, as shown on the drawings, these forms of reinforcement shall be used to achieve the same results

4.2.3 Bends

Unless otherwise indicated on the drawings or scheduled in the Bill of Quantities, the dimensions for bends shall be determined in accordance with AWWA C208.

Bends shall either be smooth formed (hot bent) or segmented. The maximum angle between oblique butt-ends of segments for mitred bends shall not exceed 22.5º. Cut-and-shut bends are not permitted. Segmented bends shall be classified as short, medium and long with radii equal to one, two or three diameters respectively. All bends shall be of the long radii type, unless otherwise shown on the drawings or specified in the Amendments or Bill of Quantities.

Mitres for bends (kinks) of 10 degrees and less shall be made in the field as part of the pipe laying operation for buried pipelines.

4.2.4 Branches and nozzles

The attachment of reinforcement to the pipe branches shall be by full penetration welding. The extent and positioning of external reinforcement is to be determined in accordance with AWWA M11.

Branch connections shall be as remote as possible from the seam weld on the barrel and shall generally be placed as follows, except where specifically indicated to the contrary on the drawings:

a) For air valve tees the centre lines of the air valve branch and the barrel shall intersect at right angles or vertically, as shown on the drawings, depending on the type of tee specified. The branch shall be flanged and have a nominal diameter greater than 50% of the main pipe diameter.

b) For scour valve tees the branch, consisting of a 90 degree bend, shall be located centrally on the pipe invert and point vertically downwards with the horizontal section at right angles to the barrel of the pipeline. The branch flange shall be set so that the scour valve spindle points vertically upwards, as shown on the drawings.

Nozzles shall be “stub in” in accordance with ANSI B31.3 and of minimum size DN25. Such nozzles shall be threaded to BSPT and provided with appropriate reinforcement. The Contractor shall ensure that the design will withstand the test pressure of the system.

4.2.5 Reducer pieces

Taper pieces shall not have more than two longitudinal weld seams and shall have a maximum angle of divergence of 10 degrees, as shown on the drawings.

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4.2.6 Pipe supports

Supports for pipework, valves and specials inside chambers and pump stations shall be designed by the Contractor to adequately secure the pipework to the walls and floors. Details and locations of the supports shall be submitted for approval by the Engineer.

4.2.7 Dimensions

The dimensions of the pipe specials and fittings are shown on the drawings.

4.2.8 Provision of cadwelding pads

Where specials are to be jointed by means of flexible couplings the manufacturer shall weld steel plates not less than 50 x 75 x 6 mm thick, 250 mm from each end of all pipes, during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for cadwelding bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

4.2.9 Shop drawings

The Contractor shall, before issuing of shop drawings for manufacture, provide detailed pipework layout drawings for approval in principle by the Engineer. Such drawings shall contain general arrangements and assemblies for the pipes, pipe auxiliaries, pipe specials and valves and include materials schedules, standard parts, etc. Drawings shall provide all the information necessary to demonstrate full compliance with the drawings and specifications and to facilitate subsequent submission of shop drawings free of fit-up error. The Contractor shall be fully responsible for determining the actual dimensions of the specials.

Pipe layout drawings shall incorporate all relevant prime and subsidiary dimensions (primarily, but not necessarily limited to, face-to-face dimensions).

Drawings shall be prepared to acceptable industry standards, an example of which shall be submitted for approval before draughting commences. Due account is to be taken in preparing drawings of the necessity, inter alia, to facilitate straight-forward subsequent fit-up on site, without undue site trimming and site preparation for butt welding, so minimizing also the necessity for extensive site repairs to, or extensions of, internal and external corrosion protection.

Only after approval of final pipework layout drawings by the Engineer shall shop drawings for manufacture of pipes and specials commence. For subsequent approval by the Engineer these shall be in such detail as is appropriate for manufacture. No manufacturing of pipework shall be permitted without approval of the shop drawings by the Engineer.

Approval by the Engineer of any drawing shall not relieve the Contractor of responsibility for correct manufacture and subsequent fit-up on site.

4.3 JOINTING

4.3.1 Flexible couplings

Flexible couplings for plain-ended steel pipe and adaptor couplings shall be either of the slip-on type complying with Clause 15 of BS 534 or of the slip-on type without centre register conforming to the drawings, as scheduled. Slip-on flange adaptors for steel pipes shall conform to the relevant drawings.

A coupling shall be able to withstand without failure a hydrostatic test pressure of twice the working pressure specified for the pipe for which the coupling is required, and coupling flanges shall be capable of

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withstanding without damage all stresses caused by proper tightening of the bolts. Rubber rings shall comply with the relevant requirements of SANS 974: Part I and shall have a hardness of 66 to 75 IRHD.

All grinding off of welds shall conform accurately with the profile of the rolled section and so that no flats occur on surfaces that are supposed to be curved. The centre register (where present) shall be ground off on either side of the weld in such a manner that all sharp edges which would result in weakening of the protective coating are removed. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

4.3.2 Flanges

Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the Drawings. Flanges not covered by BS EN 1092 shall be manufactured according to the detailed dimensions and requirements shown on the Drawings.

All flanges shall be suitable for Site welding (SW) to pipes and specials and shall conform to BS 2633, Section 7 with preparation of plate flanges as shown in Fig 41 ("slip-on") for pipes and specials up to DN 100 and Fig 39 or 40 ("bore and fillet") for pipes and specials DN 125 and larger.

The drilling of steel and cast iron flanges shall be off-centre and shall conform to the requirements of SANS 1123, BS EN 1092: Section 3.1, or ISO 7005: Part 1 as applicable, appropriate to the class of pipe specified, except that in the case of flanges, where M27 and M33 bolts are specified in BS EN 1092: Section 3.1, M24 and M30 bolts respectively shall be used as specified in SANS 1123.

Any pipe that has flanges which are incorrectly drilled will be rejected. Reaming of bolt holes to oversize dimension in order to make a particular piece fit will not be permitted.

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123, or as specified below:

a) Flange sizes up to and including DN 400 with a pressure rating up to and including 1600 kPa shall have flat joint faces, and where the pressure rating exceeds 1600 kPa, shall have a raised face sealing arrangement;

b) Flange sizes exceeding DN 400 up to and including DN 1000 shall have a raised face sealing arrangement for all pressure ratings up to and including 2500 kPa.

For flanges not covered by BS EN 1092, and for domes and conical ends, thicknesses shall be calculated and where applicable the flanges manufactured in accordance with Section 3 of BS 5500.

4.3.3 Insulated flanges

Where called for, insulating flanges and materials shall be arranged as set out in Code of Practice No. SAECC/1 or SANS 15589-1.

The design, manufacturing, supplying, installation and testing of the insulating flanges complete with spark gap arrestors shall be in accordance with drawing no. 1A-C6-066 and to the approval of the Engineer. Insulating flanges shall be provided at locations as indicated on the Drawings.

All insulating gaskets, irrespective of pressure rating, shall be full-face gaskets to prevent foreign material from collecting and creating a bridge, thus shorting out the isolation.

4.3.4 Loose flanges

Loose flanges for welding onto steel pipes on Site shall be manufactured from at least the same steel as specified for the pipes and shall be in accordance with SANS 1123 where applicable (see also 4.3.2), or alternatively in accordance with BS EN 1092.

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Loose flanges shall be suitable for field welding to pipes and specials and shall conform to 4.3.2 in respect of attachment.

4.3.5 Gasketing

Each flanged pipe and fitting of less than DN 400 and rated for PN 16 or less shall be supplied complete with one insertion piece (gasket) of the appropriate diameter and made of a material that is suitable for the maximum test pressure, and one set of bolts, nuts and washers.

Unless otherwise specified in the Amendments, asbestos gaskets in accordance with BS 1832 Grade B, and having a minimum thickness of 1,5 mm, shall be supplied for working pressures not exceeding PN 16.

Where working pressures exceed PN 16, and for DN 400 and over, rubber "O" rings dimensioned in accordance with BS EN 1092 Section 3.1, Fig. 4 for Types G and H flanges, shall be supplied to suit appropriately machined flanges.

Where flanges have not been machined in accordance with the above, spiral wound gaskets, style CG to BS 3381 shall be used. The external ring shall be made of carbon steel and electro plated. The metal windings shall consist of Grade 316 L stainless steel with asbestos filler.

Where flanges with flat faces as specified in 4.3.2, paragraph 1, are jointed, the gaskets shall be of the type manufactured by HPE and as specified below:

The gasket shall consist of a seal ring made from ultra high molecular weight polyethylene (UHMWPE) (section 10 mm x 5 mm minimum) which fits snugly inside a 3 mm thick x 30 mm wide (minimum) flat steel outer ring. The reuse of UHMWPE seal rings is inadmissible.

The outer ring shall consist either of:

a) A mild steel ring, hot-dip galvanized in accordance with SANS 121 to a minimum mean coating thickness of 65 µm. The finish shall be of even thickness to ensure that the ring bears evenly throughout between the two flanges.

   or

b) A 3CR12 steel ring where specified in the Amendments.

4.3.6 Bolts, nuts and washers

Bolts and nuts shall comply with the relevant requirements of SANS 1700 or, where high strength friction grip bolts are specified in the Amendments or considered necessary by the Contractor, the bolts shall comply with the requirements of BS 3139, and their use and design shall be as specified in BS 3294: Part 1 and BS 4604.

Locking devices for nuts shall be provided wherever there is a possibility of the nuts becoming loose during service. Bolts shall be of sufficient length for at least two screw-threads to protrude from the nut when assemblies are fully tightened. Two washers complying with SANS 1700 shall be supplied with each bolt.

All bolts, nuts and washers shall be of a material with equal or better corrosion properties than the pipe materials being joined. All anchor bolts and nuts shall be Grade 316 stainless steel or as approved.

4.3.7 Screwed joints

The threads for screwed joints shall comply with the relevant requirements of SANS 1109. Male ends shall have taper threads and female ends shall have parallel threads.

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4.3.8 Plain ended specials

Each plain ended or spigot ended special, as shown on the drawings, shall be supplied with one sleeve coupling (or such other type of coupling as is shown on the drawings) to suit the particular pipe with which the special mates. The coupling shall fit the larger end of the barrel in the case of a reducer.

4.4 PLANT

All specials and fittings shall be manufactured in an approved works which has the necessary tools, plant and equipment to manufacture pipework consistently in accordance with the specifications.

Manufacturing at only one works will be permitted. No site fabrication of specials, other than kinks of 10 degrees or less on buried pipelines, will be permitted.

4.5 FABRICATION

4.5.1 Qualified welders

Only qualified welders, certified as having passed the qualification tests as specified in Clauses 6.1 to 6.7 inclusive of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

4.5.2 Welding

Welding and inspection of welds shall be in accordance with Clauses 7 to 11.4 inclusive of API Standard 1104 or alternatively, SANS 10044: Part III. Where radiographic inspection is specified in the Amendments, the procedure followed shall be in accordance with Clause 11.1 of API Standard 1104. Only qualified radiographers as specified in API Standard 1104 shall be employed to do the radiography.

All butt welds and branch fillet welds on specials shall where practicable have an internal weld. The weld bead of this internal weld shall not protrude above the prolongation of the original inside surface of the special by more than 1 mm.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

4.5.3 Preparation of special ends for:

4.5.3.1 Mechanical couplings

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

4.5.3.2 Fillet welds

Ends for use with fillet welded sleeve joints shall be prepared as specified in 4.5.3.1.

4.5.3.3 Butt welds

Specials which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5. Square cut ends will require approval.

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For specials to be jointed by butt welding, the internal weld bead shall be ground flush with the internal surface of the pipe or special for a length of 200 mm from the ends to be jointed.

4.5.3.4 Bevelling

All bevelling, where required, shall be delayed until after all non-destructive testing has been completed.

4.5.3.5 Flanges

Ends to be fitted with flanges shall have the longitudinal or spiral welds ground to plate or sheet surface for a distance from the ends sufficient to accommodate the flange.

4.5.4 Rectification of defects

If a special fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the special to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

The repair procedure and performance on repairs shall be in accordance with Section 10 of API Specification 5L where not in conflict with SANS 719. Only qualified welders shall be employed. Each repair weld shall be marked with the welder's identifying stamp.

When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a special subsequent to hydraulic testing, the repaired special shall be retested in accordance with Clause 5.3.2 Hydraulic testing of this specification.

4.6 COATINGS AND LININGS

Coatings and linings of specials shall be undertaken in accordance with the requirements of Specification ZUT 0003.

4.7 MARKING

Upon fabrication, each special shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

a) Pipe reference number

b) Contract number

c) Date of manufacture

d) Outside diameter

e) Wall thickness/pressure rating

f) Grade of steel

g) Coating type and nominal thickness

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h) Lining type and nominal thickness

i) Mass of uncoated and unlined special in kg/m

j) Applicable drilling tables stamped on the periphery of all flanges

k) Bends shall have their "centre plane" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends during laying.

4.8 STORAGE, HANDLING AND TRANSPORT

4.8.1 Handling and rigging

Specials shall be protected against damage at all stages from manufacture to delivery. Particular care shall be taken to protect the ends of all specials against denting.

In the transportation, loading and unloading of specials, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that specials and their protective linings and coatings are not damaged.

Specials shall be so transported, stored and handled that they are not overstressed at any time and fittings are not damaged in any way. All thin-walled and soft-coated specials shall be handled with particular care and shall be so stored that they are not subjected to concentrated pressure from stones or other objects. Specials damaged or cracked in any way shall be removed from the Site at no cost to the Employer.

If cradles are used to transport the specials they must be rubber lined to avoid damage to the coating. During transportation specials shall be safely secured.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

4.8.2 Protection of pipe ends

Satisfactory temporary end covers shall be provided for the protection of flanges, prepared ends of plain-ended fittings, and threads, and to prevent damage to the internal lining during transportation and during handling on Site.

4.8.3 Material that deteriorate under the action of sunlight

All rubber rings or other materials which will deteriorate under the action of sunlight, ozone or inclement weather, shall be stored in permanent shade in lockable weather-proof sheds. Welding and the running of welding machines and electric machinery shall not be permitted in or near places where rubber or plastic products are stored and care shall be taken at all times to prevent contamination of these products by oil or other petroleum derived products.

5. COMPLIANCE WITH REQUIREMENTS

5.1 FACILITIES FOR TESTING

The Contractor shall provide at his own cost, all facilities and equipment required for testing and shall carry out all tests at his own expense. Complete records of test results shall be kept.

The testing machines shall be of a design which will allow a steady application of the test pressure and shall be equipped with an accurate pressure gauge. Provision shall be made for expelling all air from any special under test during filling and before application of the pressure.

Test calibration certificates from an independent laboratory, verifying the accuracy of all measuring and testing instruments requiring calibration, shall be provided by the Contractor. Recalibration shall be carried out as necessitated by circumstances but at intervals not exceeding 3 months.

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5.2 QUALITY ASSURANCE

All steel specials shall be fabricated and tested in accordance with an approved quality control plan and procedure. The quality assurance of all specials rated over PN 16 shall be in accordance with ISO 9002 and the manufacturer shall be in possession of a current ISO 9002 certificate.

Manufacture shall not commence until such time as the quality control plan and procedure has been approved by the Engineer.

The quality control plan and procedure shall address, as a minimum, the following tests/inspections:

a) Material certification

b) Non Destructive Evaluation (NDE) testing

c) Verification of tolerances

d) Workmanship

e) Surface preparation (e.g. cleanliness and blast profile for coatings and linings)

f) Material identification

g) Personnel certification (including welders and NDE)

h) Welding procedures and certification

i) Weld preparation

j) Compliance with drawings

k) Hydrostatic testing

5.3 INSPECTIONS

5.3.1 Visual inspections

All finished pipework shall be visually inspected and shall be free of injurious defects as defined in API 5L Section 10.7.

5.3.2 Hydraulic testing

When all aspects of fabrication have been completed, but before being cleaned, lined or coated, each and every special is to be tested to a hydrostatic pressure test of P,

Where P = the lesser of: $2 \times 0.85 \times Y \times t/D$ or 7 MPa

Y = Minimum Specified Yield Stress (MPa)

t = Nominal Wall Thickness of pipe (mm)

D = Nominal Diameter of Pipe (mm)

Pipe end plugs shall be restrained during the test to ensure that no longitudinal stresses are induced in the pipe wall. Upon completion of the hydraulic test, the ends of the pipe specials shall be tested by means of Go, No-go gauges to check whether flaring or cupping has occurred. If necessary the ends shall be expanded or ground until they comply with the specification.

The test pressure in the pipe special shall be maintained for at least 10 seconds and thereafter shall be inspected for weeps, leaks or deformation. The special will be deemed defective and may be rejected if any leaks, weeps or deformation are evident. Where defects are repaired, the special shall be re-tested. Should the special, after repair, fail to pass the second hydraulic test the Engineer may order its rejection.

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5.3.3 Non-destructive testing

Non-destructive testing shall be in accordance with Section 9 of API Specification 5L.

On completion of the hydrostatic testing (see 5.3.2) and before the ends of the specials are bevelled, non-destructive tests shall be carried out on all manual or semi-automatic welds, as follows:

a) All welds shall initially be radiographically tested (X-rayed) over 100% of the weld length. When consistently acceptable results are obtained, the number of welds to be so tested may be reduced on a sound statistically controlled basis by mutual agreement between the Engineer, Inspectorate and Contractor. At least 10% of all welds shall be radiographically tested.

b) Repairs to welds (see 4.5.4), shall be radiographically tested (X-rayed) over the full length of the repair.

Each radiograph, the test-pieces and results and interpretations of examinations and tests shall be submitted to the Engineer within 24 hours of the particular examination or test.

5.3.4 Testing of specials

Where hydrostatic testing of specials is not practicable, the welds shall be subjected to 100% dye penetrant tests to determine surface cracks, and/or where ordered by the Engineer, to one of the tests specified in 5.3.3 to determine internal defects. Dye penetrant testing shall be done as specified in Subclause 7.2.1 of SANS 1200 L.

5.3.5 Magnetic particle testing

Where requested by the Inspectorate, magnetic particle testing shall be done in accordance with ASME Boiler and Pressure Vessel Code, Section V, Article 7.

5.4 INSPECTORATE

The Engineer may at his sole discretion appoint an independent inspection authority to carry out additional Quality Surveillance at the premises of the manufacturer. The manufacturer shall provide all facilities and shall facilitate access to their premises at reasonable times as may be necessary for the independent inspectorate to perform its function.

The manufacturer's quality control records shall be available for inspection by the independent inspectorate at all reasonable times, and copies of such records shall be made available on request.

Notwithstanding any surveillance carried out by, or on behalf of the Engineer, the Contractor shall retain full responsibility for the quality of specials supplied.

5.5 MARKING PROCEDURE

All weld lengths to be radiographed shall be clearly marked by the Inspector using his identification symbol. This symbol shall appear on the respective radiograph. The radiographed weld and symbol shall not be obliterated by finishing processes until the respective weld has been accepted by the Inspector.

5.6 COATINGS AND LININGS

The testing of the coatings and linings of specials shall be undertaken in accordance with the requirements of Specification ZUT 0003.

6. TOLERANCES

Refer to Clauses 4 and 5 above.

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7. TESTING

Refer to Clause 5 above.

8. MEASUREMENT AND PAYMENT

8.1 BASIC PRINCIPLES

8.1.1 Corrosion protection

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered for item 8.2.1 will be held to cover the cost of any protection system specified.

8.2 BILLED ITEMS

8.2.1 Supply of specials

Unit: number (No)

Specials will be measured by the number of each type, class, and size.

The unit rates shall cover the cost of the provision of each special, complete with couplings and/or other jointing materials as appropriate, and for the design of all specials including all drawings and shop drawings.

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for the supply and delivery to Site of any additional couplings and jointing materials which may be required for the connection of the specials.

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Annexures

APPENDIX A. APPLICABLE STANDARDS

Reference is made to the latest issues of the following standards:

API Specification 5L	American Iron and Steel Institute - Specification for LINEPIPE
API Standard 1104 related facilities	American Iron and Steel Institute - Standard for welding pipelines and
ASME	Boiler and Pressure vessels Code, Section V, Article 7
AWWA M 11	Steel pipe - A guide for design and installation (3rd edition)
BS 534	Steel pipes and specials for water and sewage
BS 639 carbon-manganese steels	Covered electrodes for the manual metal-arc welding of carbon and
BS 1387	Steel tubes and tubulars suitable for screwing to BS 21 pipe threads
BS 1640	Steel butt-welding pipe fittings for the petroleum industry: Part 1 : Wrought carbon and ferritic alloy steel fittings
BS 1832	Compressed asbestos fibre jointing
BS 2633	Class 1 arc welding of ferritic steel pipe work for carrying fluids
BS 3139	High strength friction grip bolts for structural engineering
BS 3294	The use of high strength friction grip bolts in structural steelwork : Part 1 : General grade bolts
BS 3381	Metallic spiral wound gaskets for use with flanges to BS 1560 : Part 1 and 2
BS 4360	Weldable structural steels
BS 4604	The use of high strength friction grip bolts in structural steelwork (metric series)
BS EN 1092	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories. Steel flanges
BS EN 10222	Steel forgings for pressure purposes
PD 5500	Unfired fusion welded pressure vessels
ISO 7005	Metallic Flanges: Part 1 : Steel flanges
ISO 9000	Quality management
ISO 9002	Quality systems. Model for quality assurance in production, installation and servicing
SANS 62	Steel pipes Part 1 Pipes suitable for threading and of nominal size not exceeding 150 mm Part 2 Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specification and test methods
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)

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SANS 974	Rubber joint rings (non-cellular)
	Part I : Joint rings for use in gas, water, sewer, and drainage systems
SANS 1109	Pipe threads where pressure-tight joints are made on the threads Part 1 Dimensions, tolerances and designation Part 2 Verification by means of limit gauges
SANS 1123	Pipe flanges
SANS 1431	Weldable structural steels
SANS 1476	Fabricated flanged steel pipework
SANS 1700	Fasteners
SANS 10044	Welding
SANS 10121	Cathodic protection of buried and submersed structures
SANS 1200 L	Medium-pressure steel pipelines
SAECC/1	Code of Practice

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1. SCOPE

This Specification covers the design, manufacture and delivery to site of electrically welded low carbon steel pipes of outside diameter up to 2 280 mm, for transporting water and sewage at ambient temperatures and under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with SANS 1200 L. Where conflict between this specification and SANS 1200 L occurs, the provisions of this specification shall apply.

Interpretations and variations of this specification are set out in the Amendments preceding this Specification.

2. NORMATIVE REFERENCES

2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

a) Amendments;

b) SANS 1200 Series of Standardized Specifications;

c) SANS 1200 L: Medium-pressure pipelines (see 1. above)

d) Specification ZUT 7001 : Design and manufacture of medium-pressure steel fittings and specials

e) Specification ZUT 0003 : Painting and corrosion protection for water and wastewater works

f) Specification ZUT 7003 : Laying, jointing and testing of medium-pressure steel pipes and specials

The latest issues of the specifications listed in Appendix A shall be deemed to apply to the manufacture of pipes using either submerged arc spiral welding or longitudinal welded “cans” rolled from low carbon or steel plate and joined by submerged arc circumferential welding to form suitable pipe lengths.

3. DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

For the purposes of this Specification the definitions and abbreviations given in the applicable clauses of the specifications listed in 2.1 and the following definitions shall apply:

Cut-and-shut bend : A bend formed by cutting out one or more V-shaped sections equally disposed about a line at right angles to the axis of the pipe, preparing the cut-out edges for welding; bending the pipe to form the bend and welding the pipe shut along the prepared edges to complete the bend (see BS 2633, Fig 25)

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Fitting	:	a) A special or valve. b) Any process of jointing (except welding) straight pipes to one another and to specials and valves.
Flexible pipe	:	A pipe of which the diameter is reduced by more than 1% under an external radial force before the appearance of cracks.
"H"	:	The cross-sectional shape of a weld at a skelp.
Manual shielded electric arc process welding	:	Electric arc welding done by hand using a filler electrode coated with a material that gasifies at the point of arc and excludes oxygen from the weld, thus improving the metallurgical quality of the completed weld.
Nominal diameter (size)	:	A numerical designation of diameter which is common to all components in the piping system other than components designated by OD or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.
Nominal pressure	:	A numerical designation which is a convenient round number for reference purposes. All equipment of the same DN designated by the same PN number shall have compatible mating dimensions.
Pinhole	:	A very small hole indicating a flaw in the weld.
Pipe end bevel	:	A bevel cut made on the end of a pipe to afford a groove between abutting joints in order to receive weld metal.
Pipework	:	Includes all pipes, joints, specials, fittings and valves.
Skelp	:	The jointing edges of steel coils used in the manufacture of spiral welded pipe.
Special	:	Any pipe other than a straight pipe. Note: Under this definition shall be included all sizes of specials of shapes such as bends, tees, crosses, angle branches, reducers, tapers and flexible couplings with or without centre registers.
Straight pipe	:	A straight pipe of uniform bore and of standard or non-standard length.
Welding icicles	:	Congested droplets of metal which extend through the weld to the interior of the pipe, caused by excessive heat or improper welding technique.

3.2 ABBREVIATIONS

The following abbreviations (additional to those referred to in 3.1) shall have the meanings given:

AISI : American Iron and Steel Institute

DN : Nominal diameter (e.g. DN 200 = 200 mm nominal diameter)

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DS-AW	:	Double submerged-arc welded
E-RW	:	Electric-resistance welded
FBE	:	Flanged both ends
FOE	:	Flanged one end
ID	:	Internal diameter
MSEAP	:	Manual Submerged Electric Arc Process
MS	:	Mild Steel
OD	:	Outside diameter, which shall mean the internal diameter plus 2 x (lining thickness + pipe wall thickness)
p.e.	:	Plain ended.
PN	:	Nominal working pressure (eg. PN 10 = 1 000 kPa)
SA-AW	:	Semi-automatic arc welded
SAW	:	Submerged arc weld
Scab	:	Unbonded piece of plate in tight contact with the plate
SS	:	Stainless Steel
t	:	Wall thickness of pipes
TP	:	Test pressure
WP	:	Weld preparation

4. REQUIREMENTS

4.1 MATERIALS

4.1.1 General

Steel pipe shall be manufactured in accordance with SANS 719:2011 Edition 3.2, except as added or amended hereunder. Where the amendments hereunder are in conflict with SANS 719, the amendments shall take precedence.

4.1.2 Chemical composition (SANS 719, Clause 4.2)

Delete Clause 4.2 and replace with:

Unless otherwise billed or shown on drawings, pipes shall be manufactured from the following materials:

Nominal diameter equal to or less than 150 mm:

Medium or heavy class steel, complying with the applicable requirements of SANS 62.

Nominal diameter larger than 150 mm:

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Table 1a

Steel grade	Minimum Yield Stress (MPa)	Chemical Composition and Physical Properties
B	241	SANS 719, Table 1
300WA	300	SANS 1431
X42	289	API 5L Table 3.1 & 4.1
X46	317	API 5L Table 3.1 & 4.1
X52	358	API 5L Table 3.1 & 4.1
X56	386	API 5L Table 3.1 & 4.1
X60	413	API 5L Table 3.1 & 4.1
X65	450	API 5L Table 3.1 & 4.1

Flanges on pipe ends, where applicable, shall be manufactured from steel plate conforming to BS 4360 or SANS 1431 Grade 300W for working pressures up to PN 25. Flanges rated more than PN 25 and up to PN 60 shall be made from steel manufactured in accordance with BS EN 10222 Grade 460 or as approved. Flanges for pressures exceeding PN 60 and up to PN 250 shall be special flanges and gaskets manufactured by Hydro Power Engineering or equal approved.

4.1.3 Physical properties (SANS 719, Clause 4.3)

Insert in the first sentence after "the requirements given in table 1" the following:

"and table 1a".

4.1.4 Certification (SANS 719, Clause 4.4)

Add the following sentence:

"All information relevant to pipe fabrication shall be made available to the Engineer during the course of the manufacturing process."

4.2 DESIGN

4.2.1 Dimensional requirements

4.2.1.1 Pipe length (SANS 719, Clause 5.1.1)

4.2.1.1.1 General (SANS 719, Clause 5.1.1.1)

Add the following under Clause 5.1.1.1:

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"Unless otherwise specified, all pipes shall be manufactured in one fixed standard length between 9 m and 19.5 m. The standard lengths of pipes supplied shall be 9.14 m, 12.19 m or 18.28 m."

4.2.1.1.2 Random lengths (SANS 719, Clause 5.1.1.2)

Delete the wording of Clause 5.1.1.2 and replace with:

"Pipes of random length will be accepted subject to their total length not exceeding 10% of the supplied length for each category of pipe and subject to the length of each pipe being within 10% of a standard pipe length.

Standard pipes from which samples for destructive testing have been cut may be jointed together by butt-welding to form single pipe lengths of the required standard length.

Each change in steel grade, pipe diameter or wall thickness will be classes as a separate category."

4.2.1.1.3 Exact lengths (SANS 719, Clause 5.1.1.3)

The exact lengths of pipes shall be to a tolerance of -0 mm and +50 mm.

4.2.2 Dimensions (SANS 719, Clause 5.1.2)

Insert the following after b):

"The tolerances on outside diameters of pipe ends for pipe diameters greater than 1250mm and less than 2230mm shall be as for pipes of 1250mm diameter (refer to Table 3 of SANS 719)."

4.2.3 Wall thickness (SANS 719, Clause 5.1.3)

Delete "+10% or – 8%" and replace with:

"+13.5% or – 0%"

4.2.4 Pipe ends (SANS 719, Clause 5.1.5)

Add at the beginning of Clause 5.1.5 the following:

"Pipes shall be supplied with each end complying with one of the following criteria:

a) Bevel ended to be joined by field welding

b) Plain ended to be joined by flexible couplings

c) Bell and spigot (plain) ended to be joined by fillet weld as specified in the Amendments and Additions or Bill of Quantities

d) Flanged ends to be joined by bolts, nuts and washers.

Where both ends are specified as bevel ended or plain ended the requirements of SANS 719 Clause 5.1.5 shall apply.

Bell and spigot ends will generally be specified on pipe diameters of 508 mm or smaller.

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The welding requirements for the preparation of these pipe ends shall comply with Clause 4.4.7 of this specification."

4.2.5 Flanges

Flanges shall be designed and manufactured to BS EN 1092 Part 1 for steel flanges and Part 2 for cast iron flanges, unless otherwise specified on the Drawings. Flanges not covered by BS EN 1092 shall be manufactured according to the detailed dimensions and requirements shown on the Drawings.

All flanges shall be suitable for Site welding (SW) to pipes and specials and shall conform to BS 2633, Section 7 with preparation of plate flanges as shown in Fig 41 ("slip-on") for pipes and specials up to DN 100 and Fig 39 or 40 ("bore and fillet") for pipes and specials DN 125 and larger.

The drilling of steel and cast iron flanges shall be off-centre and shall conform to the requirements of SANS 1123, BS EN 1092: Section 3.1, or ISO 7005: Part 1 as applicable, appropriate to the class of pipe specified, except that in the case of flanges, where M27 and M33 bolts are specified in BS EN 1092: Section 3.1, M24 and M30 bolts respectively shall be used as specified in SANS 1123.

Any pipe that has flanges which are incorrectly drilled will be rejected. Reaming of bolt holes to oversize dimension in order to make a particular piece fit will not be permitted.

All flanges shall be machined overall with gramophone finish in accordance with SANS 1123, or as specified below:

a) Flange sizes up to and including DN 400 with a pressure rating up to and including 1600 kPa shall have flat joint faces, and where the pressure rating exceeds 1600 kPa, shall have a raised face sealing arrangement;

b) Flange sizes exceeding DN 400 up to and including DN 1000 shall have a raised face sealing arrangement for all pressure ratings up to and including 2500 kPa.

For flanges not covered by BS EN 1092, and for domes and conical ends, thicknesses shall be calculated and where applicable the flanges manufactured in accordance with Section 3 of BS 5500.

4.2.6 Provision of cadwelding pads

Where pipes are to be jointed by means of flexible couplings the manufacturer shall weld steel plates not less than 50 x 75 x 6 mm thick, 250 mm from each end of all pipes, during the pipe manufacturing process (i.e. before lining and coating) to provide adequate area for cadwelding bonding cables to the piping to make it electrically continuous and enable a cathodic protection system to be applied without damage to the coating.

4.3 PLANT

Pipes shall be manufactured in an approved works which has the necessary tools, plant and equipment to manufacture pipes consistently in accordance with the specifications.

4.4 FABRICATION

4.4.1 General

Only qualified welders, certified as having passed the qualification tests as specified in Clause 6 of API Standard 1104 or alternatively, SANS 10044: Part IV, shall be used to do all welding required. Copies of the certificates shall be made available to the Engineer.

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4.4.2 Forming (SANS 719, Clause 5.2.1)

Delete the sub-clause and replace with the following:

"Unless otherwise specified in the Amendments and Additions, pipes shall be formed in accordance with one of the following forming techniques:

a) Electric resistance welding (ERW). This technique may be used for pipes ranging in outside diameter from 219mm to 610mm and ranging in wall thickness from 3.5mm to 12mm.

b) Submerged arc welding (SAW). This technique may be used for manufacturing spirally welded pipes ranging in outside diameter from 219mm to 2230mm and wall thicknesses ranging from 4.5mm to 18mm.

Where automatic submerged arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside of all pipes.

The number of longitudinal weld seams on pipes shall not exceed 1 for pipes up to and including DN 1000, and 2 for pipes larger than DN 1000 up to DN 2200.

The fabrication of larger diameters and/or use of thicker plate using these techniques may be agreed between the Manufacturer and the Engineer. In both techniques, circumferential joints shall be at least 1.5m apart and longitudinal welds of mated sections shall be at least 30° apart."

4.4.3 Welds (SANS 719, Clause 5.2.2.1)

Add the following as the first sentence:

"All X-grade steel is to be welded in accordance with API 1104 'Welding of Pipelines and Related Facilities'."

4.4.4 Weld reinforcements (SANS 719, Clause 5.2.2.2.7)

All butt welds and branch fillet welds on pipes shall where practicable have an internal weld. The height of the inner weld shall not exceed 1mm.

Internal reinforcement in the form of backing rings at weld seams shall not be permitted.

4.4.5 Seams

Longitudinal seams, spiral seams and shop girth seams shall all be butt welded.

4.4.6 Rounding of pipe and sizing of ends

If it is necessary to reshape pipes after they have been welded, reshaping shall be performed by rerolling or by pressure. Reshaping of pipes by dropping or hammering is not permitted. Sizing of pipe ends to come within specified end tolerances is permitted. This may include expanding pipe ends either mechanically or hydraulically up to a maximum of 1,5% of its original diameter.

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4.4.7 Preparation of pipe ends for:

4.4.7.1 Mechanical couplings

Ends for use with mechanical couplings shall be square cut or bevelled plain ends, cut square to the pipe axis, with all edge burrs, weld splatter and scratches removed. The outside of the pipe shall be free of indentations, projections or roll marks for a distance of 250 mm from each end to permit proper make-up of the coupling. Longitudinal or spiral welds on the outside of the plain end shall be ground to plate or sheet surface for a minimum distance of 250 mm.

4.4.7.2 Fillet welds

Ends for use with fillet welded sleeve joints shall be prepared as specified in 4.4.7.1.

4.4.7.3 Butt welds

Pipes which require joints to be butt welded on site shall be supplied with ends bevelled in accordance with the requirements of SANS 719, Clause 5.1.5. Square cut ends will require approval.

For pipes to be jointed by butt welding, the internal weld bead shall be ground flush with the internal surface of the pipe or special for a length of 200 mm from the ends to be jointed.

4.4.7.4 Spigot and socket

Spigot and socket ends shall be rolled or fabricated from plate, sheet or special sections to the required shape without hammering. Longitudinal or spiral welds on the inside of the socket and the outside of the spigot shall be ground to plate or sheet surface for a distance not less than the depth of insertion of the spigot into the socket.

4.4.7.5 Bevelling

All bevelling, where required, shall be delayed until after all non-destructive testing has been completed.

4.4.7.6 Flanges

Ends to be fitted with flanges shall have the longitudinal or spiral welds ground to plate or sheet surface for a distance from the ends sufficient to accommodate the flange.

4.4.8 Rectification of defects (SANS 719, Clause 5.2.3)

Add the following to Clause 5.2.3:

"If a pipe fails to pass any of the tests specified, it will be rejected but the Engineer may permit repairs or alterations to be made to enable the pipe to pass the test.

Repairs of welded joints will be permitted during the process of manufacture. Where repairs are required the defective weld metal shall be cut out, and the parent metal prepared by grinding, and re-welded, to the satisfaction of the Engineer.

The repair procedure and performance on repairs shall be in accordance with Section 10 of API Specification 5L where not in conflict with SANS 719. Only qualified welders shall be employed. Each repair weld shall be marked with the welder's identifying stamp.

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When the repair has been made, it shall be radiographically tested (X-rayed) over the full length of the repair.

On discovery of defective welds the Engineer may, at his discretion, call for additional radiographic examination until it is shown that the necessary standard is being maintained.

Should a weld repair be required on a pipe subsequent to hydraulic testing, the repaired pipe shall be retested in accordance with Clause 5.5 Hydraulic testing of this specification.

Dents shall, where practicable, be jacked out."

4.5 COATINGS AND LININGS

Coatings and linings of pipes shall be undertaken in accordance with the requirements of Specification ZUT 0003.

4.6 MARKING (SANS 719, CLAUSE 7)

Delete this clause and replace with the following:

Upon fabrication, each pipe shall be hard stamped with a unique reference number to ensure traceability. The stamp is to be 100mm from the pipe end and next to a weld. On completion of the contract or at reasonable intervals during the contract, the following pipe information shall be supplied to the Engineer in Microsoft Excel ® format:

a) Pipe reference number

b) Contract number

c) Date of manufacture

d) Outside diameter

e) Wall thickness

f) Grade of steel

g) Coating type and nominal thickness

h) Lining type and nominal thickness

i) Forming technique

j) Length

k) Mass of uncoated and unlined pipe in kg/m

l) Applicable drilling tables stamped on the periphery of all flanges

In addition to the hard stamping, all pipes shall be clearly marked with the unique reference number in appropriate height characters in durable paint on a black background at one end of each pipe. The supplier's and Employer's name and logo shall be stencilled on each pipe.

Where specified in the Amendments, all pipes shall also be clearly marked with colour bands to reflect the grade steel and wall thickness."

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4.7 STORAGE, HANDLING AND TRANSPORT

4.7.1 Handling and rigging

The plant and rigging equipment used for the handling of pipes shall be such that no pipe shell is over-stressed during any operation.

In the transportation, loading and unloading of pipes, an adequate fleet of vehicles shall be operated and maintained at all times to ensure that pipes and their protective linings and coatings are not damaged. In particular, the use of excavation equipment for handling of pipes will not be permitted.

Coated pipes shall be moved with the use of padded slings of width sufficient to prevent damage to the coating. The slings shall be at least 500mm wide for pipes up to DN600, 600mm wide for pipes of DN700 and up to DN1200, and 800mm wide for pipes of DN1400 and larger, or as approved by the Engineer. Chain slings, hooks, wire ropes, rope slings without canvas covers, composition belt slings with protruding rivets and any other equipment liable to damage the coating shall not be used.

Slings shall be suitably rated for the loads to be handled and in good condition. The use of deteriorating and frayed slings is prohibited.

All pipes are to be lifted and handled with the aid of a “spreader” lifting beam. Special care shall be taken to ensure that no damage occurs to pipes or coatings as a result of pipes sliding on or hitting adjacent pipes. The dragging or skidding of pipes in contact with the ground is not permitted.

If cradles are used to transport the pipes they must be rubber lined to avoid damage to the pipe coating.

During transportation pipes shall be safely secured to its final destination with slings of an adequate width.

The Contractor shall be responsible for dispatching and transporting of the pipes to site and off-loading.

4.7.2 Dunnage and storage

Whenever pipes are stacked or otherwise stockpiled or are transported (unless special cradles are used), use shall be made of suitably resilient material as dunnage which shall not disintegrate or deteriorate when exposed to the elements for prolonged periods. Pipes of 6m length shall be stacked with a minimum of 2 dunnage supports. Pipes of 9m and 12m lengths shall be stacked with a minimum of 3 supports (one support at each pipe end and one at mid-span). Pipes of 18m length shall be stacked with a minimum of 4 supports at equal spacing. The supports shall have a minimum width of 500mm for pipes up to DN500 and 1000mm wide for larger pipes. The length of the support shall be a minimum length of 1.5 times the diameter of the pipe to be supported and shall be profiled to match the coated outside radius of the pipe. Pipes shall be stacked with a minimum clearance of 50mm between adjacent pipe walls and a minimum of 200mm clear of the ground.

Pipes shall be stacked with sufficient supports to prevent permanent longitudinal deflections or deformation of the pipe body in excess of 2 per cent of the pipe diameter. Pipes shall also be stacked in a manner that limits loading on lower layers of pipes. Any pipe showing permanent ovality as a result of surcharge loading shall be rejected. Dents causing a protrusion in excess of 3mm into the interior of a pipe may also result in the pipe being rejected.

Each class and size of pipe shall be stacked and stored separately.

Coated steel pipes shall always be supported on a sufficient number of approved soft bolsters to prevent damage or the permanent deformation of coatings. Coated steel pipes shall not be stacked more than two pipes high, each layer separated by bolsters.

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The number of layers of bare steel pipes in a stockpile shall not exceed:

$$N = \frac{1730.f.t}{(D-t)^2}$$

Where N is the permissible number of layers, D is the outside diameter of the pipe in mm, f is the guaranteed minimum yield strength in MPa for the steel plate, and t is the nominal wall thickness in mm.

Any material which is not delivered and off-loaded on Site in the same condition as it left the factory may be rejected by the Engineer.

4.7.3 Protection of pipe ends

Before transportation all pipes are to be fitted with end caps made from plastic or other suitable material. Each end cap must remain in place until its pipe has been laid and the pipe end is no longer open to the elements. It must, therefore, remain in place until it is no longer needed to protect the pipe from ingress of foreign material.

In addition, bevel-ended pipes are to be fitted with bevel protectors before leaving the Manufacturer's premises. These are to remain in place until removed to permit the welding operation.

5. COMPLIANCE WITH REQUIREMENTS

5.1 FACILITIES FOR TESTING

The Contractor shall provide at his own cost, all facilities and equipment required for testing and shall carry out all tests at his own expense. Complete records of test results shall be kept.

The testing machines shall be of a design which will allow a steady application of the test pressure and shall be equipped with an accurate pressure gauge. Provision shall be made for expelling all air from any pipe under test during filling and before application of the pressure.

Test calibration certificates from an independent laboratory, verifying the accuracy of all measuring and testing instruments requiring calibration, shall be provided by the Contractor. Recalibration shall be carried out as necessitated by circumstances but at intervals not exceeding 3 months.

5.2 QUALITY ASSURANCE

All steel pipes shall be fabricated and tested in accordance with an approved quality control plan and procedure. Manufacture shall not commence until such time as the quality control plan and procedure has been approved by the Engineer.

The quality control plan and procedure shall address, as a minimum, the following tests/inspections:

a) Material certification

b) Non Destructive Evaluation (NDE) testing

c) Verification of tolerances

d) Workmanship

e) Surface preparation (e.g. cleanliness and blast profile for coatings and linings)

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f) Material identification

g) Personnel certification (including welders and NDE)

h) Welding procedures and certification

i) Weld preparation

j) Compliance with drawings

k) Hydrostatic testing

5.3 INSPECTIONS

5.3.1 Visual inspections

All finished pipes shall be visually inspected and shall be free of injurious defects as defined in API 5L Section 10.7.

5.3.2 Dimensions (SANS 719, Clause 6.1.1)

Add the following as the first sentence:

"The outside diameter, ovality and straightness of each pipe is to be checked in accordance with this clause."

5.3.3 Welds (SANS 719, Clause 6.1.2)

Add the following at the end of the clause:

"The welds of each pipe are to be tested using one of the two options below. If not specifically stated elsewhere, pipes manufactured by ERW are to be tested as per Option 2 and spirally welded pipes as per Option 1.

a) Option 1 (excluding ERW pipes)

100% of the welds of all pipes shall be tested by fluoroscopic means. Where defects are detected they shall be adjudicated in accordance with API 5L and, if necessary, repaired in accordance with the requirements of API 1104.

b) Option 2 (ERW pipes)

100% of the welds of all pipes shall be tested by ultrasonic means. Where defects are detected in a pipe by means of ultrasonic testing, the defection section of pipe shall be 100% re-tested by means of X-ray and adjudicated in accordance with API 5L and, if necessary, repaired in accordance with the requirements of API 1104.

For rail, road, river and stream crossings, 100% of the total length of all welds shall be examined radiographically."

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5.4 DESTRUCTIVE TESTS (SANS 719, CLAUSE 6.2)

At least one set of the three tests described in SANS 719, Clauses 6.2.1, 6.2.2 and 6.2.3, shall be carried out for each pipe diameter and wall thickness combination. The Engineer may require that, after the first pipe, every 500th subsequent pipe of each diameter and wall thickness combination be tested.

5.5 HYDRAULIC TEST (SANS 719, CLAUSE 6.3)

Delete this clause and substitute with the following:

"When all aspects of fabrication have been completed, but before being cleaned, lined or coated, each and every pipe is to be tested to a hydrostatic pressure test of P,

Where P = the lesser of: $2 \times 0.85 \times Y \times t/D$ or 7 MPa

Y = Minimum Specified Yield Stress (MPa)

t = Nominal Wall Thickness of pipe (mm)

D = Nominal Diameter of Pipe (mm)

Pipe end plugs shall be restrained during the test to ensure that no longitudinal stresses are induced in the pipe wall. Upon completion of the hydraulic test, the ends of the pipes shall be tested by means of Go, No-go gauges to check whether flaring or cupping has occurred. If necessary the ends shall be expanded or ground until they comply with the specification.

The test pressure in the pipe shall be maintained for at least 10 seconds and thereafter shall be inspected for weeps, leaks or deformation. The pipe will be deemed defective and may be rejected if any leaks, weeps or deformation are evident. Where defects are repaired, the pipe shall be re-tested. Should the pipe, after repair, fail to pass the second hydraulic test the Engineer may order its rejection."

5.6 INSPECTORATE

The Engineer may at his sole discretion appoint an independent inspection authority to carry out additional Quality Surveillance at the premises of the pipe manufacturer. The manufacturer shall provide all facilities and shall facilitate access to their premises at reasonable times as may be necessary for the independent inspectorate to perform its function.

The manufacturer's quality control records shall be available for inspection by the independent inspectorate at all reasonable times, and copies of such records shall be made available on request.

Notwithstanding any surveillance carried out by, or on behalf of the Engineer, the Contractor shall retain full responsibility for the quality of pipes supplied.

5.7 MARKING PROCEDURE

All weld lengths to be radiographed shall be clearly marked by the Inspector using his identification symbol. This symbol shall appear on the respective radiograph. The radiographed weld and symbol shall not be obliterated by finishing processes until the respective weld has been accepted by the Inspector.

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5.8 COATINGS AND LININGS

The testing of the coatings and linings of pipes shall be undertaken in accordance with the requirements of Specification ZUT 0003.

6. TOLERANCES

Refer to Clauses 4 and 5.

7. TESTING

Refer to Clause 5.

8. MEASUREMENT AND PAYMENT

8.1 BASIC PRINCIPLES

8.1.1 Corrosion protection

Unless specific provision is made in the Bill of Quantities, no separate payment will be made for corrosion protection. The rates tendered for item 8.2.1 will be held to cover the cost of any protection system specified.

8.1.2 Pipes tested to destruction

Pipes tested to destruction and the repair of the tested pipes for use in the Works, if ordered by the Engineer, will be measured and paid on a daywork basis.

8.2 BILLED ITEMS

8.2.1 Supply of pipes

Unit: metre (m)

The supply of pipes will be measured by length. The maximum length measured will be equal to the length as laid, no deductions being made for specials and valves and no extra length measured for waste. (See Subclause 8.2 of SANS 1200 L)

Separate items will be billed for each diameter and wall thickness.

The unit rates shall cover the cost of the fabrication and supply of the pipes, complete with couplings where applicable, the cost of handling where applicable, and the cost of factory testing, inspection and transportation to Site and shall, where it is necessary to limit ovality to within the specified limits, also cover the cost of bracing the pipes internally.

Separate items are provided in the Bill of Quantities for the laying, jointing, testing and commissioning of the pipes.

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Annexures

APPENDIX A. APPLICABLE STANDARDS

Reference is made to the latest issues of the following standards:

API Specification 5L	American Iron and Steel Institute - Specification for LINEPIPE
API Standard 1104	American Iron and Steel Institute - Standard for welding pipelines and related facilities
ASME	Boiler and Pressure vessels Code, Section V, Article 7
AWWA M 11	Steel pipe - A guide for design and installation (3rd edition)
BS 534	Steel pipes and specials for water and sewage
BS 639	Covered electrodes for the manual metal-arc welding of carbon and carbon-manganese steels
BS 1387	Steel tubes and tubulars suitable for screwing to BS 21 pipe threads
BS 1640	Steel butt-welding pipe fittings for the petroleum industry: Part 1 : Wrought carbon and ferritic alloy steel fittings
BS 1832	Compressed asbestos fibre jointing
BS 2633	Class 1 arc welding of ferritic steel pipe work for carrying fluids
BS 3139	High strength friction grip bolts for structural engineering
BS 3294	The use of high strength friction grip bolts in structural steelwork : Part 1 : General grade bolts
BS 3381	Metallic spiral wound gaskets for use with flanges to BS 1560 : Part 1 and 2
BS 4360	Weldable structural steels
BS 4604	The use of high strength friction grip bolts in structural steelwork (metric series)
BS EN 1092	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories. Steel flanges
BS EN 10222	Steel forgings for pressure purposes
PD 5500	Unfired fusion welded pressure vessels
ISO 7005	Metallic Flanges: Part 1 : Steel flanges
ISO 9000	Quality management
ISO 9002	Quality systems. Model for quality assurance in production, installation and servicing

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SANS 62	Steel pipes Part 1 Pipes suitable for threading and of nominal size not exceeding 150 mm Part 2 Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specification and test methods
SANS 719	Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
SANS 974	Rubber joint rings (non-cellular)
	Part I : Joint rings for use in gas, water, sewer, and drainage systems
SANS 1109	Pipe threads where pressure-tight joints are made on the threads Part 1 Dimensions, tolerances and designation Part 2 Verification by means of limit gauges
SANS 1123	Pipe flanges
SANS 1431	Weldable structural steels
SANS 1476	Fabricated flanged steel pipework
SANS1700	Fasteners
SANS 10044	Welding
SANS 10121	Cathodic protection of buried and submersed structures
SANS 1200 L	Medium-pressure steel pipelines
SAECC/1	Code of Practice
Specification ZUT 0003	Painting and corrosion protection for water and wastewater works
Specification ZUT 7001	Design and manufacture of medium-pressure steel specials
Specification ZUT 7003	Laying and jointing of medium-pressure steel pipes and specials

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1. SCOPE

This Specification covers the laying and jointing of electrically welded low carbon steel pipes and specials of diameter up to 2 280 mm, for transporting water and sewage under working pressures of up to 2,5 MPa.

This Specification shall be read in conjunction with Specifications ZUT 7001 and ZUT 7002.

This Specification contains clauses that are generally applicable to the laying and jointing of medium-pressure steel pipes and specials. Interpretations and variations of this specification are set out in the Amendments preceding this Specification.

2. NORMATIVE REFERENCES

2.1 SUPPORTING SPECIFICATIONS

Where this Specification is required for a project, the following specifications shall, inter alia, form part of the Contract Document:

a) Amendments;

b) Specification ZUT 7002 : Manufacture of medium-pressure steel pipes;

c) Specification ZUT 7001 : Design and manufacture of medium-pressure steel specials;

d) Valves specifications

e) Flow meter specifications

f) Specification ZUT 0003 : General corrosion protection for pipelines, water and wastewater works; and

g) Standards listed in Appendix A.

3. DEFINITIONS AND ABBREVIATIONS

For the purposes of this Specification the definitions and abbreviations given in the specifications listed in 2.1 shall apply.

4. REQUIREMENTS

4.1 MATERIALS

4.1.1 General

Refer to Subclause 4.1.1 of ZUT 7001 and Subclause 4.1.1 of ZUT 7002.

Pipes and fittings shall be of the types specified in the Bill of Quantities or in the project specification and, unless otherwise required in terms of the project specification, they and their couplings shall be capable of withstanding the applicable test pressure specified in the Amendments. All pipes and fittings shall be supplied complete with couplings and jointing material.

Satisfactory temporary end covers shall be provided for the protection of threads, flanges, and prepared ends of plain-ended pipes and fittings, and to prevent damage to internal lining during transportation and during handling on Site.

4.1.2 Flanges

Refer to Subclauses 4.1.3 and 4.3.2 of ZUT 7001 and Subclauses 4.1.2 and 4.2.5 of ZUT 7002.

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4.1.3 Insulating flanges

Refer to Subclause 4.3.3 of ZUT 7001.

4.1.4 Gaskets

Refer to Subclause 4.3.5 of ZUT 7001.

4.1.5 Bolts, nuts and washers

Refer to Subclause 4.3.6 of ZUT 7001.

4.1.6 Bricks

Bricks shall be obtained from an approved manufacturer and shall be either general purpose (special), burnt clay, or engineering bricks that comply with the applicable requirements of SANS 227, or Class S14 calcium silicate bricks that comply with the applicable requirements of SANS 285.

The Contractor shall submit to the Engineer samples of the bricks he intends using in the construction of the Works. The samples of bricks that are approved will be retained by the Engineer.

4.1.7 Precast cylinders

Precast cylinders may be of spun concrete, glass reinforced polyester, or PVC, except where particular materials are required in terms of the Bill of Quantities or the project specification. Precast concrete cylinders shall comply with the applicable requirements of SANS 1294. Sectional spun concrete cylinders shall comply with the requirements for pipes of SC type, Class A, of SANS 677. Jointing between cylinders shall be of the interlocking self-centring type suitable for sealing.

4.1.8 Concrete

Concrete shall comply with the requirements of SANS 1200 G or SANS 1200 GA, as applicable.

4.1.9 Welding rods

The Contractor shall supply all the necessary welding electrodes, which shall be of the shielded type. The chemical composition of weld metal and parent metal shall be similar. Electrodes that show signs of deterioration or damage shall be removed from Site and replaced at the Contractor's expense. Electrodes shall comply with the requirements of BS 639.

4.1.10 Corrosion protection

Refer to Specification ZUT 0003.

4.1.11 Records of materials on site

The Contractor shall keep and maintain a complete and comprehensive record of each pipe, special and fitting delivered to Site. The record shall at least denote the reference number, size, pressure class, location in the pipeline, date and condition of delivery and the location of delivery and the location of storage. Copies of the record shall be submitted to the Engineer at the end of each month or whenever requested by the Engineer.

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Where pipes, specials and fittings are delivered without reference numbers, same shall be provided by stencilling, labelling or other methods approved by the Engineer.

4.2 PLANT

4.2.1 Packing

Goods shall be suitably packed in such a manner as will ensure safe and efficient transport by road or rail, and the Contractor shall include in his prices for whatever packing may be necessary in this respect. Small items particularly liable to damage or loss in transit should be crated. All crates and packing material shall, after use, become the property of the Employer, unless distinctly specified otherwise, or if returnable, shall be so at the Contractor's expense.

4.2.2 Handling and rigging

The plant and rigging equipment used by the Contractor for the handling and placing of pipes shall be such that no pipe shell is over-stressed during any operation covered by the specification.

4.2.3 Setting out

The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment and laying of the pipeline.

4.2.4 Site equipment

The Contractor shall furnish all equipment, tools, and supplies, including the necessary welding electrodes. Welding machines shall be operated within the amperage and voltage ranges recommended for each size and type of electrode. Any equipment that does not meet these requirements shall be repaired or replaced upon request of the Engineer. (Refer also API 1104 Clause 1.3.)

4.2.5 Testing

The Contractor shall provide all equipment, materials, tools, and fittings required for the performance of the tests given in Clause 5.

4.3 METHODS AND PROCEDURES

4.3.1 Laying

4.3.1.1 General

The pipelines shall be laid and bedded to even grades and to the levels and alignments shown on the drawings or as directed. It shall be laid centrally in the trench in such a manner that the side allowance conforms to the applicable value specified in Clause 8 of SANS 1200 DB. For ease of inspection and testing the pipes shall be laid with the manufacturer's class and quality identification marks visible from the top of the trench, unless, in the case of large pipes, the position of lifting eyes render this impracticable.

Control of laying and bedding shall be by means of boning rods and sight rails or an acceptable laser beam device. Sight rails shall be painted black and white and shall be fixed securely and accurately.

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4.3.1.2 Damage

Each pipe, pipe special and fitting shall be thoroughly cleaned and carefully examined for damage and defects prior to laying. Should any damaged or defective pipe, pipe special or fitting be laid, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

During laying, the anti-corrosion lining of pipes being joined by butt welding shall be protected against damage by foot traffic or weld spatter, to the satisfaction of the Engineer and in the manner described in Clause 4.3.2.4.6.

4.3.1.3 Keeping pipelines clean

Every reasonable precaution shall be taken to prevent the entry of foreign matter and water into the pipe(s). At the close of each day's work, or at any time when work is suspended for a significant period, the last laid section of the pipeline shall be plugged, capped or otherwise tightly closed until laying is recommenced.

The interior of pipes shall be perfectly clean before being laid and the Engineer may instruct that the pipe interior be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately before laying. Once a section of pipeline has been cleaned, it shall be sealed off and not be entered again unless permitted by the Engineer.

During laying and jointing of pipes and until the pipeline has passed the required acceptance tests and the trench has been backfilled, the trench shall be kept in a state which, in the opinion of the Engineer, is reasonably dry.

The Contractor shall at his own expense make good any damage to valves and fittings or clogging of off-takes or malfunctioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition.

4.3.1.4 Depths and cover

Unless otherwise specified in the Amendments, shown on the Drawings, or ordered by the Engineer, the minimum cover for pipelines shall be 1.0 m.

The minimum clearance between the outside of a pipeline being laid and the outside of any other pipe that it crosses shall be 300 mm. Where this requirement conflicts with the requirements for cover over the pipeline the Contractor shall ask the Engineer for written instructions and shall carry out the work in accordance with those instructions.

4.3.1.5 Cold stresses and deflection in pipe curvature

Pipes shall be laid free from cold stresses. No deflections shall be taken in curvature of pipes, but shall be taken with approved bends with exceptions as hereinafter specified. All deflections in pipes with flexible couplings shall not exceed those recommended by the manufacturer of the couplings after making allowance for ground movements.

4.3.1.6 Mitres to effect pipe deflections

All deflections in the axis of butt-welded steel pipelines of 10 degrees or less shall be made by mitring equally the ends of the two pipes to be joined so that the maximum mitre in any one pipe shall be 5 degrees. Where the total deflection is 3 degrees or less, the mitring may be made in one pipe end only. Ends to be mitred shall be carefully and accurately marked and then either machine cut or machine planed.

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Hand planing will not be permitted. After mitring, the pipe ends shall be re-chamfered as described in Clause 5.1.5 of SANS 719. The minimum gap between pipe end root faces before welding shall be 1,5 mm and the maximum gap shall be 3,0 mm. After mitring all pipe ends shall be thoroughly cleaned before the field weld is carried out.

4.3.1.7 Cold bends

Where the Engineer gives written approval for cold bends on pipes with diameters of 450 mm and smaller, they shall be made by the cold stretch method in such a manner as to preserve the cross-sectional shape of the pipe. The minimum radius of any such bend shall be twenty five times the outside diameter of the pipe. Approved bending shoes shall be used for bending of the pipes.

4.3.1.8 Snaking

Snaking into the trench of butt-welded sections of steel pipeline which has been factory lined and/or coated will not be permitted without the written approval of the Engineer.

4.3.1.9 Stringing of pipes

The Contractor shall ensure that pipes are strung in accordance with a method statement to be approved by the Engineer. The method statement shall cover the proper placement by diameter, wall thickness and specifications. Any movement of pipes resulting from failure to comply with the approved method statement shall be rectified at the Contractor's expense.

4.3.1.10 Handling and transporting

Pipes and specials shall be handled as specified in Clause 4.8 of ZUT 7001 and Clause 4.7 of ZUT 7002.

Wrapped pipes shall be protected from grit and other sharp objects while the pipe is in the trench prior to bedding. Walking on wrapped pipes will not be allowed. The Engineer may reject any length of wrapping on which physical damage due to any cause whatsoever is visible.

Cement mortar lined pipes shall not be moved or transported for a period of 14 days after the date of lining.

4.3.1.11 Skids

Skids of sufficient number shall be supplied to support the pipe to proper height. If a pipe is supported over the trench, skids shall be of sufficient length to prevent collapsing of the trench and of sufficient strength to carry the pipe.

For coated pipe a sufficient number of skids shall be used to prevent damage to the coating.

4.3.2 Jointing methods

4.3.2.1 Flexible couplings

The joints of steel pipes by flexible couplings shall be made only in their final laid position. Before assembling the joint, care shall be taken to ensure that pipe ends and couplings are clean and free from burrs and ridges. Such burrs and ridges shall be removed if present. Pipe ends shall be mated carefully before joints are made. Pipe ends shall be concentric and perfectly lined up and the coupling shall not be relied upon to line up or to support the pipe.

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Joints shall be made and couplings assembled to the manufacturer's instructions. Two-thirds of the number of coupling bolts, equally spaced, shall first be partially tightened up in a regular sequence, using a short spanner. The remaining bolts shall then be similarly tightened. After checking the coupling alignment, the bolts shall then be finally tightened evenly, using a torque wrench.

Where couplings without central registers are used, precautions shall be taken to ensure that the pipe ends are apart by the same distance as if a coupling with central register had been used and the coupling shall be carefully centred over the pipe ends.

Flexible couplings shall be provided with external protection as soon as the pipeline has been hydrostatically tested and electrically bonded, where applicable.

4.3.2.2 Flanged joints

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flanges. Flanges shall be installed truly square to the axis of the pipe.

In the jointing of steel pipes with flanges, special care shall be taken to align, grade and level the pipes, specials and valves to avoid straining of the flanges. All bitumen and paint shall be removed from the mating face of each flange immediately before jointing. Epoxy paints shall not be removed from flange faces. Insertion pieces that have accurately cut holes for bolts shall be placed to form a continuous one-piece ring between the flanges. Bolts shall be tightened up to ensure uniform bearing on the insertion. Care shall be taken to avoid damage to the internal surface of the pipes during assembly of the pipeline.

Wherever loose flanges are welded onto pipelines, the Contractor shall ensure that the inner lining is restored to the thickness specified for such lining and that the new repaired lining is soundly jointed to the existing lining.

In making the joint the Contractor shall ensure that the flanges are truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to watertightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and tightened equally at opposite ends first. The Contractor shall ensure that the correct jointing materials, i.e. gaskets and bolts and nuts are available when required. The gaskets shall be in accordance with Subclause 4.3.5 of ZUT 7001. In the case of insulated joints the insulated materials shall be arranged as set out in Code of Practice No. SAECC/1.

Flanged fittings shall be so installed that there are no stresses induced into the pipework specials or fittings by forcing ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.

4.3.2.3 Bolts and nuts

Bolts and nuts shall be in accordance with Subclause 4.3.6 of ZUT 7001.

Only correct diameters and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts and bolt heads. The length of bolts and studs shall be such that approximately two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite-grease compound immediately prior to assembly.

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4.3.2.4 Field welding

4.3.2.4.1 General

Field welding of pipes which have been lined will only be permitted in pipes of DN 450 and larger where a man is able to enter the pipe to make good the lining after welding and testing in accordance with Clause 5.1 has been completed. Pipes of lesser diameter may be field welded where concrete linings will be made after the pipeline has been laid and all welds have been tested and approved.

At the discretion of the Engineer, roll welding will be permitted, provided an alignment is maintained by use of skids or of structural framework to accommodate two or more lengths of pipe with an adequate number of roller dollies to prevent sag in the pipe. The entire root bead, however, shall be made with the pipe in a stationary position.

All pipes welded in the trench shall be properly laid and aligned before welding commences. Joint holes shall be excavated at all field welds. The Contractor shall not lift the pipe to provide adequate access for the welders to enable them to weld the joint.

The alignment of abutting ends shall be such that the offset will not exceed 1.5 mm. Line up clamps shall be used for joint “fit-ups”. The use of “bridges and wedges” or any method that may induce unnecessary stresses will not be permitted.

Both ends of coated and lined pipes shall be wrapped for a distance of at least 800 mm on either side of the weld by means of an asbestos mat or other approved material to ensure that weld spatter or other damage is not caused to the coating and lining during the welding process. The pipe trench shall be kept free of all dirt and water in the vicinity of the weld until after all corrosion protection measures have been completed and approved.

Destructive testing as specified in Clause 5.1.2.2 shall be carried out. The Contractor shall submit to the Engineer for approval a full procedure specification as detailed in API 1104 Clause 5.3 prior to any field welding being allowed.

4.3.2.4.2 Welding procedure and qualification of welders

Welding shall only be done by qualified welders who satisfy the requirements of API Std. 1104, Clause 6 and who have been tested at the Contractor’s expense by an Independent Inspectorate.

Before any welding of pipeline materials commences, the qualification of welders shall have been approved, all detailed welding procedure specifications with weld diagrams required for their completion shall have been submitted for approval in a neat form and the welding procedure qualification tests shall have been successfully concluded all in accordance with the relevant standard specifications. Each welder shall mark the pipe adjacent to the weld with the figure assigned to him.

Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

As far as practicable all out of trench welding shall preferably be done by an automatic submerged process and the Contractor shall provide all necessary plant to carry out this process. Manual submerged electric arc process (MSEAP) welding may be used where in-trench welding is done.

Pre- and post-heat treatment for welding shall be in accordance with API Std. 1104 if required by same and the Contractor shall provide an approved shield to protect the pipe joint from wind and weather during heat treatment and welding.

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4.3.2.4.3 Line up

Pipes shall be lined up in such a manner as to prevent damage thereto. If the pipe to be used has a longitudinal seam, these seams shall be staggered by not less than twenty degrees and welded sections, or single lengths, shall be assembled in such a manner that this seam shall remain in the top quadrant of the pipe during coating operations and after lowering into the trench.

4.3.2.4.4 Cleaning of pipe ends

Before welding, all foreign matter shall be removed from the bevelled ends. If any of the ends of the pipe joints are damaged to the extent that satisfactory welding contact cannot be obtained, the damaged pipe ends shall be cut and bevelled with an approved bevelling machine. These field bevels of pipe ends shall be made to the satisfaction of the Engineer. Should laminations, split ends, or other defects in the pipe be discovered, the joints of pipes containing such defects shall be cropped, repaired, or removed from the line as designated by the Engineer.

4.3.2.4.5 Weather conditions

No welding shall be carried out during rain or high wind unless the welder and joint are adequately protected and sheltered, to ensure that the welding is not impaired.

4.3.2.4.6 Protection of paintwork

Before welding commences, a suitable apron at least 800 mm wide shall be wrapped around both sides of the area to be welded to ensure that weld spatter or fallout from arc weld does not damage the paintwork.

During the welding of joints, the Contractor shall ensure that either rubber mats or other suitable material is laid in the pipe invert of epoxy lined steel pipes to protect the lining against damage by traffic or fall-out from arc welding at the joint. The mats shall be placed the full distance from the point of access up to the point of weld or weld inspection and shall be of sufficient width.

Workmen shall wear soft rubber soled shoes before entering lined pipes. Care shall be taken not to stroke arcs on the epoxy lined areas adjacent to the weld joint. Immediately before welding of joints, the protective tape between the ends of concrete or epoxy linings and coatings and pipe ends shall be removed.

4.3.2.4.7 Butt-welding

Pipes and specials to be joined by field welding shall be supplied with ends bevelled for welding. All welding of joints shall comply with API Std. 1104 and only approved type welding rods shall be used.

If backing rings are used, they shall be placed in position and wedged up or adjusted so that the pipe ends are completely circular and properly mated. The space between abutting pipe ends, when aligned for welding, shall be such as to ensure complete penetration without burn-through. For pipes having the same dimensions, the spacing shall be approximately 1,5 mm.

The alignment of the abutting pipe ends shall be such as to minimize the offset between pipe surfaces. For pipes of the same nominal wall thickness, the offset shall not exceed 1,5 mm. Internal line-up clamps shall be used wherever practicable and may be removed after the root bead is 50 % completed, provided that the completed part of the root bead is in segments of approximately equal lengths, spaced about the circumference of the pipe. If conditions make it difficult to prevent movement of the pipe, or if the weld will be unduly stressed, the root bead shall be completed before releasing clamp tension.

External line-up clamps shall be used where it is impracticable to use internal line-up clamps. Partial root beads made when using external clamps shall be uniformly spaced about the circumference of the pipe,

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and shall have an accumulative length of not less than 50% of the pipe circumference before the clamps are removed.

Tack-welding shall be carried out to maintain the root gap and position of the pipe ends during the welding proper. The number of tack-welds shall be kept to a minimum but shall not be less than four around the circumference of the pipe.

After proper preparation and tack-welding, the root bead shall be carried out followed by successive filler passes, and capper finish pass in accordance with the approved welding procedure.

The filler and finish beads shall be deposited by an acceptable method and each filler bead shall be approximately 3 mm in thickness. Completed welds shall have a reinforcing of not less than 0,8 mm and not more than 1,5 mm above the pipe surface around the entire perimeter of the weld, and the width of the finish or cover shall be not more than 3 mm greater than the original groove.

The number of beads required shall be governed by the wall thickness of the pipe, so that the completed weld will have the reinforcement previously specified; provided, however, that each weld shall consist of at least three beads. No two beads shall be started at the same point. No mitre welds will be permitted, and all welds are to be at ninety degrees (± 5 degrees) to the axis of the pipe. All slag and scale shall be removed from each bead for visual inspection immediately after each bead is run.

In all field butt-welds where it is possible to work inside the pipe, the inside weld shall be done first. The chemical composition of weld metal and parent metal shall be similar and the inner weld metal or reinforcement shall not extend more than 1 mm above the inside metal surface of a pipe or special, and any excess shall be removed by grinding.

Defects caused by stray welding arc flashes shall be removed by grinding, provided that the pipe wall thickness is not reduced to less than the specified minimum thickness, otherwise the portion shall be cut out and repaired.

4.3.2.4.8 Fillet welding

Welding shall be as for butt-welding as applicable. All pipes of DN 600 and over shall be welded on both the outside and the inside.

4.3.2.4.9 Welding alongside the trench

The Contractor may butt-weld factory coated and/or lined steel pipes together alongside the edge of the trench to form continuous welded pipeline sections up to a maximum length of 45 m and to lower each section into the trench, provided the pipe, coating and/or lining are in no way damaged during these operations and provided furthermore that the deflection of the pipe barrel at any point during any stage of the operation does not exceed 2% of pipe outside diameter.

The linings and coatings of factory coated and/or lined pipes jointed together outside the trench shall be made good at these joints outside the trench.

4.3.2.5 Repair of welds

Rectification of defective welds shall be in accordance with API Std. 1104 and to the satisfaction of the Engineer. All costs related to the repair of defective welds shall be borne by the Contractor. Defective welds shall be repaired immediately once they are found to be defective. The Engineer has the right to stop the Contractor proceeding with further pipe laying in the event of the Contractor delaying the rectification of defective welds. Furthermore, no consideration will be given to any claims arising from delays in construction resulting from such action.

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4.3.3 Installation of specials and fittings

4.3.3.1 General

Welding shall comply with API Std. 1104. All specials and other fittings shall be installed in accordance with the drawings and instructions of the Engineer. Where "slip-on" or sleeve couplings are to be fitted, all surfaces shall be thoroughly cleaned to a smooth finish, care being taken to remove as little of the protective coating as possible.

4.3.3.2 Bends

Bends shall be installed true to line, level and deflection and shall be anchored in concrete where required to counteract thrust. Bends shall normally be supplied with "centre planes" marked with two small punch marks close to both ends of the bends to facilitate correct positioning of the bends in laying.

4.3.3.3 Tees

Tees for air valves shall be installed with branch barrels pointing vertically upwards. Tees for scour valves shall be installed with branch barrels pointing vertically downwards or at the gradients indicated on the drawings. Tees for off-takes shall be installed as shown on the drawings.

Field installation of the off-takes from the pipelines for air and scour valve connections or any other form of off-take shall not be permitted. All tees for these off-takes and connections shall be factory manufactured.

4.3.3.4 Flanges

All flanges shall be installed with bolt holes off-centre and symmetrically off-set from the vertical centre lines of the flange. Flanges shall be installed truly square to the axis of the pipe.

4.3.3.5 Insulated flanged joints

Insulated flange joints shall be provided and installed by the Contractor where specified or instructed by the Engineer. The Contractor shall supply all materials, labour and plant required and shall complete and prove that each insulated joint after installation in the pipeline has a resistance well in excess of the resistance to earth of the pipeline on both sides of the insulating joint.

4.3.3.6 Temporary closure pipes

Temporary closure pieces shall be of the same standard, diameter and wall thickness as the pipeline, except where otherwise specified or instructed by the Engineer.

4.3.3.7 Permanent closure pipes

Permanent closure pipes shall be provided and installed as pipe laying proceeds. They shall be either butt welded to adjacent pipes, or jointed to access pipes, fittings or specials by means of slip-on couplings.

4.3.4 Temporary sealing of pipeline

4.3.4.1 Night-caps

Metal night-caps shall be used to close off all ends of each laid section of pipework when work is stopped at the end of each day or for longer periods and shall be left on the ends of sections of completed pipework until such sections are tied-in with the remainder of the completed pipeline. The night-caps shall consist of

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a steel plate welded into a half slip-on coupling which shall be provided with a sufficient number of lugs to secure the ring and gasket and shall be strong enough to withstand external water and earth pressure in the event of flooding or collapse of earth. The joint shall be watertight.

The Contractor shall also, at his own expense, blank-off all air valve, scour valve and off-take tees with at least 6 mm thick blank flanges which shall be bolted with at least four bolts to tee flanges or shall be fixed to plain ended tee branches by using half couplings welded to the blank flanges. These shall be watertight and shall not be removed until the valves or other fittings are about to be fitted.

Notwithstanding the use of night-caps, the Contractor shall, at his own expense, make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter. The Contractor shall, at this own expense and to the satisfaction of the Engineer, clean the interior of the pipeline of such contaminants.

4.3.5 Prevention of flotation

Pipes to be encased in concrete shall be prevented from flotation during concreting operations. Apart from this special case during concreting operations, the Contractor shall prevent the flotation of pipe work due to storm runoff or groundwater entering the trench before backfilling has been completed.

Methods adopted to prevent flotation shall not damage coatings or linings and shall be approved by the Engineer. Notwithstanding this the Contractor shall at his own expense repair all damage to pipework caused by flotation and/or by the methods adopted to prevent it.

4.3.6 Installation of valves and meters

Unless otherwise specified or directed, gate valves shall be set upright and butterfly valves shall be set with the main shafts horizontal. All valves and meters shall be correctly set, supported, and placed in position as the work proceeds, and shall be properly jointed to their respective pipes.

All valves and fittings shall be left in working order and shall be housed in chambers as shown on the Drawings.

Valves, meter bodies and fittings shall be supplied, painted externally and internally. The Contractor shall thoroughly clean damaged exterior painted surfaces of all valves, meter bodies and fittings of all dirt, rust, grease and other foreign matter by methods approved by the Engineer and shall make good all damaged surfaces in accordance with the requirements of ZUT 0003.

Valves requiring special adjustment after installation such as self-closing valves shall be commissioned by representatives of the valve manufacturers. Similarly, meters shall be commissioned by the respective suppliers after installation by the Contractor.

All valves and meters supplied under separate contracts, which are defective due to circumstances outside the Contractor's control shall be repaired, replaced or modified by the valve suppliers who will also be responsible for commissioning the valves.

The mass of valves or water meters shall at no time be carried by the pipe, the flange or the coupling. Support stools shall be constructed as soon as practicable after the installation of valves and meters, and shall generally be constructed of steel, concrete or masonry work. Where fabricated steel stools are approved or specified they shall comply with the requirements of SANS 10044-3 and shall be fabricated to the Engineer's approval. Supports shall be welded to the pipe only where specified and linings of pipes and specials shall be made good after welding.

Hydrostatic testing of individual sections of the pipeline shall only be carried out when all scour valves, air valves and control valves have been installed, except where otherwise instructed by the Engineer in writing.

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Should line control valves or other equipment not be delivered timeously to enable the Contractor to lay continuously and to test the pipeline, the Engineer may order the Contractor to substitute specially made temporary flanged closure pieces. Such temporary closure pieces shall be supplied and installed by the Contractor to enable laying and testing to proceed. Subsequently after installation of the control valves, etc., they shall be removed and shall become the Contractor's property. These temporary closure pipes shall have the same face to face dimensions as the line control valves and shall be fitted with a suitably reinforced control diaphragm plate for sealing of the section of pipeline where it is fitted.

Wall thickness and diameter of the closure pipes shall be the same as the pipeline. A 100 mm nominal bore valve-controlled by-pass shall be fitted externally around the diaphragm plate.

4.3.7 Casings, anchor blocks and chambers

4.3.7.1 Concrete casing

Where the Engineer requires pipes to be encased in concrete, a strength 20 MPa/19 mm, or such other strength as is scheduled, shall be used. The work shall be done as follows:

a) Concrete casing shall be discontinuous at flexible couplings in the pipeline.

b) The pipe trench for the concrete encased pipeline shall be excavated to the depth below the bottom surface of the pipe, as ordered or shown on the drawings, and to sufficient width to allow for the concrete to be placed to the full specified width. The bottom of the trench shall be trimmed true to line and grade.

c) The in situ concrete bed 150 mm thick shall be cast and the pipeline laid thereon true to line and level leaving a gap nowhere less than 50 mm between the pipe and the bed.

d) After jointing the pipes shall be secured to steel loops left in the bed. Concrete shall then be punned under and around the pipes from one side only until the bottom quarter of circumference of the pipes is in contact with the concrete bed.

e) The pipe shall be tested in accordance with the applicable tests given in Clause 5, care being taken to ensure that the pipe do not move during testing.

f) After the pipeline has been tested, suitable formwork shall be erected and concrete carefully placed and vibrated in position up both sides of the pipe. The concrete level shall be raised equally on both sides of the pipe until encasement is complete and a cover over the surface of the pipe is provided that is nowhere less than that ordered or shown on the drawings.

g) No earth filling over the concrete shall be commenced until at least 7 days after the concrete has been placed.

4.3.7.2 Anchor blocks

At tees, bends, terminal valves, end caps and where otherwise directed, anchor/thrust blocks shall be constructed to dimensions ordered or shown on the Drawings. Unless otherwise specified or indicated on the Drawings, anchor/thrust blocks and pedestals shall be constructed of 20 MPa/19 mm concrete or such other class as is scheduled.

The concrete shall be well punned round the pipe and, if in trenches, against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces will not be permitted. Excess excavation shall be replaced with the prescribed mix concrete given above for anchor/thrust blocks at the Contractor’s expense unless an item is scheduled to cover payment for overbreak. Care shall be taken to leave the

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joints accessible. No anchor/thrust blocks and pedestals shall be concreted until the approval of the Engineer has been obtained.

4.3.7.3 Valve chambers

Valve chamber shall be constructed as indicated on the Drawings. Concrete chambers shall be constructed in accordance with the relevant clauses of SANS 1200 G or GA.

Lifting and relaying of existing pipes

4.3.8 Brickwork in chambers and manholes

Each chamber and manhole shall be built to the details shown on a particular drawing or as shown on the applicable type drawing. The walls shall be constructed in an approved bond comprising header and stretcher courses with the fair face on the inside. No false headers shall be built in and only whole bricks shall be used except where closures are required to form bond.

The bricks shall be well soaked in water immediately before being laid and the course of bricks last laid shall be well wetted before fresh bricks are laid upon it. All walls shall be carried up regularly so that no part of the walling is more than 1,3 m higher than any adjoining wall.

Joints shall be flushed up solid at every course throughout the whole width of each course, which shall be laid on a solid bed of mortar of thickness not exceeding 10 mm, and, when applicable, the joints shall be raked out as the works proceeds to form a key for plaster.

Mortar for brickwork and plasterwork shall be composed of one part of cement to three parts of sand. Sand shall be clean pit sand free from clay and other impurities and, if so directed, shall be properly screened and washed.

If required, step irons for a manhole shall be built into the straight of the wall at 300 mm intervals staggered right and left in vertical rows. Cast iron fittings shall be bitumen painted. Each cast iron cover and frame shall be grouted solidly onto the shaft. Concrete surrounds of each manhole shall be finished off to suit surrounding surfaces.

4.3.9 Lifting and relaying of existing pipes

Where shown on the drawings and where scheduled, existing pipes and fittings that are to be removed shall be lifted and the materials recovered as far as is practicable. The pipes and couplings shall be removed from the trench and placed in the Contractor's site store where they shall be cleaned, sorted, and listed. A copy of the list of undamaged material recovered shall be handed to the Engineer.

Unless, in terms of the contract, other pipes are to be laid in the same trench, each trench shall be backfilled as specified in SANS 1200 DB.

Where recovered pipes are scheduled to be relaid, rubber rings, insertion packings, damaged joints, and rusted bolts shall be replaced.

Before they are relaid, an acceptable number of pipes shall be tested for compliance with the requirements of the application specification for resistance to hydraulic pressure.

4.3.10 Disinfection of potable water pipelines

After completion of the laying and testing, each potable water pipeline shall be disinfected. The Contractor will be required to submit a detailed method statement for approval by the Engineer. A minimum requirement will be that the method statement deals with the method of dosing and how the dosing rate will

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be controlled to ensure a uniform distribution throughout the pipeline to be disinfected, the chemicals to be used, the anticipated range of dosing rates and equipment to be used, and the name and qualification the Contractor's person supervising the disinfection.

Once a successful hydraulic test of the entire pipeline has been achieved and the connections have been completed, the pipeline shall be drained. The pipeline shall then be re-charged in accordance with Clause 5.1.3.5 “Initial Filling of the Pipeline”. Whilst being charged, a sodium hypochlorite solution shall be introduced into the pipeline in such a manner as to ensure that a theoretical total chlorine concentration of at least 25 ppm (mg/l) is achieved throughout the pipeline.

Once the entire pipeline has been filled in this manner, it shall be left for a 24-hour period. Thereafter, total chlorine concentrations shall be measured at each scour and off-take point. A concentration of 20 ppm total chlorine will be considered acceptable. Should this concentration not be achieved at all scours and off-takes, the Contractor shall take all steps considered necessary by the Engineer to achieve satisfactory disinfection, at his/her own cost.

Once satisfactory disinfection has been achieved, the pipeline shall be drained via the scour valves (or by other means approved by the Engineer) and sufficient sodium thiosulphate (typically 1 part of total chlorine) shall be dosed into the scour-wet wells to fully neutralise the chlorine before discharging to watercourses.

The pipeline shall then be re-charged in accordance with the stated procedure and, after 24 hours, samples will be taken by the Engineer for analysis (at no cost to the Contractor). Should the following limits not be achieved, the Contractor shall carry out at his/her own cost, all steps deemed necessary by the Engineer to achieve satisfactory disinfection:

a) E.coli: Count = 0

b) Coliforms: Count = 0

c) Faecal Streptocci: Count = 0

d) In addition to a), b) and c), the water quality shall meet the requirements for potable water of the local authority or of the authority supplying such water to the area.

4.3.11 Corrosion protection

4.3.11.1 Final painting

After successful hydrostatic testing of the pipeline, and after completion of all construction work under this Contract, all external surfaces of uncoated steelwork and surfaces of all valves and fittings shall be prepared and painted as specified in the relevant clauses of Specification ZUT 0003. In addition, all surfaces of materials which had received first coats of paint in the course of the Contract in accordance with the specifications shall receive final coats of paint of the same colour or such other colours as may be specified or instructed by the Engineer.

All paint used shall be out of the original containers of the manufacturer and such containers are to be brought onto the site unopened. No adulteration will be permitted and paints shall be used strictly in accordance with the manufacturer's instructions.

Painting shall not be done in wet or humid weather.

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4.3.11.2 Butt-welded steel pipes

As soon as practicable, but not more than 24 h after the welding of joints in the field has been approved and accepted by the Engineer, the internal lining of pipes and specials shall be made evenly continuous over the joints.

Materials for this work shall have the same properties as those used respectively for the adjacent lining or coating and shall be so applied that the finished work over the joint shall have the same quality as specified respectively for the adjacent lining or coating and shall be capable of passing the same tests as specified for adjacent lining or coating.

4.3.11.3 Metal couplings

In addition, all buried metal couplings and all metal couplings located inside chambers, shall be protected with "Denso" petrolatum as per the requirements of Specification ZUT 0003.

5. COMPLIANCE WITH REQUIREMENTS

5.1 TESTING

5.1.1 General

Testing shall be in accordance with this clause and Specifications ZUT 0003, 7001 and 7002, as relevant.

As the work proceeds, pipelines shall be hydrostatically tested by means of test equipment supplied by the Contractor.

Each test shall be carried out in the presence of the Engineer or his representative. The Contractor shall be responsible for carrying out all tests and for all expenses incurred.

When carrying out the hydrostatic tests, the Contractor shall ensure that all valves, tees, and bends are properly secured and shored to prevent movement of pipes and fittings and, should any such movement occur, the Contractor shall, at his own expense, reposition and, if necessary, repair the pipes and fittings and the securing means.

Until each section of the pipeline has been subjected to the hydrostatic test and has complied with the applicable requirement for leakage rate, the pipeline will not be accepted. The hydrostatic test shall be repeated until the Engineer is satisfied that the section under test complies with the said requirement.

5.1.2 Testing of field welds

5.1.2.1 Destruction tests

Tests as specified in API 1104 Clause 6.5 shall be carried out and approved prior to any field welding being done.

5.1.2.2 Radiographic testing

Radiographic tests and adjudication of test records shall be carried out by an Independent Inspectorate, appointed by the Engineer to act on his behalf. The Inspectorate shall be afforded every facility during the course of pipeline construction and testing to enable the inspection to be carried out effectively. 10% of the total length of all manual field butt welds and 2,5% of the total length of field welds done by an approved automatic process shall be examined radiographically with particular reference to weld intersections, using

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equipment supplied and staffed by the Inspectorate. All welds on critical sections such as river, rail and road crossings shall be 100% radiographically tested.

The Engineer reserves the right to increase the length of welds to be radiographed if results obtained are not satisfactory or to reduce the length of welds radiographed to a minimum of 4% if the standard of welding is sufficiently high to warrant such a reduction.

The Inspectorate shall process and adjudicate radiographs on site. The standard of acceptability shall be in accordance with API 1104. All welds which are found to be unsatisfactory shall be repaired and 100% re-radiographed at the Contractor's expense. The additional radiography of repaired welds shall not be deemed to be included in the overall 10% or 2,5% radiography.

Field welds may be examined by radiographic inspection as stated in API 1104. Should two or more welders participate in making the weld, the welding foreman and the Engineer's Representative shall decide which welder is responsible for the defective work. The Engineer shall be privileged in the judgement of his inspector to cut out welds for further tests. The test welds (except the initial free test referred to in 5.1.2.1) that meet the Engineer's requirements and specifications when properly tested shall be replaced with a satisfactory tie-in at the Employer's expense. Should any test weld cut from the line prove unsatisfactory to the Engineer when properly tested, it shall be replaced at the Contractor's expense. Test welds shall be cut from the line as soon as practicable after completion to avoid unnecessary delay and expense, and shall consist of an annular ring not less than 230 mm long with the weld in the middle.

When welding the line together at places where the test welds have been cut out, one weld will be used if it is practicable to pull the line back into position; otherwise, two welds will be made by setting in a short length of pipe with a minimum length of 750 mm.

The Contractor shall furnish approved types of machines for testing. A record of the results of each test weld shall be made by the Engineer's inspector and jointly signed by the Engineer's Representative and Contractor's Representative. The Contractor will be reimbursed for extra welds at the rates tendered if scheduled in the Contract as a separate item. Extra welds shall be construed to mean those welds cut out at the Engineer's request which, after specified tests, are found to meet the Engineer's specifications, except those free initial test welds referred to herein.

Claims arising from delays in construction caused by justifiable additional radiography which may be ordered by the Engineer or re-radiography of repairs, will not be considered.

5.1.2.3 Dye-penetrant testings

A 100% dye penetrant test shall be carried out by the Contractor on all field welds except where radiographic testing is undertaken.

The dye-penetrant test shall be carried out in accordance with BS 4416 and as detailed below:

a) The Contractor shall obtain the approval of the Engineer for the group of dye-penetrant and developer that he proposes to use for the test;

b) As pipe laying progresses, field welds shall be subjected to the test soon after each weld is completed;

c) In order to obtain a surface that is dry, clean and free from scale, dirt and grease, the Contractor may grind but he shall not grit blast the surface;

d) The temperature of the surface to which the developer and the penetrant are applied shall not be below 16˚C or above 52˚C;

e) Observations for indications shall be made not less than 15 minutes and not more than 60 minutes after the application of the penetrant;

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f) Any surfaces on which non-relevant indications are observed shall be explored by visual methods and, if considered necessary by the Engineer, such surfaces shall be cleaned and retested; and

g) Welds that show no relevant trace of dye on the developer will be accepted.

5.1.2.4 Visual testing

All field welds shall be inspected visually throughout their entire length by the Contractor for signs of possible faults. Full records of the testing of each joint shall be kept by the Contractor and his findings reported to the Engineer. The Contractor shall allow the Engineer and/or the Inspectorate to also inspect up to 10% of the number of field welds visually.

5.1.2.5 Testing of fillet welds

In addition to the dye penetrant tests, each fillet weld on pipes of DN 600 and over shall be air and bubble tested by pumping air into the annular space between the welds to a pressure of at least double the specified working pressure. While this pressure is maintained, all welds and connections shall be tested with soap or primer. Defects found during testing shall be repaired by the Contractor, and testing continued all at the Contractor's expense until a satisfactory result is obtained.

The test tapping point shall then be plugged in an approved manner.

5.1.2.6 General

The pipeline shall be hydrostatically tested on completion of pipe laying and after installation of all valves and fittings. Test sections shall be blanked off by making use of end-caps. Installed isolating valves within the test section shall not be used as end-caps.

The Contractor shall submit to the Engineer a detailed method statement describing the timing, methodology and scheduling of each hydrostatic pressure test to be undertaken. No test shall proceed before approval of such method statement by the Engineer.

If sections of a pipeline are encased in concrete, or where concrete anchor blocks or other structural concrete structures had been provided, the Contractor shall allow for a minimum concrete setting period of 28 days prior to the hydrostatic test being executed.

The Contractor shall supply water from an approved source for hydraulic testing of the pipeline. Pipelines designed for potable use shall be hydraulically tested and disinfected using potable water. Water used for one filling of the pipeline for hydraulic testing, one filling for disinfection and one filling after draining the disinfection water will be provided by the Employer to the Contractor, free of charge, at the connection points stated in the project specifications. Items have been provided in the Bill of Quantities to cover the cost of receiving and conveying water from the supply point to the test section of pipeline. Additional water supplied by the Employer owing to unsuccessful disinfection and/or hydraulic testing will be charged to the Contractor.

5.1.2.7 Test pressure and time of test

After the pipe trench has been backfilled the pipeline shall be tested in sections between end caps, blank flanges, or other isolating devices, at the pressures appropriate to the pipeline section under test. The Engineer may require that blank flanges or “spades” be inserted and that the pipeline be tested in reduced lengths and, in addition, at the point of maximum pressure.

Unless otherwise specified, shown on the drawings, or approved by the Engineer, the average test pressure for field testing shall be 1,25 times the pressure rating of the pipe.

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Where the pipeline is tested in sections, the Contractor will have the discretion to determine the sections in which the pipeline may be tested provided that:

a) The test sections shall be determined, taking any differences in elevation along the pipeline into account, such that the:
    i) maximum field test pressure at any point along the section is not higher than 1,5 times the pressure rating of the pipe or the maximum field test pressure permitted by the pipe manufacturer; and
    ii) minimum field test pressure at any point along the section is not less than the greater of:
        1) the pressure rating of the pipe, or
        2) 1,25 times the maximum working pressure at these points.

b) The first km (+200m,-100m) of pipeline laid is successfully tested before the subsequent section may proceed.

c) The Contractor shall make due allowance in the construction programme and in the tendered rates for the entire testing operation including for the provision of temporary end stops (flanges or bullnoses) and any other costs associated with testing the pipeline in intermediate sections.

Once filled, the pipe shall be left for 24 hours to permit maximum saturation. The section to be tested shall then be pressurised to the specified pressure and left for a further 24 hours, during which period, the pressure drop (if any) and the quantity of water required to be pumped in to restore the test pressure shall be measured and recorded. In addition, all flexible and flanged joints shall be visually inspected and there shall be no sign of leakage.

At all times when there is water in the pipeline, and particularly during filling, testing and draining of the pipeline, all air valves shall be in operation and their individually isolating valves shall be open.

5.1.2.8 Visible leaks

a) Except as allowed in b) the specified test pressure shall be maintained for a period of at least 24 hours (or such longer period as is necessary for inspection of the pipeline) during which period all pipes, pipe specials, joints, and fittings shall be carefully inspected for leaks. All visible leaks shall be made good and any pipe, pipe special, or fitting found to be defective shall be removed and replaced at the expense of the Contractor and such replacement material shall, after installation, be tested at the expense of the Contractor.

b) In the case of pipes of DN 400 and under, the test period may be reduced proportionally to the nominal diameter of the pipe, provided that in no case shall the test period be less than 1 hour.

5.1.2.9 Permissible leakage rates

The test pressure shall be maintained for a further period of 1 hour after the completion of the test period specified in Clause 5.1.3.3, during which time the volume of water required to be pumped into the pipeline for maintenance of the pressure shall be measured.

The permissible leakage for welded and flanged steel pipelines is zero (0) litres.

5.1.2.10 Initial filling of pipeline

The entire process for filling the pipeline at any time during testing or disinfection shall be carried out under the supervision of the Engineer. Under no circumstances will the Contractor be allowed to carry out filling

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of the pipeline without the supervision of the Engineer, neither shall the Contractor permit any other persons to carry out such filling without the written permission of the Engineer.

Unless otherwise specified or approved in writing by the Engineer, filling of the pipeline for hydraulic testing shall be carried out at a velocity in the main pipeline not exceeding 0.5 m/s.

Any damage to the pipeline caused by non-compliance with this clause shall be rectified at the Contractor's expense.

5.1.2.11 Connections after testing

The connections of the new pipework to the existing pipework shall only be carried out after the pipeline testing has been completed and accepted by the Engineer. For this reason, testing must be carried out against a blank flange or bullnose end cap at these locations.

5.1.2.12 Remedial measures

In the event that a pipe section fails a test, the Contractor shall carry out all remedial measures necessary to obtain a successful test of each individual section and the entire pipeline, at his/her own expense. Such remedial measures shall in no way compromise the requirements stipulated in the specifications.

5.1.2.13 Draining of the pipeline

The pipeline may have to be drained to carry out remedial measures and it must be drained before the disinfection process commences. The pipeline shall be drained via the scour valves in a manner that does not cause erosion of the streambeds or negatively impact on the environment in any way. All such drainage of the pipeline shall be carried out under the supervision of the Engineer.

5.1.3 Commissioning

The pipeline will be considered to have been commissioned and practically complete once all the associated structures are sufficiently complete to carry out their structural and hydraulic function and the hydraulic test and disinfection of the entire pipeline has been successfully completed.

5.1.4 Water tightness testing for chambers

Refer to the SANS 1200 G or 1200 GA, as applicable.

5.1.5 Tests on epoxy linings

Once all work in the pipeline has been completed bar the hydrostatic testing and backfilling, the pipeline shall be cleaned by sweeping with a soft broom and rinsing. Access to this section shall be restricted from this point forward and will only be allowed on the written consent of the Engineer.

Holiday detection testing is to be undertaken by the Contractor on the lining in order to ensure that it remained intact during the transport, handling, placing and backfilling processes. Holiday testing may also be undertaken by the Independent Inspectorate. The testing and repair procedures shall be in accordance with the requirements stipulated in Specification ZUT 0003.

5.1.6 Pipe coating integrity surveys

The Contractor shall perform the pipe coating integrity survey as defined in the cathodic protection specifications.

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5.2 TOLERANCES

5.2.1 General

No deviation will be permitted from the minimum pipe cover specified or shown on the Drawings.

5.2.2 Control points

For the purposes of this Clause, valves and pipe specials set on the centre line of the pipeline and designated changes in gradient shall be regarded as control points and shall be located with a permissible vertical deviation of ± 100 mm on the centre line. The same deviation will be permissible laterally except where the pipeline is laid at a designated distance from a fence line, kerb line, or boundary, in which case the permissible deviation shall be ± 20 mm.

Unless otherwise directed and subject to a permissible deviation (measured along the centre line) of ± 2 m, scour valves shall be located at the lowest points in pipelines and air valves at the highest points.

5.2.3 Alignment

PLAN (horizontal alignment): Unless otherwise directed, the permissible deviation from the defined alignment of the pipeline, when measured on the top centre of the pipeline, shall be ± 100 mm or ± 10% of the nominal diameter of the pipe, whichever is the larger, and the permissible deviation per pipe length shall be ± 20 mm.

LEVEL (vertical alignment): The permissible deviation from the designated level at any point on the invert of the pipeline shall be ± 50 mm or ± 10% of the nominal diameter of the pipe, whichever is the larger.

5.2.4 Manholes, valve chambers, etc.

Manholes, valve chambers and the like shall be constructed centrally on the control points and, with the exception of tolerances that affect access to bolts, nuts, etc., with a permissible deviation of ± 50mm on all clearance dimensions. The clearance dimension between the outside of each nut and bolt-head and the inside face of the wall of a structure or any other fitting shall be at least the specified value.

6. TOLERANCES

Refer to Clauses 4 and 5.

7. TESTING

Refer to Clause 5.

8. MEASUREMENT AND PAYMENT

8.1 BASIC PRINCIPLES

8.1.1 General

Excavation and backfilling of trenches, and laying of medium-pressure pipelines, will be measured separately under SANS 1200 DB and Clause 8.2 of this Specification.

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8.1.2 Night-caps

No extra payment will be made for night-caps. The supply and use of night-caps will be held to be included in the unit rate tendered for pipe laying.

8.1.3 Permanent closure pipes

8.1.3.1 Butt welding

Where closures are butt welded to other pipes, the cost of cutting the pipe, preparing the end for welding and welding as specified in SANS 719, repairing the lining and coating as specified in Specification ZUT 0003 will be held to be included in the unit rate for laying of pipes.

8.1.3.2 Slip-on couplings

Where closures are jointed to either access pipes, fittings or specials by means of slip-on couplings, no additional payment will be made for extra cutting of the pipe, preparing the end for welding, welding on the loose collar (approved 150 x 20 mm mild steel, machined round to suit coupling) or making good the lining.

Unless separately billed, the supply, transport and handling of the collar and slip-on coupling will be held to be included in the unit rate for the supply of pipes, fittings and specials.

8.1.4 Extra welds

Payment for all extra welds shall be covered by variation orders showing the location of the welds according to stake value and other necessary details. Such variation orders shall be signed by the Engineer's Representative and the Contractor's Representative in the field on the day the work is done. No payment will be made for test welds not covered by variation orders as stated above.

8.2 BILLED ITEMS

8.2.1 Lay and bed steel pipes and specials complete with couplings

a)	Pipes	Unit:	metre (m)
b)	Specials	Unit:	number (No.)

Pipes will be measured linearly as laid in the trench. No deduction will be made for specials and valves. Separate payment will be made for each type, size and class of pipe laid.

Specials will be measured separately by number of each type.

The unit rates tendered in the Bill of Quantities for laying of pipes and specials shall cover the cost of the following:

a) Inspecting, accepting, taking delivery, providing storage, taking delivery from storage on site, transporting, handling, inspecting, stringing alongside trench, forming joint (“fox”) holes, laying, jointing, cutting, scarfing, cutting mitre deflections up to 10 degrees (5 degrees per side), bevelling, maintaining line and level, jacking for ovality if necessary, provision and use of shield for heat treatment and welding if required;

b) maintenance of cleanliness including all night caps and temporary blank flanges, etc., necessary to keep the inside of the pipe dry;

c) removal, where necessary, and making good of lining and coating over the joints;

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d) radiographic examination of field welds and holiday testing of the lining, visual and dye penetrant testing;

e) testing of welders and issuing of the necessary certificates;

f) making good all linings and coatings;

g) hydrostatic testing, testing equipment and anything required to do this work, including temporary end caps and blank flanges;

h) sterilizing the pipeline where used for potable water;

i) bolts, nuts, washers, gaskets and insulating material;

j) supply and installation of steel and or concrete pipe supports (not necessarily shown on drawings);

k) building in of specials (Refer to Item 8.2.11)

No extra payment over and above the rates tendered in the Bill of Quantities will be made in respect of additional cutting and jointing of pipes required to locate valves, specials, etc., exactly.

No separate payment will be made for the supply and fitting, chipping of lining, cutting, trimming, bevelling and making good on Site of any additional couplings and jointing materials which may be required for the connection of shortened pipe closures, unless specific provision is made in the Bill of Quantities.

The unit rate tendered for laying of steel pipes and specials shall cover the cost of the laying, jointing, etc., as specified and, in addition, for final painting and surface preparation when applicable. No extra-over payment shall be made for protecting metal couplings with petrolatum wrappings as per Specification ZUT 0003.

Notwithstanding the use of night-caps the Contractor shall at his own expense make good all damage to pipe linings and fittings caused by the ingress of dirty water, silt, sand, debris, vermin, insects and other foreign matter. The Contractor shall at his own expense and to the satisfaction of the Engineer clean the interior of the pipeline of such contaminants.

A maximum payment of 85 % of the tendered rate may be made for the completed section of pipeline which has not yet been hydraulically pressure tested and disinfected. A further payment of 10% of the tendered rate will be made upon successful completion of the pressure testing for the relevant section of pipeline. The final 5% of the tendered rate will be made upon completion of disinfection of the pipeline.

8.2.2 Extra-over for mitre deflections

Unit: number (No.)

Where additional mitre deflections (up to 10 degrees) are ordered by the Engineer, these will be measured by number.

The rate shall cover the all the costs associated with mitre deflections detailed in Item 8.2.1 (a) to (f).

8.2.3 Installation of valves and meters

Unit: number (No.)

The unit rate for installation of valves and meters shall cover the cost of taking delivery of these items from storage on site, inspecting each item for visible signs of damage, transporting to the laying site, off-loading, installing and, except where separately billed, of testing and commissioning of the valves and meters in position in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.

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No extra payment over and above the rate will be made in respect of any additional cutting, turning and jointing of pipes required for the location of a valve, meter, etc. where a precise position is given on the drawings.

The tendered rate shall also cover all jointing materials and, except where separately billed, support pedestals. The rate tendered for installation of valves and meters shall also include the cost of necessary oiling and greasing of moving parts and for minor routine initial maintenance work such as tightening up leaking glands.

The unit rates shall include for the cost of making good and the repair of paintwork and final painting as specified.

8.2.4 Recover old pipeline

Unit: metre (m)

The total length of the pipeline ordered to be recovered will be measured by length for each stated depth range. No deductions will be made for valves, specials, and the like.

The rate shall cover the cost of the excavation and removal of pipes, valves, and fittings from the trench, the handling and transportation to the Contractor's store on site, the cleaning and listing of the salvaged recovered materials, and the backfilling of the trench.

8.2.5 Test and relay recovered pipe

8.2.5.1 Test recovered pipes on site before relaying

Unit: number (No.)

The rate shall cover the cost of the provision of suitable testing equipment and the carrying out of the specified test.

8.2.5.2 Relay pipeline

Unit: metre (m)

The rate shall cover the cost of transporting, handling, laying, and bedding, as well as the provision of new rubber rings or insertions, as the case may be. Couplings and bolts that have to be replaced will be paid for at daywork rates unless a suitable item such as 8.2.4.3 below has been provided in the Bill or, in the opinion of the Engineer, the need for their replacement arose from the fault or negligence of the Contractor.

8.2.5.3 Joints and couplings for recovered pipeline (Provisional)

Unit: number (No.)

The rate shall cover the provision of complete sets, each comprising a new rubber ring or insertion, as the case may be, as well as all elements of the coupling and bolts that need replacement.

8.2.6 Anchor/thrust blocks

a) Dimensions stated or given on drawing – Unit: No. or Sum

OR

b) Where, at the tender stage, no detailed drawings or dimensions are given or where only typical drawings are given:

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Concrete – Unit: m^3

Formwork – Unit: m^2

Reinforcement – Unit: ton

Except where measured by number or sum, anchor/thrust blocks will be measured as the volume of concrete, areas of formwork, and mass of reinforcement, as relevant, placed to dimensions ordered or given on the drawings and schedules of reinforcement. The relevant terms of Clause 8 of SANS 1200 G or SANS 1200 GA, as applicable, shall apply.

Where measured by number or sum, the rate or sum shall cover the cost of excavation and trimming, formwork, reinforcement (if any), and screeding of top surfaces.

8.2.7 Concrete casing

Unit: m^3

The concrete will be measured net by volume to the specified width and depth in excess of the external volume of the pipe (i.e. the volume of the pipe will be deducted).

The rate shall cover the cost of formwork (including stop ends at flexible joints), reinforcement (if any) and concrete.

8.2.8 Valve chambers

Unit: number (No.)

Valve chambers will be measured as complete units.

The rate shall cover additional excavation (see Subclauses 8.2.2 and 8.2.3 of SANS 1200 DB), materials, plant, and labour necessary for the complete construction including the installation of covers, ladders and ancillaries shown on the drawing.

8.2.9 Manholes

Unit: number (No.)

Manholes will be measured as complete units for which separate items will be scheduled for each type of manhole and depth categories.

The rate shall cover additional excavation, materials, plant, and labour necessary for the complete construction including the installation of the covers, ladders and ancillaries shown on the drawing.

8.2.10 Temporary closure pipes (Provisional)

Unit : number (No.)

Temporary closure pipes will be measured as provisional items by number only where ordered by the Engineer.

The unit rate shall cover the cost of the supply, installation, removal and making good of the pipe.

Excavation, backfilling and supply of bedding material will be measured and paid for separately as specified in SANS 1200 DB and SANS 1200 LB.

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8.2.11 Items cast or built into concrete

Unit: number (No.)

The building in (or casting into concrete) of the pipes and pipe specials will be measured by the number of each item built in.

The unit rate shall cover the installation of the pipe or pipe special as well as all additional costs of formwork, concreting and fixing of pipes and specials which are not covered by the normal tendered rates for formwork and concrete.

8.2.12 Pipe lining integrity tests

Unit: lump sum (Sum) or metre (m)

Payment for tests on linings will include for all labour, the cost of supplying fuel and production related wearing parts (bucket teeth, cutters etc) for equipment utilised, and materials to perform all tests and repair work as defined in Specification ZUT 0003. Payment for the pipeline section tested and repaired will be certified for payment only on written acceptance of successful testing and repair work as defined in Clause 5.1.6.

8.2.13 Concrete/steel valve and pipe supports

Unit: number (No.)

Except where billed separately, payment for the supply and installation of concrete or steel supports to valves, meters, pipe specials, etc. shall be included in the rates tendered for the installation of these items.

Where billed separately, the rate for supports shall cover all material, plant and labour required for the supply and installation of the support, including all anchor bolts and jointing material. In the case of steel supports, the cost of the corrosion protection shall be included in the rate tendered for the support.

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Annexures

APPENDIX A : APPLICABLE STANDARDS

API 1104	:	Standard for welding of pipe lines and related facilities.
SANS 719	:	Electric welded low carbon steel pipes for aqueous fluids (Ordinary duty)
SANS 10044-3	:	The fusion welding of steel (including stainless steel): Tests for approval of welding procedures and production welds.
SANS 1200 G	:	Concrete (structural)
SANS 1200 GA	:	Concrete (small works)
SANS 1200 L	:	Medium-pressure pipelines
SAECC/1		
Specification ZUT 7002	:	Manufacture of medium-pressure steel pipes
Specification ZUT 7001	:	Design and manufacture of medium-pressure steel specials
Specification ZUT 0003	:	General corrosion protection for pipelines, water and wastewater works

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SPECIFICATION: ZUT 7004

Valves for Water and Wastewater Installations

SPECIFICATION ZUT 7004

Valves for Water and Wastewater Installations

AMENDMENTS

There are no amendments applicable to this Specification.

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SPECIFICATION ZUT 7004

Valves for Water and Wastewater Installations

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1. SCOPE

ZUTf 7004 deals with the design, manufacture, installation and commissioning of all valves and ancillaries for the control of raw water or sewage. It furthermore covers the flange machining standards, dimensions, the range and type of gaskets, corrosion protection and jointing to be used for flange joints.

The installation shall be as shown on any applicable drawings provided with the tender documents.

The scope of work for which the Contractor is responsible is specified elsewhere.

2. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

a) Amendments to this Specification.

b) SANS 936/937, SANS 191, SANS 664 and SANS 1123

c) ZUT 0001: General Mechanical Requirements.

d) ZUT 0002: Operating and Maintenance Manual

e) ZUT 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

f) ZUT 7010: Knife gate Valves.

g) ZUT 7011: Ball Check Valves.

h) ZUT 7016: Resilient Seal Gate Valves.

i) ZUT 7017: Single Door Check Valves.

j) ZUT 7022: Air Release Valves.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

3. DEFINITIONS

For the purpose of this Section the following definitions apply:

a) **"Face to face dimension"** means the distance between the two planes perpendicular to the body axis located at the extremities of the body and ports.

b) **"Nominal pressure (PN)"** is a numerical designation, which is a convenient round number for reference purposes. It is designated by PN followed by the maximum allowable working pressure, of which the flange is intended to be a component, will be subjected under normal working conditions. This definition is in accordance with ISO 7268. All pressure units throughout this specification will be recorded in kilopascals (kPa).

c) **"Nominal size (DN)"** is a numerical designation of size that is common to all components in a piping system other than components designated by outside diameters. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions in millimetres. Nominal size is designated by DN followed by the size in millimetres. This definition is in accordance with ISO 6708.

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d) **"Tight shut off valve"** means a valve that has no leakage past the sealing faces in its closed position under test conditions.

e) **"Low leakage rated valve"** means a valve that has an agreed maximum leakage rate past the sealing faces when the valve is in the closed position.

f) **"Regulating valve"** means a valve intended for regulating pressure and flow, and which may have a clearance between the sealing faces when the valve is in the closed position.

g) **"Pressure rating"** is the maximum allowable working pressure of an installation of which the flange is intended to be a component.

4. MATERIAL SYMBOLS

Where appropriate the following abbreviations shall refer to the material designated:

- austenitic cast iron AI
- spheroidal graphite cast iron SG
- gunmetal GM
- aluminium bronze AB
- phosphor bronze PB
- mild (carbon) steel MS
- stainless steel SS
- nickel copper NC
- integral seat IS
- resilient seat RS
- weld deposited seat WDS
- cast steel CS
- polyterafluoroethylene PTFE

5. GENERAL DESIGN REQUIREMENTS

5.1 PRECEDENCE

The Project Specification has precedence over this Particular Specification. Any conflict between the technical requirements stated in the Project Specification and the technical requirements of this Specification shall be referred to the Engineer for clarification.

5.2 DEVIATIONS

The Client will not permit any substitution or deviation from the requirements of this Specification without prior approval. Any substitution or deviation from the original Specification shall be submitted to the Engineer for approval. Deviation shall only be considered during the tender stage of the project.

5.3 OPERATING CONDITIONS AND CLIMATE

Valves selected for this Contract shall be designed for various hydraulic conditions and be capable of opening and closing under these conditions. Valves shall be suitable of operating at water temperatures up to 50 °C and the quality of the water shall be assumed to be highly corrosive.

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5.4 NOMINAL PRESSURE

Each valve is assigned a nominal pressure (PN) in kPa and shall be tested in accordance with this specified pressure.

5.5 MINIMUM PRESSURE RATING

1000 kPa is considered to be the lowest acceptable pressure rating for any valve and associated equipment irrespective of lower system pressures.

5.6 DESIGN LIFE

All valves and appurtenant fittings shall be designed for a useful life of forty-five (45) years under the operating conditions specified in the Project Specification. The manufacturer would be prepared to guarantee its satisfactory performance for 5 years, if called upon to do so.

5.7 GUARANTEE

All valves shall be guaranteed against faulty design, materials and workmanship for a period of 5 years, from date of issue of the Taking Over Certificate and shall terminate with the issue of the Performance Certificate by the Engineer.

During this period the Contractor shall attend to and rectify at his own cost any defects that can be attributed to faulty design, materials and workmanship. Normal wear and tear, especially applicable to rim seal butterfly valves, but not to vulcanised rubber-lined butterfly valves, shall be excluded.

In order to avoid expiry of the guarantee while these valves are still in storage prior to installation, the Client will request the reinstatement of the guarantee at final commissioning of the Plant.

To promote reinstatement, the Contractor shall, provide the requirements for storage of the valves, prior to installation, in order for him to honour the implementation of the guarantee at a later stage. The Contractor shall inspect and approve the storage area prior to delivery of the valves.

5.8 END CONNECTIONS

All valves shall be double flanged or double spigoted or double socketed end connections as specified in the schedules.

All holes of double flanged valves shall be drilled perpendicular to the face. Cast flanges shall either be machined or spot faced on the bolt head/nut bearing faces.

Sufficient clearance shall be allowed between the body and flange to enable flange bolts to be removed or tightened. Tapped holes shall be permissible only where stiffening ribs or shaft bosses interfere with bolts.

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Flanges shall conform to SANS 1123. Flanges shall be thickened at points where tapped holes are necessary. Flanges shall have raised joint faces machined in accordance with the above standard and fitted with ring gaskets.

5.9 FASTENERS AND JOINTING MATERIAL

Valves shall be supplied complete with bolt units, consisting of a standard length bolt, nut and two washers. The stud unit, where applicable, shall be supplied with a standard length stud, nut and washer. Washers shall be fitted under all bolt/screw heads and nuts.

The manufacturer shall specify a fastening sequence for bolts (if applicable) and the torque settings (in Nm) for all bolts. These torque settings and fastening sequences shall be included in the Operation and Maintenance Manual.

In addition each valve shall be supplied with 3mm non-asbestos type gaskets or insulating gaskets complete with explosion-proof spark gap arrestors as indicated on the drawings.

Depending on the valve location in a piping system and the atmospheric conditions, the following specifications will apply:

- Black bolted units: SANS 1700
- Precision bolted units: SANS 136
- Galvanised bolted units: SANS 121 (ISO 1461)
- Stainless steel bolted units: DIN 931 complete with insulating kit (on all stainless steel and 3CR12 piping and specials and where specified).
- Stainless steel set screws: DIN 933

Where shown on the Drawings flange insulating kits shall be supplied with the correct size bolts and nuts together with two insulating washers, and insulating sleeve for each bolt. All insulating gaskets shall be of the full-face type as to prevent foreign material from collecting and creating a bridge, thus shorting out the isolation.

For all valve components, i.e. bonnet covers, glands etc., drilled holes for bolts shall be perpendicular to the flange face.

All bolts and stud units shall be the same length, appropriately sized and where applicable be corrosion protected.

5.10 VALVE SUPPORTS AND LIFTING LUGS

Valves of DN400 and larger shall have supports integrally cast with the valve body. These supports shall be designed for direct grouting or bolting to the plinths where required.

Valves over DN300 or 75 kg mass shall either have two removable eye bolts of the required strength securely attached to the valve body or lifting eyes forming an integral part of the valve body to facilitate easy handling during transport and installation.

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6. CONSTRUCTION

6.1 BODIES

Bodies shall be of sturdy construction, capable of functioning satisfactorily under abnormal operating conditions without distortion of the body or malfunction of component parts and shall be shaped to give minimum change in waterway.

Designs of bodies and components shall be free of pockets that cause eddies or accumulate debris.

Where applicable, access openings and covers shall be well designed and the creation of stress risers shall be prevented. Any gussets applicable to the design of the valve should form an integral part of the casting.

6.2 DOORS AND DISCS

Doors and discs shall, were applicable, be cast or fabricated as a unit with integrally cast hinge lugs.

Doors and discs shall operate freely. Their travel shall however be restricted by the provision of substantial stops, fitted with specified facings to minimize wear and damage to the corrosion protection.

6.3 SEALING FACES

Sealing faces shall be either replaceable stainless rings securely fixed with stainless steel fasteners or stainless steel deposit welded as specified in the Project Specification.

Faces shall be accurately machined and micro finished promoting seal life.

6.4 BEARINGS

Main bearings shall, were applicable, be external and accessible without emptying or removal of the valve body from the line.

Bearings shall be designed to take any unbalanced thrusts on doors or discs.

Bearings shall retain a low co-efficient of friction. Any possibility of bearings becoming tight during service due to ageing shall be eliminated.

Where possible, bearings shall be water lubricated with a proven record of reliable operation of not less than five (5) years.

Details of the type and construction of bearings shall be as specified in the relevant Valve Specification.

Where shafts protrude through the valve at the non-drive end (NDE) they shall be sealed with bolted stainless steel, grade 316, bearing cover plates. Screwed taper plug covers are not acceptable.

Sleeve type bearings shall be fully corrosion resistant and shall be fitted in the hubs in the valve body. Steel back bearings shall not be accepted.

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6.5 BEARING AND SHAFT SEALS

Bearing and shaft seals shall be of the "O" ring or radial cup type with machined weep holes or grooves for drainage at the gearbox mounting flange.

6.6 HAND WHEELS

All manually operated valves shall be supplied complete with cast hand wheels of sturdy construction, which shall have the wording, “OPEN” and “CLOSE” together with directional arrows legibly cast in recesses on the upper surface of the rim.

Closure of valves shall be through the clock-wise rotation of hand wheels. Valves shall be capable of being opened or closed under an unbalanced pressure equal to the Nominal Pressure. The effort required on hand wheels to open or close valves under these conditions shall not exceed the following:

VALVE SIZE	SEATING/UNSEATING	INTERMITTENT
Up to and including DN300	500 N	180 N
Above DN300	600 N	220 N

Hand wheels shall be manufactured to ensure a close fit between the hand wheel and the mating spindle head and shall be firmly fixed to the spindle head. Loose fitting hand wheels are not acceptable. Shear pins or torque clutches shall be fitted to prevent damage. Hand wheel diameters shall not exceed the dimensions as shown in the table below:

PRESSURE RATING (kPa)	VALVE SIZE (DN)	HAND WHEEL DIAMETER (mm)
1000	DN100 to DN350	250mm (max.)
	DN400 to DN500	400mm (max.)
	DN600 and larger	500mm (max.)
1600	DN100 to DN350	250mm (max.)
	DN400 to DN500	400mm (max.)
	DN600 and larger	500mm (max.)
2500	DN100 to DN350	250mm (max.)
	DN400 to DN500	400mm (max.)
	DN600 and larger	500mm (max.)
4000	DN100 to DN350	250mm (max.)
	DN400 to DN500	400mm (max.)
	DN600 and larger	500mm (max.)

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6.7 LUBRICATING POINTS

All lubricating points for grease gun lubrication shall be fitted with 1/8" BSP stainless steel button head type grease nipples. Nipples shall be painted red for easy identification. Electro-plated nipples will under no circumstances be accepted.

6.8 MARKING

6.8.1 Body Marking

All valve bodies shall be permanently and indelibly marked (cast in minimum 15 mm lettering size on castings or welded on fabricated valves) as follows:

- Manufacturer's name;
- Nominal size (DN in mm);
- Nominal pressure (PN in bar);
- Arrow to indicate the direction of flow; and

All the above markings shall be legible after painting.

6.8.2 Flange marking

In addition to the above, one of the flanges of the valve shall be clearly marked with a single set of machined notches. (3mm wide x 3mm deep across the width of the flange and painted red).

For wafer type valves, the width and depth of the notch shall be identical to that of the flanged valves. The length of the notch however shall be 12mm long.

- One notch - 1 000 kPa operating pressure
- Two notches - 1 600 kPa operating pressure
- Three notches - 2 500 kPa operating pressure
- Four notches - 4 000 kPa operating pressure
- Five notches - 6 400 kPa operating pressure

6.8.3 Gate and body marks

One face of the gate shall be marked, corresponding to a similar mark on the body, to ensure correct replacement after dismantling. The marks shall be visible and clear after coating. The details of the marking shall be shown on the drawings.

6.8.4 Identification Plate Markings

Identification plate markings shall be hard-stamped, printed or engraved on a stainless steel nameplate fitted to the valve with stainless steel cap or drive screws. If necessary a boss/raised face shall be cast integrally with the body to fit the nameplates.

Information listed on a name plate shall be as follows:

- Manufacturer's name or trade mark;

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- Nominal size (DN) in millimetres;
- Contract number;
- Nominal pressure (PN) in kPa;
- Serial number;
- Date of manufacture; and
- Mass of valve in kg.

6.9 POSITION INDICATORS

Valves of DN 300 and larger shall be fitted with accurate position indicators unless otherwise specified in the Project Specification.

Position indicating plates shall be embossed to clearly show the fully open, ¾, ½, ¼, and closed positions.

The indicator system shall be accurately installed and calibrated to give true linear indication of the valve opening. Calibration of the indicator scale shall be done in-situ to show actual valve position recorded against the actual valve operation.

All pulleys, brackets, pins, cables, counterweights, sleeves, indicator gears and fasteners shall be of stainless steel 304 or better.

Where specified, valves shall be supplied with electrical limit switches for fully open and fully closed positions plus any other I/O requirements as shown on the Drawings and I/O schedule. Limit switches will be connected to 24 V DC PLC input cards by the Contractor or his sub-contractor. The valve manufacturer shall make provision for all cable and wire connections to these limit switches.

Electronic position indicators (proximity switches) for fully open and fully closed position indication are required on all butterfly valves as specified.

7. TESTING & INSPECTION

7.1 GENERAL

Inspection and quality control shall be in accordance with ISO 9000.

Further specific requirements for quality control and testing of valves given in the following paragraphs:

7.2 PRESSURE TEST REQUIREMENTS

Valves shall be pressure tested by the manufacturer to prove the structural integrity of the body and that the fully assembled valves are capable of functioning satisfactorily under the specified

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operating conditions. Valid calibration certificates of testing equipment to be used for pressure testing of the valves by the manufacturer should be made available to the Engineer.

7.2.1 Pressure Testing

Test flanges shall be used. Tie-bolts or other forms of restraint applied across the blank flanges for the testing of flanged valves will not be permitted except in the case of wafer type valves.

Note:

- Valve undergoing pressure testing shall not be subject to shock loading.
- Valves and connections shall be purged of air prior to pressure testing.

7.2.2 Test Fluid

The test fluid for all pressure tests shall be either water with the addition of a corrosion inhibitor, or another non corrosive liquid with a viscosity at ambient temperature equal to or less than that of water.

7.3 TEST PROCEDURES

7.3.1 General

Test pressures shall be maintained for not less than five (5) minutes or as otherwise specified by the Engineer and the valves shall be watertight in all respects.

Structural and seat tests shall be executed on both sides of double seated valves i.e. gate valves.

All valves, fully assembled, shall be pressure tested by the manufacturer in accordance with Table 1.

TABLE 1

APPLICABILITY OF HYDROSTATIC PRESSURE TESTS

TEST	VALVE TYPE	
	TIGHT SHUT-OFF	LOW LEAKAGE
a) Structural		
• Body	✓	✓
• Disc Strength	✓	✓
a) Seat/Seal	✓	N/A

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7.3.2 Structural Tests

Body Test

This shall be a hydrostatic pressure test at a pressure of 1.5 times the maximum permissible working pressure at ambient temperature.

Testing of the valve bodies shall be carried out without the disc assembled and before valves are coated or lined with materials that are capable of sealing against leakages. Both ends of the body shall be blanked off so that the valve is subjected to the full pressure stresses in all directions induced by the test pressure.

The valve shall be in an open or partially open position during the test. There shall be no visually detectable leakage and/or signs of sweating through the shell of the valve during the test period.

Disc/Gate Test

This shall be a hydrostatic pressure test at a pressure of 1.5 times the maximum permissible working pressure at ambient temperature.

The valve shall be closed in the normal manner and the test pressure applied to one side of the disc with the other side open to atmosphere. There shall be no visible evidence of structural damage to or deformation of the disc or leakage through the disc or gate during the test duration.

Seepage past gland seals during structural tests shall not be cause for rejection, provided that the gland seals are watertight when the internal test pressure is reduced to 1.1 x the maximum permissible working pressure at ambient temperature.

Seat/Seal Test

This shall be a hydrostatic pressure test at a pressure of 1.1 times the maximum permissible working pressure at ambient temperature.

Each assembled valve with corrosion protection completed shall be subjected to open-ended tests for drop tightness at the permissible working pressures at ambient temperature. Valves shall be drop tight over the complete range of pressures. Valves with symmetrical seating and double acting valves shall be tested in both directions.

The maximum permissible leakage shall be as given in Table 2.

Table 2

TEST PRESSURE LEAKAGE RATES

VALVE TYPE	LEAKAGE RATE
Tight shut-off (all valves	Rate 3 * : No visible leakage for duration of test.

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VALVE TYPE	LEAKAGE RATE
except wedge gate valves)	
Low leakage (wedge gate valves only)	Rate 1 : 0.7 ml/min x DN

*Leakage rates are as defined in BS 5146: Part 2

7.3.3 Test Certificate

When a test certificate is issued it shall contain a statement by the manufacturer confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

7.3.4 Anti-static

Valves designated as anti-static shall have electrical continuity between shaft, disc and body when tested in accordance with A.2 of BS 5146: Part 1.

7.3.5 Functional Test Requirement

The manufacturer shall do a functional test on each valve. This shall consist of taking the valve through one complete cycle, from fully closed to fully open and back. The manufacturer shall take particular note that the valve position indicator is correctly calibrated.

8. FASTENERS

Fasteners shall comply with the clause “Fasteners” in ZUT 0001.

9. HANDLING AND TRANSPORT

All handling and transport of valves shall be done in accordance with the requirements of standard as set out in section of General Mechanical.

In addition the ends of valves and fittings shall be securely blanked off with temporary sturdy plywood blank flanges in order to protect the corrosion protection (lining).

Bolts and other small parts shall be sewn up in strong bags and crated. The bags shall be tagged using metallic tags and indicate the following information:

- Manufacturer's identification and contract number,
- Part numbers,
- Description,

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- Sizes and
- Quantities.

Each bag shall have the delivery address listed on a separate metallic tag.

The use of ropes, wire or chains for lifting valves without suitable padding is strictly forbidden. For transport or storage purposes, balks of timber beams shall be used to support the valves on any surface and separate them from each other.

Precautions shall be taken to support and chock the valves to prevent movement when loading onto vehicles. Valves or components of valves shall be firmly lashed or chained with padded lashing supported on sawdust bags. The area of padded surfaces shall be adequate to prevent damage to coatings.

The Site Engineer shall be notified of the delivery date and of any requirements regarding off loading and storage at site.

For Site delivery, the transportation, off-loading of equipment by crane and supervision during off-loading shall be the responsibility of the Contractor. The final inspection and acceptance of equipment supplied will be undertaken on site after off-loading has been completed. Any damage that occurs during the handling, assembly and storage of equipment at the Manufacturer or Contractor's works, including transportation to site, shall be repaired by the Contractor at his own cost, in accordance with the valve specification and to the satisfaction of the Engineer.

10. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the equipment for compliance prior to payment being made.

If the equipment is manufactured and assembled locally, the Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect equipment and fabrications in the workshop prior to despatch to Site. Fabrications shall be inspected prior to corrosion protection.

If the equipment is not manufactured locally, the Contractor shall make all arrangements and carry all costs for the Engineer, or an Engineer approved inspection authority, to inspect the equipment in the workshop prior to dispatch. The inspection shall include a full report on compliance of the equipment with this specification and this report shall be submitted to the Engineer prior to dispatch of the unit from the workshop.

11. OPERATING AND MAINTENANCE MANUAL

This section shall comply with the requirements as specified under ZUT 0002.

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12. MEASUREMENT & PAYMENT

12.001 Supply and Deliver to Site

The rates tendered shall include full compensation for the supply and delivery of the Plant to Site including supply of raw materials and bought-out items and associated operating Plant items; fabrication, manufacture and assembly; quality assurance and quality control; inspection and Factory Acceptance Testing (including attendance on inspections and tests witnessed by the Engineer); type and routine tests; application of finishes (painting and corrosion protection); trial erection and dismantling; preparation and packing for transport; transport from place of manufacture to the Site; insurance, harbour dues etc., during transport; loading and unloading; storage under appropriate conditions from date of delivery until commencement of erection; and any other work as specified. Payment will be made per unit. Payment will only be effected after full compliance of the Plant items with this Section and associated documentation has been approved by the Engineer.

12.002 Installation of Plant

The rates tendered shall include for full compensation for the installation of the Plant on Site including the provision of all labour, transport, materials and Temporary Works necessary to install the complete Works; on-site quality assurance and quality control, inspection, testing (including attendance at tests witnessed by the Engineer); the installation of all auxiliary Plant items; necessary for the operation of the installation until taken over by the Employer; the putting into service of the complete installation of the Plant; and any other work as specified.

The rate shall also include for all commissioning testing and the provision of equipment therefore including all disruptions to installation caused by such testing. Payment will be made per unit. Payment will only be effected after full compliance of the Plant items with this Section and associated documentation has been approved by the Engineer.

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SPECIFICATION: ZUT 7016

Resilient Seal Gate Valve

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1. INTRODUCTION

Zut 7016 specifies the standard requirements for resilient seal gate valves of the type with rubber lined gate.

2. SCOPE OF WORKS

2.1 GENERAL

The equipment installation to be provided by the Contractor shall be configured as shown on any applicable drawings.

2.2 WORKS TO BE PROVIDED BY THE CONTRACTOR

The detail of the work for which the Contractor is responsible is specified elsewhere.

3. NORMATIVE REFERENCES

The following documents are applicable to this specification:

- Zut 0001 - General Mechanical Requirements.
- Zut 0003 - Painting and Corrosion Protection for Water and Wastewater Works.

4. EQUIPMENT ELIGIBILITY

The valve provided shall have a successful record of use in South Africa in similar applications and shall also have had at least three years of technical support in South Africa. Service and spares shall currently be available in South Africa. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

5. PERFORMANCE REQUIREMENTS

The body shall withstand the internal pressure rating of the valve.

The valve shall open and close smoothly at a pressure difference across the gate equal to the valves' rated pressure.

The gate liner shall, in accordance with SANS 665-3, be so firmly bonded, vulcanised and accurately moulded that, when the valve is tested, the resilient material shall not become torn, loose or detached. Also in accordance with SANS 665-3, the gate shall ensure drop tightness

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over the full pressure range of the valve and the lining shall have the capacity to accept foreign matter up to 1 mm in particle size.

6. OPERATION AND CONTROL

The valve shall be positively held in position over all degrees of opening whether under pressure or not.

Clear indication of current valve position shall be provided.

Valve opening and closing direction shall be indicated.

All actuated valves shall be provided with manual operation override. Electric actuators shall also be provided with manual start and stop functions on the actuator.

7. DESIGN AND CONSTRUCTION

7.1 GENERAL

Valves shall be of the double flanged configuration.

Manually operated valves shall be provided with handwheels of a size and construction which permit easy opening of the gate when subjected to a differential pressure equal to the rated pressure difference across the gate. Handwheels shall not require a peripheral force greater than 250 Newtons (i.e. the sum of the forces on both sides shall not be greater than 250 Newtons). Suitable gearboxes shall be fitted to achieve this.

The gate shall be fully lined so that the fluid does not contact any metallic part of the gate.

The gate shall be provided with guides. Sliding surfaces of cast iron are not acceptable.

Valves shall have rising spindles unless otherwise specified or necessary because of space restrictions. Valves with non-rising spindles shall be fitted with an indication of the closing and/or the opening direction.

The spindle shall be of stainless steel.

Manually operated gearboxes shall be provided with a stainless steel grease nipple.

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

Valves shall comply with SANS 665 where applicable.

Handwheels shall be of cast metal. The handwheel shall be clockwise closing.

7.2 VALVES > DN 150

Valves larger than DN 150 shall be provided with a bypass which incorporates a small bore, flanged, metal seated wedge gate valve.

Valves above DN 150 shall have the manufacturer's name, size and working pressure cast on the valve body.

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A slipping clutch, or equivalent mechanism, shall prevent over torque which would cause damage. Shear pins and other torque limiting devices which have to be replaced after activation are not acceptable.

8. FASTENERS

Fasteners shall comply with Zut 0001.

Fasteners on the valve shall be of EN Grade 1.4401 (316) stainless steel.

Flange fasteners shall comply with the specification for the pipeline's flange fasteners.

9. MATERIALS AND CORROSION PROTECTION

The specific application shall be taken into account in the corrosion protection of valves.

The gate liner shall be of vulcanised EPDM.

Valve bodies shall be of ductile iron or of cast steel.

Cast iron valve components, including valve bodies, shall be protected internally and externally with a either a fusion bond epoxy or Rilsan (or equivalent) and shall comply with Zut 0003. Dry film coating thickness shall not be less than 200 micron.

Metal plating of ferrous materials is not an acceptable corrosion protection system.

10. INSTALLATION

Valves shall be mounted firm and level.

The weight of the valve shall be fully supported. Valves of DN 250 and over shall be provided with at least one dedicated vertical support.

Spindles shall be vertical unless approved otherwise by the Engineer.

The handwheel shall be easily accessible to the operator.

Installation shall comply with Zut 0001.

11. CIVIL AND BUILDING MATTERS

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site.

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The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

12. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the equipment for compliance prior to payment being made.

If the equipment is manufactured and assembled in South Africa, the Contractor shall make all arrangements and carry all costs for the Engineer to inspect equipment in the workshop prior to despatch to Site.

If the equipment is manufactured and assembled outside South Africa, the Contractor shall make all arrangements and carry all costs for an Engineer approved inspection authority to inspect the equipment in the workshop prior to dispatch. The inspection shall include a full report on compliance of the equipment with this specification and this report shall be submitted to the Engineer prior to dispatch of the unit from the workshop.

13. TESTING REQUIREMENTS

The valve shall be tested to be drop tight at a pressure equal to 1,1 times the nominal design pressure difference across the gate and the test certificate shall be submitted to the Engineer.

The body and gate shall be tested to an internal pressure of 1,5 times the nominal design internal pressure and the test certificate shall be submitted to the Engineer.

The correct operation of the valve shall be demonstrated to the Engineer prior to the commissioning of the Works.

14. GENERAL

The equipment shall have been successfully used in similar applications in South Africa.

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SPECIFICATION: ZUT 7022

AIR VALVES

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1. INTRODUCTION

Zut 7022 specifies the standard requirements for air valves which are used for air release and vacuum break on pipelines and for air release in pump stations.

2. SCOPE OF WORKS

2.1 GENERAL

The equipment installation to be provided by the Contractor shall be configured as shown on any applicable drawings.

2.2 WORKS TO BE PROVIDED BY THE CONTRACTOR

The detail of the work for which the Contractor is responsible is specified elsewhere.

3. NORMATIVE REFERENCES

The following documents are applicable to this specification:

- Amendments, Additions and Detailed Requirements (Zut 7022).
- Zut 0001 - General Mechanical Requirements.
- Zut 0003 - Painting and Corrosion Protection for Water and Wastewater Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4. EQUIPMENT ELIGIBILITY

The air valves provided shall have a successful record of use in South Africa in similar applications and shall also have had at least three years of technical support in South Africa. Service and spares shall currently be available in South Africa. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Equipment which does not satisfy these requirements is not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

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5. PERFORMANCE REQUIREMENTS

5.1 PIPELINES

Valves shall perform in accordance with the air discharge, air inlet and slam-free conditions specified.

In vacuum break mode, valves shall react immediately in order to prevent the pressure falling to a level which would be unacceptable in terms of the design of the pipeline.

Valves shall be capable of discharging high volumes of air through a large orifice under pressure during filling of the pipeline.

5.2 OTHER

Valves shall be capable of releasing small quantities of accumulated air at all line pressures up to and including the rated working pressure of the valve.

The large discharge orifice shall close at a differential pressure of between 4 and 6 kPa in order to minimise transient pressure effects. The valve shall continue to release air at a lower rate.

Valves shall seal drop tight at all line pressures between 0,45 bar and the rated pressure.

6. OPERATION AND CONTROL

Valves shall operate autonomously; i.e. a valve shall not require a servo mechanism to control its operation and shall not require an external power supply.

7. EQUIPMENT CONSTRUCTION AND DESIGN

7.1 GENERAL

Air release valves for water pipework shall be of the non-slam type, Vent-O-Mat RBX, or ARI or equivalent.

Air release valves for wastewater pipework shall be of the non-slam type Vent-O-Mat RGX, ARI or equivalent. Valves for wastewater and related duties shall be specifically designed for the application.

The manufacturer's name, pressure rating, nominal size, serial number, Contract number and the material designations of the body shall be permanently displayed on the valve in the form of a plate of corrosion resistant material securely fixed to the body with corrosion resistant fastenings.

A metal seated, wedge gate isolating valve shall be provided and installed so that the air valve can be isolated during full line pressure. The wedge gate valve shall have the same pressure rating as specified for the air valve.

7.2 HYDRAULIC DESIGN

Valve design and selection shall ensure that pipe collapse does not occur under a "full bore" rupture condition and, additionally, shall comply with the following criteria:

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- Air valves on pipe sizes up to DN 600 shall be designed to ensure that the internal pressure does not drop to less than 8 kPa below atmospheric pressure under a full bore rupture condition.
- Air valves for pipe sizes larger than DN 600 shall be selected on the basis of a rupture condition which shall be agreed with the Engineer.

The criteria for the valve performance shall have been confirmed by a recognized independent authority.

7.3 CONSTRUCTION

Valves shall be flanged. The flange shall comply with the flange specification for the pipeline.

It shall be possible to remove the valve's working parts without unbolting the bottom flange from the pipeline. Floats and seats shall not, however, require maintenance under normal conditions.

A stainless steel screen shall prevent foreign matter from entering and blocking the air ports.

Valves shall be designed and constructed to ensure reliable operation after long periods of non-operation.

8. FASTENERS

Fasteners on the valve shall be of stainless steel.

Flange fasteners shall comply with the flange fastener specification for the pipeline.

9. MATERIALS AND COATINGS

Ductile iron shall be protected with fusion bonded epoxy or Rilsan or equivalent to a dry film thickness of at least 200 micron in accordance with Zut 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

Floats shall be of HDPE or similar.

Seals shall be nitrile rubber or otherwise approved by the Engineer.

Carbon steels parts shall not be acceptable.

10. INSTALLATION

Each air valve shall be provided with a nozzle which shall form an accumulator pocket to capture the air bubbles entrained with the water flow. The nozzle shall be fabricated as an upstand tee and shall have a diameter of at least half the pipeline diameter. The upstand tee's height shall be equal to its own diameter or greater. The upstand shall be flanged and shall be provided with a blank flange. The blank flange shall incorporate a flanged riser which is sized for mounting the air valve onto.

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Equipment shall be mounted firm and level.

Installation work shall comply with Zut 0001.

11. CIVIL AND BUILDING MATTERS

As required in terms of the General Conditions, the Contractor shall:

- provide the details of civil and building requirements to the Engineer for incorporation into the structure.
- at an appropriate point, measure on Site.

The Contractor shall ensure that the design can accommodate a tolerance of +/- 40 mm for civil and building items constructed by others (unless a tighter tolerance is called for by the Contractor in good time and approved by the Engineer).

12. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the equipment for compliance prior to payment being made.

13. TESTING REQUIREMENTS

The valve body shall be pressure tested to 1,5 times the rated pressure of the valve for two minutes and there shall be no visible leaks.

Valves shall be tested for drop tight sealing at the rated pressure and also at a pressure of 0,45 bar above atmosphere.

A certificate indicating these test results and including the valve's serial number shall be provided to the Engineer.

The Contractor shall demonstrate the valve performance in terms of vacuum break, air release during filling and air release under line pressure. One unit of each size shall be demonstrated to the Engineer and the Employer.

The correct operation of the equipment and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works.

14. MISCELLANEOUS

Valves shall be protected against damage during transport.

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SPECIFICATION: ZUT 7023

Pipe Couplings

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1. INTRODUCTION

Zut 7023 specifies the requirements for pipe couplings to be provided by the Contractor.

Pipe couplings shall be provided for flexibility and to allow dismantling of pipework. Pipe couplings shall also be provided to accommodate possible pipe movement from settlement, etc, and to isolate machine vibration.

2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

a) Amendments, Additions and Detailed Requirements (Zut 7023).

b) Zut 0001: General Mechanical Requirements.

c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4. EQUIPMENT ELIGIBILITY

The couplings provided shall have a successful record of use locally in similar applications and shall also have had at least three years of technical support locally. Service and spares shall currently be available locally. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are also acceptable.

Couplings which do not satisfy these requirements are not acceptable unless specifically called for in the specifications or unless the Engineer agrees in writing.

5. PERFORMANCE REQUIREMENTS

The coupling shall provide a flexible joint between the two items being connected.

The coupling shall withstand the pipework pressure rating.

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6. CONSTRUCTION AND DESIGN

6.1 GENERAL

The pressure rating of the coupling shall be not less than the rating for as its pipework.

Where the type of coupling is not indicated on the drawing, pipe couplings may be of the mechanical type (VJ coupling or flange adaptor), of the stainless steel bellows type or of the rubber bellows type but, in each case, the type chosen shall be suitable for the duty.

Restraints shall only be provided where required. Restraints shall incorporate three tie bars or more.

6.2 MECHANICAL COUPLINGS

Mechanical couplings shall be of the rubber ring compression type (i.e. VJ-type flange adaptors or VJ type couplings) and shall be provided in pairs in order to accommodate axial misalignment and/or settlement. All fasteners, including studs welded to flanges, shall be of stainless steel and provided with a solids lubricant to prevent galling. Metal castings shall be of ductile iron or of stainless steel.

Couplings for stainless steel and 3CR12 pipework shall be fully of EN Grade 1.4401 (316) stainless steel construction (except for the seal).

Carbon steel and cast iron components shall be protected against corrosion by Rilsan coating.

6.3 RUBBER BELLOWS COUPLINGS

Suitably rated rubber bellows type couplings with metal backing flanges are acceptable for pipe diameters of DN 300 and below.

The bellows shall be provided with two backing flanges drilled to match their mating flanges. Bellows for low carbon steel pipework shall be provided with hot dip galvanised flanges (i.e. not zinc plated). Bellows for 3CR12 or stainless steel pipework shall be provided with matching flange material.

Rubber bellows couplings are not acceptable for bolting directly to the inlet of centrifugal pumps and mechanical couplings shall be used for this application.

6.4 STAINLESS STEEL BELLOWS COUPLINGS

Where stainless steel bellows type couplings are required, the flanges and the flange fasteners shall also be of stainless steel.

7. FABRICATION

Fabrication and welding shall comply with Zut 0001.

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8. FASTENERS

Fasteners shall comply with Zut 0001.

9. CASTINGS

Castings shall comply with Zut 0001.

10. CORROSION PROTECTION

Corrosion Protection shall comply with Zut 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

11. INSTALLATION

Installation work shall comply with Zut 0001.

Pipework shall be aligned correctly and the pipe coupling shall not be used to accommodate visible misalignment in any direction.

12. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the couplings for compliance prior to payment being made.

13. TESTING REQUIREMENTS

The correct operation of the couplings and achievement of the specified performance requirements shall be demonstrated to the Engineer prior to the commissioning of the Works.

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SPECIFICATION: ZUT 7024

Pipework Anchors

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1. INTRODUCTION

ZUT 7024 specifies the requirements for anchors for pipework to be provided by the Contractor.

2. SCOPE OF WORKS

See project specification.

3. NORMATIVE REFERENCES

Where this specification is required for a project, the following documents shall, inter alia, form part of the Contract Document:

a) Amendments, Additions and Detailed Requirements (Zut 7024).

b) Zut 0001: General Mechanical Requirements.

c) Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4. PERFORMANCE REQUIREMENTS

Pipe anchors shall resist the forces from pressure and from inertial flow changes. The pipe anchors shall restrain and anchor the pipework, valves and other heavy fittings and shall withstand loads and thrust forces and prevent them from being transferred to pump flanges and other equipment which might be damaged or have shortened lifespans.

Pipework shall accommodate settlement, expansion and contraction.

Pipework shall be structurally capable of withstanding the vibration to which it is subjected without fatigue fracture. Vibration shall be restricted to the source and shall not be transferred via pipework.

Pipe supports shall not restrict dismantling of equipment.

5. DESIGN & CONSTRUCTION

5.1 GENERAL

In order to achieve the specified performance requirements, the Contractor shall analyse the forces at isolation valves, check valves, bends, reducers and any other cause which are present

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during normal operation, during dormant conditions, during testing, during start up and during shut down of each pump individually and during operation of the pump station as a whole. The steel pipe anchors shall be designed to transfer all such forces to the concrete structure.

Pipe anchors shall be provided so that pipework does not place any external loading on items of rotating mechanical equipment such as pumps, compressors, etc.

Provision shall be made for settlement as well as for expansion and contraction due to variations in temperature or pressure.

Pipe anchors shall be designed and located so that when an item of mechanical equipment, such as a pump or blower, is removed, the associated pipework and equipment is still adequately anchored.

Pipe anchors shall be provided at or close to all heavy items such as valves of size DN 200 and larger.

Pipe anchors which only anchor the weight of horizontal pipework may be of the sliding type and shall be vertically adjustable.

Pipework anchors, other than cast-in puddle pipes, shall be of carbon steel or of stainless steel.

Pipe anchors which resist thrust forces shall incorporate doubler plates welded on the pipe and shall be as short as feasible. The doubler plates shall be of the same or greater thickness than the pipe wall thickness and shall be contoured to match the pipe. Other reinforcing designs will also be acceptable.

Low carbon steel pipe anchors shall be fabricated from heavy duty hot rolled steel sections. The complete assembly shall be hot-dip galvanised after all fabrication is completed. Welds shall be continuous “all round”; i.e. no crevices.

Stainless steel pipe anchors shall be fabricated of plate with a minimum thickness of 4,5 mm or shall be fully triangulated, boxed or closed sections. Welds shall be continuous “all round”; i.e. no crevices.

Where appropriate, 3 mm thick neoprene strips shall be placed between pipes and pipe anchors or clamps to protect the paintwork and to limit corrosion.

Where roller or sliding anchors are used to accommodate movement, suitable wear blocks shall be fixed to the pipe to prevent damage to the pipe structure from sliding and corrosion.

5.2 PIPE ANCHORS FOR STEEL PIPEWORK

The maximum allowable spacing between pipe anchors for steel (including stainless steel) pipe of diameter, d [mm], shall be calculated as follows:

Spacing (mm) = 1 500 + 6d.

This applies to pipe only. Valves and other heavy items shall be anchored separately.

5.3 PIPE ANCHORS FOR PLASTIC PIPEWORK

The maximum allowable spacing between pipe anchors for plastic pipe of diameter, d [mm], shall be calculated as follows:

Spacing (mm) = (1 500 + 6d) / 2.

This applies to pipe only. Valves and other heavy items shall be anchored separately.

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5.4 FASTENING

At least four anchor fasteners shall be provided for the foot of each pipe anchor.

Cantilevered pipe anchors are not preferred. Their spacing between anchor fasteners on the foot shall be not less than one quarter of the cantilevered length. Gussets between the column and the foot are normally required and these shall be positioned so as to minimise the distance between the gusset and the anchor fastener. The requirements in this paragraph do not apply to cantilevered pipe anchors which only provide vertical support.

Pipe anchors shall be aligned using nuts above the foot and stainless steel shims below the foot. Anchor fasteners shall be tensioned when their nuts are tightened; i.e. it is not acceptable to use a nut below the baseframe to position it; and the holding down force shall be loaded into the concrete structure.

Concrete surfaces under foot plates shall be scabbled before the pipe anchor is placed and shall be blown clean using compressed air immediately before grouting. A space of at least 20 mm shall be left and this space shall be filled using non-shrink grout once alignment has been completed. Grouting shall be done in accordance with the manufacturer's instructions. Alternative designs and installations may be submitted by the Contractor.

5.5 CONCRETE ANCHORS

Concrete pipe anchors shall be designed for purpose.

6. FABRICATION

Fabrication and welding shall comply with Zut 0001.

Pipe anchors will be inspected by the Engineer after fabrication is complete.

7. FASTENERS

Anchor fasteners shall be of EN Grade 1.4401 (316) stainless steel.

Nuts for anchor fasteners shall be provided with both a spring washer and a flat or fender washer.

Fasteners shall comply with Zut 0001.

8. CORROSION PROTECTION

Corrosion Protection shall comply with Zut 0003.

Stainless steel shall be correctly pickled and passivated. All stainless steel surfaces shall be completely clear of ferrous stain upon commissioning.

Carbon steel shall be hot dip galvanised after all fabrication has been completed.

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9. INSTALLATION

Installation work shall comply with Zut 0001.

10. INSPECTIONS

The Contractor shall make arrangements for the Engineer to inspect the pipe anchors for compliance prior to payment being made.

11. DOCUMENTS TO BE PROVIDED

Proposed designs of pipe anchors, preferably indicated on the General Arrangement design drawings, shall be submitted to the Engineer for review prior to manufacture.

The calculations for pipe anchors designed to withstand the thrust from reducers, bends and check valves shall be included.

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SPECIFICATION: ZUT 8009

Mechanical Flow Meter

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1. INTRODUCTION

Zut 8009 specifies the requirements for mechanical flow meters which provide indication of flow rate and integrated flow in pipes and which do not require a power supply.

The project specification takes precedence over Zut 8009.

2. SCOPE OF WORKS

See project specification.

The installation shall be configured as shown on applicable drawings.

3. NORMATIVE REFERENCES

The following form part of the Contract Document:

- Amendments, Additions and Detailed Requirements (Zut 8009).
- Zut 0001: General Mechanical Requirements.
- Zut 0003: General Corrosion Protection for Pipelines, Water and Waste Water Works.
- Zut 4020: In-line Pipe Strainers.
- Zut 7023: Pipe Couplings and Flange Adaptors.
- Zut 7024: Pipe Anchors.
- National Occupational Health and Safety Act and Regulations.
- BS EN 1092: Flanges and their Joints.
- SANS 1123: Pipe Flanges.
- SANS 12944-2: Paints and varnishes – Corrosion protection of steel structures by protective paint systems; Part 2: Classification of environments.

Equipment, materials and operational methods shall comply with the latest edition of relevant national and/or international standards.

4. EQUIPMENT ELIGIBILITY

The make and model of meter provided shall have a successful record of use in similar applications locally and shall also have had at least three years of technical support locally. Service and spares shall currently be available. Upgraded versions of a manufacturer's earlier designs which comply with these criteria are acceptable.

5. PERFORMANCE REQUIREMENTS

Meters shall measure the flow over the range specified.

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Meters shall be accurate to + 1 % of full scale at the maximum of the specified flow range and shall be accurate to + 3 % of full scale at one tenth of this maximum.

6. OPERATION AND CONTROL

The flow rate and the integrated flow shall be displayed locally.

7. DESIGN AND CONSTRUCTION

7.1 CONFIGURATION

The meter installation shall be provided with an upstream spool piece and its length shall be of ten diameters or more.

A downstream plain ended pipe of five diameters or more shall be provided. One flange adaptor shall be provided at each end of the pipe. Flange adaptor couplings shall comply with Zut 7023.

Pipe anchors shall comply with Zut 7024. At least one anchor shall be provided for the meter. It shall be of hot dip galvanised steel with stainless steel anchors and shall allow suitable adjustment.

7.2 METER

Meters shall be in-line, double flanged units. Flanges shall comply with SANS 1123 and/or BS EN 1092 for the pressure rating. The meter shall comply with the design specifications for the pipeline in which it is to be installed.

It shall be possible to remove the working parts without having to unbolt the meter body from the pipeline.

Meters may either be of the axial flow, propeller type or of the positive displacement type.

The complete unit shall be designed for immersion without damage.

7.3 STRAINER

A double flanged strainer shall be provided upstream of the ten diameter spool piece which guides the water into the meter. The aperture size for the strainer shall be in accordance with the requirements of the meter.

The strainer shall comply with Zut 4020.

8. MATERIALS AND COATINGS

Equipment shall comply with the table below. Components not specified in the table shall be designed to the very high - industrial category (C5-I) of SANS 12944-2.

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ITEM	MATERIAL	COATING
Body	Manufacturer's standard.	Corrosion protection suitable for the very high - industrial category (C5-I) of SANS 12944-2
Fasteners on the meter body	EN Grade 1.4401 (316)	N/A
Flange fasteners	As per pipeline.	As per pipeline.
Auxiliary metal components	EN Grade 1.4401 (316)	Pickle and passivate.
Corrosion protection shall comply with Zut 0003.		
Materials shall comply with Zut 0001.		
Stainless steel shall be correctly pickled and passivated. Stainless steel surfaces shall be free of ferrous stain and heat tint at commissioning.		
Metal plating of ferrous materials is not an acceptable corrosion protection system.		

9. FASTENERS

Fasteners shall comply with Zut 0001.

10. INSTALLATION

Installation work shall comply with Zut 0001.

The meter shall be mounted level and shall be rigidly supported.

11. SAFETY

The Contractor shall design and install equipment installations in accordance with the requirements of the country's Occupational Health and Safety regulations.

12. INSPECTIONS

The Contractor shall arrange for the Engineer to inspect the completed, cleaned installation on Site for acceptance prior to commissioning. The Contractor shall remove all litter, shall ensure that the ground is dry, that dust is not present and that all pipework has been wiped clean before the Engineer's inspection.

The manufacturer's operating and maintenance manual shall be available.

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13. TESTING REQUIREMENTS

Each meter shall be pressure tested in the factory and the test results shall be submitted to the Engineer prior to commissioning. The Contractor shall calibrate the unit and shall submit the calibration certificate to the Engineer prior to the equipment being transported to Site and prior to payment being made.

The Contractor shall successfully demonstrate the equipment operation to the Engineer prior to the commissioning of the Works.

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C4. Site Information

C4.1 General

This section describes the site at the time of the tender in order to enable the tenderer to price his tender accordingly and to decide upon his method of working, programming and risks.

The tenderer shall inform him / her on the nature of the site and inspect the site.

The Employer will consider a tender only if the site inspection and/or tenderer's meeting arranged by the Engineer has been attended by a representative who must:

- Be suitably qualified to comprehend the implications of the work involved, and
- Be the tenderer him/herself or a person in the direct employ of the tenderer

C4.2 Nature of ground and subsoil conditions

The Contractor shall familiarize himself with the conditions on site.

A Geotechnical investigation was conducted and the report is included in Annexure C6.3

C.5 Drawings

The following drawings, **FOR TENDER PURPOSES ONLY**, form part of this contract.

Name	Description
KALKFONTEIN COMMAND RESERVOIR SITE	
1000936-DRG-1100-CC-0001	KALKFONTEIN COMMAND RESERVOIR SITE EARTHWORKS PLATFORM LAYOUT AND SETTING OUT DETAILS
1000936-DRG-1100-CC-0002	KALKFONTEIN COMMAND RESERVOIR SITE EARTHWORKS PLATFORM SECTIONS SHEET 1
1000936-DRG-1100-RR-0001	KALKFONTEIN COMMAND RESERVOIR SITE GENERAL ARRANGEMENT KEY PLAN AND SETTING OUT & LIST OF DRAWINGS
1000936-DRG-1100-RR-0010	KALKFONTEIN COMMAND RESERVOIR SITE LAYOUT AND LONGSECTION
1000936-DRG-1100-RR-0020	KALKFONTEIN COMMAND RESERVOIR SITE ROAD CROSS SECTION SHEET 1 OF 6
1000936-DRG-1100-RR-0021	KALKFONTEIN COMMAND RESERVOIR SITE ROAD CROSS SECTION SHEET 2 OF 6
1000936-DRG-1100-RR-0022	KALKFONTEIN COMMAND RESERVOIR SITE ROAD CROSS SECTION SHEET 3 OF 6
1000936-DRG-1100-RR-0023	KALKFONTEIN COMMAND RESERVOIR SITE ROAD CROSS SECTION SHEET 4 OF 6
1000936-DRG-1100-RR-0024	KALKFONTEIN COMMAND RESERVOIR SITE ROAD CROSS SECTION SHEET 5 OF 6
1000936-DRG-1100-RR-0025	KALKFONTEIN COMMAND RESERVOIR SITE ROAD CROSS SECTION SHEET 6 OF 6
1000936-DRG-1100-RR-0030	KALKFONTEIN COMMAND RESERVOIR SITE ROAD PAVEMENT DESIGN ROAD PAVEMENT CROSS SECTION SHEET 1 OF 2
1000936-DRG-1100-RR-0031	KALKFONTEIN COMMAND RESERVOIR SITE ROAD PAVEMENT DESIGN ROAD PAVEMENT DETAIL SHEET 2 OF 2
1000936-DRG-1100-RR-0040	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL DETAIL OF CONTRACT NAMEBOARD
1000936-DRG-1100-RR-0041	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL GUARDRAIL ELEMENT AND POSITION DETAILS
1000936-DRG-1100-RR-0042	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL DETAILS FOR TYPE 1 INLET AND OUTLET STRUCTURES
1000936-DRG-1100-RR-0043	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL DETAILS ROAD RETAINING LAYOUT & DETAILS: GABION AND/OR WALL
1000936-DRG-1100-RR-0044	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL BERM DETAIL
1000936-DRG-1100-RR-0045	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL LAYBY DETAIL
1000936-DRG-1100-RR-0046	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL HAIRPIN WIDENING DETAIL
1000936-DRG-1100-RR-0047	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL GUARDRAIL TRANSITION DETAIL
1000936-DRG-1100-RR-0048	KALKFONTEIN COMMAND RESERVOIR SITE TYPICAL WARNING SIGNBOARD DETAIL
KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml	
1000936-DRG-1110-SS-0001	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml FLOOR SLAB LAYOUT AND SUBSOIL DRAINAGE LAYOUT AND DETAILS
1000936-DRG-1110-SS-0002	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml FLOOR SLAB BLINDING LAYOUT AND NO FINES AND MASS CONCRETE LAYOUT
1000936-DRG-1110-SS-0003	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml ROOF PLAN AND DETAILS
1000936-DRG-1110-SS-0004	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml 3D VIEW AND SECTIONS A, B & C

Name	Description
1000936-DRG-1110-SS-0005	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml GENERAL DETAILS FLOOR AND WALL JOINTS
1000936-DRG-1110-SS-0006	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml LADDER, SERVICE LANDING AND MANHOLE COVER DETAILS
1000936-DRG-1110-SS-0007	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml LEVEL INDICATOR DETAILS
1000936-DRG-1110-SS-0008	KALKFONTEIN COMMAND RESERVOIR - 3.1 Ml GENERAL NOTES
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1000936-DRG-1120-SS-0001	KALKFONTEIN COMMAND RESERVOIR PIPEWORK CHAMBER DETAILS CHAMBER RC PLAN & 3D VIEWS
1000936-DRG-1120-SS-0002	KALKFONTEIN COMMAND RESERVOIR PIPEWORK CHAMBER DETAILS CHAMBER RC ROOF PLAN & SECTIONS A, B & C
1000936-DRG-1120-SS-0003	KALKFONTEIN COMMAND RESERVOIR PIPEWORK CHAMBER DETAILS INLET PIPE SURROUND LAYOUT & DETAILS
1000936-DRG-1120-SS-0004	KALKFONTEIN COMMAND RESERVOIR PIPEWORK CHAMBER DETAILS SCOUR & OVERFLOW PIPEWORK DETAILS & SCHEDULES
1000936-DRG-1120-SS-0005	KALKFONTEIN COMMAND RESERVOIR PIPEWORK CHAMBER DETAILS OUTLET AND INLET PIPEWORK DETAILS & SCHEDULES
1000936-DRG-1120-SS-0006	KALKFONTEIN COMMAND RESERVOIR PIPEWORK CHAMBER DETAILS PIPEWORK CHAMBER AND CONCRETE BASE PLAN
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1000936-DRG-1310-CC-0001	NEW TSAKANE RESERVOIR EARTHWORKS PLATFORM LAYOUT AND SETTING OUT DETAILS
1000936-DRG-1310-CC-0002	NEW TSAKANE RESERVOIR EARTHWORKS PLATFORM SECTIONS SHEET 1
1000936-DRG-1310-RR-0001	NEW TSAKANE RESERVOIR GENERAL ARRANGEMENT KEY PLAN AND SETTING OUT & LIST OF DRAWINGS
1000936-DRG-1310-RR-0010	NEW TSAKANE RESERVOIR LAYOUT AND LONGSECTION
1000936-DRG-1310-RR-0020	NEW TSAKANE RESERVOIR ROAD CROSS SECTION SHEET 1 OF 3
1000936-DRG-1310-RR-0021	NEW TSAKANE RESERVOIR ROAD CROSS SECTION SHEET 2 OF 3
1000936-DRG-1310-RR-0022	NEW TSAKANE RESERVOIR ROAD CROSS SECTION SHEET 3 OF 3
1000936-DRG-1310-RR-0030	NEW TSAKANE RESERVOIR ROAD PAVEMENT DESIGN ROAD PAVEMENT CROSS SECTION SHEET 1 OF 2
1000936-DRG-1310-RR-0031	NEW TSAKANE RESERVOIR ROAD PAVEMENT DESIGN ROAD PAVEMENT DETAIL SHEET 2 OF 2
1000936-DRG-1310-RR-0040	NEW TSAKANE RESERVOIR TYPICAL DETAIL OF CONTRACT NAMEBOARD
1000936-DRG-1310-RR-0041	NEW TSAKANE RESERVOIR TYPICAL GUARDRAIL ELEMENT AND POSITION DETAILS
1000936-DRG-1310-RR-0042	NEW TSAKANE RESERVOIR TYPICAL DETAILS FOR TYPE 1 INLET AND OUTLET STRUCTURES
1000936-DRG-1310-RR-0043	NEW TSAKANE RESERVOIR TYPICAL DETAILS ROAD RETAINING LAYOUT & DETAILS: GABION AND/OR WALL
1000936-DRG-1310-RR-0044	NEW TSAKANE RESERVOIR TYPICAL BERM DETAIL
1000936-DRG-1310-RR-0045	NEW TSAKANE RESERVOIR TYPICAL LAYBY DETAIL
1000936-DRG-1310-RR-0046	NEW TSAKANE RESERVOIR TYPICAL HAIRPIN WIDENING DETAIL
1000936-DRG-1310-RR-0047	NEW TSAKANE RESERVOIR TYPICAL GUARDRAIL TRANSITION DETAIL
1000936-DRG-1310-RR-0048	NEW TSAKANE RESERVOIR TYPICAL WARNING SIGNBOARD DETAIL
1000936-DRG-1310-SS-0001	NEW TSAKANE RESERVOIR 250kL PRESSED STEEL TANK ISOMETRIC VIEWS

Name	Description
1000936-DRG-1310-SS-0002	NEW TSAKANE RESERVOIR 250kL PRESSED STEEL TANK ELEVATIONS
1000936-DRG-1310-SS-0003	NEW TSAKANE RESERVOIR 250kL PRESSED STEEL TANK FOUNDATION DETAILS
1000936-DRG-1310-SS-0004	NEW TSAKANE RESERVOIR INLET & OUTLET CHAMBER LAYOUTS, SECTIONS AND DETAILS
1000936-DRG-1310-SS-0005	NEW TSAKANE RESERVOIR INLET & OUTLET PIPEWORK AND SCHEDULES
1000936-DRG-1310-SS-0006	NEW TSAKANE RESERVOIR OVERFLOW PIPEWORK AND SCHEDULES
1000936-DRG-1310-SS-0007	NEW TSAKANE RESERVOIR OVERFLOW GENERAL NOTES
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1000936-DRG-1320-RR-0040	NEW MAMPURU RESERVOIR TYPICAL DETAIL OF CONTRACT NAMEBOARD
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1000936-DRG-1320-SS-0003	NEW MAMPURU RESERVOIR ROOF PLAN AND DETAILS
1000936-DRG-1320-SS-0004	NEW MAMPURU RESERVOIR 3D VIEW AND SECTIONS A, B & C

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1000936-DRG-1320-SS-0024	NEW MAMPURU RESERVOIR PIPEWORK CHAMBER DETAILS SCOUR & OVERFLOW PIPEWORK DETAILS & SCHEDULES
1000936-DRG-1320-SS-0025	NEW MAMPURU RESERVOIR PIPEWORK CHAMBER DETAILS OUTLET AND INLET PIPEWORK DETAILS & SCHEDULES
1000936-DRG-1320-SS-0026	NEW MAMPURU RESERVOIR PIPEWORK CHAMBER DETAILS PIPEWORK CHAMBER AND CONCRETE BASE PLAN
EXISTING KALKFONTEIN A TANK	
1000936-DRG-1410-CC-0001	EXISTING KALKFONTEIN A RESERVOIR EARTHWORKS PLATFORM LAYOUT AND SETTING OUT DETAILS
1000936-DRG-1410-SS-0001	EXISTING KALKFONTEIN A RESERVOIR NEW INLET CHAMBER ISOMETRIC VIEW, SECTION A, PIPE SCHEDULE
1000936-DRG-1410-SS-0002	EXISTING KALKFONTEIN A RESERVOIR NEW INLET CHAMBER LAYOUTS, SECTIONS AND DETAILS
1000936-DRG-1410-SS-0003	EXISTING KALKFONTEIN A RESERVOIR GENERAL NOTES
EXISTING KALKFONTEIN B TANK	
1000936-DRG-1420-CC-0001	EXISTING KALKFONTEIN B RESERVOIR EARTHWORKS PLATFORM LAYOUT AND SETTING OUT DETAILS
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1000936-DRG-1430-CC-0001	NEW MAMPURU EXTENSION RESERVOIR EARTHWORKS PLATFORM LAYOUT AND SETTING OUT DETAILS
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1000936-DRG-1430-RR-0010	NEW MAMPURU EXTENSION RESERVOIR LAYOUT AND LONGSECTION
1000936-DRG-1430-RR-0020	NEW MAMPURU EXTENSION RESERVOIR ROAD CROSS SECTION SHEET 1 OF 2
1000936-DRG-1430-RR-0021	NEW MAMPURU EXTENSION RESERVOIR ROAD CROSS SECTION SHEET 2 OF 2
1000936-DRG-1430-RR-0030	NEW MAMPURU EXTENSION RESERVOIR ROAD PAVEMENT DESIGN ROAD PAVEMENT CROSS SECTION
1000936-DRG-1430-RR-0040	NEW MAMPURU EXTENSION RESERVOIR TYPICAL DETAIL OF CONTRACT NAMEBOARD
1000936-DRG-1430-RR-0041	NEW MAMPURU EXTENSION RESERVOIR TYPICAL BERM DETAIL
1000936-DRG-1430-RR-0042	NEW MAMPURU EXTENSION RESERVOIR TYPICAL WARNING SIGNBOARD DETAIL

Name	Description
1000936-DRG-1430-SS-0000	NEW MAMPURU EXTENSION RESERVOIR 250kL PRESSED STEEL TANK ISOMETRIC VIEWS
1000936-DRG-1430-SS-0001	NEW MAMPURU EXTENSION RESERVOIR 250kL PRESSED STEEL TANK ISOMETRIC VIEWS
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1000936-DRG-1430-SS-0005	NEW MAMPURU EXTENSION RESERVOIR INLET & OUTLET PIPEWORK AND SCHEDULES
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1000936-DRG-3110-CC-0001	GA-MALEKANA TO KALKFONTEIN COMMAND RESERVOIR PL - GENERAL ARRANGEMENT KEYPLAN AND SETTING OUT DETAILS 8680 TO 9031
1000936-DRG-3110-CC-0018-A	GA-MALEKANA TO KALKFONTEIN COMMAND RESERVOIR PL - LAYOUT AND LONGSECTION CHAINAGE 8680 TO 8750
1000936-DRG-3110-CC-0018-B	GA-MALEKANA TO KALKFONTEIN COMMAND RESERVOIR PL - LAYOUT AND LONGSECTION CHAINAGE 8750 TO 8900
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1000936-DRG-3140-CC-0001	KALKFONTEIN TO MAMPURU PIPELINE - GENERAL ARRANGEMENT KEYPLAN AND SETTING OUT DETAILS - CHAINAGE 0 TO 450 AND 17400 TO 17788
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1000936-DRG-3140-CC-0002-B	KALKFONTEIN TO MAMPURU PIPELINE - LAYOUT AND LONGSECTION CHAINAGE 150 TO 300
1000936-DRG-3140-CC-0002-C	KALKFONTEIN TO MAMPURU PIPELINE - LAYOUT AND LONGSECTION CHAINAGE 300 TO 450
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1000936-DRG-3140-CC-0019-C	KALKFONTEIN TO MAMPURU PIPELINE - LAYOUT AND LONGSECTION CHAINAGE 17550 TO 17700
1000936-DRG-3140-CC-0019-D	KALKFONTEIN TO MAMPURU PIPELINE - LAYOUT AND LONGSECTION CHAINAGE 17700 TO 17788.03
1000936-DRG-3150-CC-0001	OFFTAKE TO NEW TSAKANE RESERVOIR - GENERAL ARRANGEMENT - CHAINAGE 420 TO 767.76
1000936-DRG-3150-CC-0003	OFFTAKE TO NEW TSAKANE RESERVOIR - LAYOUT AND LONGSECTION CHAINAGE 420 T0 570
1000936-DRG-3150-CC-0004	OFFTAKE TO NEW TSAKANE RESERVOIR - LAYOUT AND LONGSECTION CHAINAGE 570 T0 767.96
1000936-DRG-3160-CC-0001	OFFTAKE PIPELINE TO MAMPURU EXTENSION RESERVOIR - GENERAL ARRANGEMENT - CHAINAGE 295 TO 545.31
1000936-DRG-3160-CC-0002	OFFTAKE PIPELINE TO MAMPURU EXTENSION RESERVOIR - LAYOUT AND LONGSECTION - CHAINAGE 295 TO 545.31
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1000936-DRG-0210-CC-0002	TYPICAL DETAILS BEDDING DETAIL SHEET 1
1000936-DRG-0210-CC-0003	TYPICAL DETAILS BEDDING DETAIL SHEET 2
1000936-DRG-0210-CC-0033	TYPICAL DETAILS AIR VALVE CHAMBER TYPE 1 SHEET 1
1000936-DRG-0210-CC-0034	TYPICAL DETAILS AIR VALVE CHAMBER TYPE 1 SHEET 2

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1000936-DRG-0230-SS-0016	TYPICAL DETAILS CAST IN COVERS AND FRAMES CHAMBER SUMPS
1000936-DRG-0240-MM-0018	TYPICAL DETAILS AIR VENT SHEET 1
1000936-DRG-0240-MM-0019	TYPICAL DETAILS AIR VENT SHEET 2
1000936-DRG-0230-SS-0018	TYPICAL DETAILS STEEL STAIR AND HANDRAILINGS SHEET 1
1000936-DRG-0230-SS-0019	TYPICAL DETAILS STEEL STAIR AND HANDRAILINGS SHEET 2
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C6.2 ENVIRONMENTAL MANAGEMENT PLAN .....

C6.3 GEOTECHNICAL REPORT .....

ZUTARI
IMPACT. ENGINEERED.

Health & Safety Specification

Mampuru Bulk Water Scheme
Package 1:Phase 1A -Reservoirs

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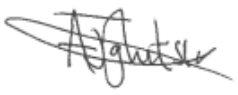
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1 OVERVIEW

1.1 Project Description (This project)

The project entails the construction of several new reservoirs and access roads, and refurbishment of inlet works to existing steel tanks in Mampuru villages. .

The Client (in terms of the Construction Regulations) for whom this project is executed is Sekhukhune District Municipality.

1.2 Purpose of this Document

The purpose of this Health and Safety Specification (H&S Specification) is to describe the minimum requirements for all personnel working on the project in order to achieve the primary H&S objective that all activities are completed with zero harm. This document was drafted by a H&S Agent on behalf of the Client, the person for whom the construction work is being performed (as per the Construction Regulations definition).

This H&S Specification was created using a risk-based approach considering:

- Legislative requirements
- A project H&S baseline risk assessment and
- The scope of work

This document is to be read and understood in conjunction with:

- The project specific technical specifications including geotechnical reports
- The project specific scope of works
- The relevant environmental study reports
- The Designers' inputs as far as materials and methods that cannot be eliminated during design and which need to be taken in to account by the contractors when pricing the work. Designers have the responsibility to mitigate H&S hazards on site as far as possible by means of design interventions. The aim being to reduce the health & safety risks on site to an acceptable level. Apart from the construction related hazards, designers play an important role as far as reducing H&S hazards during the operations and maintenance phases by designing out such hazards as far as possible. Designers need to be competent in their disciplines. Competent being defined as: adequate and relevant experience, knowledge, training, and qualifications.

This H&S Specification applies to all personnel working on the project including the Client, the Engineer (i.e. any Designers involved on the project), Principal Contractor(s) and Contractors engaged to perform work under a contract of works / services. This H&S Specification applies until final completion of all works under this project.

Compliance to the Occupational H&S Act and Regulations (Act 85 of 1993) and the Mine Health & Safety Act and Regulations (Act 29 of 1996) (where this is triggered) by all Contractors shall not be limited to the contents of this H&S Specification. **For that purpose, relevant legal requirements have not been repeated in this document again. It is the responsibility of each Designer and Contractor to know, understand and comply with the relevant legal requirements**.

A suitable, sufficiently documented and coherent H&S Management Plan (HSMP) is to be compiled by the Principal Contractor(s) and each Contractor based on the requirements of the reference documents listed below.

The Contractor's HSMP shall include the headings of this H&S Specification. The relevant headings start at paragraph 1.5. The Contractor's HSMP need not following the headings in the exact order as this

Specification. In this H&S Specification, the H&S requirements (the what) are stipulated. **Each Contractor in their HSMP need to indicate how they will arrange their processes, implement and manage each of these aspect in order to give effect to this H&S Specification**

1.3 Reference Documents

- Occupational H&S Act and Regulations (Act 85 of 1993)
- Compensation for Occupational Injuries and Diseases Act (Act 130 of 1993)
- Basic Conditions of Employment Act(,Act 75 of 1997)
- Labour Relations Act (Act 66 of 1995)
- Environmental Management Plans
- This project specific H&S Specification

1.4 H&S Returnables

Each Contractor shall provide the following documentation and information for tender evaluation purposes as part of their H&S documentation:

- Site organogram
- Valid letter of good standing with compensation commissioner (or similar insurer)
- Roles and responsibilities of legal appointees
- CVs of all legal appointees
- CVs of H&S Officer(s) as well as proof of registration with the SACPCMP of the safety officer(s)
- An indication whether H&S Officer(s) on this project are employed by your company, or whether they are outsourced.
- H&S Policy
- Copy of H&S management plan of previous similar project
- Copy of emergency response plan of previous similar project
- Copy of excavation safe work procedure and fall protection plan of previous similar project
- H&S risk management procedure, including risk matrix and risk assessment methodology used
- Copies of risk assessments of three high risk / main activities of previous similar project
- Five (5) year synopsis of incident statistics per project (a minimum of three projects) including LTIFR, first aid cases and medical treatment cases:
    - Budget for OHS on each of the projects
    - Actual cost for OHS on each of the projects
    - Total hours worked on each project
    - Fatal and lost time incidents to be described in detail
- Overview of selection process of Contractors
- Construction H&S file index
- Contractor's H&S disciplinary procedure
- Health, safety and security cost breakdown for this project for relevant items such as:
    - Medical fitness examinations
    - H&S administration – pre-mobilisation
    - H&S administration during contract
    - Induction training and the provision of an H&S induction officer
    - Personal protective equipment
    - Compliance to vehicle and mobile plant requirements
    - Security

- o H&S Officer(s) - note that each principal contractor appointed by the client would need to appoint a full-time H&S officer.
- o Signage
- o First aid
- o Emergency preparedness - take note of the minimum requirements set out under the emergency preparedness heading herein below
- o Specific training during contract
- o Other (please specify)

1.5 Suspension of Work

The Contractor agrees that the provisions of this specification are not negotiable, and any relevant violation is considered to be a material and substantial breach of Contract.

The Contractor must not cause, permit, or tolerate a hazardous, unsafe, unhealthy or environmentally unsound condition or activity over which it has control at the site.

If the Contractor becomes aware of any hazardous, unsafe, unhealthy or environmentally unsound condition, including a violation of any of the H&S requirements, he must immediately notify the Engineer. Thereafter, appropriate steps must be taken, where necessary and as agreed between the Engineer and the Contractor, to remove from site, eliminate, terminate, mitigate, and/or rectify the identified condition. If remedial action is not implemented within the agreed time, the Contractor has the responsibility to stop work related to the identified condition unless mitigations are implemented. Any condition or act that poses an immediate threat must always be stopped immediately.

Should the Engineer observe an unsafe act / condition or become aware of an unsafe act / condition, the Engineer must direct the relevant Contractor to stop the work related to that act / condition, immediately if it poses an immediate threat. Each Contractor must at their own cost and risk, modify its method of work in order to work safely to the satisfaction of the Engineer. See also Authority to Stop Work.

Where the Principal Contractor or any of its Contractors are identified to be performing work where the H&S controls are not implemented as required, the relevant Contractor shall be in breach of this Specification.

Continued non-compliance to legislation and project H&S requirements may result in site stoppages / suspension of work and potential breach of contract.

Non-conformance with project H&S requirements may result in disciplinary action against relevant individual(s) which may include removal from the project. Incidents involving but not limited to the following issues shall call into effect the agreed project disciplinary procedure which will be drafted by the Principal Contractor(s) for this project:

- Fatal risks identified on the project
- Drug and alcohol abuse at the worksite
- Breaching of isolation and tagging procedures
- Tampering / misusing or damaging of safety equipment
- Speeding – on and off site
- Any breach where a blatant disregard of H&S requirements is demonstrated
- Repeat high risk / serious deviations or non-conformances
- Horseplay

Instant removal (post investigation) shall apply for a deliberate high-risk action / unsafe behaviour. Contractors will also be required to have their own disciplinary procedures.

The requirements of this paragraph (Suspension of Work) must be included in an appropriate manner in the Principal Contractor(s) induction training content.

1.6 Definitions

Standard terms and definitions as defined in legislation is applicable and not repeated in this document.

For project-specific H&S terms and definitions, refer below:

- ALARP

As low as reasonably practicable.

- Contractor

Means an employer who performs construction work.

This includes the Principal Contractor, any of his [sub]-Contractors and Contractors employed by the Client or the Engineer on this project. Where reference is made to “each”, “any” or “all” Contractors this also includes the Principal Contractor and should be applied as such in the context of the relevant topic where found.

See also the definition for Principal Contractor.

- Consolidated H&S File

Means a H&S File containing all documentation required in terms of the OHS Act and Regulations, and must include a record of all drawings, designs, materials used and other similar information concerning the completed structure, a comprehensive and updated list of all contractors on site accountable to the Principal Contractor including the agreements between them and the type of work being done.

- Daily Safe Task Instruction (DSTI)

A DSTI is a “mini risk assessment” conducted daily by individual work teams prior to commencement of any work and involves the participation of all team members.

- Disabling injuries

A disabling injury is an injury that can result in temporary partial disablement, temporary total disablement, permanent disablement or serious disfigurement after all medical treatment and rehabilitation has taken place.

It disables a person from performing the tasks he/she was executing during the normal cause of his work and includes losing partial use of a limb or loosing part of a limb.

- Disabling injury frequency rate (DIFR)

$$DIFR = \frac{No\ of\ DIs\ x\ 200{,}000}{Exposure\ Hours}$$

- Emergency

An emergency is any abnormal and dangerous and/or environmentally threatening situation needing prompt action to control, correct and return to a safe condition. Types of emergencies include: - fire - explosion - chemical spills - gas leak (toxic or flammable) - natural events - impact events - civil disturbances - external events, e.g. loss of services or emergency in neighbouring facility – and significant discharge / spillage.

- First aid injury

A work injury requiring one-time treatment and any follow-up visit for observation, or minor scratches, cuts, burns, splinters and the like which do not normally require medical care. Such treatment is considered to be first aid even if administered or supervised by a medical practitioner.

- High-potential incident

A high-potential incident is a near miss or minor injury incident that could have resulted in a lost time injury or worse.

- Hot work

Any work which may introduce a source of ignition into an area in which flammable or combustible materials may be stored or handled or be present.

- Incident

An occurrence having the potential of causing injury, disease, plant, property, or environmental damage and includes a near-miss.

- Lost time injury (LTI)

Is an injury or occupational illness that results in one or more day / shifts away from work, excluding the day of the incident.

- Lost time injury frequency rate (LTIFR)

$$LTIFR = \frac{No\ of\ LTIs\ x\ 200{,}000}{ExposureHours}$$

- Medical treatment injury (MTI)

Is an injury or occupational illness which is not classified as lost time, but which results in loss of consciousness or medical treatment other than first aid.

- Medical treatment injury frequency rate (MTIFR)

$$MTIFR = \frac{NoofMTIsx\ 200{,}000}{ExposureHours}$$

- Near miss

An occurrence having the potential of causing injury, disease, plant, property, or environmental damage which must be reported forthwith to the immediate Supervisor.

- Planned Task Observation (PTO)

A PTO is an on-site interaction with an individual or team to verify competence and understanding of H&S and technical responsibilities in the carrying out of tasks. This is conducted by comparing behaviour of the individual or team with the requirements of the relevant task's method statement, risk assessment and safe work procedure.

- Principal Contractor

Means an employer appointed by the Client to perform construction work. The project may opt to appoint more than one Principal Contractor responsible for various disciplines/packages of work. A Balance of Plant Principal Contractor will be appointed who will be active on site from the commencement date of the construction stage and will remain on site through until completion of the works. This Contractor will co-ordinate the 'site-wide' H&S induction process as well as the medical services and security on site, among other duties.

Where reference is made only to Principal Contractor this should be applied as such in the context of the relevant topic where found. Where reference is made to 'Contractor' then this could also mean 'Principal Contractor'.

- Recordable injury

All injuries classified as:

- first aid injuries,
- medical treatment injuries,
- lost time injuries, and
- disabling injuries.

- Recordable injury frequency rate (RIFR)

$$RIFR = \frac{NoofRIsx\ 200{,}000}{ExposureHours}$$

- Visible Felt Leadership (VFL)

A process of formal and recorded H&S interactions between management and work force to implement and promote the H&S culture of the project.

2 SCOPE

The following infrastructure will be constructed under package 1:

- New 3.1 ML Kalkfontein Command Reservoir (Civil and Mechanical)
- Kalkfontein Chambers(Civil and Mechanical)
- Access Road to Kalkfontein Command Reservoir
- Existing Kalkfontein Tank A Inlet Works (Civil and Mechanical)
- Existing Kalkfontein Tank B Inlet Works (Civil and Mechanical)
- New 250kL Tsakane Steel Tank (Civil and Mechanical)
- Tsakane Chamber (Civil and Mechanical)
- Access Road to Tsakane Reservoir
- New 1.2 ML Mampuru Reservoir (Civil and Mechanical)
- Mampuru Chambers (Civil and Mechanical)
- Access Road To Mampuru Reservoir
- New 250kL Mampuru Extension Steel Tank(Civil and Mechanical)
- Mampuru Extension Tank Chambers (Civil and Mechanical)
- Access Road to Mampuru Extension Tank

The detailed scope of work to be carried out is identified in the contract documents.

3 H&S MANAGEMENT SYSTEM FRAMEWORK, POLICIES AND STANDARDS

3.1 H&S Policies

The Project is committed to the planning, implementation and maintenance of an effective H&S system. The project H&S Policy is attached as Appendix A. Each Contractor should align their policy, approach and management system accordingly.

3.2 Fatal Risk Controls

With consideration of the baseline risk assessment, the Principal Contractor shall demonstrate by means of a procedure how fatal risks will be managed through:

- The identification and evaluation thereof
- The control thereof (i.e. a permit system)
- Alignment of the emergency response plan

3.3 Contractors H&S Management System (HSMS)

Contractors' HSMS shall align itself with the requirements of this H&S Specification, the project H&S Policy and the project baseline risk assessment.

4 STRUCTURE AND RESPONSIBILITIES

4.1 Project organogram

Each Contractor must provide an organogram of all site personnel. The organogram must show the H&S functions and key line management positions which have H&S responsibilities. It must include legal references where applicable e.g. First Aider GSR 3(4).

Each Contractor shall make the necessary appointments for the construction phase. The list below indicates the minimum requirements and is not exhaustive.

These appointments must be in writing and responsibilities and duration (i.e. "to end of contract") clearly stated. This information must be communicated to and agreed with the appointees.

Copies of appointments must be submitted to the H&S Agent together with detailed CV's that clearly reflect qualifications, training, experience and knowledge. Previous work experience needs to clearly indicate the responsibilities and relevant OHS Act appointments the person held.

All key appointments will be approved by the H&S Agent and the Engineer and any changes of appointees or appointments must be communicated to the Engineer and agreed upon before being implemented. The H&S Agent and the Engineer reserves the right to conduct interviews with proposed key appointees.

Appointment description	**Appointment required in terms of**
Assistant construction manager	Construction Regulation 8(2)
Blasting supervisor	Explosives Regulation 12 and Construction Regulation 13(2)(k)
Bulk mixing plant supervisor	Construction Regulation 20(1)

Appointment description	Appointment required in terms of
Confined space supervisor	General Safety Regulation 5
Contractor	Construction Regulations 7(1)(c)
Construction H&S Agent	Construction Regulations 5(5)
Construction H&S Officer	Construction Regulations 8(5)
Construction manager	Construction Regulation 8(1)
Construction vehicle, mobile plant and machinery Supervisor	Construction Regulation 23(1)(d)
Construction welfare facilities supervisor	Construction Regulation 30
Construction work supervisor	Construction Regulation 8(7)
Construction vehicles and mobile plant operators (drivers)	Construction Regulation 23
Temporary electrical installation controller	Construction Regulation 24(c)
Emergency, security and fire coordinator	Construction Regulation 29
Excavation supervisor (including piling)	Construction Regulation 13(1)
Fall protection plan developer	Construction Regulation 10(1)(a)
Fall protection supervisor	Construction Regulation 10(1)
First-aiders	General Safety Regulation 3(4)
Fire-fighting equipment inspector	Construction Regulation 29(h)
General machinery competent person	General Machinery Regulations 2(1)
Hot works permit co-ordinator	H&S Specification Requirement
Incident investigator	General Administrative Regulation 9(2)
H&S Induction officer	Construction Regulation 7(5)
Lifting activity supervisor/ master rigger	Driven Machinery Regulations 18
Lifting machines and equipment inspector	Construction Regulation 22 and Driven Machinery Regulation 18(11)
Occupational H&S committee members	OHSA Section 19(1)
Occupational H&S representatives	OHSA Section 17(1)
Portable electrical equipment inspector	Electrical Machinery Regulation 9
Principal contractor	Construction Regulation 5(1)(k)
Rigger / Rope access supervisor	Construction Regulations 18(1)(a)
Risk assessor	Construction Regulation 9(1)
Scaffolding supervisor	Construction Regulation 16

Appointment description	Appointment required in terms of
Scaffolding inspector	Construction Regulation 16
Scaffolding erector	Construction Regulation 16
Stacking and storage supervisor	Construction Regulation 28
Subordinate construction work supervisor	Construction Regulation 8(8)
Suspended platform supervisor	Construction Regulation 17(1)
Suspended platform performance tester	Construction Regulation 17(8)(c)
Temporary works designer	Construction Regulation 12(1)
Temporary works supervisor	Construction Regulation 12(2)
Traffic safety officer	H&S Specification Requirement

The following positions (where applicable) for each Contractor, have specific H&S roles and responsibilities, which are outlined in detail in Appendix B. These need to be clearly communicated to the individuals and may be included in their OHS Act appointment letters where relevant:

- Project Director, Project Manager or other similar person that have overall responsibility for this project for all aspects of it not just health, safety and environment
- Construction Manager / Assistant Construction Manager(s)– full-time on site and in his absence an alternate must be appointed. The Construction Manager may not be appointed for any other site.
- Construction Supervisor(s)
- Construction employees
- Sub-Contractors
- Site H&S Officer

4.2 H&S Personnel Resourcing

H&S personnel appointed to the project will have the necessary core competencies, skills and experience to effectively manage all aspects of H&S on the project. Contractors shall ensure their H&S personnel are appointed as follows:

- A full-time H&S Officer to be appointed by each Principal Contractor on this project. Sub-contractors will need to appoint part-time H&S Officers who will need to be involved on the project as agreed between the Client/owner's H&S Agent and the applicable Principal Contractor. The Principal Contractors' and sub-Contractors' H&S Officers shall have the necessary registration with the SACPCMP (South African Council for Project & Construction Management Professions).

The H&S Agent and the Engineer will evaluate all Contractor's organograms, CV's and resourcing and reserves the right to require the appointment of additional H&S staff.

4.3 Authority to Stop Work

All project personnel have the authority to place H&S considerations above other priorities. This extends to the authority of not doing something, unless it can be done safely, without posing risk to themselves, others or the environment.

This authority must be communicated to all project personnel at project inductions and regularly reinforced during group gatherings, toolbox talks and pre-start meetings. The Contractor must provide proof in his induction content that this authority was communicated to all.

Penalties may be imposed on the Principal Contractors and Contractors for ongoing non-compliance with the provisions of the Client's H&S Specifications, the Principal Contractor's H&S Management Plan as well as the relevant sub-Contractor's H&S Management Plan and site H&S procedures and rules, including: **Owner's Engineer rules, procedures, and specifications; Client rules/protocols**. **The Principal Contractor can also impose penalties on its sub-Contractors and on other stakeholders within its area of responsibility.**

5 H&S LEGAL AND OTHER REQUIREMENTS

The Client appoints Principal Contractors in terms of the Construction Regulations who in turn may appoint Contractors.

All Contractors' primary legal obligations are to:

- Comply with all relevant H&S legislation
- Comply with any specific obligations imposed on duty holders
- Comply with all contractual requirements for H&S and the environment
- Comply with relevant industry standards and codes of practice contingent with the scope of works
- Consider the lessons learned and recommendations from various authorities with respect to the scope of works.

6 H&S PERFORMANCE MEASUREMENT

H&S Key Performance Indicators (KPI's) have been established for the project to ensure that both lagging and leading indicators are being measured and tracked. The Table below defines the KPIs for the project. The Principal Contractor shall communicate status of KPI's to the Engineer and other stakeholders monthly with incidents being reported forthwith.

The Principal Contractor will review the project statistics at the end of each reporting period and on a three-monthly basis identify trends within the reports. Any trends identified and actions arising will be included in the project Deviation Register. Both the trend reports and the actions arising will be presented formally to the H&S Agent and the Engineer.

Table 6-1: H&S KPI's

See also Reporting requirements in this H&S Specification

Indicator Type	Criteria	Responsibility	Measure
Leading indicators	Audit of Contractors	Principal Contractor	Within 30 days of mobilisation and then monthly > 95% compliance score to be achieved Contractors achieving <80% = stop work
	Training needs analysis and compliance All staff	Client, the Engineer, Principal Contractor and Contractors	Achieve 90% compliance with identified training requirements - within 2 months of mobilisation Achieve 100% compliance with identified requirements by the 3rd month *Note: Statutory training requirements and competencies to be at 100% at all times.*

Indicator Type	Criteria	Responsibility	Measure
	Principal Contractor H&S audits	H&S Agent	Within 30 days of mobilisation and then monthly
	H&S management plan review	Principal Contractor	Every 6 months
	Planned Task Observations (PTO's)	Principal Contractor and Contractors	100% execution of scheduled PTOs *Note: Schedule to be approved by the Engineer and H&S Agent.*
	Safety interactions / Visible Felt Leadership	Client, the Engineer, Principal Contractor and Contractors	100% execution of scheduled interactions *Note: Schedule to be approved by the Engineer and H&S Agent*
	Pre-start meetings / Daily Safe Task Instructions (DSTI's)	Principal Contractor and Contractors individual work teams facilitated by the relevant Construction Supervisor	For each work team before each shift commences and when the daily activities change
	Toolbox talks	Principal Contractor and Contractors	Daily / Weekly
	Project H&S committee meetings	The Engineer, Principal Contractor and Contractors	Monthly
	Method statements, Risk assessments and Safe Work Procedures	Principal Contractor and Contractors	All tasks at all times
	Hazard and near miss reporting.	All personnel	100% of all near misses reported
	Deviation Register	Principal Contractor	Maintained daily (*Digital app, or excel s/sheet)* 100% of recommended critical actions (from high or critical risks) closed out by nominated date. Weekly reporting of status 3-monthly trends
	Suggestions / initiative scheme implemented	Principal Contractor	Monthly suggestion topic rewarded
	Repeat significant deviations (with the potential for medical treatment or worse)	Principal Contractor	Nil repeat significant deviations
	Repeat significant incidents (with a classification of medical treatment or worse)	Principal Contractor	Nil repeat significant incidents
Lagging indicators	Fatalities or serious disabling, immobilisation injury	All stakeholders	Zero
	Disabling injury frequency rate (DIFR)	All stakeholders	0
	Lost time injury frequency rate (LTIFR)	All stakeholders	0
	Medical treatment injury frequency rate (MTIFR)	All stakeholders	≤0.5
	Total recordable injury frequency rate – the total number of first aid cases, medical treatment cases, lost time injuries and disabling injuries	All stakeholders	≤1.5
	Occupational illness	All stakeholders	Zero
	Property damage (PD)	All stakeholders	≤2 per month for project

6.1 H&S Improvement Planning

The project strives to objectives and targets in order to achieve the goal of ZERO HARM.

Where, in the opinion of the Client, the Engineer or H&S Agent, certain aspects of H&S need improvement, an improvement plan shall be compiled by the Principal Contractor to address the situation. An example is included as Appendix E.

The improvement plan shall be drafted with the involvement of at least the following:

- Section 16.2 appointee
- Construction Manager
- Relevant discipline competent person(s) e.g. excavation supervisor, fall protection plan developer, mobile plant operator, etc.
- H&S Officer
- Relevant discipline supervisor(s)
- H&S Representatives

The method of communicating the contents of the improvement plan to the project team shall be described in the Principal Contractor's HSMP.

7 H&S COMMUNICATION AND CONSULTATION

7.1 External H&S Communication

External communication is any communication across the boundaries of the project. These include, but are not limited to:

- To and from the Client
- To and from any regulatory authorities
- To and from parent organisations
- To and from landowners

The Principal Contractor is responsible for establishing, maintaining and providing the initial contact point for communication and reporting requirements with external agencies such as mines, inspectorate and emergency services agencies.

Communication between the project and the parent organisations will consist of, but are not restricted to:

- Incident notifications
- Safety alerts
- H&S reporting
- General advice
- Audit reports

7.2 Internal Communication

The communication of H&S matters occurs via the Principal Contractor's Construction Manager and the Engineer.

The Construction Manager will ensure that appropriate communication and consultation processes are established and maintained to facilitate effective consultative mechanisms involving workers, Contractors, staff and H&S Representatives. The following table shows the consultation and communication mechanisms that will be utilised on the project. All consultation and communication mechanisms shall be documented, and attendance registers / proof shall be kept where necessary.

Table 7-1: CONSULTATION AND COMMUNICATION MECHANISMS

Strategy	Purpose	Participants	Frequency
DSTI's	Forum for planning of daily site activities, opportunity to discuss H&S hazards, risks, previous incidents, changes to work / areas. Opportunity for workers to ask questions.	All personnel	Every shift
Toolbox talks	Discussion on site H&S performance and presentation of H&S topics.	Principal Contractor and Contractors work groups, facilitated by Supervisor	Daily / Weekly According to schedule
Principal Contractor and Contractors H&S meeting(s)	To discuss the H&S performance including incidents and audit outcomes, the suitability of the project's H&S management system arrangements and to provide strategic direction. The evaluation of internal and external changes that may impact on the effectiveness of the project's H&S management program. The identification of opportunities for improvement to ensure a continuation of the level of effectiveness of their own HSMPs and control of risks associated with forthcoming activities. Incident prevention and strategies to achieve zero harm.	Principal Contractor and Contractor Management including H&S staff	Monthly
H&S committee	To discuss H&S performance, issue resolutions, improvements.	Representatives from all key stakeholders including elected H&S representatives and management representatives (	Monthly
H&S interactions (Visible Felt Leadership)	To have a positive safety interaction with workers in order to reinforce the correct culture.	Principal Contractor and Contractors' CR8(1)/CR8(2), S16(2), PM and other line management, the Engineer's staff and Client project team.	According to approved schedule
H&S notice boards – Principal Contractor to supply at site offices & laydown areas, eating areas and camp sites	To display and communicate H&S related information Reports of significant incidents H&S alerts Milestones in H&S performance Emergency preparedness information Policies Awareness information on specific relevant topics e.g. dirt road safety.	Principal Contractor and Contractors	To be updated as information is provided
H&S alerts	To communicate incidents, near misses and hazards that has occurred.	Issue to all project personnel	As required
Safety stand downs	To enable the project manager, the owner's Engineer, the H&S Agent, or one of the Principal Contractors and other relevant leaders to address the workforce as a whole group.	All project personnel including all Contractors.	As required. Following significant events. To celebrate success.

7.3 Safety Moment

Every formal meeting with 4 or more attendees shall commence with sharing a safety moment. A safety moment is a process whereby relevant H&S information is shared with the group as a constant reminder of the implemented safety culture. Examples can be work related or not.

7.4 Visible Felt Leadership (VFL)

A positive safety culture will be a focal point for the successful delivery of the project H&S management program.

It is intended to have all Contractors implement and display the correct leadership behaviour that recognises both safe and at-risk behaviours. The program shall include but not be limited to:

- Routine in-field safety interactions and conversations with project personnel at their workplace to discuss safe and at-risk work practices as they apply to the work being undertaken
- Immediate recognition of safe behaviours
- Immediate agreement on what corrective actions are required to address at risk behaviours

The purpose of VFL is to influence:

- A high level of H&S awareness amongst the site workforce and management
- Regular recognition and praise for safe practices
- Immediate modification of at-risk behaviours

The management levels required to participate in VFL's (safety interactions) are the Principal Contractor and Contractors' CR8(1)/CR8(2), S16(2), Project Managers as well as other line management. This will be according to a schedule that each Contractor is responsible to include as part of their HSMP. The Principal Contractor is responsible to draft the guidelines and provide the training regarding safety interactions.

7.5 Reward and Incentive Schemes

Each Contractor shall in his HSMP propose a reward and incentive scheme in support of the project safety culture and H&S performance improvements. They will be designed and implemented so that H&S is not compromised to maximise any material or financial reward.

Reward and incentive schemes should not be linked to any lag indicator (incident statistics).

7.6 Communication mechanisms

Each contractor to provide for reliable and consistent communication between the site office and the work team in the form of e.g.:

- Cell phones
- WhatsApp groups
- Two-way radios where cell phone reception is unreliable or absent.

8 HAZARD IDENTIFICATION AND RISK MANAGEMENT

H&S risk management is a systematic method of identifying H&S hazards and existing controls which are then assessed (qualitatively or quantitatively) to evaluate the level of risk relating to a particular hazard and to determine the best control method to achieve a consistent tolerable or "as low as reasonably practical" (ALARP) level of risk for each hazard across the project.

Hazard identification and risk management at various levels and stages of this project are:

- Level 1: Baseline risk assessment and risk register.
- Level 2: Task specific risk assessment and coupled to safe work procedures.
- Level 3: Continues / pre-task hazard assessment (DSTI's).
- Level 4: Issue based risk assessments (e.g. after incidents).
- Level 5: Specialised studies (e.g. risk workshops).

8.1 Level 1: Baseline Risk Assessment

The Principal Contractor and each of the Contractors shall ensure that all operations and activities applicable to the project are covered by a formal high-level Baseline Risk Assessment process where potential hazards are identified, analysed, evaluated, controls implemented (applying the hierarchy of controls) and communicated to relevant parties involved. Consideration must be given to the project Baseline Risk Assessment, attached as Appendix D.

Each Baseline Risk Assessment shall be reviewed regularly by each of the relevant Contractors during the life of the project and will remain the higher-level document pertaining to identification of hazards. The Contractor's Baseline Risk Assessment process must identify all potential emergencies including those where the public and the community might be involved. Security as well as mental health issues must be included.

8.2 Level 2: Task Specific Risk Assessments

A task risk assessment is the examination of steps within a given job or task, identification of hazards associated with the task and evaluation of controls applying the hierarchy of controls.

Task specific risk assessments must be developed by work crews for all work-related task such as loading / off-loading, lifting machinery operations, erection and dismantling of scaffolding, manual handling and working at heights, welding and casting of concrete to name a few. Provided there are no changes to the work group, work process, work environment or to plant or equipment, a risk assessment may remain valid for the duration of the project but must be reviewed daily by the work team via the DSTI process.

The nominated responsible person(s) (e.g. CR8(1), CR8(2), CR8(7) and CR8(8) as is applicable) are responsible for identifying tasks for conducting task risk assessments with their teams relevant to the tasks / activities. The appointed Risk Assessment Competent Person must facilitate the risk assessments, not perform them on his own. Task Risk Assessments must be signed off by the Risk Assessment Competent Person and relevant CR8(1), CR8(2), CR8(7) and CR8(8) appointees.

The outcome of the task specific risk assessment needs to be communicated to the relevant work teams (communication attendance register) and copies of these must be available on site at all times where the work is performed.

Each task shall have its own risk assessment. If an existing task risk assessment is being used, it shall be reviewed in detail for the project before being reapplied. All task risk assessments shall be submitted to the H&S Agent and the Engineer for review two weeks (10 working days) prior to commencing the task. For this purpose, each Risk Assessment must have a unique number and formally submitted via document control. The matching safe work procedures will have corresponding numbers.

Each Contractor shall maintain a register of approved risk assessments. No work shall commence without a H&S Agent and Engineer reviewed risk assessment.

8.3 Level 3: Continuous Risk Assessments / DSTI's /

A Daily Safe Task Instruction (DSTI) is a simple and effective tool for the management of hazards and risks within the workplace. It enables Supervisors, work teams and individual employees to quickly assess a situation for hazards and to introduce controls to make the situation safe. A DSTI's is based on a simple checklist / evaluation tool that is completed prior to commencing work. It can be made task specific, rather than using a generic one for all activities.

All Contractors will be trained in the use of the DSTI's as part of the project induction. The DSTI shall be completed daily prior to commencing work related tasks. Due consideration must be given to changes or deviations from normal practice, changes in the work environment e.g. terrain, weather and health hazards when conducting the DSTI's.

Where a DSTI identifies a hazard or risk not previously identified in a risk assessment, the Supervisor or nominated person shall ensure the existing task risk assessment and/or baseline risk assessment is amended and revised as necessary. All visitors to a particular work area must also sign the DSTI(s) for that area as acknowledgement of identified hazards.

(D)08. Pre-work Hazard Identification and Risk Assessment.

8.4 Level 4: Issue-based Risk Assessment

An issue-based risk assessment will be conducted as soon as an issue arises. They are appropriate for the management of change in the workplace, for example:

- When a high-potential near-miss or other incident occurred
- New machinery / equipment is introduced into the workplace
- Processes or procedures change
- New knowledge regarding a chemical substance comes to light, to name a few.

The same technique and approach is applied as when task specific risk assessments are conducted. The outcomes of all issue-based assessments will be incorporated into the baseline risk assessment. Relevant task specific risk assessments need to be drafted or updated where relevant.

8.5 Level 5: Specialised Studies

Specialised studies must be facilitated by a person utilising specialised risk management tools and methods. This can typically include critical H&S risks, strategic business management, project risk workshops, Hazop studies, Hazcon studies, change management and safety in design issues where controls are required to achieve ALARP and / or approval to proceed must be given by the Engineer. The Principal Contractor will be instructed to convene the relevant risk workshop / studies at the discretion of the Engineer.

8.6 Potential Hazards / Near Miss Reporting

All identified potential hazards and near misses will be reported, in addition to the hazard identification and risk assessment processes already described, using a form specifically drafted for this purpose by the Principal Contractor. The form must be customised / adjusted to suit project specific needs. The form can be filled in by any person, signed off by the relevant Supervisor and submitted to the Principal Contractor's H&S staff on site. The purpose of this is to identify new items that need to be added to the baseline or task specific risk assessments.

8.7 Risk Assessment Reviews

Each Contractor shall conduct and document risk reviews to support their planning process. Planned review dates must be included in the Risk Assessment Register. Risk assessment reviews must also be after any incident associated with a particular risk assessment document.

8.8 Construction Vehicle and Mobile Plant Risk Assessments

To ensure an item of plant is fit for its purpose, Contractors shall develop or obtain documented hazard identification, risk assessment and risk control processes for all construction vehicles and mobile plant (including hire equipment and lifting machines) as follows:

- Before first use at the project site
- After major service
- After modification

- Before use in an unusual operating mode

Such risk assessments must be undertaken by suitably qualified and experienced persons, documented and records retained by the Contractors. Together with the assessment of construction vehicle and mobile plant risks, the contractors will need to undertake a comprehensive traffic study incorporating construction vehicle hazards impacting the local community among other hazards. This study would need to be at the time of drafting the site-specific health & safety plan, before commencing work on site. Risk assessments for equipment mobilising to the project site shall consider:

- Loading & off-loading of the equipment
- Entanglement of lifting slings or other loose items in moving parts
- Crushing or striking by moving or falling objects
- Cutting or stabbing by sharp objects
- High pressure fluids
- Electrical shock or burns
- Earth leakage devices
- Burns from hot or cold surfaces
- Slips, trips and falls
- Ergonomic design of access and egress (three points of contact to be maintained)
- Seating (including operator safety restraints)
- Vibration
- Noise
- Exhaust fumes
- Operating instruction and warning signage
- Functionality of safety devices
- Compliance to legal requirements
- Line of sight and operator blind spots.

During the assessment of risks, the identification of hazards shall consider:

- Loading and off-loading activities
- When operating under normal conditions
- Abnormal or unusual operations
- Maintenance and servicing operations
- Decommissioning of plant or equipment.

Particular attention will be given to documented plant and equipment risk assessments when developing control measures to manage procurement, operations, servicing, maintenance and replacement / decommissioning of plant and equipment.

Principal Contractors and Contractors shall ensure that plant and equipment risk assessments are recorded and retained in their respective registers at the project site and made available to all persons and for audit purposes.

The H&S Agent and the Engineer reserves the right to have any of the Contractors remove items of plant from the project site that does not comply with legal requirements, manufacturer’s requirements, the Contractor’s own requirements and the requirements of this H&S Specification.

All plant and equipment need to be inspected and approved by the Principal Contractor’s GMR(2) appointee prior to being brought onto the premises. The process and documentation to be used to form part of the Principal Contractor’s HSMP and File. This will apply to all construction vehicles, mobile plant, and machinery, lifting machines, equipment and specialised tools.

A dossier containing the following information shall be available in the cab with each respective construction vehicle, mobile plant, lifting machine, crane or similar plant:

- Updated and signed risk assessment and safe work procedure for that specific type of equipment
- Copy of latest inspection report (daily inspections)
- Permit issued by workshop GMR 2 appointee (where applicable)
- Maintenance plan / schedule
- Test certificate (where applicable)
- Pressure test certificate (where applicable)
- Comprehensive report in the case of lifting machine
- Rope certificate in the case of lifting machine
- 3, 6 and 12 monthly inspections for slings, chains, hooks, or similar.

9 METHOD STATEMENTS AND SAFE WORK PROCEDURES

9.1 Method Statements

The Contractor shall compile method statements and submit same to the Engineer for review at least 10 working days prior to the work commencing.

The Engineer shall review the method statements and the following persons shall sign off on this document:

- Resident engineer
- Assistant resident engineer (relevant to his/her area of operations)
- H&S Manager

Method statements shall be developed for all high risk and non-routine tasks. Method statements shall include:

- Extent and scope of the work
- Specific sequential steps / instructions on how to perform the work
- Reference to required plant, tools and equipment
- Potential hazards
- High level control measures relating to those hazards
- Reference to all relevant risk assessments and safe work procedures for the specific tasks that will make up the work of a specific method statement
- Reference to applicable legal appointments and competencies required.

9.2 Safe work Procedures

The Contractor shall compile safe work procedures and submit same to the Engineer for review at least 10 working days prior to the work commencing.

The Engineer shall review the safe work procedures and the following persons shall sign off on this document:

- Resident engineer (relevant to area)
- Assistant resident engineer (relevant to his/her area of operations)

Safe work procedures shall include reference to:

- Control measures to mitigate or reduce risk
- Supervisory requirements, including level and frequency
- Responsibilities of competent persons and/or legal appointees
- Required personal protective equipment

- Required plant, tools and equipment
- Inspection regime relating to plant, tools and equipment
- Relevant risk assessment(s)
- Specific exclusions or pre-requisites (i.e. specific medical certificates of fitness or competencies)
- Emergency management procedure, and any special arrangements required for the task

10 OPERATIONAL CONTROL (CONSTRUCTION)

The following table lists those activities for which system procedures or safe work procedures will be required together with the required supporting documents. The list is not exhaustive, and all Contractors must produce a similar complete table in their HSMP referencing all relevant topics, system procedures and safe work procedures that will be applied on this project. A topic might be covered by more than one safe work procedure if complex e.g. Mobilisation and Site Establishment.

Inclusive of specific supporting documents that are legal requirements (e.g. first aid box inspection checklist), Contractors will indicate all relevant supporting documents they intend to use for each of the system and safe work procedures.

10.1 Operational Control (Construction) – Health

Table 10-1: OPERATIONAL CONTROL – HEALTH

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents (minimum)
Abrasive Blasting and Cleaning	Regulations for HCA (2020) General Safety Regulations 5	The purpose of this SWP is to establish H&S requirements for workers and Contractors when carrying out abrasive blasting and cleaning activities. This document must include the health hazards, environmental impacts and confined spaces where applicable. A permit system must be incorporated.	Topic specific pre-start checklist Permit to work
Hazardous Chemical Agents	Regulations for HCA (2020)	This SWP applies to all activities where workers and Contractors are storing and handling hazardous chemical substances.	SDS Approval Application Form
Dust Management	Regulations for HCA (2020)	This SWP applies to all activities that generate or has the potential to generate dust.	Dust Management Plan Form
Fatigue Management	Basic Conditions of Employment Act	The purpose of this SWP is to establish the minimum H&S requirements for managing fatigue related to project activities. These include, but are not limited to work that requires Normal scheduled activities Intense concentration or manual activity, Shift work, Night work, Driving vehicles	Fatigue Hazard Checklist Monthly Labour Return Form
Fitness for Work	Construction Regulation 7(8)	The purpose of this SWP is to ensure that workers perform their activities in a fit state.	Risk profile
Food Safety		This SWP applies to all project related activities where food is prepared, served, stored and consumed.	Food Safety Checklist
Hot Work, Cutting and Welding	Construction Regulation 29 General Safety Regulation 9	This SWP applies to all activities involving hot work, cutting and welding carried out. This document must reference confined spaces if applicable. A permit system must be incorporated.	Hot Work Permit Welding Fume Assessment Form
Noise Management and Hearing Conservation	Noise - Induced Hearing Loss Regulations	This SWP applies to all plant, systems and work areas where there is a risk of hearing loss from noise exposure. Examples include but are not limited to: Operation of noisy plant Working in an area where there is noisy plant Workers / Contractors who must pass through noisy areas	Hearing conservation plan
Occupational Hygiene	Regulations for HCA (2021)and Environmental Regulations for Workplaces	This SWP applies to all areas that present a risk to the health of workers and Contractors through occupational health risk exposure.	Assessment of potential exposure Medical surveillance plan Health Monitoring Plan Form
Personal Protective Equipment (PPE)	General Safety Regulation 2	This SWP applies to all activities where personal protective equipment is required on the project. It provides guidance on the selection, use, training and maintenance of personal protective equipment.	Project Personal Protective Issue Register

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents (minimum)
Spray Painting	General Safety Regulation 4	This SWP applies to all spray-painting activities carried out on the project.	Permit to Work Spray Painting Pre-Start Checklist
Drugs and Alcohol Management	General Safety Regulation 2A	The focus of the procedure is the management of drugs and alcohol, and the applicable minimum standards, testing methods and management of results	Project Drug and Alcohol Testing Program Form

10.2 Operational Control (Construction) – Safety

Table 10-2: OPERATIONAL CONTROL – SAFETY

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents
Access Control	General Safety Regulation 2C	The purpose of this SWP establishes the minimum requirements for project personnel and vehicles accessing the work site along the entire project. It shall also regulate the control of public and animals, as well as designated entrances, flag personnel and arrangements over weekends and holidays.	Workplace Inspection Checklist Traffic Management Plan)
Barriers, Signage and Delineation	Construction Regulation 13, 26 and 27	The purpose of this SWP is to establish H&S requirements for when carrying out design and installation of barriers, signage and delineation.	Barriers, Signage and Delineation Checklist
Geotech investigation activities	Construction Regulation 13 & 23	This SWP would need to include the elements associated with the Geotech investigation activities which would include excavation work, drilling inspection holes, the use of the drilling rigs and associated plant and equipment, and the like.	Mobile Plant and Machinery Inspection Checklists. Excavation and Trenching Permit Inspection checklists & safe declaration of excavations Excavation and Trenching Log Form
Blasting Explosives	Explosives Act	The purpose of this SWP is to establish the minimum H&S requirements for the management of blasting and explosives. This SWP applies to all activities that may involve the management of explosives as part of blasting activities. The focus of the explosives aspect of the procedure is the management of risks associated with use of the explosives. A permit system must be incorporated.	Blast Management Plan Form
Preparation of roads to site(s)	Construction Regulation 23 SARTSM Road Note 13 where applicable	This SWP would need to set out the procedures relating to the widening of existing roads and the construction and upgrading of new and existing roads to site camps, the solar PV site, BESS location, and the WTG sites.	Construction Vehicle and Mobile Plant Inspection Checklists. Traffic Management / Accommodation Plan (for road signage and works delineation)
Camp Management	Construction Regulation 30 Facilities Regulation	The purpose of this SWP establishes the minimum H&S requirements associated with occupying a project camp.	Camp Set-up Checklist
Confined Spaces	General Safety Regulation 5	This SWP applies to all activities where a person may enter a confined space. A permit system must be incorporated.	Confined Space Classification Tool Form Project Confined Space Register Confined Space Permit to Work

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents
			Gas monitor calibration certificate
Cranes and Hoists	Driven Machinery Regulation 18 Construction Regulation 22 and 23	This SWP applies to all activities relating to the management and operation of cranes and hoists.	Crane and Hoist Pre-Mobilisation Checklist Crane and Hoist Pre-Start Inspection Checklist Hoist Pre-Start Inspection Checklist Crane and Hoist Register Template Lifting Plan Template Form
Demolition work	Construction Regulations 14	This SWP applies to all demolition activities which involve dismantling or demolishing a structure or part of a structure that is load bearing or otherwise related to the physical integrity of a structure.	Demolition Work Planning Checklist
Electrical and Compressed Air Portable Power Tool Use	Pressure Equipment Regulation	This SWP applies to all activities relating to the management and use of electrical and compressed air portable power tools.	Portable Power Tool Register
Excavation and Trenching	Construction Regulation 13	This SWP applies to all excavation, trenching, digging and ground penetration activities. A permit system must be incorporated. The Excavation Competent Person will be required to have a qualification in the geotechnical field.	Excavation and Trenching Permit Inspection checklists & safe declaration of excavations Excavation and Trenching Log Form
Piling for Foundations	Construction Regulation 13 & 23	This SWP applies to the process of piling activities which would include the use of a piling rig, the placement of concrete and the associated reinforcing steel, and the trimming of such concrete to connect the pile with the concrete base structure.	Construction Vehicle and Mobile Plant Inspection Checklists.
Explosive Power Tool Use	Construction Regulation 21	This SWP applies to all activities where explosive power tools (EPT) are used. Examples of when explosive power tools may be used include fixing formwork to concrete, suspending ceilings, conduit fixing, fixing steel decking to structural steel. A permit system must be incorporated.	Pre-Start Explosive Power Tools Checklist Explosive Power Tool (EPT) Charges Record Register
Fixed Ladders Steps and Elevated Walkways	General Safety Regulation 13	This SWP applies to all activities relating to the design, installation and / or use of fixed ladders, steps and elevated walkways. A permit system for any work at height will be implemented.	Fall Protection Plan Permit to Work Inspection checklists
Scaffolding, Formwork, Support work and other temporary works.	Construction Regulation 12 & 16	This SWP applies to activities involved in the design, inspection and approval of temporary works, as well as the supervision of temporary works operations.	Temporary works inspection and approval form Inspection Checklist
Concrete batching and concrete to work locations	Construction Regulation 20	This SWP applies to the installation and use of the concrete batch plant (bulk mixing plant) as well as the management of concrete and other structures.	Batch plant inspection checklist

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents
Structures	Construction Regulation 11	This SWP applies to ensuring that concrete and other structures are constructed in accordance with the approved designs and are inspected during construction to ensure that such structures meet the design specifications.	Structural drawings Daily inspections of concrete until adequately cured
Heavy Vehicle Operation	Construction Regulation 23	This SWP applies to all activities relating to the management and operation of all heavy vehicles.	Heavy Vehicle Checklist Heavy Vehicle Register Crane and Hoist Inspection Checklist Lifting Equipment Checklist PMP Inspection Checklist Dossier Lifting Plan Template Form Traffic Management Plan
High Voltage Electrical Work Earthing and Testing	Electrical Installation Regulations Construction Regulation 24	The purpose of this SWP is to ensure the H&S when conducting High Voltage (HV) electrical work earthing and testing activities. A permit system shall be incorporated.	HV Earthing and Testing Equipment Register Permit to Work
Isolation, Lock out and Tag-out	General Machinery Regulation 4	The purpose of this SWP is to control hazards associated with working on live system and to control energies prior accessing the area or equipment. This SWP applies to all activities being carried out involving the isolation, lockout and tag out of energy sources and simultaneous operations (SIMOPS) where relevant.	Lock-out and isolation permit Isolation Management Plan Register for SIMOPS
Journey Management		The purpose of this SWP is to control the hazards related to travelling long distance / time. This SWP applies to all driving activities that are carried out as part of the project, and are either > 2 hours in duration, that are non-route or a first-time trip to an unknown / unfamiliar location.	Journey Management Plan Template
Lifting Equipment	Driven Machinery Regulation 18	The purpose of this SWP is to ensure the use of correct lifting equipment as well as its maintenance. It applies to all activities relating to the management, operation and use of lifting equipment.	Pre-Start Lifting Equipment Checklist Lifting Equipment Register
Light Vehicle Use	Construction Regulation 23	The purpose of this SWP is to control all activities relating to the management and use of light vehicles as part of the project. Roll-over protection will be required for all construction vehicles where this risk exist.	Drug and Alcohol Policy Operational Practice – Travel Policy Light Vehicle Inspection Checklist The installation of speed monitoring devices in construction vehicles
Low Voltage Electrical Work and Testing	Electrical Installation Regulations Construction Regulations 24	The purpose of this SWP is to control all activities relating to the management and operation of Low Voltage (LV) Electrical Work and Testing activities.	LV Earthing and Testing Equipment Register
Materials Loading and Unloading	Construction regulations 23 & 27	The purpose of this SWP is to control the following materials loading and unloading activities: Loading and Unloading of all materials onsite Loading and Unloading of all equipment onsite Safe operation of all lifting equipment to achieve the above	Materials Loading and Unloading Checklist Pre-Delivery Checklist

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents
		Safe operations with loading and unloading areas Preventing service providers of off-loading equipment and material with non-compliant vehicles and lifting equipment.	
Mobilisation and Site Establishment		The purpose of this SWP is to establish the minimum H&S requirements and outline the required standards for workers and Contractors when managing and undertaking mobilisation and site Establishment activities.	Project Risk Register Safety Management Plan Template
On-site Refuelling, Servicing and Maintenance		The purpose of this SWP to address the hazards and establish minimum control requirements for refuelling, servicing and maintenance of vehicles and plant. Refuelling includes the following: At a fixed or mobile location where minor storage of fuels are present (e.g. petrol, diesel) At a fixed location where fuel is stored in a bulk storage tank At locations on a project site where fuel is stored in mobile bulk storage tanks	Dangerous Goods and Hazardous Chemicals Register Fire risk assessment by Principal Contractor
Portable Ladders and Work Platforms	General Safety Regulation 13A	This SWP applies to all activities relating to the use of a portable ladder or work platforms.	Portable Ladder and Work Platform Inspection Checklist
Construction vehicles and mobile plant.	Construction Regulation 23	This SWP applies to all activities relating to the management and operation of construction vehicles and mobile plant. Roll-over protection shall be required for all construction vehicles.	Powered Mobile Plant Pre-Mobilisation Checklist Powered Mobile Plant Pre-Start Inspection Checklist Powered Mobile Plant Register Powered Mobile Plant Risk Assessment Template Form Vehicle and Powered Mobile Plant Movement Plan Form The installation of the speed monitoring devices in construction vehicles
Prevention of Falls from elevated positions and Falling Objects	Construction Regulation 10	This SWP applies to all working at heights activities carried out on the project whenever work is performed above a permanent floor level, and / or the situation exists where tools, equipment or anything else can fall or be dropped from any height. It covers requirements for: Designing, constructing, using, inspecting, servicing and disposing of work platforms. SWP / risk assessment for all work done at height. Control measures using the hierarchy of controls. Fall prevention, fall-restraint and fall-arrest equipment. A permit system must be incorporated.	Fall protection plan Personal Fall Protection Equipment Register Working at Height Permit Permit to Work
Project Site Security Access by Community Access by domestic/ farm animals		This SWP applies to all activities relating to project site security.	Project Site Security Risk Assessment Form

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents
Steel Fixing and Structural Steel Works		This SWP applies to all activities relating to steel fixing and structural steel works on the project.	Bending schedule
Temporary Electrical Installations	Electrical Installation Regulations Construction Regulation 24	This SWP applies to all activities relating to the management and operation of temporary electrical installations.	Weekly and daily inspection checklists Temporary Electrical Equipment Register COC
Traffic Management/ Man machine Interface	Construction Regulation 23 and 27	This SWP applies to all activities that may involve the interaction of vehicles, plant, workers and pedestrians. The focus of the procedure is the management of risks associated with ensuring that traffic hazards are adequately identified and controlled, and that obligations associated with the use of gazetted roads, and any roads associated with access to the site.	Traffic Management Checklist Traffic Control Plan Inspection Checklist
Transport and Restraint of Heavy Plant and Supplies	Construction Regulation 23	This SWP applies to all activities that may involve the transport of heavy plant. The focus of the procedure is the management of risks associated with ensuring that adequate load restraints are used for all loads, and that obligations associated with the use of gazetted roads, and any roads associated with access to the site.	Transport and Restraint of Heavy Plant Inspection Checklist
Tyre and Wheel Management		This SWP applies to all activities that may involve the management of tyres and wheels / rims, including selection, use, maintenance and repair. The focus of the procedure is the management of risks associated with the management of tyre and wheel risks, and that any related activities are completed safely, without damage to plant, property or persons.	Tyre and Wheel Maintenance Checklist
Working Alone and or in Remote Locations		This SWP applies to all activities carried out alone and / or in remote locations as part of the project. The scope of this SWP does not apply to the following: Work from home arrangements, or where the location is remote from the home of the worker, but the location itself is not remote by definition Work in countries outside the country	Journey Management Plan Form Trip Plan Form Check In / Out Form
Working on, Over or Near a Body of Water	Construction Regulation 26	This SWP applies to all activities that involve working in, over or near a body of water, such as: Dredging to prepare for the erection of a structure Working adjacent a canal, river or natural water course Working adjacent, above or within a water storage tank	Pre-Start Working on, Over or Near a Body of Water Checklist
Working Near Overhead Power Lines	Electrical Machinery Regulations	This SWP applies to all activities relating to work near an overhead power line, including: Overhead electric distribution lines on poles (high or low voltage) Overhead electric transmission lines on towers Dedicated overhead electric lines used by public transport authorities (e.g. tramways and railways) Privately owned overhead electric lines The use of dummy lines shall be incorporated into this SWP	Work Near Overhead Powerlines Risk Assessment Template Form Vehicle and Powered Mobile Plant Movement Plan Template Form

SWP Topic	Legal Ref	Scope / Summary	Supporting Documents
Working Outdoors or in Hot or Cold Environments	Environmental Regulation 2	This SWP applies to all activities where workers and Contractors are involved in working outdoors or in hot or cold environments including: Work in hot climatic conditions Work in enclosed spaces heated by natural UV radiation Work in enclosed spaces cooled by artificial cooling (i.e. refrigeration) Work in cold climatic conditions	Working in Hot or Cold Environment Form

11 INCIDENT MANAGEMENT

All incidents and near misses must be reported immediately to the worker's Supervisor, the Engineer and the Client in particular if there is:

- An actual lost time or medically treated injury
- An incident that had obvious potential to be a lost time or medically treated injury
- A recordable spill on an unsealed area
- Reportable incidents as per legal requirements
- A major event

The Supervisor will notify the Construction Manager who will notify the Engineer and the Client representative of incidents. Whilst all reported incidents will be investigated, the level of investigation depends on the severity / potential severity of the incident. The following table describes the severity level and the corresponding investigation level.

Table 11-1: LEVEL OF INVESTIGATION GUIDE

Severity/potential severity level of the Incident	Guide	Level of Investigation
Low A spill less than 50 L	First aid cases Medical treatment cases	5 Why or similar
Medium A spill between 51-1000 L	Lost time incidents	TapRoot / ICAM
High A spill above 1000 L	Lost time incidents, disabling injury/ illness and fatalities	TapRoot / ICAM

All incidents will be recorded in the Principal Contractor's project incident register (i.e. in an electronic / online system or an excel spreadsheet) in order to manage and draw trends from the information. The register will be the source for statistical monthly reports. The Principal Contractor will maintain the register. All Contractors are required to keep their own records and statistics as well. However, Contractors are required to produce information and statistics in accordance with the project requirements.

A flow chart detailing the incident investigation process shall be provided as part of the Principal Contractor H&S management plan.

11.1 Reporting to Authorities

Normal practice dictates that project incidents are reported by each employer (Contractor) as required under Section 24 & 25 of the OHS Act, to the statutory bodies.

The following incidents have to be reported to the regulator (Dept. of Employment & Labour):

- Fatality and all other incidents referred to in Section 24 & Section 25 of the OHS Act.

Incidents reportable to the regulator are of serious nature and should follow the protocol below:

- Make the area safe immediately to prevent further injury or incident
- First aiders and other emergency personnel notified if injured parties are involved
- Barricade area off to prevent entry or disturbance of incident site
- Construction Manager and site H&S Officer notified (a telephone call will suffice) followed by official reporting as per the Principal Contractor's process
- Reporting to the regulator within the required timeframe
- Preliminary investigation report submitted within 12 hours of occurrence
- Completed investigation report submitted
- For all high / critical incidents a taproot / ICAM investigation will be conducted.

11.2 Corrective and Preventative Action

The Principal Contractor is responsible to maintain the Incident Register, whether in electronic / online format or in an excel spreadsheet. The format of which will be agreed with the H&S Agent. The Incident Register must be able to provide sufficient information and knowledge to the Principal Contractor in order to identify trends easily. It must make provision to capture the necessary corrective and preventive actions derived from the incident investigations.

Corrective and preventative actions can be triggered by the following activities.

- Incidents
  - Short-term actions
  - Long-term actions
- Inspections
- Audits
- Meetings
- Interactions and planned task observations
- Pre-task risk assessments (DSTI's)
- Trend analysis

All action items will be captured and managed in a central project Deviation Register.

11.3 Injury Management

The Principal Contractor shall provide an injury management plan for the project that will include consideration for the following:

- First aid plan
- Response personnel
- Equipment (paramedic store), supplies / location
- Communication requirements
- Emergency number / process, and
- Escalation process (e.g. to hospital or air evacuation)
- Medical treatment and rehabilitation
- Plan to engage local medical and health providers
- Workers compensation process
- Notifications to relevant authorities and institutions
- Suitable duties plan and injury management plan
- Re-training

12 DOCUMENT AND RECORDS MANAGEMENT

12.1 Documentation

The Engineer is responsible for ensuring documents are maintained, are current and are distributed to the Client, project personnel, Contractors and other interested parties as required. Each of the Contractors are required to maintain the necessary documents listed below and to make these available to the Client, the Engineer, the H&S Agent, or to other interested parties when reasonably required to do so.

Project documentation will be maintained as a minimum for the following:

- Method statements
- Safe work procedures and supporting documents
- Risk assessments
- Fall protection plans
- H&S Management Plans
- Emergency response plans
- Training needs analysis
- Organograms
- Project induction training content and records
- Minutes of H&S committee meetings
- Minutes of all meetings with a H&S component
- Pre-start meeting minutes
- Toolbox talks content and attendance
- H&S information issued (alerts, notices and campaigns)
- H&S issue resolution records
- H&S monitoring results / reports
- Planned Task Observation reports (PTOs)
- H&S Agent audit reports
- Site instruction related to H&S
- Statutory reporting
- Project monthly report
- Safety, health and environmental action closeouts
- Fit for work results including medical fitness certificates
- Incident investigation reports
- Incident register
- Deviation register
- Appointment letters and proof of competencies
- Improvement plans
- Any other H&S record generated throughout the life of the project

12.2 Records and Record Management

All H&S records will be managed and maintained to the requirements of the Owner's Engineer's document management protocol, when submitting or issuing documents and records.

At the start of the construction phase of the project the H&S Agent and the Engineer will agree which H&S records need to be submitted to the Engineer via document control. This will be communicated to the Principal Contractor. The Principal Contractor's procedure regarding records management will address safe archival and safe back-up systems.

12.3 Consolidated Health and Safety File

At the start of the project the Principal Contractor together with the H&S Agent shall agree on the format and folder structure of the Consolidated H&S File and which documents and records will form part of it. This will be an electronic format and the arrangements to scan hard copy records and documents generated on site will be contained in a written procedure. The necessary records will be scanned and archived on a monthly basis and the procedure will apply from the first month onwards.

The consolidated H&S File must be handed over to the Client upon completion of the construction work.

13 OCCUPATIONAL HEALTH AND RELATED

13.1 Pre-Site Access Medical & Exit Medicals

Contractors shall ensure all personnel working under their control at the project site have successfully completed a pre-employment medical prior to commencing work on the site. The pre-employment medical shall be conducted by a suitably qualified occupational health practitioner and shall be specific to the nature of the work the individual will undertake and must include:

- Big-5 drug test
- Audiometric testing
- Lung function test
- Physical examination
- Appropriate pre-employment medical questionnaires (i.e. working at height questionnaire)
- Completed Annexure 3 of the Construction Regulations in addition to the issued medical fitness certificate

13.2 Fitness for Work

All Contractors will implement a fitness for duty program that addresses the possible effects of the following aspects in relation to safe conduct of work:

- General level of personal fitness and / or medical conditions that need to be managed
- The consumption of alcohol and illicit drugs
- The use of other drugs (prescription, pharmaceutical or illicit)
- Fatigue
- Stress

Contractors shall document and implement a fitness for duty program in line with these requirements and are to ensure that personnel under their control and authority comply with their fitness for duty program. Contractors shall document and implement a process to manage personnel using non-prescribed and prescribed medication that may affect performance whilst operating plant or equipment or undertaking tasks at the project site. This process must refer to the circumstances during which the disciplinary procedure will come into effect.

13.3 Fatigue Management

The fatigue management framework for the project is provided as a guide for the management of working hours in support of fatigue management:

- Personnel shall not work more than 13 days straight
- Planned rosters do not require the working of more than 12 hours per day and no more than 45 hours a week.
- A 10-hour break shall occur between the finalisation of one shift and the commencement of the next work beyond 12 hours in any one shift requires a risk assessment and defined approvals
- Industry collective agreements with the bargaining council with regards to overtime to be considered.

Contractors shall consider H&S issues in relation to employee / shift handovers when scheduling work shifts and hours of work and shall implement and effective process for the review and approval of all work required outside of the above framework.

Contractors shall perform a fatigue risk assessment on their proposed roster and submit them for review to the H&S Agent and the Engineer.

A clear and formal process shall be established by the Engineer whereby a contractor needs to:

- Request for overtime work
- Provide proof of affected individuals' hours already worked in the month/week and project to date
- Total hours it will result in for those individuals for the relevant week and month
- Compliance to the above fatigue management requirements

13.4 Drugs and Alcohol

All persons working on or visiting the site shall:

- Have a blood alcohol content (BAC) of 0.00, and
- Have a urine concentration of drugs at or below the cut off levels for tested drug classes

All personnel entering the project site will be exposed to the following drug and alcohol testing programs (including the Client's representatives and the Engineer's personnel). Where camp accommodation is provided, those in control of camps where alcohol is sanctioned shall develop responsible service of alcohol guidelines for the serving and consumption of alcohol.

The Contractors shall develop and implement a procedure to manage drugs and alcohol, including the management of positive drug and alcohol test results for their area of responsibility.

The Contractors shall ensure that all personnel leaving home or the camp site for work do not at any time, take or work under the influence of any illicit drugs or alcohol.

The measures to be taken by the Contractors to confirm this shall include:

- 100% of all staff tested daily for alcohol using calibrated equipment
- Testing for drugs and alcohol of personnel following their involvement in an incident
- Testing for drugs and alcohol of such personnel on reasonable suspicion
- Unannounced random testing for drugs and alcohol
- Self-assessment (voluntary) testing facilities for drugs and alcohol.

The Contractors shall ensure that:

- The workplace collection and testing for drug and alcohol is done by personnel trained to do so
- A register of all drugs and alcohol testing that occurs at the site is maintained
- Drug and alcohol testing results are reported to the Engineer as part of the weekly H&S performance reporting process and shall include:
  - Weekly and project to date count of drug tests completed
  - Weekly and project to date count of alcohol breath tests completed
  - Weekly and project to date count of positive drug test results
  - Weekly and project to date count of positive alcohol test results

Contractors in consultation with the H&S Agent will agree the number of random tests as a percentage of persons entering the site to ensure an appropriate number of project personnel are covered.

13.5 Occupational Hygiene

Contractors shall ensure that adequate procedures and controls are in place to manage personnel exposure to known atmospheric contaminants in the occupational environment as described in legislation.

Contractors shall document and implement a process to ensure:

- Initial assessment of potential exposure by conducting a risk assessment on all potentially hazardous substances in accordance with Regulations for Hazardous Chemical Agents.
- Hygiene monitoring is conducted to confirm (or indicate otherwise) the presence of contaminants, or other agents that may affect the H&S of personnel and where identified, implement an ongoing monitoring program.
- Personnel are not exposed to a substance or mixture in a concentration that exceeds the exposure standard defined by legislation
- The results of health monitoring are provided to those to which they relate
- Records of health monitoring conducted are maintained in compliance with legislative requirements
- Occupational hygiene includes the management of noise, vibration, gases, fumes, airborne particulates and other physical stressors.
    - Noise induced hearing loss is a highly underrated occupational condition. Occupational noise emitted by construction machinery and power tools must be controlled as far as possible by implementing engineering solutions such as noise dampening, regular maintenance, servicing and inspection, screening off the noise, and reducing the number of persons exposed. Personal protective equipment such as earmuffs and earplugs must also be used in conjunction with engineering controls so as to reduce noise exposure to below the acceptable levels. Each and every contractor is required to identify sources of noise which could impact on its personnel, to then assess the levels of noise, followed by implementing the necessary control measures to reduce the noise to acceptable levels. This must be clearly set out in the Contractor's hearing conservation programme contemplated in the NIHL Regulations.
    - Designers also have a role to play with regards to designing out the need for materials, methods and activities which have the potential of exposing personnel to noise levels over the permissible levels e.g. chasing into floors and walls.
    - Ergonomics is the study of how workers relate to their workstations. We advise the Principal Contractor and Contractors to take this into consideration when conducting risk assessments, thereby improving the worker-task relationship, which will in turn improve productivity and reduce chronic conditions such as back strains, joint problems and mental fatigue, amongst others.
    - Designers also have a role to play with regards to designing out the need for materials, methods and activities which have the potential of exposing personnel to ergonomic hazards e.g. the use of lighter, easier to handle materials and products.
    - Exposure to dust (silica, etc.), fumes, vapours, and other hazardous chemicals agents / particulates through inhalation or skin contact: Chemical stressors identified by the Contractors on this project must be managed by the respective Contractors who must also prevent exposure to workers/visitors other than their own employees.
    - Designers also have a role to play with regards to designing out the need for materials, methods and activities which have the potential of exposing personnel to hazardous chemical agents by substituting such products for substances and agents less hazardous.

Contractors shall document and implement an alternative process where occupational hygiene monitoring is not reasonably practicable.

13.6 Personal Hygiene

Contractors shall ensure that personnel under their control maintain high standards of hygiene, cleanliness and waste removal in connection with the performance of their work and ensure:

- All work areas are maintained in a clean and tidy state and waste materials are promptly and appropriately disposed of

- Adequate toilet and ablution facilities are provided in accordance with legislative requirements and ensure that personnel have ready access to such facilities

Where camp accommodation is provided, persons in control of the camps shall develop procedures to ensure camp accommodation, facilities and meal rooms are kept in a clean and tidy manner, to the requirements and satisfaction of the H&S Agent and the Engineer and any legislative requirements including those for food safety.

13.7 Smoking

Contractors shall not permit smoking at the site except within designated smoking areas selected in accordance with applicable laws, rules, regulations, policies, hazards present at the site and any direction given by the Engineer or the H&S Agent.

13.8 Health Promotions

The project will implement health promotion programs that raise awareness of healthy lifestyle. As a minimum the project will obtain, disseminate and display health a fitness information to raise awareness to health issues. The project will aim to select health promotion programs to coincide with national health programs.

The project health promotion programs are intended to function as a collaborative approach involving the Engineer and all Contractors.

The Principal Contractors will also need to assess the construction related health risks and what the risks are for the local communities surrounding the project site. Although the site(s) will be remote and far from formal communities, this assessment of health risks will still need to be undertaken.

14 H&S AUDITS, INSPECTIONS AND OTHER INTERACTIONS

The purpose of inspections, audits, interactions, planned task observations and other related activities are to:

- Monitor compliance with requirements
- Evaluate H&S management system effectiveness, and
- Identify room for improvement.

14.1 Planned H&S Audits and Inspections

Inspections and audits required on the site are, but must not be limited to:

- Informal daily site inspections
- Formal site inspections including those required by legislation e.g. excavation inspections, mobile plant inspections, lifting tackle inspections, etc.
- Principal Contractor self-audits
- Contractor audits
- Safety Interactions / Visible Felt Leadership

The Principal Contractor is obligated to conduct monthly audits (at least once every 30 days) on all Contractors appointed by it and keep audit reports as records. Contractors have to audit their sub-

Contractors and keep records of these audits in *their* health & safety files, made available on request where such sub-Contractors will be on site for longer than a month. The Principal Contractor has to submit the audit criteria intended to be used on sub-Contractors together with the H&S Management Plan. The H&S Agent will conduct monthly audits on the Principal Contractor's H&S Management Plan to ensure that Contractors are working in accordance with the agreed H&S requirements/procedures. Further site inspections and visits will also take place.

In addition to the agreed Client H&S audits on the Principal Contractor, the H&S Agent will require a formal written feedback report after each audit, to be compiled by the Principal Contractor. This will be the official response to the H&S Agent's report and must be submitted within 3 working days from receipt of the audit report. This report should outline the steps the Principal Contractor has taken or will be taking in order to comply with the noted deviations.

Inspections and audits will cover but not be limited to plant and equipment, work methods, tools used, storage facilities and maintenance activities, housekeeping, access & egress, contingency systems, competencies of staff, PPE, behaviour, risk assessment and safe work procedure reviews etc. Formal site inspections and audits shall be planned, scheduled and executed accordingly.

All information regarding the deviation, the corrective and preventive actions resulting from inspections and audits shall be captured on a Deviation Register for tracking and close-out. The Principal Contractor is responsible for the project's Deviation Register and will require from Contractors' H&S personnel to provide or capture the necessary information accordingly. The template for the Deviation Register will be agreed with the H&S Agent.

The table below depicts the minimum monitoring activities required for this project.

Table 14-1: MONITORING PLAN

		Frequency					
Type	**Conducted by**	**Construction Pre-start**	**Daily**	**Weekly**	**Monthly**	**Three Monthly**	**6-monthly**
Contractor's Site Inspections: Construction Manager/ Assistant Construction Manager, Supervisors, Safety Reps and H&S Officer	Principal Contractor Contractors		X As per legislation and Contractor's own requirements	X As per legislation and Contractor's own requirements	X As per legislation and Contractor's own requirements	X As per legislation and Contractor's own requirements	
Engineer Inspections: Project Manager, Resident Engineers	The Engineer		X	X			
Safety Interactions: Management, Middle Management, Supervisors, H&S staff	The Engineer, Principal Contractor Contractors			X According to schedule			
Principal Contractor H&S Management Systems Audit:	Principal Contractor	X					X Yearly
RA and SWP Reviews Construction Supervisors and H&S personnel	Principal Contractor Contractors					X According to schedule	X According to schedule
H&S Agent Audits	TBD				X		
Audits on Contractors: H&S personnel	Principal Contractor				X		
PTO	Principal Contractor Contractor		X According to schedule				

14.2 Planned Task Observations

The Principal Contractor shall have a schedule for conducting Planned Task Observations (PTO's) to be done by the Construction Manager, Assistant Construction Managers, Construction Supervisors, specific competent persons appointed and H&S personnel. Where necessary this will also cover all Contractors' work. Conducting PTO's must be covered in the project's induction (purpose etc.), but a separate training session must be held for the relevant person who will conduct PTO's.

14.3 H&S Issues Raised through Audits, Inspections and other Interactions

H&S issues identified through workplace inspections and audits will be addressed immediately on site where possible or work stopped where the situation is life-threatening. Where deviations are observed a safety interaction with the individual(s) must be held in order to determine the reason for the deviation and

to change behaviour. All H&S deviations must be captured on a project Deviation Register even if closed out on site. This is for the purpose of trend analyses. The Principal Contractor is responsible to maintain the Deviation Register and must identify trends from repeat deviations and implement the necessary interventions. Progress of actions will be reviewed weekly by the Principal Contractor's project management team facilitated by their H&S Officer.

The minimum headings to be included in the Deviation Register are: Area, Construction Supervisor's name, relevant Contractor, potential incident category (equipment damage or MTI etc.), work stopped or not, risk type (origin of the risk e.g. procedure not followed or unsafe act etc.), responsible person, dates, close-out status. The Deviation Register can be in an electronic / online format or in an excel spreadsheet.

14.4 Independent Audits

The Principal Contractor will conduct a yearly audit on his HSMS and the application thereof on this project. This audit could be carried out by a H&S Officer not affiliated to the project in question.

14.5 Reporting

The Principal Contractor's H&S Officer shall report project statistics including the leading indicators on a regular basis to the Engineer. See also Key Performance Indicators.

The following items listed in the table below shall be maintained and reported weekly on a Monday by the Principal Contractor to the Engineer, for the previous week. The information will include those of the Contractors.

Table 14-2: WEEKLY STATISTICS REPORTING

General	Lag Indicators	Lead Indicators
Staffing levels	Equipment / plant damage incidents	Number of safety interactions completed
Hours worked	First aid injuries	Trends from Deviation Register
	Medical treatment injury (MTI)	New RA / SWP's developed
	Lost time injuries (LTI)	Near misses reported
	Environmental incidents	Number of PTO's conducted
		Fitness for work testing results (alcohol & drugs)
		Number of VFL's conducted

The following items listed in the below table shall be maintained and reported monthly by the Principal Contractor to the Engineer, on the 5th working day of each month. The information will include those of the Contractors.

Table 14-3: MONTHLY STATISTICS REPORTING

See also H&S targets and key performance indicators.

General	Lag Indicators	Lead Indicators
Staffing levels	Equipment/plant damage incidents	Number of safety interactions completed
Hours worked	First aid injuries	Trends from Deviation Register
	Medical treatment injury (MTI)	New RA / SWP's developed
	Lost time injuries (LTI)	Near misses reported
	Environmental incidents	Number of PTO's conducted
		Fitness for work testing results (alcohol & drugs)
		Number of VFL's conducted
		Audit results (self-audit and Contractors';)
		Updated training needs analysis - % rolled out
		Status and results from documentation reviews
		Toolbox Talks conducted
		H&S Committee meetings
		Deviation register status (closed out vs open)
		Repeat of significant deviations

General	Lag Indicators	Lead Indicators
		Repeat of significant incidents
		Suggestions / initiative schemes
		Trends from Incident Register

15 TRAINING AND COMPETENCY

15.1 Training Needs Analysis

The Principal Contractor and each of the Contractors will complete a training needs analysis (TNA) and skills/staff matrix of their professional staff, trades and other employees who will be involved in the project. The skills/staff matrix must also track mobilisation dates, medical fitness certificate expiry dates and de-mobilisation dates amongst others. All Contractors are required to make their TNA available to the Engineer and H&S Agent for audit and inspection purposes as required. Further employee training needs may be determined in accordance with an individual's changed responsibilities, changed duties or changed location.

The type of training (which will form part of the TNA) includes, but will not be limited to, the following:

- Contractor specific induction
- Scaffolding erection and inspection – accredited training for scaffold erectors and inspectors
- Safe working at heights including harness fitting and fall resistant systems (all personnel required to work at height) – accredited training
- Waste management training module (all personnel)
- Environmental management (basic) (all personnel)
- Manual handling training (all personnel)
- Equipment / operator competencies – accredited training
- Emergency response training (all personnel at induction and when emergency response plan is updated)
- Visible Felt Leadership / PTO / Safety interaction training (applicable personnel)
- Advanced and off-road driver training – accredited training (persons with driving licenses and who are authorised to drive vehicles on site as well as to and from site)
- Skills upgrading and refresher training (applicable personnel)
- Electrical power tool operation (i.e. Angle grinders) – accredited training (applicable authorised users)
- Work permits, tagging and isolation procedures (applicable personnel and all supervisors)
- First aid – accredited (first aiders)
- Fire safety awareness use of firefighting equipment (all personnel) – accredited training
- Hazard identification and hazard awareness (all personnel) – this does not refer to the communication of the content of the risk assessments and safe work procedures
- Conducting DSTI's (all personnel)
- Legal liability (Supervisory and management level) – accredited training
- Policies training (all personnel at induction)
- Specific H&S Management System communication training (e.g. content of SWP for drugs & alcohol, reporting of incidents, fatal risk controls etc.) (all personnel at induction)
- Technical specific skill such as blasting, electrical, confined space entry and geotechnical etc. (applicable personnel e.g. those who will be exposed to the associated risks and the supervisors involved)

Where SETA accredited training is available, these will be used.

Note: **The Excavation Competent Person will be required to have a qualification in the geotechnical field**.

15.2 Training and Competency Register

The Principal Contractor and Contractors will maintain a competency register (matching the skills/staff matrix) that will indicate all current information / competencies of all employees. This register is to be made available to the Engineer and the H&S Agent for audit and inspection purposes as required. Each employee will also have a personal dossier that will contain all relevant information such as:

- Copy of ID
- Legal appointment letters with relevant proof of training and or competencies
- Medical fitness certificate
- Proof of other relevant training such as induction according to the TNA
- Proof of PPE issued

Dossiers will be kept at the site office and will be available at all times.

15.3 Personnel Selection, Competency and Training

All Contractors including the Engineer shall ensure that all site personnel hold current and relevant qualifications for the work they are required to perform and that the records are maintained and available on site.

Competency assessments shall be conducted by all the Contractors where competencies are not evident or where a person only has experience but no formal training / qualifications. The relevant Contractor shall ensure personnel do not commence any task until such assessments have been conducted. Record of these assessments must be readily available for audit purposes. Where possible all personnel will be trained and verified for competency as per their training needs analysis and competency register before mobilisation to site. The competency register must indicate which individuals this will be required for.

Internal competency assessments for Excavation Competent Person appointments in the absence of a geotechnical qualification will not be accepted.

15.4 Training Before Approval to Mobilise to Site

The table below identifies the minimum training prior a person commencing work on site. As part of the mobilisation process each Contractors shall comply with the below mandatory requirements for this project.

Competency and awareness requirements for Contractor personnel shall be described in the Contractor's HSMP.

As part of the mobilisation process, the Principal Contractor will submit the qualifications, competencies as well as evidence of the verification of the competencies to the H&S Agent and the Engineer for acceptance before mobilisation to site can take place.

As part of the mobilisation process, each Contractor will submit the qualifications, competencies as well as evidence of the verification of the competencies to the Principal Contractor for acceptance before mobilisation to site can take place.

Once a person is approved to mobilise to site participation in the Principal Contractor's project induction will be arranged with notification to the relevant Contractor.

Table 15-1: MANDATORY REQUIREMENTS FOR MOBILISATION

	Legal Liability	Incident Investigation Techniques	Hazard Awareness	Supervisor H&S training	Project H&S Induction	Fitness for Work
Project Manager	Y		Y		Y	Y
Construction Manager(s)	Y	Y	Y	Y	Y	Y
Supervisors	Y	Y	Y	Y	Y	Y
Project Engineers	Y		Y		Y	Y
H&S personnel	Y	Y	Y		Y	Y
Everybody (including the Client)			Y		Y	Y

15.5 Site Induction and Orientation

Prior to entering any work area, personnel and visitors will be required to complete the project specified induction(s) and training related to their tasks, scope of work and duration of intended stay on site.

15.6 Training & Qualification Records

Records pertaining to the qualifications of any person mobilised on the project will be contained in his / her personal dossier and shall be made available to the H&S Agent and the Engineer on request. The records shall be readily accessible.

16 EMERGENCY PREPAREDNESS AND RESPONSE

The Principal Contractor is responsible to draft the project emergency response plan (ERP) and it needs to address all potential risks and provide suitable responses to assure well-being of all personnel. The plan must identify, by risk assessment, all potential emergency situations and mitigation strategies associated with potential emergency situations. This process must include local government and community involvement. It is foreseen that the Principal Contractor who will be on site from commencement to completion, will co-ordinate the project emergency preparedness plan on site (or on the two sites as it may be).

The Emergency Response Plan (ERP) must include consideration for the following aspects:

- First aid / medical (life support) response during an emergency - identify procedures for responding to credible emergencies within reasonable time frames considering the ‘two sites’ and the isolated locations of WTGs under construction.
- Identify measures to be undertaken to prevent or reduce the risk of an emergency, including emergency response training that involves local emergency service groups wherever practicable
- Fire response
- Evacuation which may need to include an air evacuation option
- Rescue / response to a remote location incident
- Escalation to crisis management plan

- Identify procedures for communicating with employees, consultants, Contractors, the Engineer and relevant authorities in the event of, and during, an emergency (communications matrix)
- Identify the roles of those responsible for executing the ERP in the event of an emergency
- Identify requirements and procedures for accessing personnel and equipment resources during an emergency
- Identify adequate equipment and resources for responding to credible emergencies
- Outline procedures for interfacing with the Engineer and the Client to ensure transfer of emergency response and management to the Client at appropriately defined severity levels
- Specify a process for periodic updates of the plan to incorporate lessons learned from previous incidents and exercises
- Meet the requirements set out in the legislation
- Frequency and manner of emergency drills / response testing
- Post emergency management

16.1 Contractors Emergency Response Plans

Contractors shall use the project emergency response plan drafted by the Principal Contractor, as their own. Where additional or unique emergencies are identified these need to be incorporated into the project emergency response plan.

16.2 Emergency Response Testing

The Principal Contractor will perform adequate emergency response drills and exercises to facilitate the practicing of the site ERP and supporting response and rescue arrangements to ensure it is able to provide adequate response during an emergency situation.

Testing of the emergency response process will be completed through a collaborative approach involving the Engineer and all Contractors. The Principal Contractor must indicate in its HSMP the scope and management of the drills and exercises. Within one month of mobilisation the Principal Contractor will conduct the first drill and thereafter at intervals not exceeding 3 months. Proper records of the drill exercise must be kept.

16.3 Medical Services

Contractors shall ensure that appropriate first aid, medical care facilities (paramedic/life support) and qualified personnel in the form of a paramedic operative are provided at or near the project site where work under the contract is being performed. The appropriate first aid and medical care services shall be determined in accordance with statutory legislation and the project baseline risk assessment. An air evacuation option would also need to be investigated as far as identifying the closest location of such responder (and estimated time frames for response), whether this will be covered by Workman's Compensation insurance, and the procedure for making use of such service if and when necessary. This should include arrangement for primary health and dental care for site personnel. The above would need to be discussed and negotiated between the Client/Owner and the Principal Contractor before contractual appointment.

Contractors shall:

- Maintain a register of first aid kits and contents as well as for paramedic equipment
- Inspect first aid and project medical care facilities monthly by a competent person
- Maintain records of all persons treated for work related injuries (incident register)

17 CONTRACTOR AND SUPPLIER MANAGEMENT

17.1 Procurement

Procurement will be part of the project safety by design process and will conform to the relevant sections of the project contracting procedures. This H&S Specification must be included in all contractual and tender / procurement documentation. The Principal Contractor is required to provide this H&S Specification and the project's Baseline Risk Assessment to all Contractors who intend to tender for subcontracted parts of the works.

17.2 Contractor Management

Contractor selection and management is a critical element in the successful delivery of a project. As the level of risk and potential exposure to harm varies according to the differing nature and extent of scopes of work or services to be performed, the Principal Contractor needs to clearly define in his HSMP how the different types of Contractors will be managed. The Principal Contractor has the right and the responsibility to provide templates and the necessary training to those Contractors that would not have the necessary H&S maturity e.g. Contractors and personnel that need to be locally procured due to the contractual arrangements requiring this on the project. Under no circumstances must a Contractor be allowed to use complete documents (e.g. HSMP, risk assessments etc.) of the Principal Contractor as their own.

Even small localised Contractors must be trained and mentored regarding H&S requirements so that these Contractors can take ownership of their own H&S. The training requirements identified for Contractors must form part of a training needs analysis for that purpose, identified, documented and enforced by the Principal Contractor of such Contractors.

Any Contractor is responsible for ensuring all of its sub-Contractors meet the requirements applicable to itself in relation to the sub-Contractor's work in this document, the Principal Contractor's HSMP, their own HSMP and legislation.

Each Contractors shall ensure that all project H&S requirements are communicated to their employees, sub-Contractors, suppliers and visitors along with the relevant contents of the Contractor's H&S processes and procedures prior to commencement of work or visits to site.

17.3 Contractor Selection

Contractors are the key to positive project H&S performance - therefore they will be required to demonstrate their workforce's capabilities and competencies to perform work on the project as well as the provision of adequate resources before formal appointment. The tender/negotiation returnable documents which need to be submitted by Contractors in an effort to ensure that they are assessed for H&S competent and resources.

The Principal Contractor must indicate in its HSMP how Contractors will be selected based on their H&S competence and resources and which documentation will be required from them during tender phase. They also need to indicate what the H&S "BoQ" will comprise of in order to ensure that Contractors make sufficient provision for H&S requirements. The Principal Contractor needs to facilitate a tender briefing meeting during which the H&S requirements must also be highlighted. Should tender clarification meetings take place, the Principal Contractor must share sufficient information during these.

Apart from the competence and resources assessment of tenderers or during negotiations with Contractors, the Principal Contractor must provide in its HSMP a "go-no-go" checklist with which to evaluate each Contractors 'primary compliance H&S documentation' before allowing them to mobilise to site. This would include the approval of the Contractor's project/site-specific HSMP.

17.4 Contractor Kick-Off Meetings

After the Contractor has been approved to commence activities but prior to mobilising to the project site each Contractor's management representative and safety professional(s) will attend an H&S kick-off meeting with members of the Principal Contractor. Minutes of the meeting must be kept.

The Principal Contractor must indicate in its HSMP the proposed agenda for such an H&S kick-off meeting.

Once mobilised to site, it is expected that each of the Contractors with its sub-Contractors will conduct its own kick-off meetings on a scheduled basis and as the need arises, for each separate phase of the project. Contractor kick-off meetings can be attended by the Engineer or any of his representatives or the H&S Agent as the need arises.

17.5 Visitors to Project/Contractor Facilities

All personnel, including service providers (e.g. deliveries) and the Client who are required or intend to visit site for the purpose of meetings, inspections, discussions or deliveries, shall:

- Notify the Principal Contractor's Construction Manager of the intended visit
- Wear the correct PPE as required (safety shoes, long sleeved trousers & shirts, hard hat, safety goggles, and reflective vest) and any additional item the Principal Contractor might require
- Report to the Principal Contractor's relevant site office before going to site
- Carry out a vehicle pre-start inspection where necessary
- On arrival undergo a visitor's induction at the Principal Contractor's site camp
- Sign in on the visitors register and wait for their escort
- Be escorted always while on the project site
- Prior to leaving the project, return visitors pass and sign out on the visitors register
- Be subjected to alcohol breathalyser tests
- Follow instructions of relevant Contractor personnel.

The Principal Contractor must indicate in its HSMP how these minimum requirements and any additional requirements he feels is necessary will be communicated to visitors and managed properly. Special attention must be given to deliveries and off-loading of plant and equipment by service providers with potentially unsafe lifting equipment. A pre-delivery or pre-mobilisation checklist done by service providers must be implemented.

17.6 Contractor Monitoring

The Principal Contractor must develop an audit schedule to monitor the compliance of the Contractor(s) against their own plans as wells as against the project H&S requirements. The results will be documented in a written report including any required corrective actions. Corrective actions will be communicated formally and recorded in the project's Deviation Register. The Principal Contractor must indicate in its HSMP what actions will be taken against Contractors not achieving a pre-determined minimum compliance score and as per the KPI's for this project.

All sub-Contractors and suppliers will be required to:

- Strictly observe all subcontract conditions regarding H&S - in particular, adhering to the HSMP, and following any safety instructions issued by the Project Manager, Construction Manager, Supervisors, Project Engineers or Project Safety personnel
- Provide competent supervision for their employees and where required on the project, ensure that Supervisors have the required qualifications and written authority prior supervising any personnel on the project
- Ensuring all Contractor personnel are formally inducted and orientated to the site

- Provide general industry specific inductions and safety training for their employees, and all necessary PPE and general safety equipment
- Ensure that all personnel and equipment go through the project's mobilisation process
- Ensure that all hazardous chemicals agents have gone through the Principal Contractor's chemical approval process
- Comply with the reporting procedures for hazards, accidents and incidents, and ensure their employees comply with those procedures
- Maintain their plant, vehicles and equipment, and ensure their employees are holders of the relevant certificates of competency
- Provide H&S data to the Principal Contractor's H&S Officer, as and when requested
- Encourage active participation in the site H&S committee
- Comply with the primary obligations imposed on them by the relevant binding H&S Act and Regulations by ensuring:
    - The H&S of their employees, and their own H&S; and
    - That the H&S of others and the environmental are not affected by the way in which they conduct their work activities.

18 MANAGEMENT OF CHANGE

The impact of change on H&S risks will be risk assessed and documented by the Principal Contractor and communicated to all its staff as well as those of the Contractors. A change management plan or procedure will be in place which encompasses the requirements for this project.

The Principal Contractor is required to ensure that changes are identified, analysed systematically, authorised by an appropriate authority, and implemented in a manner that does not present an unacceptable risk to the construction / commissioning workforce, the environment or the community.

The potential changes identified should be those that if these changes occur, could result in incidents.

Examples of change:

- New equipment, materials, products or a change of equipment configuration (new model or different type / manufacturer)
- Design or construction changes not approved by the design engineer
- Abnormal changes in workplace conditions (road speeds, road works, and high-risk activities)
- Changes in job method (requires different tools and work method etc.)
- Commissioning new plant (unfamiliar with process and function etc.)
- Staff replacements
- Deviation from safe work procedures and/or method statement

19 MANAGEMENT REVIEW

The Principal Contractor is required to conduct regular reviews of at least:

- Its own HSMS, processes and procedures and how it is applied on the project
- The applicability of key documents such as the HSMP, the Fall Protection Plan, the Emergency Response Plan etc.,
- Risk assessments and safe work procedures.

Regular audits either done internally by the Principal Contractor or the H&S Agent will examine the continued suitability of the project's H&S management system and procedures.

The Principal Contractor must indicate in his HSMP the type of documents that will be reviewed regularly and the frequency of the reviews. The review process will also apply to the Contractors H&S documentation.

The client or H&S Agent may conduct regular reviews of the Contractor's H&S management system, and the findings of these will be communicated to the Contractors' H&S team to identify avenues of improvement.

APPENDIX A

Project Health & Safety Policy

We value the health and safety of our employees, clients, visitors, business partners and the community. We foster a robust culture in which health and safety is demonstrated by personal commitment and integration into our everyday tasks.

All parties are to demonstrates their commitment to health and safety by:

- implementing and maintaining an effective Health and Safety Management Framework
- establishing measurable objectives and performance targets for continual health and safety improvement and measuring performance against these targets
- identifying health and safety hazards, assessing the risks arising from those hazards and eliminating or minimising those risks
- applying safe design principles to plant, substances or structures that encompass the project lifecycle
- implementing and maintaining safety processes for installing, constructing or commissioning plant or structures
- complying with applicable legislation, codes of practice and standards, or where the project's standards are higher,
- adopting and applying those standards
- reporting and investigating incidents, encouraging reporting of any unsafe conditions or behaviours and taking the necessary actions to eliminate or minimise risks
- promoting and maintaining constructive health and safety consultation with our employees, business partners and relevant stakeholders
- reviewing, monitoring and verifying the implementation and maintenance of the Health and Safety Management Plan to continuously improve health and safety performance
- implementing targeted processes aimed at preventing injuries and ill-health
- adopting active injury management to support return to work practices
- providing adequate information, training, instruction or supervision necessary to protect all persons from risks to their health and safety arising from work carried out and to maintain a safe work environment.

We recognise that this policy requires visible health and safety leadership. We expect our employees, clients, visitors and business partners to embrace its health and safety culture and commit to this Policy.

This policy will be made available to all interested parties and reviewed annually.

APPENDIX B

Roles and Responsibilities

The minimum roles and responsibilities listed here do not constitute the extent of the wording that should be included in any applicable appointment letter but should serve as a guideline when drafting applicable appointment letters.
The roles and responsibilities as set out here will apply to the Principal Contractors and Contractors where any of these are applicable.

Project Director, Project Manager or similar person responsible for overall delivery of the project

The PD / PM has the responsibility for ensuring overall health, safety and environmental performance of the project. The Project Manager is the key person for, and is responsible to:

- Ensure the development of the HSMP, associated procedures, forms and the like, their authorisation, issue and review
- Actively promote H&S as a value for all persons on site, and always incorporate health, safety and environment into all aspects of management
- Be accountable for the provision of adequate H&S resources, services, facilities and initiatives to effectively implement and manage the H&S program
- Ensure clear lines of responsibility and accountability for health, safety and environment, in part by including responsibility and authority for it in all appropriate job descriptions
- Facilitate the participation of persons with appropriate construction, operational and / or technical knowledge and skill to provide H&S input into design meetings / workshops as well as H&S risk assessments
- In conjunction with Construction Manager, develop a specific focus on consideration of H&S risks in the project procedures
- Ensure that provisions requesting information on sub-Contractors' HSMPs, risk assessments and clauses governing health, safety and environment, are drafted and incorporated in all tender documentation and subcontracts, respectively
- Establish KPI's for the project
- Regularly review the H&S performance of the project, including the monthly H&S report and identify and implement corrective action for negative trends identified
- Develop and implement an audit program that provides independent advice and information to management on the integrity of the ongoing implementation of the HSMP
- Establish and maintain current information on the relevant legislation, Codes of Practice and the like
- Establish key performance indicators for subordinates and undertake at least a 6-monthly performance appraisal to highlight performance and address improvement opportunities
- Give specific consideration to health, safety and environment when selecting sub-Contractors, in conjunction with the Construction Manager and site H&S Manger for the project
- Ensure that sub-Contractors provide relevant and adequate information on H&S with their tenders including a HSMP, lead and lag indicator demonstrating the Contractor's H&S performance as well as evidence that adequate resources have been budgeted for.
- Allow sufficient time for the site H&S Manger to evaluate a potential contractor's H&S documentation during tender stage and during pre-mobilisation stage. **No Contractor is allowed to mobilise to site unless their H&S File has been approved by the Principal Contractor's site H&S Officer**.
-

Construction Manager (including Assistant Construction Manager)

The Principal Contractor's Construction Manager is responsible to:

- Undertake and comply with the statutory roles and responsibilities of the duty holder for the project site
- Promote and facilitate cooperation on health, safety and environmental issues amongst sub-Contractors and between sub-Contractors and the Engineer's personnel
- In conjunction with the project site H&S Officer, ensuring that health, safety and environment remains a value for all persons on site throughout the duration of the project
- Include health, safety and environment as an agenda item at all site management meetings
- Establish a site H&S committee, ensure their regular meetings and attend them
- Facilitate the participation of persons with appropriate construction, operational and / or technical knowledge and skill to provide H&S input into design meetings / workshops and risk assessment
- Ensure that risk workshops are planned well ahead of the delivery, adequately resourced, executed and any actions are closed out prior the delivery of the works
- In conjunction with the project H&S Officer develop H&S documentation for ensuring that H&S issues are adequately identified and documented so that they can be managed during the construction and later phases.
- Ensure that appropriate communication and consultation processes are established and maintained with employees and sub-Contractors, e.g. safety committees, toolbox talks etc.
- Ensure that emergency procedures are developed and maintained for site in conjunction with relevant external emergency services agencies and major sub-Contractors
- Assign to appropriate Supervisors' responsibility for any additional work or administrative procedures (including risk assessments)
- In conjunction with the PD / PM give specific consideration to health, safety and environment when selecting sub-Contractors
- Assign responsibility for, and personally conducting, hazard inspections, and accident and incident investigations, and ensuring corrective or preventative action is taken to remedy any deficiencies, and following-up such action to completion
- Ensure a positive reporting culture, hazards, incidents, etc., by all project personnel
- Ensure that the project training needs analysis is conducted and that all site personnel undertake the required induction and safety training as identified
- Nominate a person or persons for supervising complex lifts and inspecting cranes and lifting gear whenever a lifting study or critical lifting study is required
- Together with the PD / PM regularly review the H&S performance of the project including the monthly H&S reports and counteract any unwanted trends with corrective actions
- Ensure all site personnel receive current information on amendments to any H&S related Act and regulation, and subordinate legislation

Construction Supervisors

Supervisors are responsible for the health and safety of persons working under their supervision. Specifically, in their work areas, they will:

- Ensure their own and sub-Contractor's employees are provided with, and trained in the correct use and maintenance of, personal protective clothing and equipment
- Conduct hazard inspections, participate in accident and incident investigations and ensure that preventative and corrective action is taken to remedy any deficiencies
- Conduct regular inspections of their work area and document the inspection on the project specific forms / templates.

- Conduct DSTI's / pre-task risk assessments with their teams
- Attend safety coordination meetings
- Review (in consultation with the work team) risk assessments for all work activities, modify where necessary to reflect the specific requirements of the activity and ensure all persons in the team are fully briefed on how to do the job safely as per the safe work procedures.
- Ensure that high standards of housekeeping are established and maintained in their work area
- Ensure H&S records are up to date
- Act consistently with the acceptable behaviour requirements of the project
- Conduct safety interactions and PTOs as scheduled.

Construction Employees and Sub-Contractors

All construction workers, whether employees of the Principal Contractor or sub-Contractors, will be required to:

- Undertake a site-specific induction prior to commencing work on the site and attend all scheduled safety training sessions
- Follow their Supervisors' instructions with respect to health, safety and the environment on site (if at all uncertain as to what action to take in their area of work, they should seek direction from their Supervisor or the Construction Manager)
- Report all actual and potential hazards, accidents and incidents to their Supervisor
- Not engage in any prescribed occupation, activity or task (as described in the relevant regulation) unless they hold the relevant competency certificate and have been appointed in writing by the Construction Manager, as is relevant
- Keep their amenities and work areas clean and tidy, and
- Observe the following obligations imposed on employees by:
    - Complying with instructions given for the purpose of health, safety and environment
    - Use personal protective clothing and equipment provided by their employer, and use it as instructed
    - Not to wilfully or recklessly interfere with or misuse anything provided for health, safety and security on the site
    - Not to wilfully place at risk the health, safety and security of any person on the site
    - Not to wilfully injure himself or herself, and
    - Behave in a manner that does not put any person or property at risk

Site H&S Officer

As directed by the project PD / PM, the H&S Officer is responsible for assisting the Construction Manager to implement responsibilities and accountabilities.

- Update and administer the HSMP and other relevant H&S documentation
- Ensure that all Contractors submit method statements, risk assessments and safe work procedures of all activities identified in the HSMP for approval prior to commencement of the activity
- Conduct scheduled and random measuring and monitoring of Contractors' compliance with the HSMP, the Contractor's HSMP and all related documentation, and advise the Construction Manager of any sub-standard performance
- Conduct scheduled and random inspections and advice the Construction Manager of any sub-standard performance
- Assist the Construction Manager in incident investigations, and ensure that preventative and corrective action is taken to remedy any deficiencies
- Provide health, safety and environment related input to the monthly project reports to the Construction Manager

- Assist in regular H&S awareness campaigns amongst all contract personnel on site
- Facilitate the development of H&S consultation arrangements with employees and Contractors, including the safety committee(s)
- Attend safety coordination meetings
- Assist in preparation and site-specific inductions for all employees commencing work on the project
- Ensure that any H&S issues requiring the attention of the Construction Manager are brought to his attention in a timely manner
- Provide general health, safety and environmental advice
- Participate in stakeholder liaison on safety issues as requested
- Notify the Construction Manager immediately of any work-related injuries and illnesses.
- No Contractor is allowed to mobilise to site unless their H&S File has been approved by the Principal Contractor’s site H&S Officer.

APPENDIX C

Application To Cross Eskom's Powerlines With Water Pipeline

Eskom

SANCON DEVELOPMENTS
1 Grasmere Street
BENDOR 0699

Date:
26 September 2024

Enquiries:
Xander Neethling
+82 349 6971

Per e Mail: brian.sancon@outlook.com,

APPLICATION TO CROSS ESKOM'S POWERLINES WITH WATER PIPELINE

Dear Mr Mbetse,

With reference to your application dated 25 September 2024 to cross Eskom's Powerlines with your Water Pipeline, permission is hereby granted under the conditions listed on the attached document.

Kindly indicate your acceptance of these conditions by initialing each page and signing in the appropriate area on the last page and returning this copy to Eskom.

Yours faithfully,

Xander Neethling
SENIOR SUPERVISOR – LAND & RIGHTS

Distribution Division
LimLanga Cluster / Limpopo Operating Unit
92 Hans van Rensburg Street POLOKWANE 0699
PO Box 3499 POLOKWANE 0700
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Eskom Holdings SOC Ltd Reg No 2002/015527/30

Annex B – Generic conditions applicable to the co-use of an Eskom servitude or restriction area.

1. Access and egress

1.1. Eskom shall at all times retain unobstructed access to and egress from its servitudes.

2. Approvals (additional)

2.1. Eskom's consent does not relieve the applicant from obtaining the necessary statutory, land owner or municipal approvals.

2.2. The applicant will adhere to all relevant environmental legislation. Any cost incurred by Eskom as a result of non-compliance will be charged to the applicant.

3. Eskom Cables

3.1. Eskom's underground cables must be placed in sleeves encased in concrete across the width of the servitude, at the applicant's expense. This is only required in certain situations such as where frequent excavations might occur in the cable area. Materials to be used and relevant dimensions shall be determined by the internal assessor and by Project Engineering.

3.2. All underground cables in or crossing Eskom overhead sub-transmission and transmission servitudes shall be protected by concrete slabs placed 300mm above cables with danger tape markings and cable route / position indicated by standard concrete monuments.

4. Dimensions

4.1. No construction or excavation work shall be executed within 6 metres from any Eskom power line structure, and/or within 5 metres from any stay wire and/or within 5 metres from any underground Eskom cable..

5. Earthing

5.1. All work within Eskom's servitude areas shall comply with the relevant Eskom standards in force at the time.

5.2. For exceptional cases the internal assessor must refer to Transmission Line Engineering, tel. (011) 800 8111.

6. Expenditure

6.1. If Eskom has to incur any expenditure in order to comply with statutory clearances or other regulations as a result of the applicant's activities or because of the presence of his equipment or installation within the servitude or wayleave area, the applicant shall pay such costs to Eskom on demand.

7. Explosives

7.1. The use of explosives of any type within 500 metres of Eskom's services shall only occur with Eskom's prior written permission. If such permission is granted the applicant must give at least fourteen working days prior notice of the commencement of blasting. This allows time for arrangements to be made for supervision and/or precautionary instructions

to be issued in terms of the blasting process. The internal assessor must refer the applicant to the power line engineer.

7.2. Blasting: refer to the *Mine Health and Safety Act, 1996 (Act 29 of 1996) Regulation 17.6(a) and Regulation 4.16(2)*

7.3. Blasting: Regulations in terms of *Explosives Act 26 of 1956,* remain valid under *Explosives Act 15 of 2003,* Chapter 10 "Use of blasting Materials". Regulation 10.17.1 of Explosives Act 15 of 2003 prescribes that when blasting is to be done within 500 (five hundred) metres of any electricity infrastructure, written confirmation must first be obtained from Eskom concerning the protection of electricity infrastructure.

8. Ground level variations

8.1. Changes in ground level may not infringe statutory ground to conductor clearances or statutory visibility clearances or on the depth levels at which Eskom underground cable are laid, usually 1-1.2m. After any changes in ground level, the surface shall be rehabilitated and stabilised so as to prevent erosion. The measures taken shall be to Eskom's requirements.

9. Indemnity

9.1. Eskom shall not be liable for the death of or injury to any person or for the loss of or damage to any property whether as a result of the encroachment or of the use of the servitude area by the applicant, his/her agent, contractors, employees, livestock or wildlife, successors in title, and assigns. The applicant indemnifies Eskom against loss, claims or damages including claims pertaining to consequential damages by third parties and whether as a result of damage to or interruption of or interference with Eskom's services or apparatus or otherwise.

9.2. Eskom will not be held responsible for damage to the applicant's equipment. The applicant's attention is drawn to sections 1 to 3 of the *Criminal Matters Amendment Act (Act 18 of 2015)* which deals with Offences relating to essential infrastructure, as amended, which stipulates that the applicant can be fined and/or imprisoned as a result of damage to Eskom's apparatus.

10. Machinery

10.1. No mechanical equipment, including mechanical excavators or high lifting machinery, shall be used in the vicinity of Eskom's apparatus and/or services, without prior written permission having been granted by Eskom. If such permission is granted the applicant must give at least seven working days prior notice of the commencement of work. This allows time for arrangements to be made for supervision and/or precautionary instructions to be issued. The Eskom persons to be contacted in this regard are:

Mr Pfukani Khoza (Sector Manager)
+27 13 265 6482
+27 81 230 9669
khozapf@eskom.co.za

11. Permission to do work

11.1. No work may commence unless Eskom has received the applicant's written acceptance of the conditions specified in the letter of consent and/or permit and the approval is valid for a period of such date or period as specified in the letter and/or permit.

11.2. The applicant or his / her contractor on site must at all times be in possession of the letter of consent. Should the site agent or contractor on site not be able to produce the required approval on inspection, all site activities will be stopped.
11.3. Eskom's rights and duties in the servitude shall be accepted as having prior right at all times and shall not be obstructed or interfered with.
11.4. NOTE: Where and electrical outage is required, at least fourteen work days is required to arrange same.

12. Remedial action

12.1. Under no circumstances shall rubble, earth or other material be dumped within the servitude or Way Leave restriction area. The applicant shall maintain the area concerned to Eskom's satisfaction. The applicant shall be liable to Eskom for the cost of any remedial action which has to be carried out by Eskom.

13. Safety

13.1. The clearances between Eskom's live electrical equipment and the proposed construction work shall be observed as stipulated by **SANS 10280-1:2017** included as part of the ***Electrical Machinery Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993).***
13.2. Equipment shall be regarded electrically live and therefore dangerous at all times.
13.3. In spite of the restrictions stipulated by **SANS 10280-1:2017** included as part of the ***Electrical Machinery Regulations of the Occupational Health and Safety Act, 1993 (Act 85 of 1993),*** as additional safety precaution, Eskom will not approve the erection of Houses, or structures occupied or frequented by human beings under the power lines and only after consideration of all alternatives, within the servitude area.
13.4. Eskom may stipulate any additional requirements to eliminate any possible exposure to Customers or Public coming into contact or be exposed to any dangers of Eskom plant.
13.5. It is required of the applicant to familiarize him/her self with all safety hazards related to Electrical plant.

Annex C – Specific conditions

1. Canals/pipelines

1.1. As a general rule, ***parallel*** encroachment into overhead power line servitudes or way leave areas is limited to 2 (two) metres from the boundary of the servitude. This distance allows reasonable maintenance access to Eskom in the servitude and leaves space for the upgrading of power lines.

1.2. The angle of the crossing should preferably be from 45 degrees to 90 degrees.

1.3. In the event of a proposed metal pipeline running ***parallel*** to the power lines, indication must be given that the pipeline will be adequately earthed at intervals of one kilometre, or less. The pipeline must also be adequately protected against the effects of induction and earth faults. Eskom recommends that all work on the pipeline be carried out between two working earths.

1.4. Wherever a pipe runs within the Eskom servitude, pipeline markers shall be placed at intervals of minimum of ten metres apart.

1.5. Wherever any pipe crosses Eskom services, the edge of the excavation shall not come within six metres of the Eskom services and structures. Where this cannot be achieved, or where there is a risk of a ruptured pipe eroding a tower foundation, the pipe joints are to be placed in concrete.

1.6. At a pipeline crossing, corrosion-free sleeves must be installed at least 600 mm below undisturbed ground level to provide for future installation of Eskom cables. The number and diameter to be determined by the internal assessor.

1.7. In case of a proposed canal or above ground pipe a bridge shall be provided to allow permanent Eskom vehicle access to the servitude. This bridge, if of conductive material, shall be earthed, but the earthing shall **not** be onto Eskom structures or within five metres of Eskom's own earthing.

ANNEX E – Acceptance of Conditions and Indemnity

From:

_____

On behalf of:

_____

To:

Eskom Limpopo Land & Rights

92 Hans van Rensburg Street

POLOKWANE 0700

INDEMNITY

In consideration of Eskom having agreed to us using the Eskom restricted area situated at the following Properties:

1. Remainder of DE GOEDEVERWACHTING 332 KT
2. Portions 1, 2 and Remainder of BOSCHKLOOF 331 KT
3. Remainder and Portion 1 of MOOIMEISJESFONTEIN 363 KT
4. Portion 34 of BELVEDERE 362 KT
5. Portion 1 of STEELPOORTPARK 366 KT
6. Portion 3, 10 and 11 of KALKFONTEIN 367 KT
7. Remainder and Portion 7 of STEELPOORTDRIFT 365 KT

for purposes of crossing the following Eskom powerlines

1. Chrome Rhodium 33 kV Powerline (Twice)
2. Merensky Jane Furse 132 kV Powerline (Once)
3. Merensky Jane Furse Uchoba 132 kV Powerline (Twice)
4. Merensky Winterveld 22 kV powerline (Eight times)
5. Merensky Lavino 22 kV Powerline (Four times)
6. Jane Furse Tubatse 22 kV Powerline (Once)
7. 2 X Parallel 132 kV Powerline Servitudes (Twice)

, and having regard that electricity is transmitted over the said restricted areas, we, the undersigned hereby agree and undertake:

1. To keep Eskom indemnified and to hold Eskom harmless against all loss, expense or damage from any cause arising including, but not limited to, death of or injury to any person or the loss of or damage to any property, which Eskom may sustain as a result of having agreed to the use of the above servitude area/s or as Grantee not taking the required safety precautions within the servitude area and which is caused by the negligence of the Grantee or its employees, contractors agents or property..
2. To pay to Eskom on demand whatever sum of loss or damages that is certified as such, by an Eskom official, whose appointment and authority need not be proved, and such certificate shall be *prima facie* proof of the said loss or damages. We waive the benefits of the exceptions *non causae debiti, non numeratae pecuniae* and *excussionis* and any other exceptions which may be pleaded in respect of this indemnity.
3. To pay to Eskom on demand all legal costs and charges incurred in obtaining or endeavouring to obtain payment of all amounts due in terms of this Indemnity.
4. If during the period of this indemnity, any claim is made against Eskom by any third party for loss or damages from any cause arising out of the use of the above servitude area, including the taking of or failure to take necessary safety precautions, the Grantee shall, immediately upon being notified thereof by Eskom, at its cost and expense undertake the

defence of such claim in Eskom's name and for Eskom's benefit, subject to Eskom's instructions and input in such defence, Eskom's written consent shall be obtained before any settlement of compromise is agreed to or before any indulgence or waiver of rights are considered.

5. If any claim is instituted against the Grantee by any third party because of their presence and/or activities in the above servitude area the Grantee will immediately upon receipt or notification of such claim inform and keep Eskom informed until the matter is finalised.
6. The Grantee agrees to abide by the terms of the Co-Use agreement.
7. The Grantee is aware that damage to Eskom's essential infrastructure is a criminal offence, and the offender may be fined and/or imprisoned in Law.
8. The Grantee warrants that it is aware of all safety measures relating to Electrical infrastructure.
9. This indemnity shall commence on the signature date and shall terminate on the agreed date or when the use of the servitude area has ended, whichever is later.

ACCEPTANCE OF CONDITIONS

I, (Full names)_____

Herewith unconditionally accept the stipulations in the Letter of Consent pertaining to my co-use of an Eskom servitude or restricted area.

Estimated Start date of Activities: _____

Estimated Completion Date of Activities: _____

Signed at _____ on _____/ _____/ _____

Signature: _____

Witness 1: _____

Witness 2: _____

APPENDIX D

Baseline Risk Assessment

Baseline Risk Assessment												
Risk Identification					**Risk Analysis**			**Risk Treatment**	**Risk Analysis (with Risk Controls in place)**			
Risk No.	**Task / Situation**	**What are the hazards?** *What aspects of work could harm workers or the public?*	**Risk event / description** *What can go wrong?*	**Impact / and or consequences** *How can these hazards harm workers or the public and what are the consequences that can result?*	**Inherent Risk**			**Risk Controls**	**Current Residual Risk**			
					Consequence	**Likelihood**	**Risk Level**		**Consequence**	**Likelihood**	**Risk Level**	
1	Surveying	Snakes, scorpions, ticks	Risk of snake bites / encounter with poisonous snakes - no treatment facility in close proximity. Scorpion sting - venom. Tick bite - fever.	Fatality, major jury	Catastrophic	Unlikely	High	Emergency preparedness and response plan - including air evacuation of injured persons. Induction training on snake awareness. Snake-bite management procedure.	Minor	Unlikely	Low	

	Incidental	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost Certain	Medium	Medium	High	Critical	Critical
Likely	Medium	Medium	High	High	Critical
Possible	Low	Medium	Medium	High	Critical
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

Likelihood Ratings	General Definition	Probability	History of Occurrence	How Soon It May Occur	Frequency
5 - Almost Certain	Is expected in most circumstances	90% or greater chance of occurring	Known to have occurred frequently in the past	Occur within next 12 months	Could occur once per week
4 - Likely	Will probably occur in most circumstances	60% - 89% chance of occurring	Known to have occurred several times in the past	Occur within next 24 months	Could occur once per month
3 - Possible	May occur at some time	30% - 59% chance of occurring	Known to have occurred infrequently in the past	Occur within next 3 – 5 years	Could occur once per year
2 - Unlikely	Doubtful that it will occur	5% - 29% chance of occurring	Known to have occurred infrequently in the past but unlikely for the firm	Unlikely to occur within next 5 years	Could occur once in 10 years
1- Rare	Could occur in exceptional circumstances	less than 5% chance of occurring	Unknown to have occurred	Rarely occur within next 5 years	Could occur once in 100 years

Consequence Ratings	1 - Incidental	2 - Minor	3 - Moderate	4 - Major	5 - Catastrophic
Health and Safety	First Aid Case, or an injury or illness not requiring treatment	A medical treatment case (MTC) / or restricted work case (RWC)	Any Lost Time Incident (LTI), ie. an illness or injury resulting in one or more consecutive days or shifts off work	Disabling injury or illness i.e. amputation and/or permanent loss of bodily function, or any kind of permanent health impact	Single or multiple fatality

APPENDIX E

H&S Improvement Plan (Example)

Internal Context	External Context
• **Engineer / Client's Agent responsibility**	• **Clients expect an ingrained H&S culture**

Key Objectives (to get us where we want to be)		Key Performance Indicator (timing in months)	Measure (Review)
u	Behaviour and attitude change	Decrease in number of unsafe acts and number of related deviations (12 months)	Monthly feedback on progress
○	Increase compliance levels	Decrease in number of deviations and near miss incidents (3)	Monthly feedback on progress
○	Facilitate ownership for H&S with key contractors' management	Visible coaching leadership (1)	Monthly feedback on progress
○	Implement control measures for high risk activities	Verification of implemented control measures (1)	Monthly feedback on progress

#	Actions / Strategies (to achieve objectives)	Responsibility	Due	Status	Comments
1a	Design and implement an incentive program for Supervisor level.				Idea identified, will be implemented next year.
1b	Design and implement an incentive program for worker / labourer level.				Same as above, subject to go-ahead from client
1c.	Implement a "positive feedback / well done" interaction during any PTO/CTO as well as "what do you think you/we can improve on".				
2a.	Contractor to identify 5 tasks generating most deviations – retrain workers via TT's and give proof of re-training.				
2b.	Contractor's PTO / CTO during following week to address these 5 tasks.				
3a.	Contractor to conduct PTO's / CTO's according to contract (Supervisors and above) – quality to be checked.				All PTO / CTO submitted to client on a CD, and transmittal kept
3b.	Contractors' management to conduct weekly VF's and walk-abouts.				Take part in daily walks on site.
3c.	Pledge signing workshop				Use client format, liaise with client to conduct workshop
4a.	Present short training session for excavation competent persons – get approval.				
4b.	Practical emergency procedures to be drafted as "TT's".				
4c.	Practical emergency procedures (as TT's) to be communicated (practically).				Excavation rescue still outstanding, could not be done due to wet soil conditions, rescue format drafted and discussed with all as a TT.

In diversity there is beauty and there is strength.

MAYA ANGELOU

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IMPACT. ENGINEERED.

ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPr):

PROPOSED MAMPURU BULK WATER SUPPLY PROJECT

FETAKGOMO TUBATSE LOCAL MUNICIPALITY

SEKHUKHUNE DISTRICT MUNICIPALITY

LIMPOPO PROVINCE

SEKHUKHUNE DISTRICT MUNICIPALITY

OCTOBER 2024

POLYGON
ENVIRONMENTAL PLANNING

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ACRONYMS

BAR	Basic Assessment Report
CLO	Community Liaison Officer
DFFE	Department of Forestry, Fisheries and Environment
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EMPr	Environmental Management Programme
IDA	International Dark-Sky Association
LEDET	Limpopo Department of Economic Development, Environment and Tourism
PSC	Project Steering Committee
NEMA	National Environmental Management Act (Act No. 107 of 1998, as amended)
NWA	National Water Act, 1998 (Act No. 36 of 1998, as amended)
WUL	Water Use Licence
WWTP	Wastewater Treatment Plant

1. DEFINITIONS

1.1 DEFINITIONS

For the purpose of this document, the following definitions apply:

Audit

A systematic and, wherever possible, independent examination to determine whether activities and related results conform to planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve the organisation's policy and objectives

Continual improvement

Process of enhancing the environmental management programme to achieve improvements in overall environmental performance in line with the organisation's environmental policy

Documentation

Any written information describing, defining, specifying, certifying or reporting activities, requirements, policy or results

Environment

Surroundings in which the organisation operates, including air, water, land, natural resources, flora, fauna, humans, and their interaction

NOTE: Surroundings in this context extend from within an organisation to the global system.

Environmental aspect

Element of an organisation's activities, products or services that can interact with the environment

NOTE: A significant environmental aspect is an environmental aspect that has or can have a significant environmental impact.

Environmental impact

Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

Environmental Management Programme

A guideline document or directive, forming part of the overall management system, outlining the mitigation, monitoring and institutional measures to be taken during the;

- project implementation phase,
- project construction phase, and
- project operational phase,
- to avoid or control adverse environmental impacts – also including the actions needed to implement these measures.

Environmental objective

Overall environmental goal, arising from the environmental policy, that an organisation sets itself to achieve, and which is quantified where practicable.

Environmental performance

Measurable results of the environmental management system, related to an organisation's control of its environmental aspects based on its environmental policy, objectives and targets.

Environmental policy

Statement by the organisation of its intentions and principles in relation to its overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets.

Environmental target

Detailed performance requirement, quantified where practicable, applicable to the organisation or parts thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives.

Hazard

A source or a situation with a potential for harm in terms of human injury or ill-health, damage to property, damage to the work place environment, or a combination of these.

Hazard Identification

The process of recognising that a hazard exists and defining its characteristics

Incident

Undesired event that has the potential to lead to an accident

NOTE: Term "incident" includes both accidents as well as no-loss incidents, called "near-misses".

Inspection

Examination or measurement to verify whether an item or activity conforms to specified requirements, using the techniques of quality control.

Interested and or Affected Party

Individual or group concerned with or affected by the environmental performance of an organisation.

Mitigation measures

Mitigation measures encompass all actions taken to eliminate, offset or reduce potentially adverse environmental impacts to acceptable levels (World Bank, 1999:1).

Occupational Exposure

Occupational Exposure of adult workers who may be exposed to EMF under controlled conditions, in the normal course of and intrinsic to their particular employment. These workers will have been made aware of the potential risks of exposure and they will be able to take appropriate precautions.

Organisation

Company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration. The Organisation in this case refers to the Sekhukhune District Municipality.

NOTE: For organisations with more than one operating unit, a single operating unit may be defined as an organisation.

Qualified Personnel

Characteristics or abilities gained through education, training and/or experience which enables an individual to carry out a specific task in accordance with specific requirements.

Risk

The combination of predicted frequency and consequences of a specified undesired event occurring due to the realisation of a hazard

Risk Assessment

The overall process of estimating the magnitude of risk and deciding whether or not the risk is tolerable

Safety

Freedom from unacceptable risk or harm

Site (also “The Site”)

All physical locations where contractors & sub-contractors will be performing tasks related to the tender/project allocated to them.

Tolerable Risk

A risk that has been reduced to a level that can be endured by the organisation having regard to its legal obligations and its own Occupational Health & Safety policy

Work Instructions

A document which sets out how a particular task is to be done, what is required and how it shall be recorded

2. EMPR BACKGROUND, PURPOSE & OVERVIEW

2.1 BACKGROUND & DETAILS OF EAP WHO PREPARED THE ENVIRONMENTAL MANAGEMENT PROGRAMME

POLYGON ENVIRONMENTAL PLANNING was commissioned by ZUTARI (on behalf of the SEKHUKHUNE DISTRICT MUNICIPALITY) to compile an Environmental Management Programme (EMPr) that would outline the,

- mitigation,
- monitoring and
- institutional measures,

to be taken during the planning & construction, to avoid and/or control adverse environmental impacts that could result.

The implementation of the EMPr by the contractors of the Sekhukhune District Municipality will assist in minimising and managing the environmental impacts associated with the project.

This EMPr was developed to be a practical, flexible working document and is based on actual on-site analyses of prevailing circumstances and activities undertaken at the Site.

DETAILS OF EAP WHO PREPARED THE ENVIRONMENTAL MANAGEMENT PROGRAMME

This Environmental Management Programme (EMPr) was compiled by:

Company: Polygon Environmental Planning
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Qualifications of EAP:
- BSc (Hons) Geography – *cum laude* (2004, University of Pretoria)
- BSc Geography – (2003, University of Pretoria)
- 19 years' experience as EAP
- Registered EAP (EAPASA) – registration number 2019/933
(See attached Curriculum Vitae)

2.2 SCOPE & OBJECTIVES OF THE EMPR

It is essential to develop measures to eliminate, offset or reduce impacts on the environment during the implementation and operational phases of a project. The integration of such measures to protect the environment during the implementation and operational phase of a project, can be done by clearly defining environmental requirements within an Environmental Management Programme (or EMPr) (World Bank, 1999:1).

EMPr's provide a link between 1) the predicted environmental impacts (that will be induced by a certain development/project), and 2) implementation and operational activities.

Generally, an EMPr performs the following functions;

- it outlines the anticipated environmental impacts of a project/activity,
- it outlines the measures to be taken to mitigate these impacts,
- it outlines responsibilities for mitigation of impacts.

Definition of an "Environmental Management Programme (EMPr):

An EMPr is a guideline document/directive outlining the mitigation, monitoring and institutional measures to be taken during project implementation, construction and operation to avoid or control adverse environmental impacts, as well as the actions needed to implement these measures (World Bank, 1999:1).

Definition of "mitigation measures":

Mitigation measures encompass all actions taken to eliminate, offset or reduce potentially adverse environmental impacts to acceptable levels (World Bank, 1999:1).

The objectives of the EMPr are:

- to identify and manage the potential environmental aspects (impacts) that could result from the project at the SITE;
- to ensure that the environmental performance of all employees as well as suppliers and/or contractors, over which the company has control or can be expected to

have an influence over, at least meet minimum environmental requirements when undertaking their activities;

- to establish and maintain a programme of remedial actions to address degradation of the environment that has resulted from past activities;
- to continually evaluate the effectiveness of the EMPr and make improvements where necessary.

3. EMPr & PROJECT INFORMATION

3.1 PROJECT BACKGROUND

The Sekhukhune District Municipality is of the intention to install bulk water supply infrastructure to improve the water supply capacity for serval communities within the greater Steelpoort area. The proposed project will consist of following:

Project Name: Mampuru Bulk Water Supply Scheme

Project Description: The project will consist of the following main components:

- Proposed construction of several pipelines totalling approx. 70km length with sizes of a diameter between 75mm and 400mm.
- Proposed construction of approx. 3 steel tanks and 6 concrete reservoirs (sizes between 250m^3 and 7 400m^3):
  - Kalkfontein command reservoir – 3,100kl concrete reservoir
  - Tshakane tank – 250kl steel tank
  - Mampuru Ext tank – 500kl steel tank
  - Mampuru reservoir – 1,200kl concrete reservoir
  - Spitskop command reservoir – 7,400kl concrete reservoir
  - Ga-Phasha reservoir – 1,300kl concrete reservoir
  - Stocking reservoir – 700kl concrete reservoir
  - Mapodile reservoir – 3,000kl concrete reservoir
  - Dithamaga tank – 600kl steel tank
- Two Pump stations at Ga-Malekana WTW (169kW) and Dithamaga (29kW).
- Construction of access roads to reservoirs and associated platforms with a combined length of approx. 3,1 km.

Project Location: The project area is located in the Fetakgomo Tubatse Local Municipality area, Sekhukhune District, Limpopo Province. The new pipelines are proposed to connect at the existing Ga-Malekana Water Treatment Works and will connect with existing as well as new reservoirs to assist with water supply in some the following areas: Ga-Malekana, Tsakane, Kalkfontein, Ga-Mampuru, Ga-Phasha,

Stocking, Ga-Mopodile, Tukakgomo, Dithamaga, Degoedeverwachting & Steelpoort Ext.2. The infrastructure is proposed on the following affected properties: Remainder & Portion 2 of the Farm Eerstegeluk 327 KT, Remainder, Portions 1 & 2 of the Farm Boschkloof 331 KT, Remainder, Portions 1, 2 & 5 of the Farm De Goedeverwachting 332 KT, Portions 28, 29 & 43 of the farm Spitskop 333 KT, Remainder of the Farm Annex Grootboom 335 KT, Portion 1 of the Farm Grootboom 336 KT, Portions 34 & 35 of the Farm Belvedere 362 KT, Remainder and Portion 1 of the Farm Mooimeisjesfontein 363 KT, Remainder of the Farm Steelpoortdrift 365 KT, Portion 1 & 21 of the Farm Steelpoortpark 366 KT, Portions 3, 10 & 11 of the Farm Kalkfontein 367 KT.

3.2 ENVIRONMENTAL MANAGEMENT PROGRAMME

3.2.1 INTRODUCTION

Mitigation seeks to find better ways of doing things, minimise or eliminate negative impacts, enhance project benefits and protect public and individual rights. The applicant/proponent has a responsibility to avoid or minimise impacts, and programme for managing impacts.

This report serves to prescribe measures to reduce, limit, eliminate or compensate for impacts, to acceptable/insignificant levels. The term ‘mitigate’ means to ‘allay, moderate, palliate, temper, intensify’. In environmental terminology this term is used as follows:

- mitigation of a negative impact;
- to reduce the significance of an impact;
- mitigation/optimisation of a positive impact;

Hereunder the potential to mitigate each of the negative impacts identified will be discussed. Certain mitigation measures will be proposed and an indication will be given of how these proposed mitigation measures will influence the significance and status of each identified impact. Recommendations are arranged in order of sequence i.e. Planning/construction and Operational phases.

Mitigation should permeate through all stages of the development process. It is also essential that the mitigation programme be monitored during the construction and operational phases, to ensure compliance.

The stipulations of this report should be conveyed to contractors and persons responsible for construction. This report should be issued as a stand along document to all parties involved with the planning, implementation and operation of the proposed project.

3.2.2 WHAT IS AN EMPR?

It is essential to develop measures to eliminate, offset or reduce impacts on the environment, to acceptable levels before the implementation and operational phases of a project commence. The integration of such measures to protect the environment during the implementation and operational phase of a project, can be done by clearly defining environmental requirements within an Environmental Management Programme (or EMPr) (World Bank, 1999:1).

EMPr's provide a link between 1) the predicted environmental impacts (that will be induced by a certain development/project), and 2) implementation and operational activities.

Generally an EMPr performs the following functions;

- it outlines the anticipated environmental impacts of a project,
- it outlines the measures to be taken to mitigate these impacts,
- it outlines responsibilities for mitigation of impacts.

Definition of an "Environmental Management Programme" (EMPr):

An EMPr is a guideline document/directive outlining the mitigation, monitoring and institutional measures to be taken during project implementation, construction and operation to avoid or control adverse environmental impacts, as well as the actions needed to implement these measures (World Bank, 1999:1).

Definition of "mitigation measures":

Mitigation measures encompass all actions taken to eliminate, offset or reduce potentially adverse environmental impacts to acceptable levels (World Bank, 1999:1).

3.2.3 GEOGRAPHIC SCOPE OF THIS EMPR

This EMPr shall apply to all areas that will be affected by activities that will be undertaken as part of the project.

3.2.4 TIME FRAME OF THIS EMPR

This EMPr shall apply to all actions that will be undertaken between the date of issuing of the Environmental Authorisation (EA) and until the maintenance period after completion of construction has lapsed.

3.2.5 EMPR TO INFORM PLANNING

During planning and design, the proponent and its planning consultants and contractors, should take into account the recommendations of this EMPr so that it is positively utilized on a pro-active basis to aid in the mitigation of impacts.

3.2.6 EMPR TO CONTRACTORS (INCLUDING ENVIRONMENTAL AWARENESS PLAN)

At the outset of the construction phase, an Environmental Awareness Plan should be presented to the lead contractor and an induction session must be presented to the construction workers, with specific concentration on those aspects that directly affect the workers or in which workers will be directly involved.

The stipulations of this mitigation programme (EMPr) should be conveyed to contractors prior to the commencement of construction. Contractors should acknowledge receipt thereof in writing (this can be achieved by including this EMPr as an annexure to the tender and/or contract documents).

Environmental Awareness, in which the contents of this EMPr are explained to the contractor (including the site agent, CLO and Health & Safety officer), must be done by the appointed ECO (who will monitor compliance of the EMPr and conditions of the EA).

The environmental risk which will result from the construction activities must then be communicated to the laborers during the daily/weekly toolbox talks.

A copy of the construction-phase environmental awareness plan must be available onsite at all times during construction.

In case of decommissioning, a decommissioning environmental awareness plan must be compiled by the ECO and presented to the lead contractor responsible for overseeing the decommissioning or destruction activities. An induction session must also be presented to the workers, and a copy of the environmental awareness plan must be available onsite at all times until decommissioning and site rehabilitation have been completed.

3.2.7 INCORPORATE RECOMMENDATIONS INTO CONSTRUCTION CONTRACTS

Construction-phase mitigation guidelines and clauses should be written into contract documents as specifications, in addition to the minimum requirements as set out in the SABS Standardised Specification for Civil Engineering Construction.

Additional clauses should be added as necessary in response to specific impacts that may be identified during the detailed design stage.

3.2.8 EMPR MONITORING

Environmental compliance monitoring should be done by an independent Environmental Control Officer (ECO) on at least a monthly basis throughout the construction phase. Should any instances of non-compliance be found, this must be brought to the attention of the contractor or site foreman, along with recommended measures for rectifying the non-compliance.

Monitoring reports, indicating the level of compliance with the specifications of the EMPr, must be submitted to the Limpopo Department of Economic Development, Environment and Tourism (LEDET) by the ECO at six-monthly intervals (or as indicated in the EA by LEDET) and at the end of the construction phase (also refer to Section 3. 4 MONITORING & REPORTING for more information on the monitoring process)

3.2.9 NOTIFYING THE PUBLIC

Adjacent landowners and the public at large were informed of the proposed activity as part of the EIA process.

3.3 RECOMMENDED ENVIRONMENTAL IMPACT MANAGEMENT MEASURES

3.3.1 PLANNING PHASE MITIGATION GUIDELINES

3.3.1.1 Implementation recommendations

Mitigation measures:

During planning and design the proponent and its consultants and contractors, must take into account the recommendations of this Environmental Management Programme, so that it is positively utilized on a pro-active basis to aid in the mitigation of impacts.

Responsible Party:

Proponent (Sekhukhune District Municipality), planning consultants and contractors. Impact prevention, mitigation and/or management measures during the construction phase are ultimately the responsibility of the applicant/EA holder (Sekhukhune District Municipality), unless the responsibility is transferred to another entity. The appointed contractor will however be responsible for the day-to-day implementation of the EMPr, and different components may be implemented by different sub-contractors, for instance erosion control measures will mostly be the responsibility of the earthworks contractor).

Time frame:

During planning/pre-construction phase

3.3.1.2 Incorporate recommendations into construction contracts

Mitigation measures:

Construction phase mitigation guidelines and clauses should be written into contract documents as specifications, in addition to the minimum requirements as set out in the SABS Standardised Specification for Civil Engineering Construction.

Additional clauses should be added as necessary in response to specific impacts that may be identified during the detailed design stage. These conditions should be adhered to by all contractors and their compliance will be monitored on a continual basis.

Responsible Party:

Proponent (Sekhukhune District Municipality), planning consultants and contractors

Time frame:

During planning/pre-construction phase

3.3.1.3 Activity/Impact: The destruction of vegetation during initial investigations

Mitigation measures:

When visiting the site during the planning phase, use should be made of existing access roads as far as possible.

Responsible Party:

Proponent (Sekhukhune District Municipality), planning consultants and contractors

Time frame:

During planning/pre-construction phase

3.3.1.4 Activity/Impact: Uncertainty amongst local residents about who will benefit from the project

Mitigation measures:

Effective dissemination of the intentions of the proponent should take place throughout the area. Ongoing consultation with the community/local residents should take place. Prior to employment of individuals the proponent should liaise with the community/local residents. The Ward Councilors of the Municipality must assist the contractors with the consultation process.

Responsible Party:

Proponent (Sekhukhune District Municipality), Ward Councilors, planning consultants and contractors

Time frame:

During planning/pre-construction phase

3.3.2 CONSTRUCTION PHASE MITIGATION GUIDELINES

3.3.2.1 IMPACT: SITE ESTABLISHMENT

3.3.2.1.1 ACTIVITY: DEMARCATION OF THE SITE

Mitigation Measures:

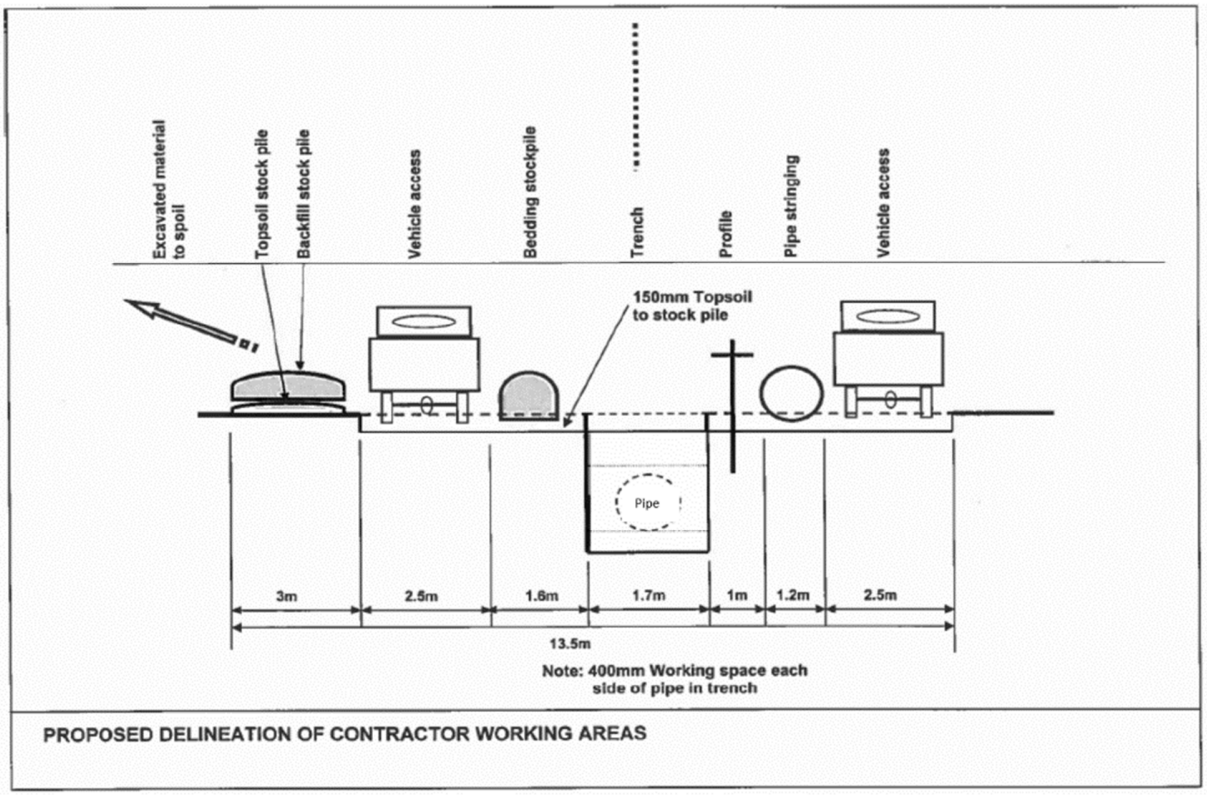
Identify and demarcate the extent of the site and associated Works Areas (construction site)

In sensitive environments (as indicated in the sensitivity maps), or where access into no-go areas takes place, then the area must be demarcated with a perimeter fence/danger tape/shade netting, the specification of which must be adequate to address the problem. This will be determined on site in collaboration with the EO / ECO.

Maintain site demarcations in position until the cessation of construction works.

Maintain animal movement corridors as specified by the EO / ECO.

For pipelines, a servitude width of approximately 13.5m (see image below) is permitted for machine excavation, and 6m for manual excavation, unless otherwise specified by the EO / ECO. This working servitude must accommodate all construction related activities, including materials storage, access routes etc. Minimise the extent of the Works Site footprint as much as is possible.



In sensitive environments including the riverine areas of the Steelpoort and Molawetse Rivers as well as their tributaries (as indicated in the sensitivity maps), this working servitude must be reduced as far as possible.

Maintain the demarcation line, and ensure that no personnel or construction materials move outside the designated site.

Do not use the site for any other purpose other than for the proper carrying out of the Works under the Contract.

Do not establish any site Works besides those specified and allowed for in the successful tender, unless specifically agreed upon with the EO / ECO.

Do not establish any activities or operations that, in the opinion of the EO / ECO are likely to adversely affect the aesthetic quality of the environment.

In the event that such activities and operations are deemed to be necessary, then ameliorative actions to reduce the adverse effects must be taken. Actions will be specified by the EO / ECO.

Use environmentally friendly, water based paint to mark natural features where necessary. Marking for surveying and other purposes must be done using pegs, beacons or rope and droppers.

Responsible Party:

Contractor (Surveyor of setting out construction site)

ECO will demarcate sensitive sites

Time frame:

During planning/pre-construction phase

3.3.2.1.2 ACTIVITY: PROTECTION OF VEGETATION AND NATURAL FEATURES

Mitigation Measures:

The Ecological Report made the following conclusion and recommendations regarding the proposed route for the pipeline in order to limit the impact on the biological environment:

Most significant current impacts observed within the study area include mining & processing activities, agriculture, wood harvesting and overgrazing, which brings with it habitat & biodiversity loss (both in plant and animal species), significant soil erosion and aesthetic impacts (impacting particularly on the sense of place). It is important to note that the proposed development will be taking place within an area already faced with numerous environmental impacts and challenges. Notwithstanding, there is still a responsibility by the proposed development to tread lightly within an already degraded environment. Some sites which were assessed did however manage to avoid the majority of significant impacts listed above and boasted a near natural state and high ecological sensitivity. The proposed development is supported under the condition that mitigation measures are adhered to.

The outcomes of the Aspects and Impacts Registers indicate that the majority of the

activities within the proposed development will have Medium to Medium-Low impact on the applicable environment (taking into account that some impacts were also rated as Low and Medium-High) as long as mitigation strategies are applied and upheld.

The following is mitigation is recommended in terms of protection of flora:

- **Reservoirs** –The following proposed areas for reservoir construction will need special care as they fall within sensitive areas or areas wherein which protected tree species were found: Stoking Reservoir (Sensitive area as well as Marula trees on access road), Mapodile Reservoir (Marula tree close to existing reservoir) and Spitskop Reservoir (Marula tree and Shepherd's tree close to reservoir & access road). The Dithamaga Reservoir also boasted an increased species presence and sensitive habitat (especially with the associated pipeline route towards Annex A and through the closest watercourse), which requires as little disturbance of the natural habitat as possible.
- **Access Roads –** New access roads which traverse particularly sensitive areas however include: Stoking Reservoir (with Marula trees en route and comprising of quite a lengthy road) and the Spitskop Reservoir access road modification, which also encounters Marula and Shepherd's trees en route.
- **Pipelines –** Pipelines traversing particularly sensitive areas include the: Stoking reservoir pipeline and Dithamaga pipeline towards Annex A (encountering large Marula trees) and Dithamaga towards Spitskop (encountering Marula, Torchwood and Sekhukhune Bushman's tea trees at the nearest watercourse) with site coordinates at 24°50'10.56"S & 30° 9'5.90"E.
- Degraded areas should be rehabilitated.
- The route follows the boundary of a number of riparian zones. Keep construction out of these riparian zones as far as possible.
- Only vegetation within the construction site should be removed whilst vegetation outside the construction site should be left intact.
- Rehabilitation of stream crossings should follow best practises which may include hydro seeding and cover net will limit erosion where river to section.

A survey to verify the occurrence of Protected trees (as identified in the Ecological Report) must be undertaken before site clearing is to commence by the appointed ECO.

An application for a license to damage/destroy Protected trees (in terms of Section 15(1) of the National Forests Act no 84 of 1998) must be submitted to the Department of Forestry, Fisheries and Environment and the license must be issued before any Protected trees may be damaged or removed.

Identify, locate and map all plants and natural features to be protected during construction as indicated in the Ecological Assessment Report. These plants and features include, but

are not limited to, Red Data Species, Protected Plants, Sensitive Communities, Riparian Vegetation, Wetlands, Drainage Lines and Aesthetically Significant Areas. The contractor, with the assistance of the ECO, will protect identified plants (at the distance of the outermost dripline) and natural features using barricade fencing like shade netting and steel droppers.

Protected as well as endemic plant species in terms of the Limpopo Environmental Act, was identified in the Ecological Report; the *S. birrea* trees occurring in the vicinity of the Stoking, Mapodile and Dithamaga Reservoirs; *Lydenburgia cassinoides*, *Balanites Maughamii* and *S. birrea* in the area located between Spitskop and Dithamaga; *Boscia albitrunca* and *S. birrea* in the vicinity of the Spitskop Reservoir and *B. albitrunca* and *S. birrea* in the vicinity of the Future Link near the pipeline route must be demarcated using danger tape or barricade fencing like shade netting and steel droppers before any construction activities takes place by the contractor in collaboration with the EO/ECO.

During construction, the area should be monitored by the EO / ECO to ensure that these plants are not affected by construction activities. The Movement of construction vehicles must be limited to existing roads in the affected area.



Photo of *Sclerocarya birrea* – *Marula* (left) and *Boscia albitrunca* – Shepards' tree (right) (Photos: Bateleur Ecological services).

Where damage to protected plants and natural features is a problem, then these must be fenced for protection.

Any large trees must be retained where possible to limit the impact on the direct environment.

Aloes and succulents must be replanted in the adjacent vicinity of the construction area. Large aloes must be replanted in such a manner as to screen the construction area.

Maintain plant demarcations in position until the cessation of construction works.

Locate construction camps on the outside fringe of the riparian vegetation zone.

The EO / ECO may add to this list, as long as motivation for doing so is in line with the criteria used to initially identify the plant or feature (i.e. either during the Environmental Impact Assessment or Project Screening Exercise, whichever is relevant).

Do not disturb, deface, destroy or remove plants or natural features, whether fenced or not, for the duration of the Contractor's presence on site, unless otherwise specified by the EO / ECO.

The Contractor will be held liable for the replacement of any plant or feature under the protection of these specifications that is removed or damaged by the Contractor's negligence or mismanagement.

Do not remove any large trees without the permission of the EO / ECO. In all areas mark trees earmarked for removal prior to felling for approval by the EO / ECO.

No open fires are permitted under trees.

No material storage or laydown is permitted under trees.

Avoid locating buildings and structures (temporary or otherwise) under trees wherever possible.

No heavy equipment, machinery and vehicles may be parked under any tree, unless authorized by the ECO.

No vegetative matter may be removed for firewood on site.

<u>Responsible Party:</u>

Contractor

ECO will mark/indicate protected & endangered plants

Time frame:

During planning & Construction phase

3.3.2.1.3 ACTIVITY: PROTECTION OF FAUNA

Mitigation Measures:

Identify animal species, populations and nests to be relocated (none was however identified during the EIA study). Relocate affected fauna (if any are discovered during construction) to areas where they will not be at risk. Plan such operations well in advance.

According to terrestrial ecological report, the occurrence of most fauna to occur naturally in the vicinity of the pipeline construction site is typically low with some fauna to occur more frequently. Of all the fauna to potentially exist in the different areas of the pipeline sites, 45 species were identified to be protected species, but their inhabitation in the vicinity of the pipeline areas are unlikely as the ecology has been degraded to a significant extent and neither their food sources nor ideal breeding sites are supported (A list of all the fauna as well as protected species can be found in the ecological report).

Natural habitats for protected amphibians including *Pyxicephalus edulis, P. adspersus* & *Breviceps sylvestris sylvestris,* protected mammals including *Mellivora capensis* & *Redunca arundinum,* a number of protected reptiles such as *Chamaesaura macrolepis* & *Python natalensis* as well as several protected birds such as *Aquila rapax* & *Torgos tracheliotus* should be avoided.

No domesticated animals (i.e. chickens and pigs) are permitted at the construction site.

No wild animal may under any circumstance be handled, removed or be interfered with.

No wild animal may be fed on site.

No wild animal may under any circumstance be hunted, snared, captured, injured or killed. This includes animals perceived to be vermin. The Contractor will be held liable for the replacement of any animal injured or killed due to the construction activities.

The contractor (with the assistance of the EO / ECO) will regularly undertake checks of the surrounding natural vegetation, in fences and along game paths to ensure no traps

have been set. Remove and dispose of any snares or traps found on or adjacent to the site.

Ensure that the Work Site is kept clean, tidy and free of rubbish that would attract animal pests.

Have problem animals and vermin removed by an appropriate organization or authority (i.e. such as the Parks Board, the SPCA or a registered exterminator).

Ensure that domesticated animals belonging to the local community are kept away and are safe from any unprotected Works.

Ensure trenches are properly barricaded.

Pipeline trenches need to be dug with escape routes or sloped head and tail angles so that any animals which may fall into these trenches may be able to escape.

Do not make use of any pesticides, unless approved by the EO / ECO.

Responsible Party:

Contractor

ECO will monitor sensitive areas

Time frame:

During planning/pre-construction phase and construction phase

3.3.2.1.4 ACTIVITY: PROTECTION OF CULTURAL HISTORICAL ASPECTS

Mitigation Measures:

A Heritage Impact Assessment of the proposed water supply infrastructure was conducted to determine the presence of cultural heritage sites and the impact of the proposed development on these non-renewable resources. During the survey 25 heritage features was recorded, but not all the features have heritage significance. The heritage features that need further mitigations to be protected, are described below.

1. The first is a historical bridge that will be retained *in-situ* and will not be directly impacted by the pipeline. The site has a high significant heritage value. It is recommended that the area be monitored when groundworks take place.

2. The second is 3-5 graves which are located besides gravity main 693078717970515009 and is cordoned off with palisade fencing. These graves will be retained *in-situ* and not directly impacted by the proposed pipeline. If any additional graves are found they should ideally be preserved in-situ or alternatively relocated according to existing legislation. It is recommended that the area be monitored when groundworks take place. Contractor to make note and inform subordinates.

3. The third is 3-5 graves which are located 100m from the future-link and is cordoned off with palisade fencing. These graves will be retained *in-situ* and not directly impacted by the proposed pipeline. If any additional graves are found in future they should ideally be preserved in-situ or alternatively relocated according to existing legislation. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates.

4. Single marked grave located along gravity main 693078717970515009. The grave may be impacted by the groundworks that will take place in the vicinity of the grave. It is recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the grave be adequately cordoned off.

5. Single marked grave located along gravity main 693076677861049409 and the start of access road to Spitskop Command reservoir. The grave may be impacted by the groundworks that will take place in the vicinity of the grave. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the grave be adequately cordoned off.

6. Single marked grave located along gravity main 693077085882942529. The grave may be impacted by the groundworks that will take place in the vicinity of the grave. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the grave be adequately cordoned off.

7. More than 6 marked graves located along gravity main 693066803738174034. It is recommended that the area be monitored when groundworks take place.

The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the grave be adequately cordoned off.

8. 2 marked graves located along gravity main 6930668037381740 26. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the grave be adequately cordoned off.

9. 1 marked grave located along rising main 7253127803089145 07 and gravity main 7253124796632022 80. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the grave be adequately cordoned off. The pipe line to follow the access route to avoid the grave.

10. Formal cemetery located along gravity main 6930668037381740 33. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the grave be adequately cordoned off.

11. A second formal cemetery located along gravity main 6930668037381740 33. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) **Access to the cemetery must be allowed and not be obstructed during construction.**

12. A third formal cemetery located along gravity main 6930668037381740 33. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics) and that the cemetery should be appropriately cordoned off. **Access to the cemetery must be allowed and not obstructed during construction. The pipeline may need to move slightly from current location.**

13. A fourth formal cemetery located along gravity main 6930668037381740 33. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics). **Access to the cemetery must be allowed and not be obstructed during construction.**

14. A fifth large formal cemetery located along gravity main 693066803738174035. It is recommended that the area be monitored when groundworks take place. The contractor should take cognisance of the grave and alert subordinates. It is further recommended that a 5m buffer be imposed (instead of 30m due to logistics). **Access to the cemetery must be allowed and not be obstructed during construction.** It is further recommended that the pipeline be moved further north east to run along the property line (The pipeline route was rerouted to run along the outside boundary).

15. Terrace walling in association with square house foundations- modern period - not archaeological. It is recommended that the area be monitored when groundworks take place. Terrace walls to be avoided.

16. House foundations- modern period. It is recommended that the area be monitored when groundworks take place.

17. Abandoned modern homestead – It is recommended that the area be monitored when groundworks take place.

18. Abandoned modern building - Not applicable for protection with no mitigations recommended.

19. Cement water canal – (Not indicated on 1:50 000 maps, thus unlikely to be older than 60 years) – to be avoided as it is used for agriculture.

20. 3 areas identified with non-diagnostic ceramic sherd scatter – These sites have a low significance but it is recommended that the area be monitored when groundworks take place.

21. Early farmers site consisting of recorded features: Midden, cattle dung deposit, lower grinding stone and possible grinbin stand. The site has a medium significance and it needs to be monitored. It is recommended that the area be monitored when groundworks take place and be avoided where possible – however not in direct pipeline location.

22. 2 sites were identified with low concentrations/scatter of Middle Stone Age stone tools, which is no longer in context, although it is recommended that the area be monitored when groundworks take place.

The contractor together with the EO / ECO must identify, locate and map all features and sites of social and / or cultural historical significance to be protected during construction (as indicated above and the Heritage Impact Assessment Report). These features include, but are not limited to, inhabited houses, graves, historical structures, culturally

significant sites (such as initiation schools) and archaeological finds. The identified features will be protected using barricade fencing like shade netting and steel droppers.

Where damage to protected features is a problem, then these must be fenced for protection.

Maintain demarcations in position until the cessation of construction works.

Do not disturb deface, destroy or remove protected features and sites, whether fenced or not, for the duration of the Contractor's presence on site, unless otherwise specified by the EO / ECO.

If any chance archaeological finds, graves or skeletal material are unearthed, halt Works in that area immediately and inform the EO / ECO as per Change find Procedure indicated below.

Chance Find Procedures:

The following procedural guidelines must be considered in the event that previously unknown heritage resources or burial grounds and graves are exposed or found during the life of the project.

Initial Identification and/or Exposure (Chance Find):
If during the construction, operations, or closure phases of this project, any person employed by the developer, one of its subsidiaries, contractors and subcontractors, or service provider, find any artifact of cultural significance, this person must cease work at the site of the find. They must report this find to their immediate supervisor, and through their supervisor to the senior on-site manager.

The initial procedure when such sites are found aim to avoid any further damage. If during the construction, operations or closure phases of this project, any person employed by the developer, one of its subsidiaries, contractors and subcontractors, or service provider, finds any artifact of cultural significance the following steps and reporting structure must be observed in both instances:

- The person or group (identifier) who identified or exposed the heritage resource or burial ground must cease all activity in the immediate vicinity of the site;
- The identifier must immediately inform the senior on-site Manager of the discovery;
- The senior on-site Manager must make an initial assessment of the extent of the find, and confirm the extent of the work stoppage in that area and ensure that the site is secured and control access;
- The senior on-site Manager will inform the ECO and Health and Safety (HS) officer of the chance find and its immediate impact on operations. The ECO will then contact the project archaeologist.

Chance Find Procedures: Heritage Resources:

In the event that previously unidentified heritage resources are identified and/or exposed during construction or operation of the project, the following steps must be implemented subsequent to those outlined above:

- The project archaeologist must be notified of the discovery;
- The project archaeologist will visit the site for a field based assessment of the finds and appropriate mitigation measures will then be presented to the developer;
- Should the specialist conclude that the find is a heritage resource protected in terms of the NHRA (1999) Sections 34, 35, 37 and NHRA (1999) Regulations (Regulation 38, 39, 40), the project archaeologist will notify the South African Heritage Resources Agency (SAHRA) and/or the Limpopo Provincial Heritage Resources Agency (LIHRA) on behalf of the developer; and
- Based on the comments received from SAHRA and/or LIHRA, the project archaeologist will provide the developer with a Terms of References Report and relevant associated costs if necessary.

Chance Find Procedures: Burials and Graves:

In the event that previously unidentified burial grounds and graves are identified and/or exposed during construction or operation of the project, the following steps must be implemented subsequent to those outlined above:

- The project archaeologist must immediately be notified of the discovery in order to take the required further steps:
    - The local South African Police Service (SAPS) will be notified on behalf of the developer;
    - The project archaeologist will inspect the exposed burial and determine in consultation with the SAPS if any additional graves may exist in the vicinity as well as the temporal context of the remains, i.e.:
        - forensic
        - authentic burial grave (informal or older than 60 years, NHRA (1999) Section 36); or
        - archaeological (older than 100 years, NHRA (1999) Section 38);
- Should the specialist conclude that the find is a heritage resource protected in terms of the NHRA (1999) Section 36 and NHRA (1999) Regulations (Regulation 38, 39, 40),the project archaeologist will notify SAHRA and/or LIHRA on behalf of the developer;
- SAHRA/LIHRA may require that an identification of interested parties, consultation and /or grave relocation take place;
- Consultation must take place in terms of NHRA (1999) Regulations 39, 40, 42; and 5. Grave relocation must take place in terms of NHRA (1999) Regulations 34.

Chance Find Procedures: Palaeontological finds:

It is noted that following the findings of the desktop Palaeontological Impact Assessment it is unlikely that fossils will be affected by the proposed Mampuru Bulk Water Supply Scheme development. In the unlikely event that fossils are discovered in the overlying Quaternary alluvial deposits the following procedure is required.

1. If fossils are found or exposed by excavation in unconsolidated Quaternary deposits they must be inspected by the environmental officer or designated person.
2. If fossils are noted in the unconsolidated Quaternary sands (includes bones, insects or plants) a suitably qualified palaeontologist must be approached for a verdict.
3. Fossil material displaced by excavation should be placed in a protected area, in this way development activities will not be held up.
4. Appropriate photographs of the fossils which have been noted should be sent to a qualified palaeontologist for a verdict on how to proceed. This may require a site inspection and excavation by the palaeontologist.
5. Fossils that are deemed to be of good quality or of scientific importance by the palaeontologist must be removed and curated in a recognised palaeontological museum collection where they can be made available for further study.
6. Before fossils are removed from the site a collecting permit must be obtained from SAHRA, and the required permitting procedures and requirements must be followed.
7. If the fossil material is deemed by the registered palaeontologist (as a result of photographic evidence or a site visit) to not be worthy of excavation and curation in a museum collection, the material will not be removed.
8. Mitigation will involve an attempt to capture all rare fossils and systematic collection of all fossils discovered by a registered palaeontologist. This will require routine collecting protocols involving descriptive, diagrammatic and photographic recording of fossils and exposures. The fossils and appropriate contextual samples will be processed to create an archive collection.
9. Should a major *in situ* occurrence be exposed, excavation will immediately cease in that area so that the discovery is not disturbed or altered in any way until the appointed palaeontologist has investigated the find.

10. Should no fossils be discovered in the process of development and excavations have been completed, no further monitoring will be required.
11. Any site visits by a registered palaeontologist and/or excavation of fossil material required, will be undertaken at the cost of the developer.

Responsible Party:

Contractor

ECO will assist to demarcate and monitor heritage features

Time frame:

During planning/pre-construction phase and construction phase

3.3.2.1.5 ACTIVITY: TOPSOIL CONSERVATION

Mitigation Measures:

Ahead of all construction, strip the entire available topsoil layer. Stockpile separately from overburden (subsoil and rocky material).

In the absence of a recognizable topsoil layer, strip the upper most 300mm of soil.

Co-ordinate Works to limit unnecessarily prolonged exposure of stripped areas and stockpiles. Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area.

Strip and stockpile herbaceous vegetation, overlying grass and other fine organic matter along with the topsoil.

Do not strip topsoil when it is wet.

Store stripped topsoil in an approved location and in an approved manner (refer to section 3.3.2.4 EXCAVATIONS and section 3.3.3 REHABILITATION PERFORMANCE SPECIFICATIONS) for later reuse in the rehabilitation process.

Stockpile topsoil stripped from different sites separately, as reapplication during rehabilitation must preferably be site specific. If necessary keep a stockpile register.

Do not mix topsoil obtained from different sites.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.1.6 ACTIVITY: DEBUSHING AND DESTUMPING

Mitigation Measures:

The contractor is to obtain permission from the EO / ECO to proceed with debushing. Only debush specified areas required for construction activities.

Wood and plant material can be taken to a designated area where locals can collect it for fire wood.

Retain trees and stumps in remaining areas to function as refuges and habitats unless otherwise specified.

Utilise the method of debushing most appropriate for the environment and species in question. Favour mechanical rather than chemical methods wherever possible.

Where chemical methods are used, ensure that particular care is taken to avoid environmental damage. Manufacturers' instructions are to be adhered to at all times.

During felling and the clearing of woody vegetation, avoid the removal of and / or damage to the lower strata of vegetation, the basal grass cover and topsoil layer wherever possible.

Wood obtained from de-bushing and de-stumping remains the property of the landowner and must be stockpiled in areas designated by him and approved by the EO / ECO.

Where there is a need, stockpile brush wood of diameter less than 50mm for later use during rehabilitation.

Dispose of remaining plant material and stumps as solid waste. Upon approval by the EO / ECO, the plant material may be buried on site. Specifications for topsoil stripping, backfilling of excavations and rehabilitation will apply in this regard.

Only carry out de-stumping upon instruction by the EO / ECO. In all other instances trees must be cut as close as possible to the ground level and roots retained (for soil binding and habitat creation).

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.2 IMPACT: SITE INFRASTRUCTURE

3.3.2.2.1 ACTIVITY: STRUCTURES AND ACCOMMODATION

Mitigation Measures:

Locate all buildings and structures within predetermined zones as per the approved layout plan.

Locate all temporary (and permanent) labour housing within predetermined zones off site.

Secure housing sites using 1,2m high fence. In areas where security or theft is a problem, the fence height may be increased to 1,8m or even 2,4m and topped with razor wire. These fences are to remain in position until the cessation of Works.

Ensure that essential services (including showers, appropriate sanitation and drinking water facilities) are provided for all housing sites.

Maintain essential services in a functional state. These may not be overloaded. Defects and inadequacies must be rectified immediately.

Provide a designated place for food storage, preparation and consumption. Food storage must be separate from sleeping quarters and waste storage areas.

Service all labour housing with cooking facilities, preferably gas or electricity.

Allow for household amenities, such as washing and drying of clothes, as well as areas for social interaction (if necessary).

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.2.2 ACTIVITY: CONTRACTORS CAMP AND LAYDOWN AREAS

Mitigation Measures:

Only security and emergency personnel are to be housed on the construction site.

Locate all storage areas and material laydown sites within predetermined zones as per the approved layout plan.

Additional areas required by the contractor for laydown and storage must be approved by the EO / ECO.

Keep the camp and all its storage and laydown areas secure and neat at all times and employ appropriate access control measures during construction.

Clearly indicate which activities are to take place within which areas of the site.

Position security lighting so that it does not pose a nuisance to residential properties, tourist facilities or a danger to road users.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.2.3 ACTIVITY: ROADS AND ACCESS

Mitigation Measures:

Develop all permanent and temporary roads and access routes as indicated on the approved Sketch Plans.

Slight deviations of alignment are permitted, so as to avoid significant vegetation specimens and communities, natural features and sites of cultural and historical significance. These deviations must be approved by the EO / ECO.

Make use of existing roads and tracks where feasible, rather than creating new routes.

Ensure that adequate vehicle turning areas are allowed for.

Where construction will obstruct existing access, be sure to allow for alternative temporary access routes.

In general, construction routes should not be wider than 3m in sensitive areas (areas indicated on the sensitivity map), with passing bays where two-way traffic is required.

Any additional routes and turning areas required by the contractor must be approved by the EO / ECO.

Plan additional access routes to avoid significant vegetation specimens and communities, natural features and sites of cultural and historical significance.

Routes should not traverse slopes with gradients in excess of 8%. Where this is unavoidable, stabilise the road surface.

Avoid planning routes through wetlands as far as possible: seek an alternative route.

Avoid routes through drainage lines and riparian zones (i.e. Steelpoort and Molawetse Rivers as well as their tributaries) wherever possible. Where access through drainage lines and riparian zones is unavoidable (i.e. for pipelines), only one road is permitted, constructed perpendicular to the drainage line. Avoid roads that follow drainage lines within the floodplain.

Where drifts are built through rivers, ensure that Reserve releases (i.e. for sustained downstream ecological requirements and basic human needs) are catered for and that no damming-up is experienced.

Adequate culverts are required as to have a minimal impact on water flow patterns through the drainage line.

Ensure that causeways result in minimal disruption to flow patterns, both upstream and downstream of the crossing, and do not cause damming of the water at the crossing.

Enforce speed limits at all times, both on public roads and on site roads.

Allow for safe pedestrian and cycling access and crossing where necessary.

Ensure that only authorised roads and access routes are used.

Vehicles may not leave the designated roads and tracks and turnaround points will be limited to specific sites.

Maintain all access routes and roads adequately in order to minimise erosion and undue surface damage. Repair rutting and potholing and maintain stormwater control mechanisms.

Runoff from roads must be managed to avoid erosion and pollution problems.

Regularly remove topsoil (and other material) accumulated in side drains of roadways to keep these open and functional.

Clear up any gravel or cement spillage on roads.

Clean and make good any damage to public or private roads caused by the Contractor during the construction phase.

No offroad driving is permitted, unless authorised by the Project Manager.

Do not permit vehicular or pedestrian access into natural areas beyond the necessary work site.

Plan for proper access control where routes pass through pristine / sensitive areas (as indicated in the sensitivity map), to prevent unauthorised and potentially environmentally destructive access by locals.

The Project Manager will indicate whether or not it is necessary to keep a photographic record of temporary or permanent rights of way over private property as permitted during construction.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.2.4 ACTIVITY: GATES AND FENCES

Mitigation Measures:

Protect and maintain existing private property, fences and gates.

Respect the open or closed status of gates for the duration of the construction period.

Prevent unnecessary vehicular and personnel access into adjacent undisturbed areas.

In the interests of containing environmental damage and ensuring public and wildlife safety, it may be necessary to erect temporary fencing around the portion under construction.

For linear projects, small sensitive areas (as indicated above) must be fenced where necessary, as the work site progresses.

Additional fencing may be specified by the Safety Officer or EO / ECO to counter problems arising on site. The contractor must erect such fencing and or gates when and where required by the EO / ECO, and re-erect and maintain temporary fencing and or gates as necessary.

Fences must be aligned to avoid significant vegetation specimens and communities, natural features sites of cultural and historical significance (as indicated above) and animal movement corridors. All alterations must be approved by the EO / ECO.

Limit clearing for fencing to the removal of trees and shrubs within 1 m of the fence line. No removal of the grass cover or topsoil is to occur within this width.

Use shade cloth to screen Work Areas that are exposed to public areas and roads.

Retain temporary fencing and / or gates in position until replaced by permanent fencing or until the EO / ECO directs their earlier removal.

If temporary fencing and or gates are removed temporarily for the execution of any part of the Works then these must be reinstated as soon as practicable by the Contractor.

Fencing material (i.e. shade netting) used must be strong enough to prevent animals from gaining access to trenches. Fencing material should not pollute the environment as it disintegrates over time e.g. danger tape.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.3 IMPACT: SITE MANAGEMENT

3.3.2.3.1 ACTIVITY: RUBBLE AND WASTE ROCK

Mitigation Measures:

Store inert building rubble and waste rock at designated areas to be agreed upon with the EO / ECO.

Subject to approval by the EO / ECO and landowner, certain borrow pits and / or quarries may be utilised for the disposal of waste rock and inert building rubble.

If no on-site disposal opportunities exists, then rubble and waste rock must be disposed of at the nearest registered solid waste disposal facility.

Responsible Party:

Contractor

ECO to approve

Time frame:

During Construction phase

3.3.2.3.2 ACTIVITY: SOLID WASTE

Mitigation Measures:

Collect all domestic waste in adequate numbers of litter bins/bags located as required on the Work Site and within the Contractors camp.

Where feasible, collect waste paper, glass and metal waste separately and arrange for collection by recycling contractors.

For linear projects, provide litter bins at regular positions.

Litter bins must be equipped with a closing mechanism to prevent their contents from blowing out and to prevent animals from opening them.

Ensure that personnel make use of the litter bins provided. Keep all Work Sites, (especially areas where the labourers have lunch and tea) and at the Contractors camp tidy and litter free at all times.

Empty litter bins weekly (or as required before they reach capacity).

Where necessary, dedicate a storage area on site for the collection of construction waste.

Unless otherwise specified by the EO / ECO, remove stored domestic waste to the nearest registered solid waste disposal facility.

Ensure that solid waste is transported properly, avoiding waste spills en-route.

No solid waste may be burned on site.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.3.3 ACTIVITY: LIQUID WASTE

Mitigation Measures:

Provide portable chemical toilets at all Work Sites, unless a connection to a sewer is possible, or a proper sealed septic tank is installed which can be emptied as required.

Ensure that adequate numbers of conveniently located site toilets are available on all Work Sites at all times in quantities related to the number of users (1 toilet per 15 users is advised).

Do not locate any site toilet within the 1:100 year floodline, or within a horizontal distance of 100m (whichever is greater) of a watercourse, drainage line or identified wetland.

Maintain and clean site toilets regularly as is required to keep them in good, functional working order and in an acceptable state of hygiene.

Remove contents of toilets to the municipal waste water treatment facility.

Combine drinking water facilities with hand washing facilities near site toilets.

Responsible Party:

Contractor (and services provider responsible for portable chemical toilets)

Time frame:

During Construction phase

3.3.2.3.4 ACTIVITY: HAZARDOUS WASTE

Mitigation Measures:

Store hazardous waste in appropriately designated areas.

Ensure compliance with all national, regional and local legislation with regard to the disposal of hydrocarbons, chemicals, solvents and any other harmful and hazardous substances and materials.

Collect any hazardous waste in receptacles located on a drip tray on site pending disposal.

Have a hazardous waste spill kit available at the site.

Retain waste oils and batteries for recycling by the supplier wherever possible.

Regularly dispose of all hazardous waste not earmarked for reuse, recycling or resale (such as oil contaminated with chlorinated hydrocarbons, electrical cleaning solvent, certain chemicals and fluorescent tubes) at a registered hazardous waste disposal site.

Contain chemical spills, and arrange for cleanup / control by the supplier, or by professional pollution control personnel.

Responsible Party:

Contractor (and services provider responsible for hazardous waste removal)

Time frame:

During Construction phase

3.3.2.3.5 ACTIVITY: POLLUTION CONTROL

Mitigation Measures:

Do not locate any reservoir, dam or depot for any substance which causes or is likely to cause pollution within the 1:100 year floodline, or within a horizontal distance of 100m (whichever is greater) of a watercourse, drainage line or identified wetland.

Do not dump waste of any nature, or any foreign material into any drainage line or wetland.

Do not allow the use of any drainage line or wetland for swimming, bathing, or the cleaning of clothing, tools or equipment.

Prevent the discharge of water containing polluting matter or visible suspended materials directly into drainage lines or wetlands.

Deflect any unpolluted water / runoff away from any dirty area (including plants, maintenance areas, workshops and contractors yards).

Otherwise clean, but silt laden water may be discharged overland, provided no erosion is resultant from this discharge.

Where necessary, turbid water pumped from excavations within rivers must be passed through a sand filter or settling pond before being released back into the river. Discharge of this water must be in a controlled manner, and no erosion may result.

Ensure that no stormwater is allowed to enter any drainage installation for the reception, conveyance, storage and / or treatment of sewage.

Water may only be discharged into a stormwater or sewer system with the permission of the local authority.

Immediately clean any accidental oil or fuel spills or leakages.

Do not hose oil or fuel spills into a storm water drain or sewer, or into the surrounding natural environment.

Clean small oil or fuel spills with an approved absorbent material which forms part of the spill kit.

Contain oil or fuel spills in water using an approved oil absorbent fibre.

Treat soil contaminated by oil or fuel using one of the following approved methods, as per instruction of the RE / EO / ECO:

a) Remove the soil to the depth of the contamination and dispose of at a registered Hazardous Waste Disposal Site.
b) Remove the soil to the depth of the contamination, and regenerate using approved bio-remediation methods.

Report major oil or fuel spills to the provincial Department of Water and Sanitation, as well as to the relevant Local Authority.

Carefully control all on-site operations that involve the use of cement and concrete (this applies to areas other than the batching plant).

Limit cement and concrete mixing to single sites where possible.

Use plastic trays or liners when mixing cement and concrete: Do not mix cement and concrete directly on the ground.

Dispose of all visible remains of excess cement and concrete after the completion of tasks. Dispose of in the approved manner (solid waste concrete may be treated as inert

construction rubble, but wet cement and liquid slurry, as well as cement powder must be treated as hazardous waste).

Contain water and slurry from cement and concrete mixing operations as well as from batching area wash bays. Direct such waste water into a settlement pond or sludge dam for later disposal.

Do not allow the washing of trucks delivering concrete anywhere but within designated wash bays equipped with runoff containment. Direct such waste water into a settlement pond or sludge dam for later disposal.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.3.6 ACTIVITY: BLASTING

Mitigation Measures:

The specifications included under this section do no exempt the Contractor from complying with all the Regulations as included in the Explosives Act (Act No. 15 of 2003). The contractor is further referred to this Act and all its regulations.

Plan the type, duration and timing of blasting procedures with due cognisance of other land uses and structures in the vicinity.

Inform local landowners and communities ahead of any blasting event.

"When blasting is to be carried out within 500m of any building, railway, public thoroughfare, powerline, telephone line, pipeline, sports field or any place where people congregate, then these must be inspected and their condition photographically recorded prior to blasting. The provisions and requirements of the relevant authorities must be complied with. These include:

- Spoornet concerning railways;
- The South African Roads Agency concerning national roads;
- Eskom concerning powerlines;

- Telkom concerning telecommunications lines;
- Water boards and local authorities, concerning the protection of water mains, gas mains, sewers and sewerage mains and electric cables;
- Any other authorities who have jurisdiction in the area."

Favour the use of nitrate-free explosives wherever possible (i.e. methods including as drilling and black powder, expanding mortar or old-fashioned plugs and feathers).

Make use of noise mufflers and / or soft explosives during blasting.

When blasting, take measures to limit flyrock.

Give audible warning of a pending blast at least 3 minutes in advance of a blast.

Collect and remove all flyrock (of diameter 150mm and larger) which falls beyond the cleared working area, together with the rock spill.

Responsible Party:

Contractor (and sub-contractor responsible for blasting)

Time frame:

During Construction phase

3.3.2.3.7 ACTIVITY: AIR QUALITY (DUST AND SMOKE)

Mitigation Measures:

Manage dust resultant from the Works and fugitive dust in an efficient and environmentally sensitive manner - the production of dust and damage caused by dust must be regulated by regular watering of the work areas.

Speed of haul trucks and construction vehicles must be reduced to limit excessive dust creation.

Ensure that a dust control system (i.e. sprinkler or vacuum) is installed and maintained in an operating condition at crusher/sifting plants.

Dust from the construction site must not disturb economic or social activities (including schooling and sporting activities) in the vicinity of the construction site.

No open fires are permitted anywhere on site.

Construction vehicles should be maintained in good working order to not produce excessive smoke.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.3.8 ACTIVITY: NOISE CONTROL

Mitigation Measures:

Unless otherwise specified by the EO / ECO, normal work hours will apply (i.e. from 06h30 to 17h00, Mondays to Saturdays).

Ensure that employees and staff conduct themselves in an acceptable manner while on site, both during Work hours and after hours.

No loud music is permitted on site or in the Camp site.

If noise levels at the boundaries of the site exceed 7dB above ambient levels, then the local health authorities are to be informed.

Notify adjacent landowners of after-hours construction Work and of any other activity that could cause a nuisance.

Respond to community complaints with regard to noise generation, taking reasonable action to ameliorate the impact.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.3.9 ACTIVITY: FIRE CONTROL

Mitigation Measures:

Take adequate precautions to ensure that fires are not started as a result of Works on site: the Contractor will be held liable for any damage to property adjoining the Site as a result of any fire caused by one of his employees.

Establish and maintain fire breaks around the Work Sites if as and when specified by the EO / ECO and as required by applicable legislation and the local authority.

Do not permit any fires or open flames in the vicinity of a wetland, especially during the dry season.

A minimum requirement for construction in a high fire risk area is a water truck or cart, with a minimum capacity of 5000 litres, equipped with pump and hose (minimum length 30m) which must be permanently on site.

Ensure that the Work Site, the contractors' camp and all living quarters are equipped with adequate fire fighting equipment. This includes at least rubber beaters when working in veld areas, and at least one fire extinguisher of the appropriate type irrespective of the site.

Take immediate steps to extinguish any fire which may break out on the construction site.

No open fires are permitted anywhere on site - Restrict contained fires for heating and cooking (i.e. in a fire drum) to designated areas on site. Prevent employees from creating fires randomly outside designated areas.

Do not store any fuel or chemicals under trees.

Do not store gas and liquid fuel in the same storage area.

Do not permit any smoking within 3m of any fuel or chemical storage area, or refueling area.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.3.10 ACTIVITY: HEALTH & SAFETY

Mitigation Measures:

The specifications included under this section do no exempt the Contractor from complying with all the Regulations as included in the Occupational Health and Safety Act (Act 85 Of 1993). The contractor is further referred to this Act and all its regulations.

The safety of all construction and operational personnel, as well as any member of the public on the site is the responsibility of the Contractor.

Control access onto and off the site by means of a register system. This includes visitors.

Ensure that first aid / emergency facilities / procedures are in place.

Ensure that all personnel are trained in basic site safety procedures.

Keep a register with contact numbers of all people employed and one relative for each.

Keep a list of all relevant emergency numbers in an easily accessible location on site.

Keep a record of all incidents, accidents and illnesses on site and make the information available at meetings.

Ensure that proper footwear is worn by employees at all times.

Ensure that employees are issued with and make use of the necessary safety equipment when working in dusty, noisy and / or dangerous situations. Such equipment may include, but is not necessarily limited to hardhats, goggles, masks, earplugs, gloves, safety footwear and safety ropes as required.

Ensure that adequate drinking water, wash water and sanitary facilities are available at all times and on all work sites.

Where necessary, provide a designated place for food storage, preparation and consumption on site. This should be a shaded area.

Ensure that personnel are transported legally, and in a safe and responsible manner.

Ensure that all vehicle and machine operators are qualified and licensed to operate their vehicles / machines.

Protect dangerous excavations or Works that may pose a hazard to humans and animals. Demarcate these areas with fencing/shade cloth as required and post the appropriate danger signs. Respect workers' right to refuse work in unsafe conditions.

Responsible Party:

Contractor (Health and Safety Officer to insure implementation and compliance)

Time frame:

During Construction phase

3.3.2.3.11 ACTIVITY: OPTIMISATION OF THE LOCAL ECONOMY

Mitigation Measures:

Where appropriate, use should be made of labour intensive construction methods - local emerging contractors should be used as well as sourcing labourers from the nearby villages/towns.

Optimal benefit can be derived in the local economy by the preferential employment of local tradesmen and sub-contractors.

Sourcing of raw materials and construction materials should take place in the local and sub-regional economy.

Responsible Party:

Proponent & Contractor

Time frame:

During Pre-construction & Construction phase

3.3.2.3.12 ACTIVITY: UNSOCIAL ACTIVIITES ON SITE

Mitigation Measures:

Implementation of security on the construction site is necessary. Only authorised persons should have access to the site. The site needs to be properly secured for the duration of the construction period and strict control of labour implemented.

Prostitution, drinking, crime, vandalism etc. generally only arise where labourers are away from home. If the majority of the labour force is recruited locally, incidence of prostitution and other un-social activities could be reduced.

Transportation of labour to and from the site, should take place in an orderly manner to discourage loitering on adjacent areas and possible increase in crime.

Responsible Party:

Contractor (and appointed security services)

Time frame:

During Construction phase

3.3.2.4 ACTIVITY: EXCAVATIONS AND TRENCHES

Mitigation Measures:

Undertake excavations carefully, incorporating appropriate drainage.

For significant trees (as indicated by the EO / ECO), trenching must be 3m away from the stem.

Excavate and backfill trenches on a progressive basis (as far as possible).

Ensure that no trench longer than 1000m is exposed at any one time (as far as possible).

Limit the amount of time that the trenches are open as much as possible.

Programme excavation to take place once the required materials are on site. This facilitates the immediate laying of services and/or construction of subsurface infrastructure and minimises open trench time.

Exit ramps should be constructed at regular intervals to provide escape routes for animals, reptiles and amphibians.

Corridors should be provided at strategically placed intervals to provide land animals safe access across the pipeline construction route.

Trenching through wetlands and drainage lines may only be undertaken upon instruction by the EO / ECO. In such a situation be sure to return the profile of the wetland / drainage line to one similar to the pre-construction profile. No ridge or channel feature may remain.

The following mitigation measures for stream crossings as indicated in the Aquatic Biodiversity Assessment must be implemented as well as the methodology for construction for Stream Crossings (See Section 3.3.2.6.1. below).

The following mitigation measures were proposed for the pipeline stream crossings:

- Implement erosion control measures such as silt fences, sediment basins, and sediment traps to prevent soil erosion and minimise sedimentation in water bodies.
- Establish vegetative buffers along the pipeline route to reduce surface runoff and stabilise the soil.
- Develop and implement a spill prevention and response plan that includes measures to prevent pipeline leaks and spills, as well as procedures for prompt response, containment, and clean up in the event of a spill.
- Conduct regular monitoring and management of vegetation along the pipeline corridor to prevent the introduction and spread of alien invasive species.
- Implement measures such as manual or mechanical removal, herbicide application, or targeted grazing to control and eradicate invasive vegetation.
- Establish a comprehensive water quality monitoring program to regularly assess the condition of nearby water bodies and detect any changes or contaminants associated with the pipeline.
- Monitor key parameters such as pH, dissolved oxygen, temperature, turbidity, and concentrations of specific pollutants.
- Develop habitat restoration and enhancement plans to mitigate the loss of aquatic biota.
- Implement measures such as habitat creation and re-vegetation of watercourse areas to promote the recovery and protection of aquatic ecosystems.
- Design and construct stream and watercourse crossings to minimise disturbance to watercourses and maintain natural hydrological flow patterns.

- Implement techniques such as directional drilling or trenchless technologies to minimize excavation and disturbance to water bodies.
- Incorporate buffers for the watercourse areas into the pipeline design.
- Ensure that construction activities are conducted in a manner that minimises soil disturbance and runoff.
- Use impermeable liners or berms in areas where spills or leaks may occur to prevent contaminant infiltration into groundwater.
- The management of the site in terms of vegetation, roads and stormwater need to be guided by an ecologist to ensure the impacts are minimized,
- Pipeline crossing of aquatic ecosystems must be upstream of existing in situ earth dams.
- Resampling of sites during the rainy season to ensure flow in the system.
- Monitoring plan to include these aspects as baseline.
- Minimising of impact of sediment with emphasis on additional ingress during construction.
- All roads and pipelines crossing watercourses must be designed to ensure ecological and hydrological connectivity, span watercourses over the width of the entire watercourse and must be able to withstand 1 in 100 year floods as a minimum

Responsible Party:

Contractor

ECO to monitor and provide recommendations were necessary

Time frame:

During Construction phase

3.3.2.5 STOCKPILES, STORAGE AND HANDLING

3.3.2.5.1 ACTIVITY: TOPSOIL

Mitigation Measures:

Topsoil is to be handled twice only – once to strip and stockpile, and once to replace and level.

Position topsoil stockpiles separately from the excavated soil.

Ensure that all topsoil is stored in such a way and in such a place that it will not cause the damming up of water, erosion gullies, or wash away itself.

In linear projects, stockpile topsoil in windrows parallel to the excavation.

In riverine areas, stockpile topsoil above the riverine zone.

Remove exotic / invasive plants and broad leaf weeds that emerge on topsoil stockpiles.

If topsoil is to be stockpiled for extended periods, especially during the wet season, then the ECO may recommend one of the following measures:

- The re-vegetation of the stockpiles with indigenous grasses.
- The covering of the stockpiles with a protective material such as hessian mats.

Ensure that topsoil is at no time buried, mixed with spoil (excavated subsoil), rubble or building material, or subjected to compaction or contamination by vehicles or machinery. This will render the topsoil unsuitable for use during rehabilitation.

The Contractor will be held liable for the replacement of any topsoil rendered unsuitable for use during rehabilitation, for reasons due to this negligence or mismanagement on site.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.5.2 ACTIVITY: SPOIL

Mitigation Measures:

Position spoil (excavated subsoil) next to the excavation area e.g. trench.

Spoil material should not damage existing structures like fences, walkways, roads etc.

Spoil material should be placed at least 1 meter away from the edge of the trench to prevent the walls of the trench from collapsing.

Any additional spoil storage area required by the contractor must be approved by the EO / ECO. The following information may be required for approval:

- The location, description of and access to proposed sites.
- The quantity of material to be stored as spoil.
- The types of material to be stored as spoil (i.e. blast rock, excavated rock, subsoil etc.).
- The proposed method of storing spoil.
- A proposal for the reinstatement and rehabilitation plan, including the final profile.
- Written approval from the landowner / relevant authority that material may be stored on the land in question, subject to conditions.

In linear projects, spoil must be positioned in windrows parallel to the excavation.

Position spoil on the higher side of a disturbed area, and above a 1:20 year flood line wherever possible.

Ensure that all spoil is stored in such a way and in such a place that it will not cause the damming up of water, erosion gullies, or wash away itself.

Store spoil in low heaps, not exceeding 2m in height.

Do not store spoil in drainage lines.

Properly rehabilitate any permanent spoil dumps as soon as work in that area is complete.

In general, no slopes steeper than 1(V):3(H) will be allowed.

Bury the coarser material beneath the finer material, and overlay all permanent spoil heaps with a layer of topsoil at least 200mm thick.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.5.3 ACTIVITY: VEHICLES AND EQUIPMENT

Mitigation Measures:

Vehicles used during construction must have the minimum impact on the environment or other road users. The size, height and weight of the vehicle must be kept in mind.

Regularly check vehicles, machinery and equipment operating on site to ensure that none have leaks or cause spills of oil, diesel, grease or hydraulic fluid.

No vehicles, machinery or equipment with leaks or causing spills may be allowed to operate on the construction site. These must be sent to the maintenance yard or workshop for repair, or must be removed from site.

Ensure that the maintenance of all vehicles and equipment, including oil and lubricant changes, takes place only within properly equipped, bunded maintenance areas or workshops.

Only emergency and essential repairs of vehicles and equipment may take place on site.

Provide drip pans for generators, or any machinery that will be in position for longer than one day.

Drip trays are to be watertight, and must be emptied regularly and before rain events. The contents of drip trays are to be treated as hazardous waste.

Day to day parking of vehicles is to be on hard surfacing wherever possible.

Where oil and fuel spills are expected, parking is to be on an impervious surface with adequate pollution control mechanisms in place.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.5.4 ACTIVITY: FUEL

Mitigation Measures:

Do not locate any fuel depot within the 1:100 year floodline, or within a horizontal distance of 100m (whichever is greater) of a watercourse, drainage line or identified wetland.

Store fuel at temporary depots within a bunded area.

Provide impervious paving adjacent to fuel tanks, upon which vehicles must park during re-fuelling. This will help to accommodate fuel spills during re-fuelling.

The only permitted method of fuel transfer, is by means of a pump / controlled valve / tap / hose / funnel.

Treat spills within the bund and the contents of the sump as hazardous waste.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.5.5 ACTIVITY: HAZARDOUS SUBSTANCES

Mitigation Measures:

Ensure compliance with all national, regional and local legislation with regard to the storage, transport and use of hydrocarbons, chemicals, solvents, explosives and any other harmful and hazardous substances and materials.

Position hazardous substance stores in areas not threatening human life or the environment.

Keep a record of all hazardous substances stored on site for submission to the EO / ECO.

Store all hazardous substances in secure, safe and weatherproof facilities, underlain by a bunded concrete slab to protect against soil and water pollution.

Clean any accidental spills immediately, treating the spilled material and used cleaning products as hazardous waste.

Provide for controlled loading / unloading areas, underlain by an impervious paving or PVC sheet to protect against soil and water pollution.

Ensure that personnel handling hazardous substances have been educated in terms of the correct handling, use and disposal thereof.

Empty containers in which hazardous substances were kept are to be treated as hazardous waste.

Responsible Party:

Contractor

Time frame:

During Construction phase

3.3.2.6 EROSION CONTROL

3.3.2.6.1 ACTIVITY: SURFACE WATER MANAGEMENT

Mitigation Measures:

No water may be abstracted from any surface water body for the purpose of construction unless authorized by the Department of Water & Sanitation.

Where possible, recycle water on the construction site.

Avoid over-wetting, saturation and unnecessary runoff during dust control activities and irrigation.

Do not drain, fill or alter in any way, any wetland or drainage line, including the riverbanks unless this forms part of the construction Works, or upon specific instruction by the EO / ECO.

Do not allow surface water or storm water to be concentrated, or to flow down cut or fill slopes or along pipeline routes without erosion protection measures being in place.

Line overflow and scour channels with stone pitching along their length and at their points of discharge to prevent soil erosion. The point of discharge must be at a point where there is dense natural grass cover.

Ensure that channels do not discharge straight down the contours. These must be aligned at such an angle to the contours that they have the least possible gradient.

Ensure that overland discharge occurs over areas that have a minimum cover of 90% grass cover at a minimum height of 150mm. This applies to areas downslope of the discharge point as well.

Where possible, undertake river diversions outside of the rainy season.

It is recommended that the corridor cleared must be as narrow as possible – only wide enough for the insertion of the pipeline, where the pipeline will cross drainage channels.

The rehabilitation must include stabilisation of the stream banks to ensure no erosion occurs in future. Standard procedures must be followed, i.e. stabilisation of the stream banks, rehabilitation during and after construction and the use of silt traps during the construction.

General methodology for construction of Stream Crossings will be handled as follows, or as indicated in the Engineering Preliminary Design Report:

River crossings

The pipelines included in this project will cross several rivers, streams and dongas. The river, stream and donga crossings comprise all crossings of defined water courses in which water flows or may occasionally flow as a result of surface run-off. A significant river, stream or donga are considered to have a minimum Catchment Area of 1km^2 and a watercourse length of at least 1km.

New river and stream crossings will be done via trenching. The preferred method of crossing rivers, i.e. major streams, is by installing the pipeline beneath the stream bed, thereby reducing the risk of vandalism and also eliminating future maintenance requirements.

The option of using trenchless technology to drill underneath the Steelpoort riverbed using Horizontal Directional Drilling (HDD) will also be undertaken. The HDD method would have very minimal environmental impact on the Steelpoort River compared to the conventional trenching methods.

The rivers, streams and dongas are broadly grouped in the next three categories:

Dongas and dry streams

Dry water courses (eroded in the case of dongas) which normally have no flow, except for brief periods during and after heavy downpours and rainstorms. These water courses can effectively be crossed without any deviation of flow and pose little risk, especially during the dry winter period.

Donga is a term used to describe a dry, eroded watercourse that channels water flow during heavy rains. Dongas are usually big gaping crevices in the earth which are made wider and deeper by every heavy rainfall event. Dongas usually develop and worsen through poor land management practice, lack of erosion control and overgrazing. Once vegetation has disappeared from the land and is no longer able to slow down the water flow, dongas develop and cut deeply into any sloping land, causing the soil to be washed away.

Minor streams

Water courses which have intermittent or low flows during the rainy season and can effectively be crossed by damming and pumping of water, or deviating of water by means of pipes or dug deviations.

Major streams

Water courses (or rivers) which have flow all year round of magnitude and depth that cannot be managed by pumping and can only be effectively crossed by more expensive methods. The construction approach for these three categories will be different and are described below:

Donga and dry stream construction methodology

Trenching will be done using normal trenching equipment and techniques. Special stream bank protection will not be necessary, with the exception of pipeline trench plugs which must be installed in the approach trenches to prevent the possible entry of ground

water and/or stormwater. The period for crossing the donga or dry stream during normal conditions shall be kept to a minimum from the start of construction of the crossing to completion. The intent of this time constraint is to avoid storm event sediment transport from the unprotected excavation to potentially sensitive perennial stream reaches downstream of the crossing.

Donga and dry stream crossing pipelines must be encased in reinforced concrete. The top surface of concrete encasements or adjacent pipes must not protrude above natural bed level of streams, nor must it in any way interfere with water flow or be the cause of bed erosion. The bottom of concrete encasement will, where possible, be cast onto firm or solid rock, and excavations will be deepened if necessary to achieve this goal. Where rock is shallow, a cutting can be blasted into the rock and the pipe encased into the trench created in this manner.

Overland flow will be diverted over or away from the trench and the trench will be dewatered immediately before pipe laying and kept dewatered until completion of back filling. Damage to foundations, structures or other parts of the crossing caused by flooding due to failure of any part of the diversion or protective works or due to any other cause will be repaired.

Protective works and surplus spoil will be removed immediately after having served its purpose and the site will be reinstated to its original condition, which will include reinstatement of adjacent land that may have been flooded, bed erosion or changes in location of water courses.

Restoration of stream banks to original contour and re-vegetation will be promptly undertaken and completed.

Minor stream construction methodology

Where the pipeline crosses minor streams with flowing water, the flume stream crossing technique will be used. Prerequisites for construction of a flume crossing include:

- Construction of an equipment crossing structure, if needed, either up or down stream of the proposed flume crossing.
- Construction of sand bag trench plugs upland of each stream bank in the pipeline trench to prevent storm water sediment transport from the upland trenches in to the stream.
- Installation of over land flow diversions parallel to both stream banks and greater than 3m upland from the stream bank. These silt traps would be positioned to the extent

necessary to isolate stream side disturbances, including spoil piles, from the stream. Overland flow shall be diverted over or away from the trench and the trench shall be dewatered immediately before pipe laying and kept dewatered until completion of backfilling.

In the flume crossing technique, the following construction steps will be implemented:

- Flume pipe(s) would be installed in the streambed and aligned with the stream flow. These flume pipe(s) would be sized to pass a flow equal to 150 percent of existing flow to account for minor storm events.
- The flume system would remain in place for all streambed trenching, pipe placement, bedding, and backfill. The backfill would be capped at original stream contour with local stream substrate removed during excavation or equivalent stone fill.
- The flume system would be removed prior to reseeding of stream bank/streamside areas and prior to removal of other streamside protection measures.

Typically, the diversion of a stream through a flume crossing system would not exceed 2 weeks from start of construction through the removal of the flume. The intent of this time constraint is to minimize the risk of a storm event washing out the diversion structures or over-topping the diversion structures, resulting in the uncontrolled transport of sediment from the unprotected excavation to potentially sensitive perennial stream reaches downstream of the crossing.

In the area between the silt traps and the stream, stream bank restoration to original contour and re-vegetation would be completed prior to removal of the crossing that would restore to the stream channel.

In this same area, streamside re-vegetation efforts should begin no later than at the time of the removal of the crossing. Prior to removal of the streamside silt traps, the appropriate re-vegetation by reseeding and mulching would be completed in the areas upland of the silt fences.

Major stream crossing methodology

The flow of the river must not be inhibited during construction.

In order to minimize the impact to the river and cost, construction should as far as possible be carried out in the dry season (April to September) when the water level is low and the river is mostly dry.

The river health and water quality will be monitored before, during and after construction with the view of restoring water quality to the baseline.

Stream crossing Erosion protection measures

The catchment area is prone to erosion. In order to minimize the risk of the pipeline being damaged by the active erosion of dongas the use of riprap is proposed.

The final size of the riprap will be calculated in accordance with the SANRAL Drainage Manual for riprap and stone pitching.

Responsible Party:

Contractor

ECO to monitor and provide recommendations were necessary

Time frame:

During Construction phase

3.3.2.6.2 ACTIVITY: EROSION PROTECTION

Mitigation Measures:

Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and Work Areas.

Retain natural trees, shrubbery and grass species wherever possible.

Do not permit vehicular or pedestrian access into natural areas beyond the demarcated boundary of the Work Area.

Avoid access into seasonally wet areas and / or turf soils during and immediately after rainy periods, until such a time that the soil has dried out.

Utilise only light equipment for access and deliveries into areas of unstable soils, in areas where erosion is evident, and at stream and river embankments.

Limit vehicular access into rocky outcrops and ridges.

Institute adequate sedimentation control measures at river crossings and when excavation or disturbance within riverbanks, or the riverbed takes place.

Address erosion donga crossings as river crossings, applying soil erosion control and bank stabilisation procedures as specified by the EO / ECO.

Do not allow erosion to develop on a large scale before effecting repairs. When in doubt, seek advice from the EO / ECO.

Repair all erosion damage as soon as possible and in any case not later than six months before the termination of the Maintenance Period to allow for sufficient rehabilitation growth.

In general, slopes steeper than 1(V):3(H) or slopes where the soils are by nature dispersive or sandy, must be stabilised. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology. One or more of the following methods may be required:

- Topsoil covered with a geotextile, plus a specified grass seed mixture.
- A 50:50 by volume rock:topsoil mix 200mm thick, plus specified grass seed mixture.
- Logging or stepping (logs placed in continuous lines following the contours).
- Earth or rock-pack cut-off berms.
- Benches (sand bags).
- Packed branches.
- Ripping and scarifying along the contours.
- Stormwater berms.

Near vertical slopes of 1(V):1(H) or 1(V):2(H) must be stabilised using hard structures, preferably with a natural look, and with facilities allowing for plant growth. The EO / ECO will specify a solution in terms of the most appropriate approved method and technology. One or more of the following methods may be required:

- Retaining walls (loffel or otherwise)
- Stone pitching
- Gabions
- Shotcrete

Protect the slopes of all river diversions. One or more of the following methods may be used, as specified by the EO / ECO:

- Sandbags
- Reno mattresses
- Plastic liners and / or coarse rock (undersize rip-rap)

During the course of construction, the EO / ECO may identify additional slopes in need of stabilisation and will specify actions in terms of the most appropriate approved method and technology.

Responsible Party:

Contractor

ECO to monitor and provide recommendations

Time frame:

During Construction phase

3.3.2.6.3 ACTIVITY: CONTROL OF ALIEN PLANTS

Mitigation Measures:

Identify and take note of all exotics and invasive plants – This was done as part of the Terrestrial and Aquatic Biodiversity Assessments (Refer to the mentioned Reports).

Control exotics and invasive plants to be eradicated. Control involves killing the plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion.

Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge.

Follow manufacturers instruction when using chemical methods, especially in terms of quantities, time of application etc.

Ensure that only properly trained people handle and make use of chemicals.

Dispose of the eradicated plant material at an approved solid waste disposal site. If no toxic sprays or persistent poisons were used during eradication, then the wood may be sold or donated.

Rehabilitate all identified areas as soon as practically possible, utilising specified methods and species.

Responsible Party:

Contractor

ECO to monitor and provide recommendations

Time frame:

During Construction phase

3.3.3 REHABILITATION PERFORMANCE SPECIFICATIONS

3.3.3.1 ACTIVITY: REMOVAL OF STRUCTURES AND INFRASTRUCTURE

Mitigation Measures:

Clear and completely remove from site all construction plant, equipment, storage containers, temporary fencing, temporary services, fixtures and any other temporary Works.

Materials that will not be used again must be sold if possible or rehabilitated to blend in with the surrounding landscape.

Ensure that all access roads utilised during construction (which are not earmarked for closure and rehabilitation) are returned to a usable state and / or a state no worse than prior to construction.

Responsible Party:

Contractor

Time frame:

During Rehabilitation phase

3.3.3.2 ACTIVITY: INERT WASTE AND RUBBLE

Mitigation Measures:

Clear the site of all inert waste and rubble, including surplus rock, foundations and batching plant aggregates.

Load and haul excess spoil and inert rubble to fill in borrow pits / dongas or to dumping sites indicated / approved by the EO / ECO.

Remove from site all domestic waste and dispose of in the approved manner at a registered waste disposal site.

Subject to approval by the EO / ECO and landowner, certain borrow pits and / or quarries may be utilised for the disposal of waste rock and inert building rubble.

Responsible Party:

Contractor

ECO to give approval

Time frame:

During Rehabilitation phase

3.3.3.3 ACTIVITY: HAZARDOUS WASTE AND POLLUTION CONTROL

Mitigation Measures:

Remove from site all temporary fuel stores, hazardous substance stores, hazardous waste stores and pollution control sumps. Dispose of hazardous waste in the approved manner.

Remove from site all pollution containment structures. Dispose of materials that will not be used again as hazardous waste.

Remove from site all temporary sanitary infrastructure and waste water disposal systems. Take care to avoid leaks, overflows and spills and dispose of any waste in the approved manner.

Responsible Party:

Contractor

Time frame:

During Rehabilitation phase

3.3.3.4 ACTIVITY: FINAL SHAPING

Mitigation Measures:

Backfill all prospecting boreholes, excavations and test pits with in-situ material.

Make safe all borrow pits, quarries and dangerous excavations by backfilling, grading and blasting as required.

In general, no slopes steeper than 1(V):3(H) are permitted, unless otherwise specified by the EO / ECO. Steeper slopes require protection. The rationale is that the new slopes must mimic the natural slopes and topography.

Where possible, programme the backfill of excavations so that subsoil is deposited first, followed by the topsoil. Compact in layers for best results.

Deficiency of backfill may not be made up by excavating haphazardly within the Work Site. Additional fill may only be imported from borrow areas as approved by the Department of Mineral Resources & Energy (DMRE).

Monitor backfilled areas for subsidence (as the backfill settles) and fill depressions using available material.

Dismantle and flatten temporary drifts and river crossings, reinstating all drainage lines to approximate their original profile.

Shape all disturbed areas to blend in with the surrounding landscape.

Ensure that no excavated material or stockpiles are left on site and that all material remaining after backfill is smoothed over to blend in with the surrounding landscape.

Responsible Party:

Contractor

Time frame:

During Rehabilitation phase

3.3.3.5 ACTIVITY: TOPSOIL REPLACEMENT AND SOIL AMELIORATION

Mitigation Measures:

The principle of Progressive Reinstatement must be followed wherever possible. This includes the reinstatement of disturbed areas on an ongoing basis, immediately after the specified construction activities for that area are concluded.

Execute top soiling activity prior to the rainy season or any expected wet weather conditions.

Execute topsoil placement concurrently with construction where possible, or as soon as construction in an area has ceased.

Replace and redistribute stockpiled topsoil together with herbaceous vegetation, overlying grass and other fine organic matter in all disturbed areas of the construction site, including temporary access routes and roads to the original depth (i.e. as much as was removed prior to construction). These areas will be quantified by the EO / ECO.

Place topsoil in the same area from where it was stripped. If there is insufficient topsoil available from a particular soil zone to produce the minimum specified depth, topsoil of similar quality may be brought from other areas of similar quality. The EO / ECO will advise.

The suitability of substitute material will be determined by means of a soil analysis addressing soil fraction, fertility, pH and drainage, and approved by the EO / ECO.

Do not use topsoil suspected to be contaminated with the seed of alien vegetation. Alternatively, the soil is to be sprayed with specified herbicides (ECO to specify).

Shape and mound topsoil to 200mm from the top of manholes and valve chambers which protrude above ground and over pipelines to facilitate subsequent consolidation of the backfill.

Ensure that storm water run-off is not channeled alongside the gentle mounding, but that it is taken diagonally across it.

Shape remaining stockpiled topsoil not utilised elsewhere in an acceptable manner so as to blend in with the local surrounding area.

After topsoil placement is complete, spread available stripped vegetation randomly by hand over the top-soiled area.

Responsible Party:

Contractor

ECO to provide recommendations

Time frame:

During Rehabilitation phase

3.3.3.6 ACTIVITY: RIPPING AND SCARIFYING

Mitigation Measures:

Rip and scarify all areas following the application of topsoil to facilitate mixing of the upper most layers. The EO / ECO will specify whether ripping and scarifying is necessary, based on the site conditions immediately before these works begin.

Rip and scarify all disturbed (and other specified) areas of the construction site, including temporary access routes and roads, compacted during the execution of the Works.

Rip and scarify along the contour to prevent the creation of down-slope channels.

Rip and scarify all areas at 300mm intervals (but not more than 400mm intervals), ensuring that the lines overlap. Do not rip and scarify areas under wet conditions, as the soil will not break up.

Responsible Party:

Contractor

ECO to provide recommendations

Time frame:

During Rehabilitation phase

3.3.4 OPERATIONAL PHASE MITIGATION GUIDELINES

The following section will address a range of mitigation actions that might manage the predicted impacts associated with the operation of the different components of the development.

3.3.4.1 ACTIVITY: MAINTENANCE

Mitigation Measures:

Allow for a maintenance period of one year following practical completion, unless otherwise specified.

Landscape maintenance is to be undertaken by suitably qualified persons, making use of the appropriate equipment.

Cordon off sensitive areas that are under rehabilitation as no-go areas using shade netting to prevent vehicular, pedestrian and animal access.

Delay the re-introduction of stock to all rehabilitation areas until an acceptable level of re-vegetation has been reached. Fencing may be used, or the area may be covered by branches.

Re-vegetation must match the vegetation type which previously existed, unless otherwise indicated in the Contract or specified by the EO / ECO.

Base the new carrying capacity of rehabilitated land on the status quo rather than the regional estimate.

Control weeds by means of extraction, cutting or other approved methods. Regulation 15 of the Act on the Conservation of Agricultural Resources (as amended), Act No. 43 of 1983, determines that the establishment of declared weeds and invasive plants during and after development should be prohibited.

For planted areas that have failed to establish, replace plants with the same species as originally specified. The same species as originally specified must be used unless otherwise specified by the EO / ECO.

A minimum grass cover of 80% is required, and individual plants must be strong and healthy growers at the end of the Maintenance Period.

In the case of sodding, acceptable cover entails that 100% cover is attained by the specified vegetation.

Bare areas that show no specified vegetation growth after three months of the Rehabilitation Work are to be spread with additional topsoil, ripped to a depth of 100mm and re-planted, re-sodded, re-hand sown or re-hydroseeded.

Responsible Party:

Contractor (ECO to provide recommendations)

Time frame:

Operational phase / maintenance period

3.3.5 DECOMMISSIONING PHASE

Should the facility for any reason be closed, an Environmental Management Programme relating to the rehabilitation of the area shall be submitted to LEDET for approval.

3.4 MONITORING & REPORTING

For the purposes of this document environmental monitoring is defined as “the repetitive and continued observation, measurement and evaluation of environmental data to follow changes over a period of time to assess the efficiency of control measures”.

Monitoring has a smaller scope, usually at a project or programme level. Monitoring is undertaken on an ongoing basis for the duration of the project, programme or activity – usually before, during, and after implementation of each project or programme.

3.4.1 Compliance Monitoring (Regulatory Permit Monitoring)

Environmental protection and management can be ensured through the monitoring of compliance by a regulating organisation such as the Department of Environmental Affairs (or in this case LEDET). Compliance with environmental laws, regulations, permits, licenses etc., is controlled through effective monitoring and compliance assessment. Such compliance must be monitored to ensure that control mechanisms have the desired effect.

Compliance monitoring aims to:

- Determine compliance with applicable laws, regulations, permit conditions, orders and settlement agreements;
- Review and evaluate the activities of the regulated body; and
- Determine whether or not conditions presenting imminent and substantial endangerment may exist.

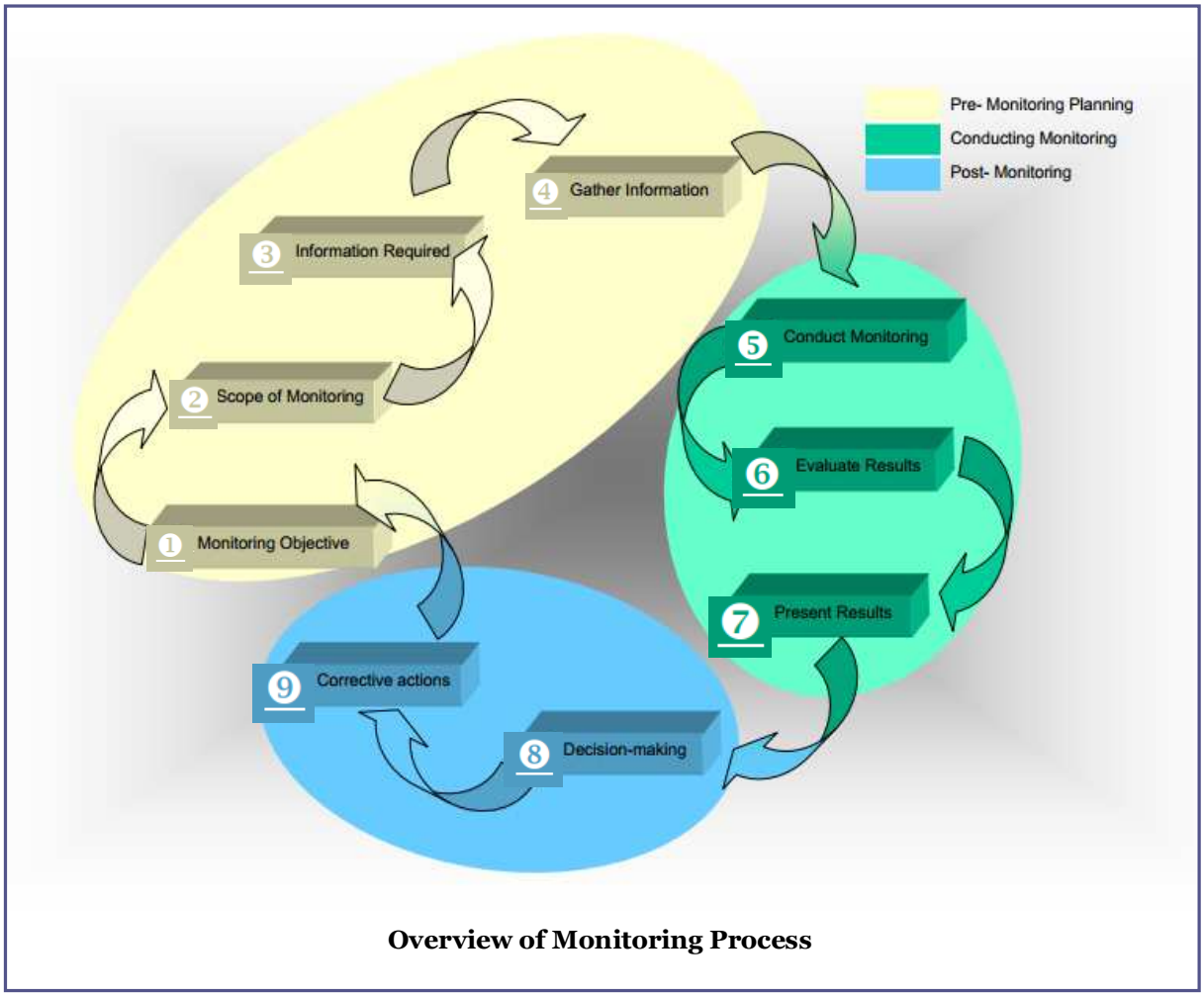
Compliance monitoring consists of a wide range of activities in six basic categories which may overlap:

1. Surveillance - a pre-inspection activity to obtain general site information prior to entering the site;
2. On-site inspections may include record reviews, observations, sampling, interviews, etc., and may have different foci.
3. Investigations are more detailed inspections and may be needed if an inspection or record review suggests the potential for serious, widespread, and/or continuing violations.
4. Record reviews may be conducted at the regulator's offices, or at the site, and may or may not be combined with fieldwork.
5. Records may be derived from routine self-monitoring requirements, inspection reports or remote sensing.
6. Targeted information gathering may be used to provide or acquire more accurate information on the status of compliance and/or environmental conditions.

3.4.2 Monitoring Process

The purpose of monitoring is to follow changes over a period of time and to assess the efficiency of control measures, through a process of repetitive and continued observation, measurement and evaluation of environmental data. Checklists are the most widely used monitoring tools however other monitoring tools include electronic decision support instruments, online digital monitoring instruments and before and after pictures.

The monitoring process is designed such that the process is applicable at a strategic, programme or project level. Specific indicators need to be monitored regularly to ensure that projects/programmes, are socially, environmentally and ecologically sustainable. Further, the monitoring process is applicable to all types of monitoring.



Overview of Monitoring Process

(Department of Water Affairs, 2005)

Step 1 – Monitoring Objective

Monitoring objectives need to be determined, bearing in mind the environmental goals and objectives of the EMPr and the Environmental Authorisation (EA once issued). Legislation, regulations and best practices should also be borne in mind when determining objectives. Examples of monitoring objectives could include:

- ensuring legal compliance, for instance monitoring to ensure that permit conditions are met or compliance to the EMPr, EIA, etc. (compliance monitoring);
- monitoring of pre-determined indicators e.g. ensuring that the water in a river downstream of a dam is of the correct quality (baseline monitoring);

- ensuring that environmental programmes are effective and used correctly for their intended purpose (programme evaluation monitoring);
- reduce environmental liability on an environmentally sensitive project (e.g. monitoring of suitable indicators may allay the public's concerns, cumulative impact monitoring);
- Periodic inspection of a project to ensure compliance with the EMPr, rehabilitation specifications and best practices (inspection monitoring); or
- a combination of the above.

Once the objective has been determined, appropriate checklists and other tools can be used.

Step 2 – Scope of monitoring

Before monitoring can begin, the scope must be clearly defined, based on the objectives. Usually only one project or programme is monitored at a time.

Step 3 – Information required

The general information that will be required includes the details of the actual project. The following information may be needed:

- what is the purpose of the project?
- what type of project is it?
- copy of the EA, EMPr, EIA report, etc.
- what activities are involved, etc.

If indicators are being monitored, background information is also required regarding the indicators to be monitored and tools that will be used during the project. Information on the targets and timeframes associated with each indicator is required.

Step 4 – Gather Information

Depending on the objective of the monitoring, a variety of tools can be used to assist in monitoring. Checklists are often used to gather information during monitoring. The checklists could be used for monitoring however one would need to adapt the checklists for specific types of monitoring. Additional checklists may need to be designed for the different types of monitoring.

Suitable monitoring points for each indicator should be identified at the project site or in nearby areas as required. Suitable intervals for monitoring each indicator should be determined. The project team should be made aware of what types of monitoring will be carried out during the project, and when and where the monitoring would occur in order to monitor the correct information.

Monitoring must be conducted by a suitably qualified person.

Step 5 – Conduct Monitoring

The checklists will be based on the requirements of the EA and EMPr approved during the EIA process. Checklists may also be based on relevant laws and regulations. Monitoring of indicators can be carried out through making observations and taking samples at the monitoring points, at the predetermined intervals. The information will be gathered using the checklist mentioned above as well as any other suitable tools (e.g. bio-monitoring lists, on-line digital data, etc).

Step 6 – Evaluate Results

The results of the monitoring are evaluated by comparing the information gathered with the targets that were originally identified. Evaluating monitoring results would involve a similar process to that for auditing, with the exception that certain specific monitoring tools will have their own methods of evaluation. The evaluation/interpretation of the monitoring data is considered the most crucial step of the monitoring process. Decisions on instituting corrective actions are based on the interpretation of the monitoring data.

Step 7 – Present Results

Monitoring results can be presented as a completed checklist, however it is advisable that trends analyses are compiled. Trend reports are an interpretation of the results of the monitoring reports, and are presented in the form of easily understood graphics.

Unlike audit results, it is unlikely that monitoring results will be included in annual reports, though they will probably form part of project reports. The monitoring results must be stored in a suitable information system as they will be required for auditing purposes.

Step 8 – Decision Making

The decision-making process will be less strategic and more focused on correcting environmental performance problems. In monitoring, the decision making process is driven by the need to resolve the non-compliance immediately.

Step 9 – Corrective Actions

Instituting corrective action in the monitoring process is more immediate than the auditing process. All non-compliance issues will need to be corrected immediately in other words it may not be possible from a timing perspective to implement policy changes in order to improve monitoring results. The corrective action will be specific to each project and may

need the input from all parties working on the project such as the planners, engineers, contractors, I&APs, etc.

3.4.3 Writing a Monitoring Report

The checklists and monitoring reports for environmental monitoring should be kept by the environmental manager & contractor and should be stored in a suitable information system. The checklists and reports must be available for use when conducting an audit of projects, programmes, policies etc. It is the responsibility of the person conducting the monitoring to ensure that the environmental monitoring report or checklist is accurately completed, the observations made during the monitoring are correct and a true reflection of the actual situation and that the interpretation of the data is logical and factual. The party responsible for performing the environmental monitoring must sign the monitoring report.

A monitoring report will not be a detailed report, as much of the monitoring information will be contained in the completed checklists. The monitoring report must begin with basic administrative information related to the monitoring. This includes the date/s that the monitoring was conducted, the type and objective of the monitoring, how the information on the checklist was obtained, who performed the monitoring, which checklists were used and any problems encountered during the monitoring process.

The monitoring report should then have a summary that identifies the key findings and recommendations of the monitoring, including a summary of compliance and non-compliance. A more detailed description of the important monitoring results should then be compiled. The report should also include a physical description of the site, the indicators (if relevant) and monitoring sites. The type of information that will be included in the report is dependent on the type of monitoring that was required for the specific purpose.

The report must clearly suggest recommendations or corrective actions that will assist in attaining compliance. Corrective actions will vary widely and should be decided upon by the person with the delegated powers to institute change.

It is crucial that the monitoring report includes all relevant supporting information, the checklists in particular must be completed in full. Diagrams, photographs, and other data may also form part of the report.

Recommendations to address areas of non-compliance or opportunities to reduce the risk of harm or detriment to the environment resulting from the activity, may also be included. The recommendations should be prioritized and dates for instituting corrective actions should be included where necessary.

3.4.4 Instituting Corrective Action, Continual Improvement and Preventative Measures

Corrective action for monitoring usually involves simple measures designed to stop the immediate problem for the short-term. Identifying the simple cause of a monitoring finding is fairly straightforward. The checklists should allow the monitor to highlight the areas where environmental problems have arised. An examination of the facts should then enable the monitor to understand the problem and identify the cause. Corrective actions need to be devised which are specific to each problem. The assistance of a higher-level decision-maker may be useful in establishing appropriate corrective actions. A suitable deadline for the implementation of a corrective action should be determined. Further monitoring of this corrective action must be included in all future monitoring programmes.

The municipality and/or its appointed project engineer shall appoint an ECO to monitor compliance with the EMPr (above) - especially the following shall be monitored:

- Limiting of disturbance caused by construction activities (geographical area),
- Effective waste management,
- Minimisation of disturbance of biota,
- Legal compliance (including the stipulations of the Environmental Authorisation).

The proponent shall conduct inspections of the construction site on a regular basis. The following persons shall attend such inspections

- the site engineer,
- the contractor &
- the municipality.

The proponent shall document the findings of his monitoring actions.

The proponent shall keep a DOCUMENTED COMPLAINTS REGISTER. For the purposes of receiving complaints, the contact details of the proponent shall be clearly displayed at the main entrance to the site. The nature of complaints that are received shall be brought to the attention of LEDET and the contractor(s). The proponent shall give a suitable written response to complainants where required.

See enclosed pro-forma “COMPLAINTS REGISTER” – under Appendices (section 5 of this document).

The proponent contractor shall document "environmental incidents" on an "ENVIRONMENTAL INCIDENT REPORT SHEET" (EIRS) within 1 day (24 hours) from the time that the incident has occurred.

See enclosed pro-forma "ENVIRONMENTAL INCIDENT REPORT SHEET" (EIRS) – under Appendices (section 5 of this document).

In an instance where an "environmental incident" is recorded, the proponent shall take appropriate action to correct the "environmental incident". Such action shall be in accordance with the nature and scale of the recorded incident. Such corrective action shall be implemented as soon as possible after the occurrence of the incident.

"Corrective action" undertaken by the proponent shall also include the rehabilitation of secondary environmental disturbance/damage resulting from undertaking corrective action. The re-occurrence of an environmental incident shall be avoided through the implementation of suitable precautionary measures to prevent the recurrence of such.

Contractors shall report environmental incidents to the proponent during the weekly site visits. A course of action shall then be decided upon jointly (as a precautionary measure to avoid the re-occurrence of these types of incidents).

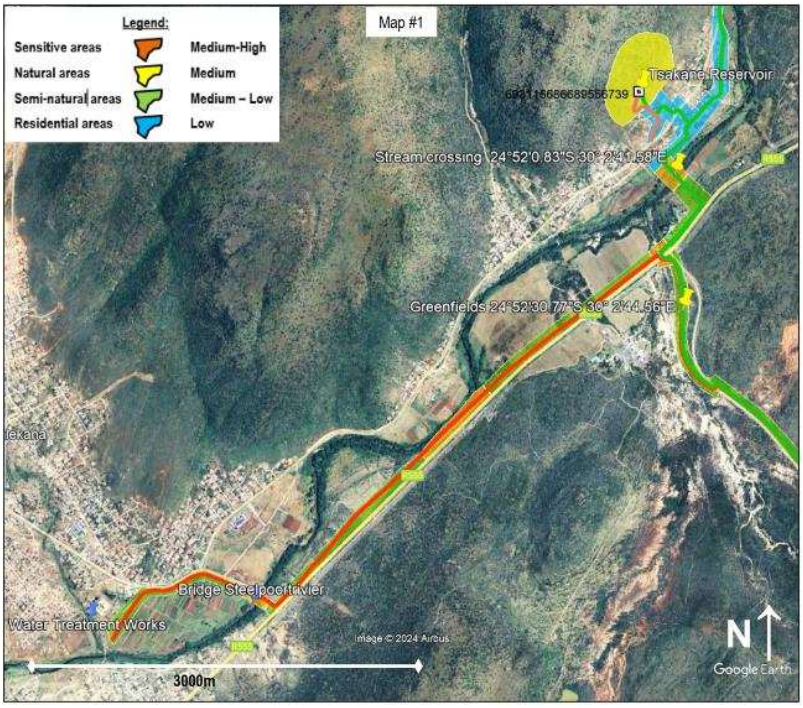
3.5 CONCLUDING REMARK

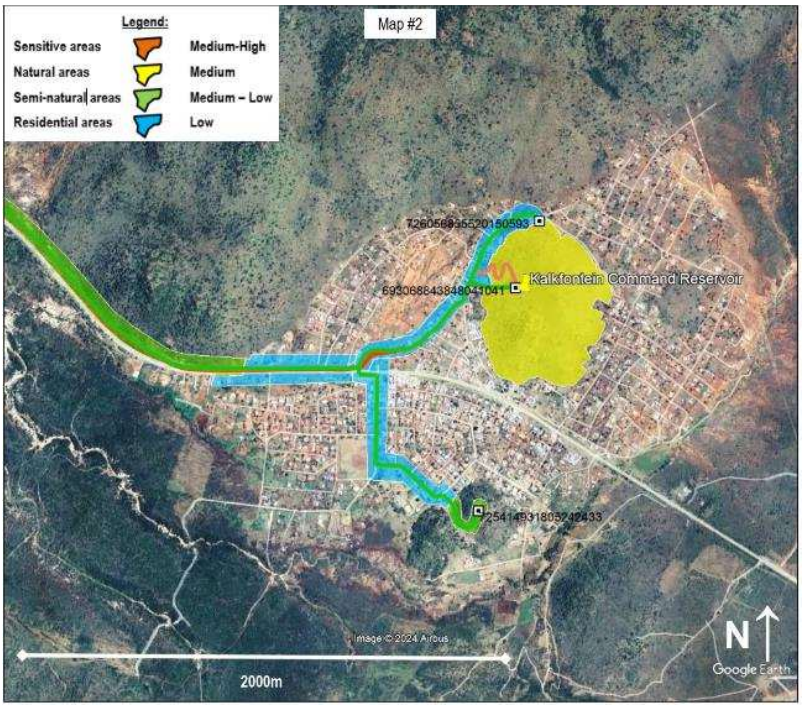
This document should be viewed as a dynamic document and additions should be made to it as other impacts/issues are identified during the course of the project. Where additions or alterations are made, the parties responsible for decommissioning, maintenance etc. should be informed of this in writing – such parties should acknowledge receipt of such additions/amendments in writing.

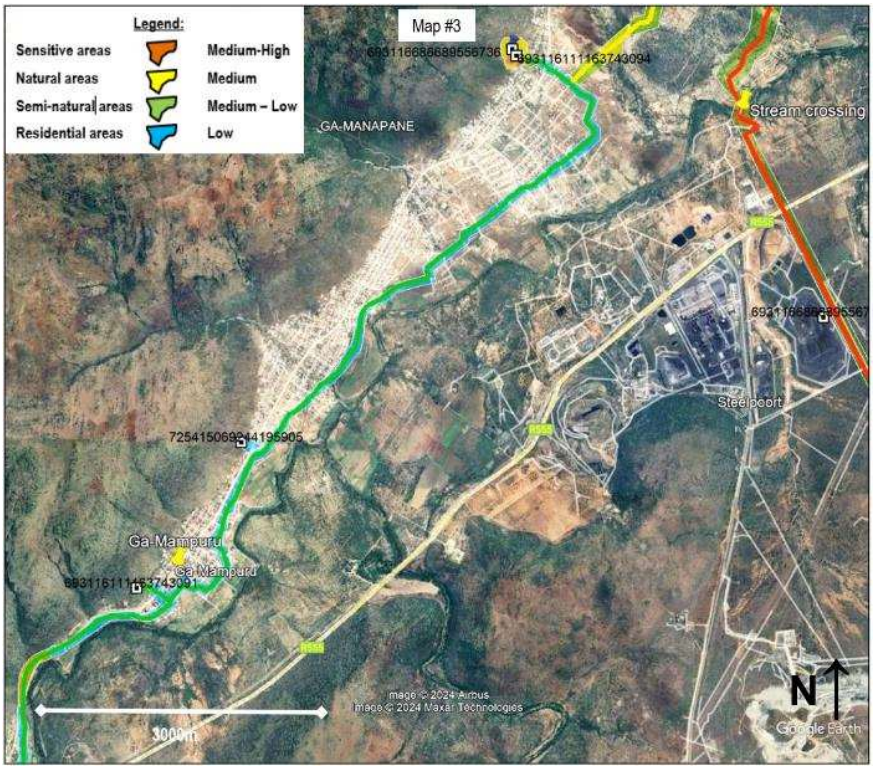
In conclusion it can be stated that several negative and positive impacts/effects can potentially arise from the proposed development. These can however be mitigated through the implementation of a number of mitigation measures (as contained in this Environmental Management Programme).

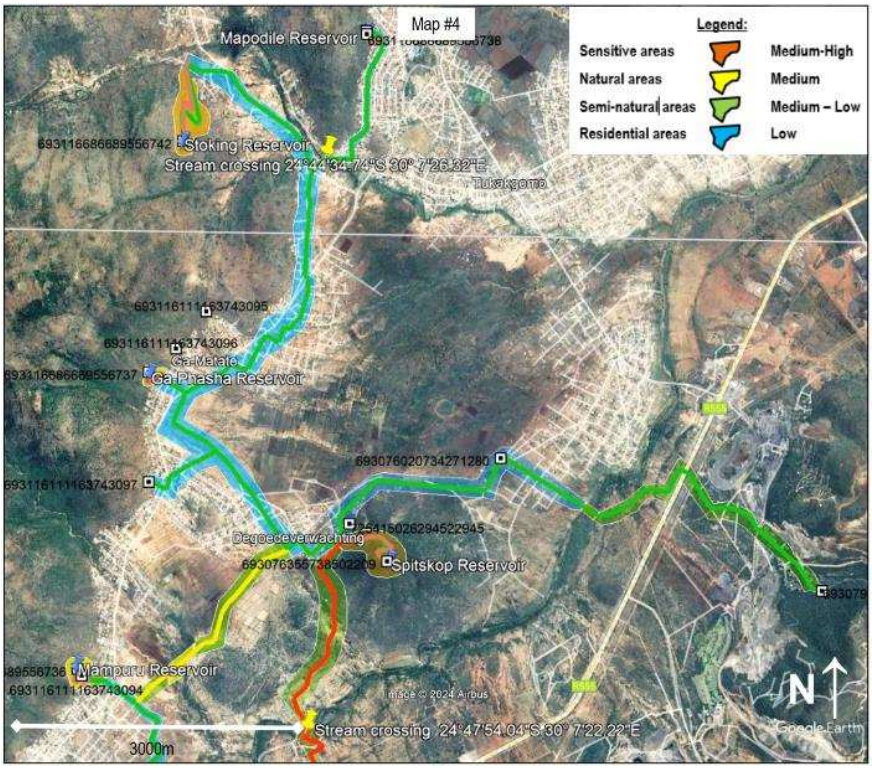
4. SENSITIVITY MAPS

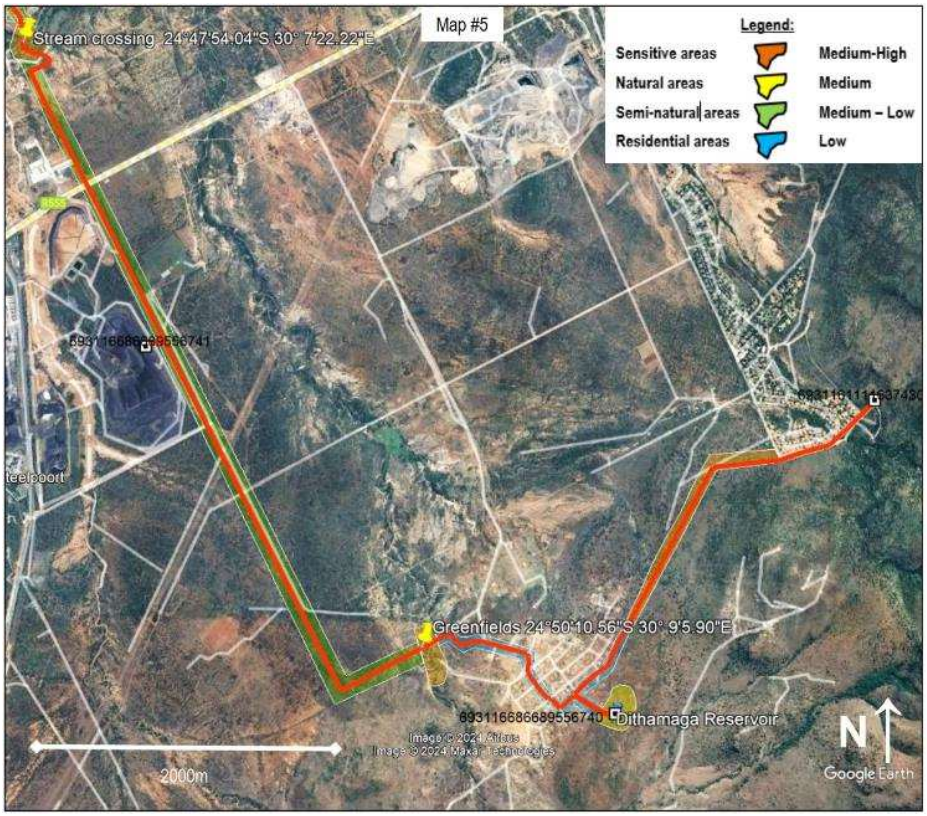
1.1 Terrestrial Ecological Sensitivity Maps:



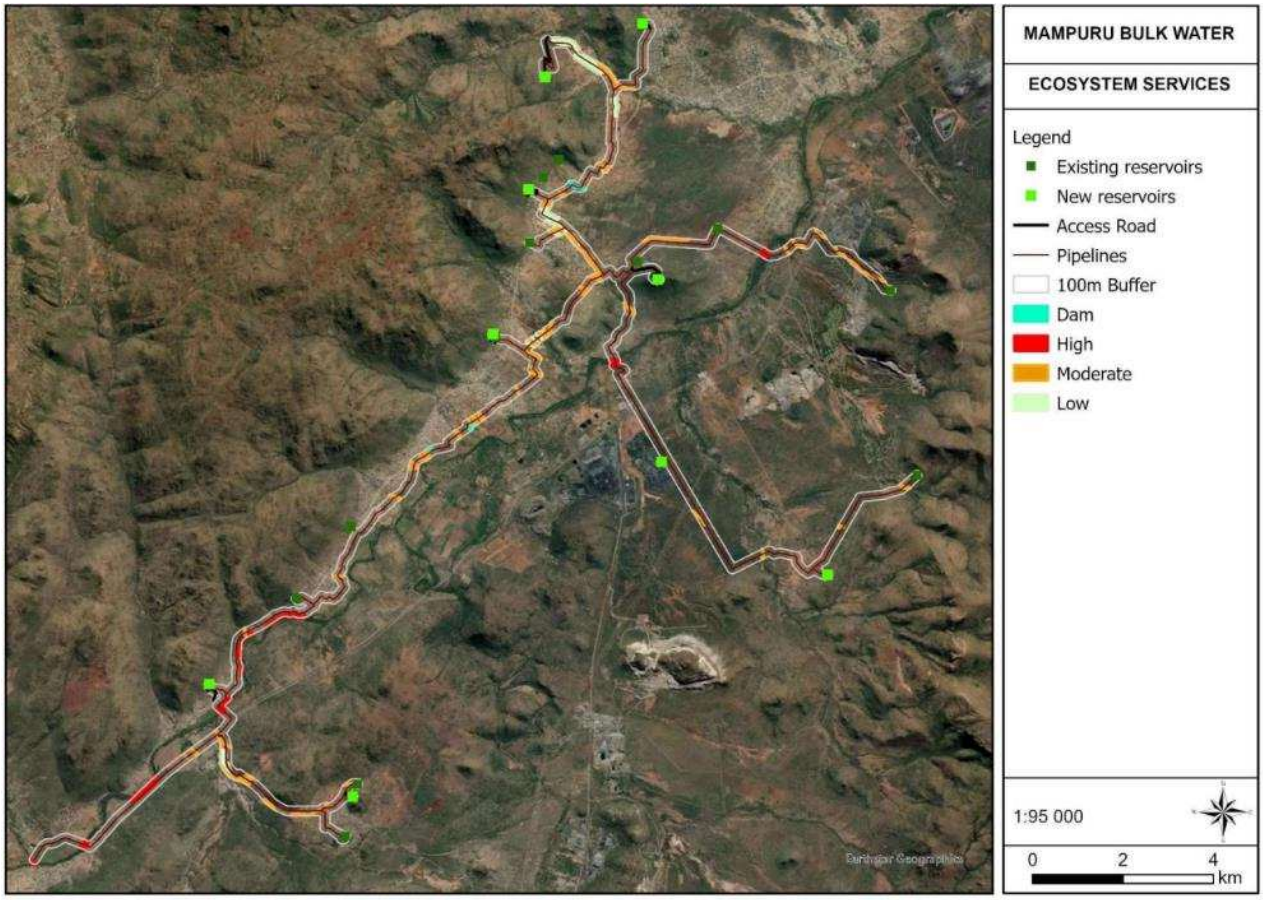



Map #3
Legend:
Sensitive areas
Natural areas
Semi-natural areas
Residential areas
Medium-High
Medium
Medium – Low
Low
GA-MANAPANE
Stream crossing
Steelport
Ga-Mampuru
Ga-Mampuru
3000m
N
Google Earth


Map #4
Legend:
Sensitive areas
Natural areas
Semi-natural areas
Residential areas
Medium-High
Medium
Medium – Low
Low
Mapodile Reservoir
Stoking Reservoir
Stream crossing 24°44'34.74"S 30° 7'26.32"E
Ga-Phasha Reservoir
Degoedeverwachting
Spitskop Reservoir
Mampuru Reservoir
Stream crossing 24°47'54.04"S 30° 7'22.22"E
3000m
N
Google Earth


Map #5
Legend:
Sensitive areas
Natural areas
Semi-natural areas
Residential areas
Medium-High
Medium
Medium – Low
Low
Stream crossing 24°47'54.04"S 30° 7'22.22"E
Greenfields 24°50'10.56"S 30° 9'5.90"E
Dithamaga Reservoir
2000m
Google Earth

1.2 Aquatic Ecological Sensitivity maps (Riarean areas):

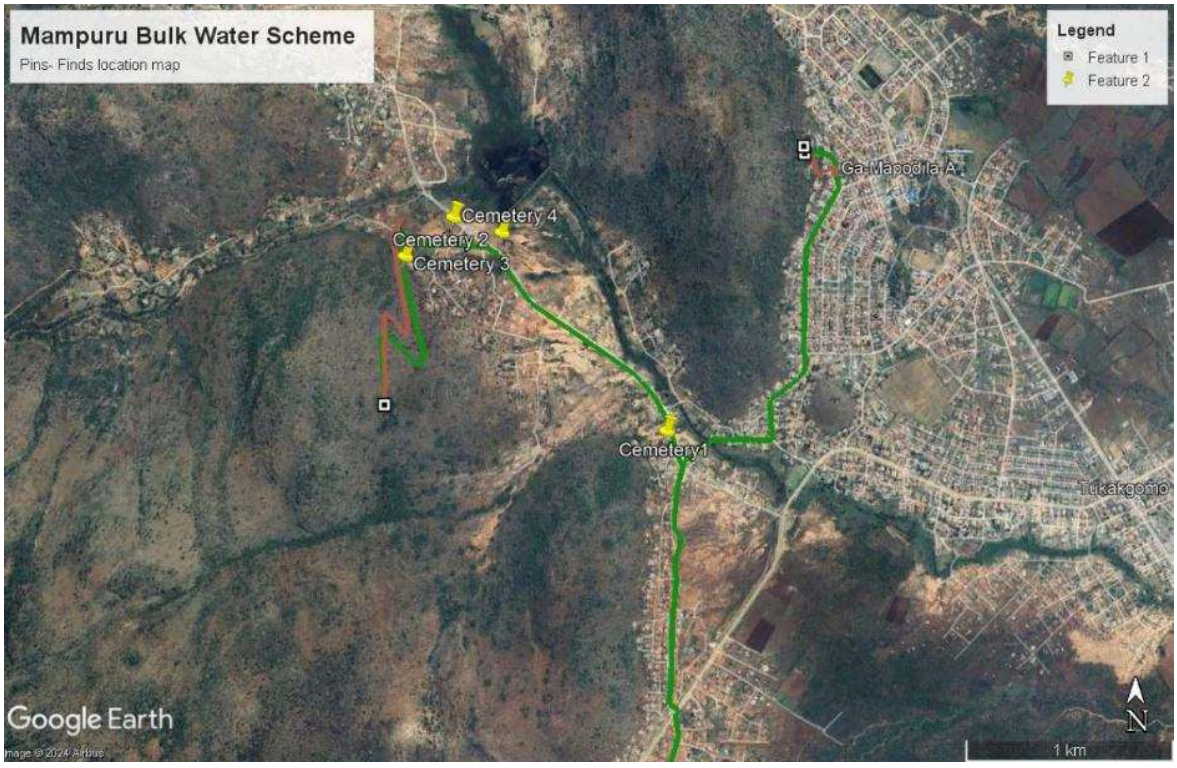


1.3 Heritage Finds Maps:



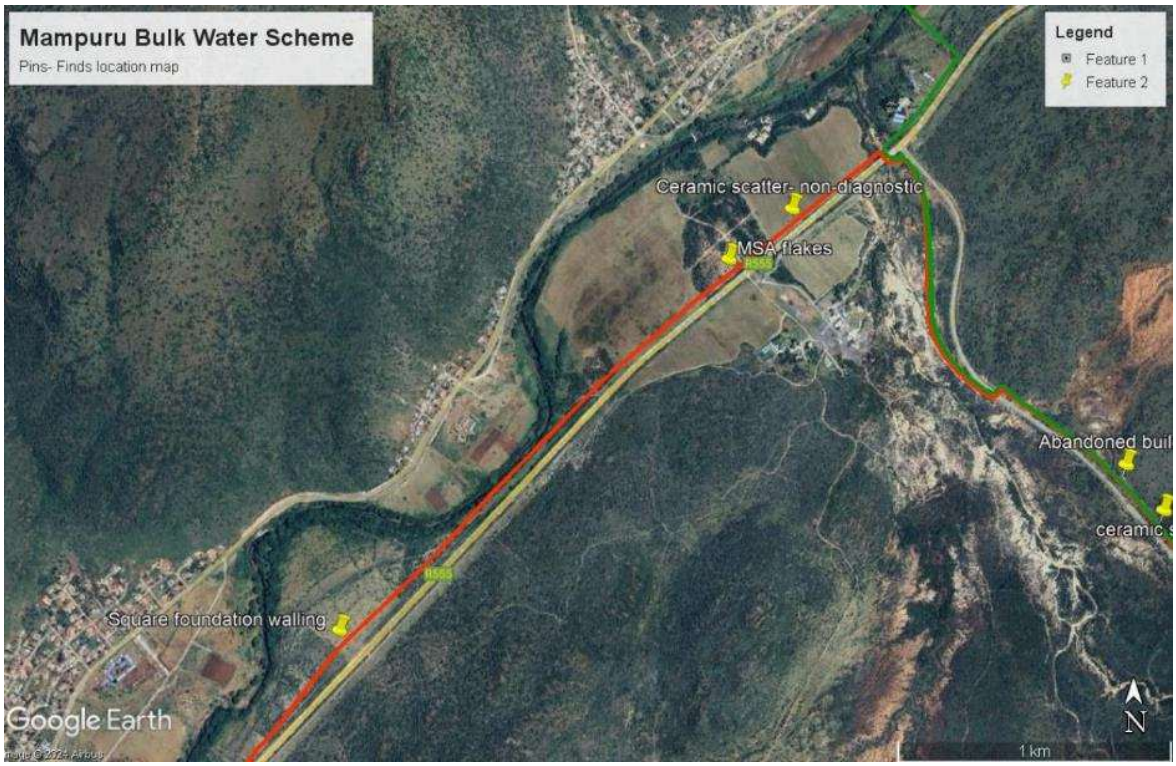



Mampuru Bulk Water Scheme
Pins- Finds location map
Legend
Feature 1
Feature 2
Cemetery 5
Graves 6
Grave 3
Graves 1
Grave 5
Degoedeverwachting
Grave 4
Graves 2
House foundations
Low concentration ceramics
MSA low concentration
Google Earth
2 km
N

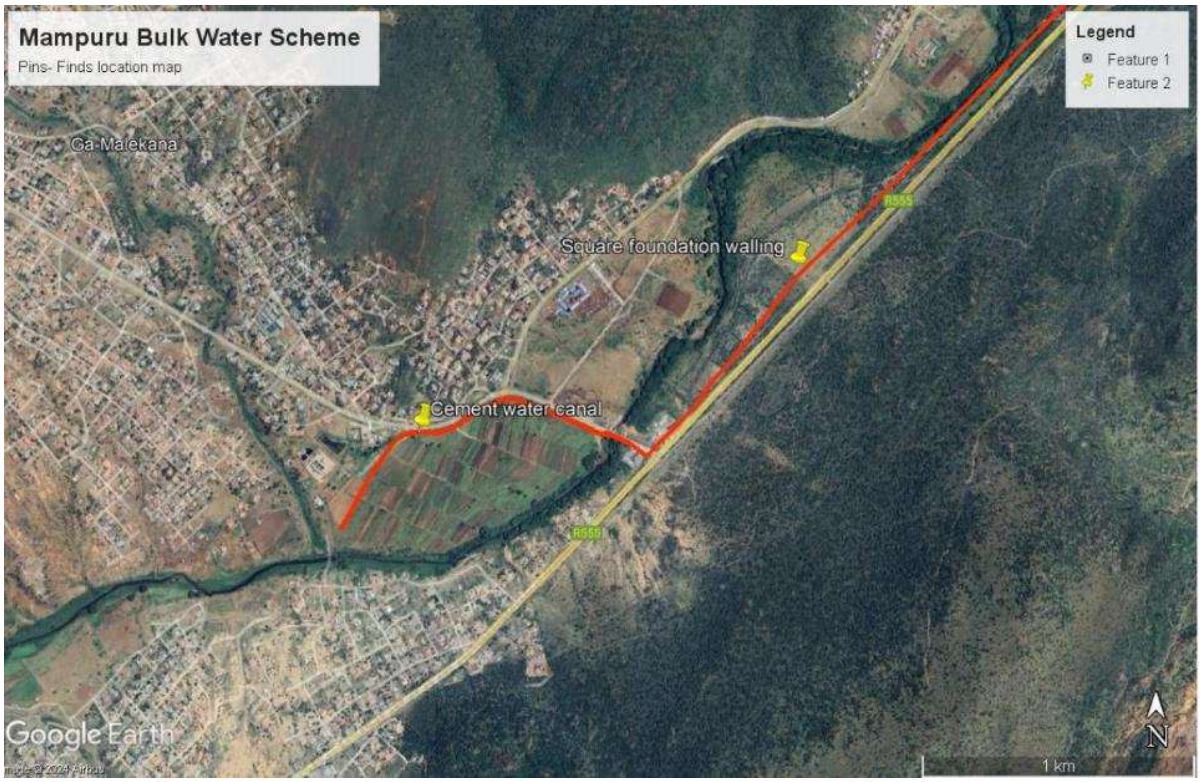

Mampuru Bulk Water Scheme
Pins- Finds location map
Legend
Feature 1
Feature 2
Ga-Mapodile A
Cemetery 4
Cemetery 2
Cemetery 3
Cemetery1
Tukakgomo
Google Earth
1 km
N


Mampuru Bulk Water Scheme
Pins- Finds location map
Legend
Feature 1
Feature 2
House foundations
Low concentration ceramics
MSA low concentration
A-MANAPANE
R555
Google Earth
1 km
N


Mampuru Bulk Water Scheme
Pins- Finds location map
Legend
Feature 1
Feature 2
Ga-Mampuru
Graves 7
R555
Google Earth
1 km
N


Mampuru Bulk Water Scheme
Pins- Finds location map
Legend
Feature 1
Feature 2
Ceramic scatter- non-diagnostic
MSA flakes
Abandoned buil
ceramic s
Square foundation walling
R555
Google Earth
1 km
N


Mampuru Bulk Water Scheme
Pins- Finds location map
Legend
Feature 1
Feature 2
Ceramic scatter- non-diagnostic
MSA flakes
R555
Abandoned building
ceramic scatter
Abandoned modern homestead
Grave 8
Google Earth
1 km
N


Mampuru Bulk Water Scheme
Pins- Finds location map
Legend
Feature 1
Feature 2
Ga-Malekana
Square foundation walling
Cement water canal
R555
R555
Google Earth
1 km
N

5. APPENDICES

ENVIRONMENTAL INCIDENT REPORT SHEET	
NAME OF PROJECT: ..... **DATE AND TIME OF RECORDING:**	
INCIDENT DESCRIPTION: (attach additional documentation e.g. photos or sketches where necessary)	
Incident number:	Date of incident: ..... Time of incident: .....
1. Location of incident	
2. Volume of material involved (e.g. litres or m^3) or number of features damaged	
3. Cause(s) of incident	
DESCRIPTION OF CORRECTIVE & PREVENTIVE ACTIONS TAKEN:	
4. Materials and methods used for mitigation of the incident during and immediately after its Occurrence	
5. Disposal methods followed with Contaminated material (where Relevant)	
6. Steps taken to prevent a re-Occurrence of the incident	
7. Additional actions required by Environmental officer	
Signature of contractor's Representative:	I hereby certify that the above is a true and accurate account of the incident and the corrective and preventive actions taken _____ Signed Date
Signature of environmental officer:	I hereby certify that the above is a true and accurate account of the incident and the corrective and preventive actions taken _____ Signed Date

COMPLAINTS REGISTER **NAME OF PROJECT: .....** **DATE AND TIME OF RECORDING: .....**	
DESCRIPTION OF COMPLAINT RECEIVED: (attach additional information where necessary)	
Complaint number:	Date of complaint: ..... Time of complaint: .....
Complaint received from:	Name: ..... Address: ..... Tel no.: .....
Cause(s) of complaint	
DESCRIPTION OF CORRECTIVE & PREVENTIVE ACTIONS TAKEN:	
Materials and methods used for mitigation to prevent a re-occurrence	
Signature of contractor's representative:	I hereby certify that the above is a true and accurate account of the complaint that was received and the corrective and preventive actions taken Signed Date
Signature of environmental officer:	I hereby certify that the above is a true and accurate account of the complaint that was received and the corrective and preventive actions taken Signed Date

REGISTER OF RESPONSE TO COMPLAINT(S)

NAME OF PROJECT: .....

DATE AND TIME OF RECORDING: .....

DESCRIPTION OF COMPLAINT RECEIVED: (attach additional information where necessary)

.....

.....

.....

Complaint number:	Complaint received from: Name: ..... Address: ..... Tel no.: .....

DESCRIPTION OF RESPONSE PROVIDED TO THE COMPLAINANT (INCLUDING CORRECTIVE AND PREVENTIVE ACTION TAKEN):

.....

.....

.....

Signature of contractor's representative:	I hereby certify that the above is a true and accurate account of the complaint that was received and the response given Signed: Date:
Signature of environmental officer:	I hereby certify that the above is a true and accurate account of the complaint that was received and the response given Signed: Date:

6. REFERENCES

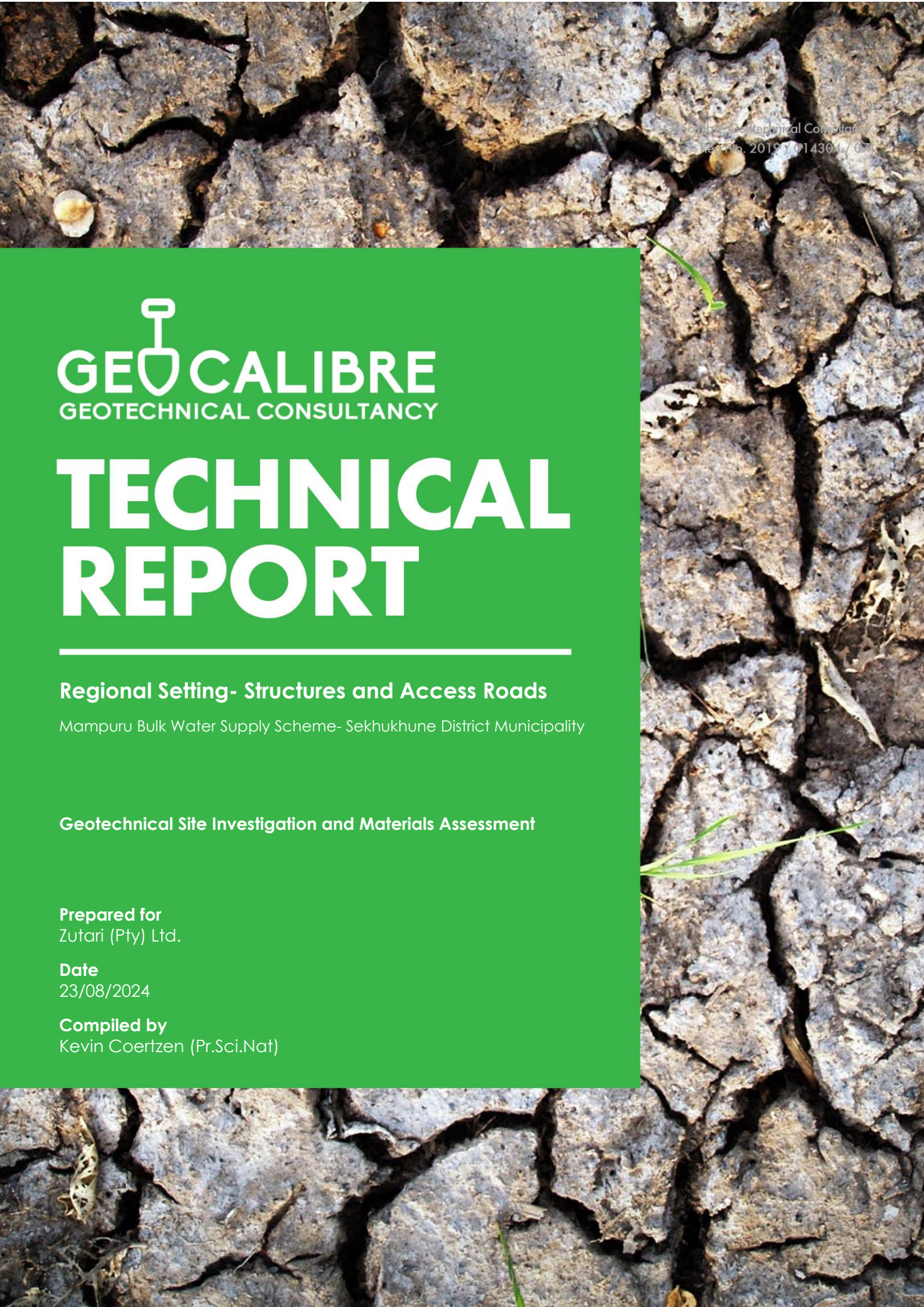
Department of Water Affairs and Forestry, 2005 Environmental Monitoring and Auditing Protocol. Integrated Environmental Management Sub-Series No.1.7 . Second Edition. Pretoria.

Department of Water Affairs and Forestry, February 2005 Environmental Monitoring and Auditing Guideline. Integrated Environmental Management Sub-Series No. IEMS 1.7. Third Edition. Pretoria. Appendix J: Environmental Best Practice Monitoring Report: Construction

Heritage Scoping Report for proposed new Mampuru Bulk Water Scheme, Mampuru Village, Shasha Heritage Consultants, May 2024

Riparian Biodiversity Assessment Report: Proposed Mampuru Bulk Water Scheme, from Ga-Malekane to Legotong and Mapodile, Fetakgomo Tubatse Local Municipality, Limpopo Province, Limosella Consulting, May 2024

Terrestrial Ecological Assessment Report: The Proposed Establishment of Reservoirs and Bulk Water Supply Pipelines as part of the Proposed Mampuru Bulk Water Supply Scheme, Near Steelpoort, Sekhukhune District, Limpopo Province, Bateleur Ecological Services, April 2024



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

TECHNICAL REPORT

Regional Setting- Structures and Access Roads

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Geotechnical Site Investigation and Materials Assessment

Prepared for
Zutari (Pty) Ltd.

Date
23/08/2024

Compiled by
Kevin Coertzen (Pr.Sci.Nat)

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Technical Report

GC24/144-RS

23 August 2024

Regional Setting- Structures and Access Roads

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Project Details

Report Title	Regional Setting- Structures and Access Roads
Report Reference	GC24/144- RS
WAS/WSP	Sekhukhune District Municipality (SDM)
Contract Reference	SK08/3/1-30/2017/2018
Project Engineers	Zutari (Pty) Ltd.
Report Description	Geotechnical Site Investigation and Materials Assessment
Report Version	Final Report

Report Compilation and Signatory

GeoCalibre Geotechnical Consultancy (Pty) Ltd.

Kevin Coertzen
Professional Natural Scientist (400011/17)
NHBRC Competent Person (Barcode 3000179078)
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1200

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1. Project Introduction

1.1. Background

A series of detailed reports have been compiled to shed light on the various phases of the Geotechnical Site Investigation- and associated Materials Assessment- conducted in support of the planned upgrades and additions to the existing **Mampuru Bulk Water Supply Scheme.** The scheme falls under the jurisdiction of the Sekhukhune District Municipality within the Limpopo Province of South Africa.

The formal contract details are as follows:

- **WAS/WSP:** Sekhukhune District Municipality (SDM)
- **Contract Number:** SK08/3/1-30/2017/2018
- **Project Engineers:** Zutari (Pty) Ltd.

Individual reports have been compiled for the planned new **water storage structures** set to form part of the upgrades and additions to the existing bulk water scheme. Separate reports have been created for the planned structures and their access roads, with the various sections in the report referring to specific attributes/routes- for easy reference.

The report breakdown for the project is as follows:

- GC-24-144RS- Regional Setting- Structures and Access Roads
- GC-24-144A- Kalkfontein Command Reservoir- 3000 kl
- GC-24-144B- Tsakane Steel Tank- 250 kl
- GC-24-144C- Dithamaga Concrete Reservoir- 600 kl
- GC-24-144D- Mampuru Concrete Reservoir- 1200 kl
- GC-24-144E- Ga-Phasha Steel Tank- 1300 kl
- GC-24-144F- Spitskop Command Reservoir- 15000 kl
- GC-24-144G- Stoking Concrete Reservoir- 700 kl
- GC-24-144H- Mapodile Concrete Reservoir- 3000 kl

1.2. Terms of Appointment

GeoCalibre Geotechnical Consultancy was appointed by Zutari (Pty) Ltd. (Polokwane Branch) to undertake the required near surface site investigation.

The information presented in this document is based on the information supplied by the Client prior to the commencement of the investigation; therefore, GeoCalibre Geotechnical Consultancy (Pty) Ltd- shall not be held liable for, and is indemnified against all actions, claims, demands, losses, liabilities, costs, damages and expenses prompted by, or in connection with, inaccurately relayed information pertaining to the site and/or the development.

The exact nature and design of the future structures across the greater water scheme were not defined at the time of this study, with this near surface investigation utilising typical attributes of structures of this nature to guide the analysis and corresponding recommendations.

1.3. GeoCalibre- Company Background and Information

GeoCalibre is a specialist geotechnical consulting firm made up of a team of qualified professional geo-practitioners. The firm was established out of a love for the industry and an urge to define a new calibre of professional consulting.

GeoCalibre uses advanced scientific methods to create accurate and reproducible geotechnical models; successfully guiding the implementation of site-specific design precautionary measures/engineering solutions. The methodology followed throughout the investigative process accounts for the nature and location of the development as well as adhering to the standards of our practice (SANS and SAICE).

Investigations undertaken by GeoCalibre are overseen by suitably qualified Engineering Geologists *professionally registered* (Pr.Sci.Nat) with the South African Council of Natural Scientific Professions (SACNASP)- in accordance with all the relevant and required procedures and legislations. GeoCalibres employees are also members of the South African Institute for Engineering and Environmental Geologists (SAIEG).

1.4. Limitations of the Geotechnical Assessment

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an **initial phase near surface geotechnical study**- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The results of this level of assessment provides an overview of the geotechnical character of the site, as well as listing prominent adverse geotechnical characteristics. Once access/mobility has been modified follow-up studies can be conducted, where required.

The presented geotechnical models are based on a data base of available information, on-site soil profiles and the results from soil laboratory tests. Parcels of land within the developmental area which are free of excavations are modelled through interpolation and extrapolation of known testing locations, to identify problem issues of a geotechnical nature on which this report is based.

Geological conditions are seldom uniformly developed and areas and positions where geological and geotechnical conditions on the site might vary locally from those described and assessed in this report.

A centerline and materials assessments primarily focus on near surface attributes along the length of any given linear structure (i.e., access roads and pipelines). The primary aim of such a study is to assess the near surface geotechnical nature of the site in relation to planned development. Shallow and/or basic studies of this nature generally do not include specialist geotechnical studies for attributes such as complex surficial structures, thick fill embankments (existing or future), pipe jacking, natural slope/cutting stability, blasting and/or rock crushing attributes and/or soil/rock mechanics. In depth geotechnical studies across target areas can be undertaken by GeoCalibre as part of follow-up studies.

The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result of either natural processes or human activity. If a substantial lapse of time occurs between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we urge that our report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions.

In addition, advancements in the practice of geotechnical engineering and engineering geology and changes in applicable practice codes may affect the validity of this report. Our investigation did not include the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.

1.5. Development within 1 : 100 year-flood lines

It must be noted that the National Water Act (Act 36 of 1998) states the following regarding development within the 1 : 100 year-flood line of any stream or river (Thompson, 2006): **Section 21(c):** Impeding or diverting the flow of water in watercourses (including alteration of the hydraulic characteristics of flood events) requires licensing according to the Act.

Section 21(i): Any action that may alter the bed, banks, courses or characteristics of watercourses (including flood events) requires licensing according to the Act, including: widening or straightening of the bed or banks of a river to allow for the construction the housing development and altering the course of a river partially or completely (i.e.: river diversion) to be able to use or develop the area where the watercourse originally was.

The National Water Act does not prohibit development within 1 : 100 year-flood lines; however, the Act requires detailed analysis of the effects of the proposed development on the surrounding environment, with special reference to surface and sub-surface water flow. The Act requires that suitable precautionary measures be implemented to limit the effect within and downstream from the proposed development.

1.6. Codes of Practise and Investigative Standard

The investigation was carried according to the following standard practice codes and guidelines:

- Guidelines for Urban Engineering Geological Investigations (SAIEG & SAICE, 1997) for urban development.
- Site Investigation Code of Practice put forward by the Geotechnical Division of SAICE (2010).
- SANS 2001-DP1:2011 Earthworks for buried pipelines and prefabricated culverts.
- SANS 10400.
- Applicable technical specification documents of South Africa (TRH, TMH, COLTO/COTO and SAPEM).
- The guideline and specification documents by the South African Institute of Engineering and Environmental Geologists (SAIEG) and South African Institution for Civil Engineers (1997), AEG/SAIEG/SAICE (2002) were consulted.

1.7. Information Sources

- **Geological Map:**
  - Geological Series Map 2430 Pilgrim's Rest; scale 1:250 000 (digital format)
- **Hydrogeological Data:**
  - SADC Groundwater Information Portal (SADC GIP)
  - Hydrogeological Series Map 2330 Phalaborwa (1998); scale 1: 500 000 (digital format)
  - Electronic Maps of the Water Management Areas and Drainage Regions in South Africa- DWAF [Department of Water Affairs and Forestry]- 1996 and 1999 (www.dwa.gov.za).
- **Topocadastral maps:**
  - 2429 Dd; scale 1:50 000 (digital format)
  - 2430 Ca; scale 1:50 000 (digital format)
  - 2430 Cc; scale 1:50 000 (digital format)
- **Provided by the Client:**
  - Structure location and planned access road route
- **Remote Sensing Information:**
  - Google Earth Pro ™
  - Planet GIS Limpopo Cadastral Land Layer (2022)
- **Available geotechnical reports:**
  - Numerous geotechnical reports from the region compiled by Kevin Coertzen (Pri.Sci.Nat and MSAIEG)

1.8. Scope of the Investigation

A near surface geotechnical site investigation was carried out across each of the areas in question in order to assess the mechanical nature of the underlying strata and model the geomorphological nature of the local setting. Following the assessment, GeoCalibre provides recommendations on the implementation of **site-specific engineering solutions.**

The aim of the overall site investigation can be summarised as follows:

- Establishment of a **regional geological**, **geomorphological** and **geo-technical** model for the site.
- To delineate the **succession of strata** (soil and rock) underlying the site; with the identification of problematic **physical, chemical** and **mechanical** characteristics which may influence the development.
- To quantify the **in-situ mechanical properties** of the soft materials underlying the site; specifically, with regards to the proposed future developments.
- To compute the **excavatability properties** of the materials underlying the site.
- To assess shallow **groundwater** patterns.
- To evaluate the basic **re-usage potential** of the materials underlying the site.
- To aid the development moving forward through the formulation of an **accurate geotechnical model** for the site under investigation.

The near surface site investigation was undertaken in order to assess the basic engineering geological character of the site, focussing on the geotechnical properties which will affect the development potential of the area in question with regards to the **installation of civil engineering services** and the construction **surficial water storage structures** and their associated **gravel access roads**.

The investigation excludes the following aspects, where applicable:

- Geophysical, resistivity, or corrosion studies.
- Dolomite stability or undermining Investigations
- Detailed hydrological, hydropedological, hydrogeological, pedological, flood line, or wetland delineation studies.
- Excavations by means of light/heavy earth moving equipment and associated soil and/or rock sampling.
- Footprint studies along the pipeline routes for the various water treatment works, pump stations, river crossings and pipe jacking sites.
- Borehole drilling and/or rock strength analysis.
- Detailed slope stability assessments.
- Geo-environmental assessments.
- Township establishment/land rezoning (SANS 634).

1.9. Investigative Methodology

The investigation is undertaken in a number of phases in order to achieve the aims discussed above. The investigative phases are as follows:

- **Phase 1: Introduction and Regional Assessment of the Site**
- **Phase 2: Geotechnical Analysis- Structures**
- **Phase 3: Geotechnical Analysis- Access Roads**
- **Phase 4: Data Assessment and Report Compilation**

1.9.1. Phase 1: Introduction and Regional Assessment of the Site

The collation and evaluation of all the available topographic, geo-morphological and geological data across the investigated site and its' surroundings. This assessment is done through the use of available regional maps and remote sensing images.

This section of the report will include a description and summary of the site's nature, based on existing literature, and is supplemented with the compilation of a series of base maps.

1.9.2. Phases 2 and 3: Geotechnical Analysis

Phases 2 through to 4 shared a similar methodology (presented below); with the distribution of testing locations, depth and nature of sampling/testing and footprint specific geotechnical observations at any given portion of the site relating to the nature of the planned structures at said location.

Trenching

The field work phase of the investigation was conducted by GeoCalibre across June and July 2024.

Access to- and mobility- across the target areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by **hand** across the footprints of the planned structures and along the routes of the various access roads.

Across the various sites, between TWO (2) and TEN (10) test pits were excavated by means of **pick-and-shovel** (local labour digging by hand). A total of **50 test pits** were excavated across the greater project area.

Additionally, where applicable, available **exposures/cuttings** situated within close proximity to the various sites were logged and sampled. In many cases, the local cuttings provide greater exposures- both laterally and vertically- of the in-situ materials as compared to the small hand excavated trial pits.

Test pits were distributed across the various sites placed at locations chosen on merit to map and model variances in the underlying strata. Test pit locations were primarily based on the Client's specific outcomes (footprint analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model. Following a detailed site walkover and associated existing services' mapping exercise, planned trial pits were adapted on ground level.

The succession of soil layers exposed within the test pits and exposures were logged by GeoCalibre. The description of soil profiles is done according to SANS 633:2012 which describes the moisture, colour, consistency, structure, (soil) texture and origin. Following detailed logging, a series of detailed photographs were taken of the different soil layers.

Table 1 below presents a breakdown of the trial pits excavated across the various water storage structure and access road sites.

Table 1: Trial Pit Breakdown

Trial Pit Breakdown- Structures and Access Roads			
Description	**Storage Capacity (kl)**	**Access Road Length (m)**	**Combined Quantities**
Kalkfontein Command Reservoir	3000	360	6
Tsakane Steel Tank	250	500	6
Dithamaga Concrete Reservoir	600	-	2
Mampuru Concrete Reservoir	1200	500	7
Ga-Phasha Steel Tank	1300	480	6
Spitskop Command Reservoir	15000	2330	14
Stoking Concrete Reservoir	700	1190	9
Mapodile Concrete Reservoir	3000	500	7

Sampling

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development. Laboratory testing commenced on the samples collected during the field work phase of the investigation.

Undisturbed sample extraction was not possible/feasible across the various sites as a result of the granular nature and elevated consistency of the foundation zone materials. For this reason, the mechanical assessment of subsoils will be based on the available disturbed soil test results and field observations (i.e., structure, composition, and consistency).

Laboratory Testing

Standard foundation/road indicator and soil compaction tests were conducted by Tzaneen Lab (**SANAS Accredited- 17205**) on disturbed and bulk soil samples.

These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the proposed construction. The following tests were conducted:

I. Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage)- (SANS 3001: GR10/11)

II. Particle-size Distribution (SANS 3001: GR1)

III. Maximum Dry Density vs. Optimum Moisture Content (SANS 3001: GR30)

IV. Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method) (SANS 3001: GR40)

V. pH and Electrical Conductivity (chemical testing)

In-situ Testing- DCP Testing

In-situ penetration tests were conducted alongside and between the excavated test pits in order to determine the quantitative soil consistency conditions.

Standardised DCP tests (8 kg hammer falling 575 mm with a tip/cone of 60°) were implemented as to give an indication of the consistency of the in-situ material of the layer house in question. Soil strength and stiffness are correlated with consistency of earthy soil material and penetrometer testing is used to determine the consistency of both cohesive and non-cohesive materials.

In the design of light structures and roadways, the DCP is a practical test used for onsite measuring of material strength. The test results can be correlated with the California Bearing Ratio (CBR) by applying a formula; results of which can be correlated to the laboratory tests conducted on the soils from the same location. Furthermore, an inferred depth to bedrock can be modelled using the DCP refusal depths. Although not exact, these depths aid in formulating a regional excavation model across the development area.

1.9.3. Phase 4: Data Assessment and Report Compilation

The investigation concluded with the compilation of numerous technical reports detailing the methodology utilised during the study and the summarised results obtained. This includes a potential geotechnical evaluation of the site based on the cumulative results of the near surface investigation.

2. Regional Description of the Environment

2.1. Study Area Location and Description

The **study area** for this investigation is seen to fall within the far south eastern portions of the Limpopo Province of South Africa. Furthermore, the study area is located within the jurisdictive boundary of the Sekhukhune District Municipality, within the bounds of the Fetakgomo Tubatse Local Municipality. As depicted on Image 1 below- on a more localised scale, the study spans the **agglomerate of villages** across the Steelpoort Valley- situated to the south west of **Steelpoort** (Image 1 and Figure 1).

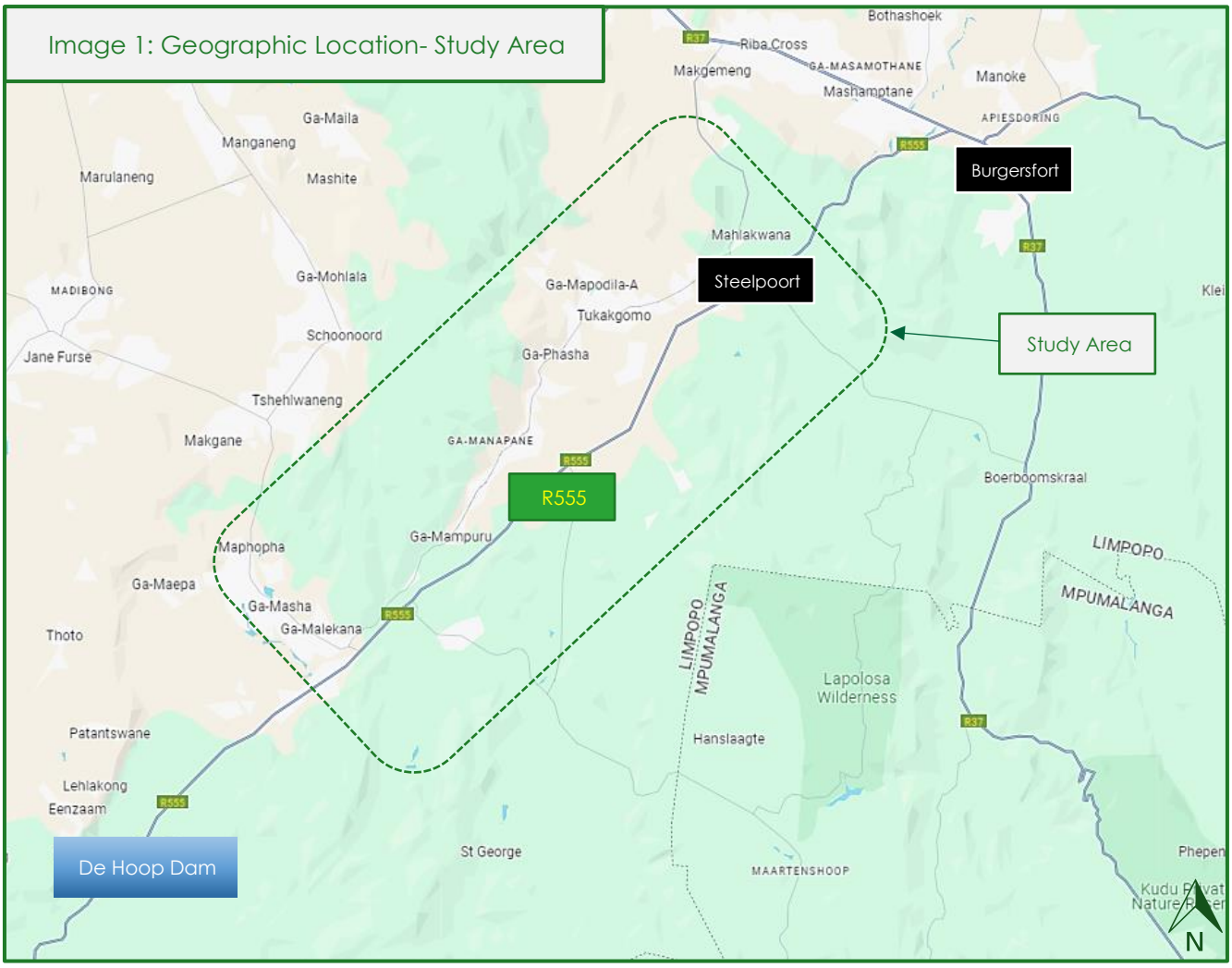


Image 1: Geographic Location- Study Area

Sekhukhune District Municipality (SDM) is a Water Services Authority (WSA) and Water Services Provider (WSP) in accordance with its powers and functions in terms of the Water Services Act, Act 108 of 1997. SDM relies on two major rivers where two large dams are located within its jurisdiction: namely the **Flag Boshielo Dam** on the Olifants River and the **De Hoop Dam** on the Steelpoort River.

As indicated on Image 1, The **De Hoop Dam** is situated approximately **35 km** south west of Steelpoort. As presented by ARQ, at 85 m in height and comprising approximately 1 million m^3 of concrete, the De Hoop Dam is the largest Roller Compacted Concrete (RCC) dam in South Africa. The De Hoop Dam provides the bulk storage for Phase 2A of the Olifants River Water Resources Development Project (ORWRDP), which augments water supply in Limpopo Province.

Water from the De Hoop Dam supports the mining and industrial activities this portion of the Limpopo Province and serves as the primary water supply to the local communities.

2.2. Site Breakdown- Mampuru Bulk Water Supply Scheme

The Mampuru Bulk Water Scheme is a strategic water project from SDM which supplies water to the various end users across the Steelpoort Valley.

The site for this investigation does **not** cover the entire water distribution area- but rather focuses **primarily** on the geotechnical attributes across the **planned water storage sites** (reservoirs and storage tanks), their **access roads** and the various **pipeline routes** which cumulatively form part of the planned **upgrades** and **additions** to the existing scheme**.**

The planned structures are situated along/upon the various ridges which combined to form the mountainous landscape- with the identified sites principally spanning **undeveloped/unaltered land.** The following **water storage structures** and **access roads** form the focal point of this series of reports:

1. **Command Reservoirs**

   a. **Kalkfontein Command Reservoir-** proposed **3 Ml concrete reservoir** located within the south western extent of the study area. A **360 m** gravel road planned to serve as the primary access to its location.

   b. **Spitskop Command Reservoir-** proposed **15 Ml concrete reservoir** located upon a prominent radial ridge- situated within the central to north eastern extent of the study area. Existing access road **notably steep** for this reason a new ~**2300 m** road is planned to serve as the primary access to its location.

2. **Concrete Reservoirs**

   a. **Mampuru Concrete Reservoir-** proposed **1.2 Ml concrete reservoir** located within the central extent of the study area. A **500 m** gravel road planned to serve as the primary access to its location.

   b. **Stoking Concrete Reservoir-** proposed **0.7 Ml concrete reservoir** located along the flank of a major ridge within the northern extent of the study area. A **~1200m** road planned to serve as the primary access to its location- with the increased length as a result of the mountainous terrain.

   c. **Mapodile Concrete Reservoir-** proposed **3 Ml concrete reservoir** located within the northern extent of the study area. Footprint adjacent to an existing reservoir. Access road to the existing platform via a gravel road of **~500m**- planned to be upgraded.

   d. **Dithamaga Concrete Reservoir-** proposed **0.6 Ml concrete reservoir** located within the far eastern extent of the study area. No major access road planned for this structure.

3. **Steel Tank Reservoirs**

   a. **Tsakane Steel Tank Reservoir-** proposed **0.25 Ml steel tank reservoir** located within the south western portion of the study area. A **500 m** gravel road planned to serve as the primary access to its location, a section of which is operational/existing- to be upgraded.

   b. **Ga-Phasha Steel Tank Reservoir-** proposed **1.3 Ml steel tank reservoir** located within the central to northern portion of the study area. A **480 m** gravel road planned to serve as the primary access to its location.

Additional to the above defined water storage structures, the investigation also covers **numerous bulk water pipeline routes.** These routes generally traverse the agglomerate of villages within the study area as well as the undeveloped parcels of land which separate them. Detailed attributes relating to the various pipelines are presented in a separate series of reports.

The various new pipeline routes can be summarised as follows:

- **Rising mains-** approximately **8 rising main pipelines** form part of the planned additions to the existing scheme. Although separate, the rising mains are generally present across the **south western** and **central** portions of the study area. Based on the available routes, the rising mains exhibit a **combined length of roughly 24 km.**
- **Gravity mains-** approximately **23 gravity main pipelines** form part of the planned additions to the existing scheme. These pipelines are distributed across the vast majority of the study area**.** Based on the available routes, the gravity mains exhibit a **combined length of roughly 40 km.**
- **Future link-** a **single (1)** future link pipeline route of **~2.5 km** was presented by the Client. This route is situated in the central extent of the study area- traversing predominantly undeveloped land- connecting the gravity mains network as described above.

The planned upgrades and additions to the existing Mampuru Bulk Water Scheme serve an integral part in the socio-economic development in the region. The geotechnical properties of these separate attributes are dealt with individually in the series of reports to follow. Separate reports have been created for the planned pipelines, structures and their access roads- with the various sections in the report referring to specific attributes/routes- for easy reference.

The surface across the vast majority of the study area was seen to display a reworked nature attributed to past and ongoing human activities in the region. This reworking was predominantly related to the township establishment undertaken in the region, including anthropogenic features such as services, roadways/pathways, scattered heaps of dumped fill, basic earthworks and vegetation depletion/deforestation. These combined actions have not only artificially diversified the topographical nature of the investigated area, but also its geotechnical character.

The exact extent of the existing surface and subsurface infrastructure in this region is not known. Confined spaces, sealed surfaces, existing services and active routes were avoided during the field work phase of the investigation.

The planned developments across the cumulative study area will encompass the subdivision of this terrain into various land-use zones i.e., infrastructural units, stream/road crossings, roadways, and services etc. Each of these zones require their own set of geotechnical assessments and associated engineering solutions.

Images 2A and 2B to follow graphically depict the breakdown of the planned additions to the existing bulk water supply scheme in question.

Image 2A: Study Area Breakdown- New Water Storage Structures and Pipelines

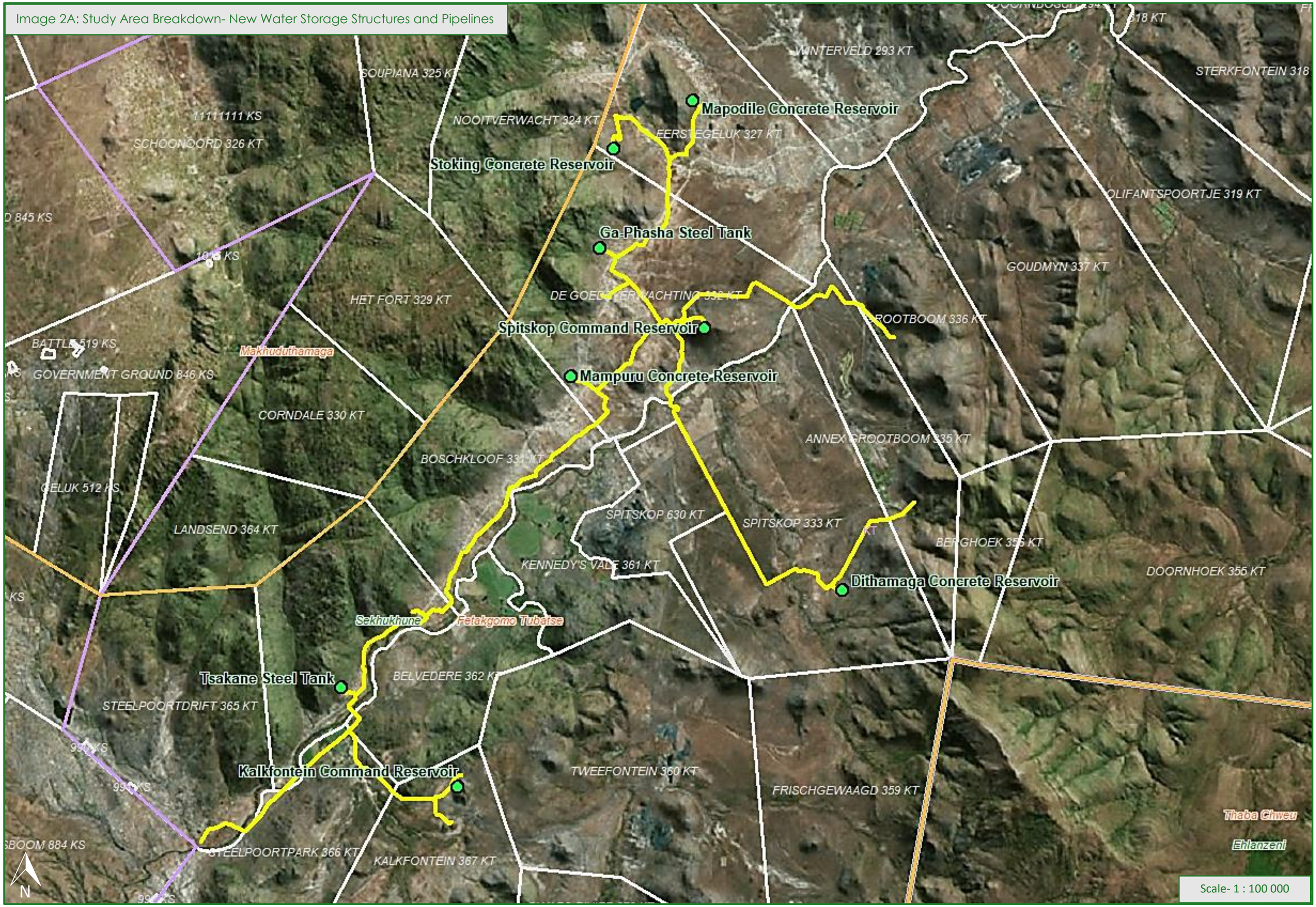
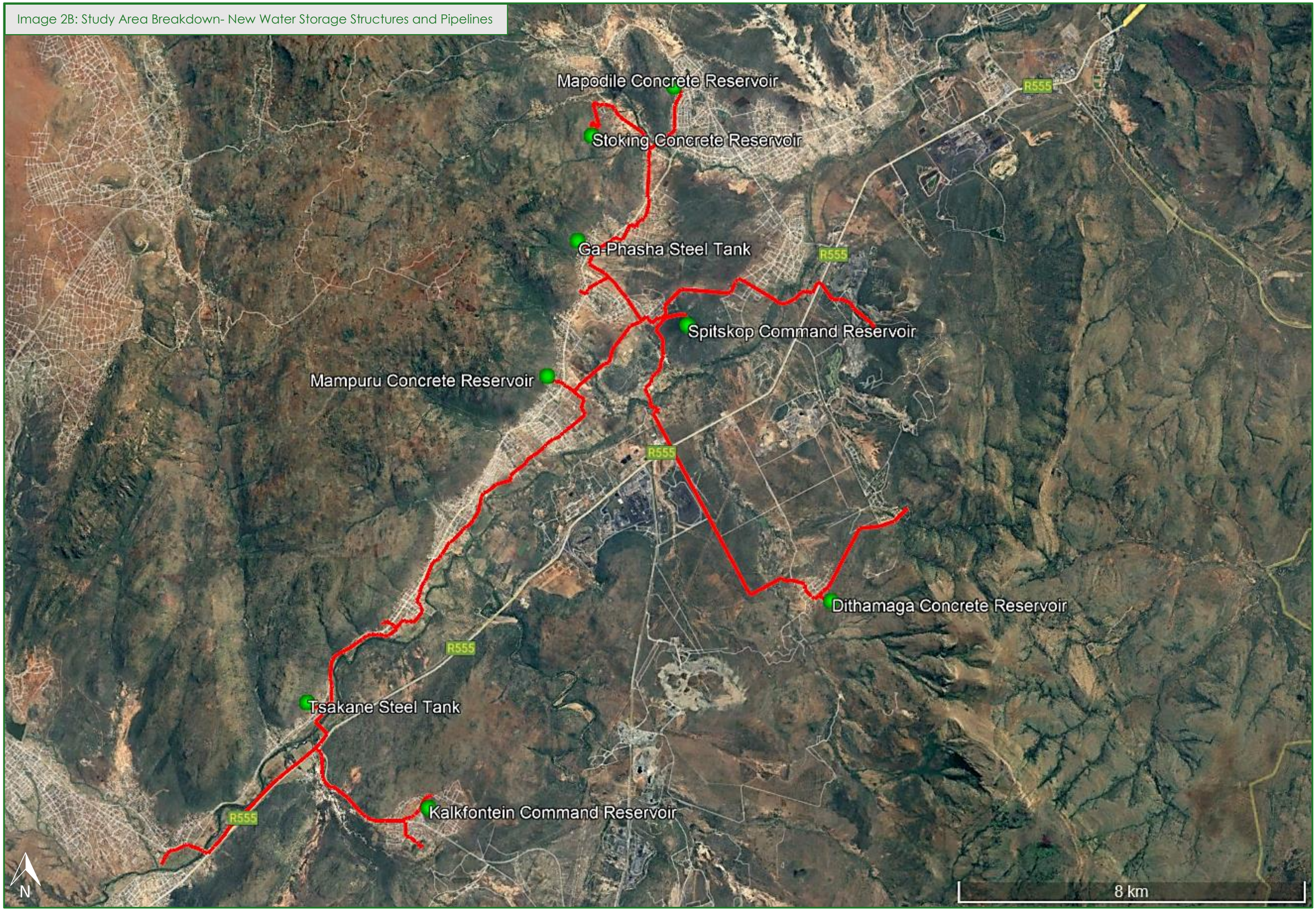


Image 2B: Study Area Breakdown- New Water Storage Structures and Pipelines



3. Regional Geomorphological Setting

3.1. Topographic Overview

Topography is based on elevation profiles from the available remote sensing information and basic field observations. This does not substitute land survey data. Topography and regional hydrology (e.g., steep slopes, very flat slopes, defined drainage features, and rapid changes in slope) affect the distribution of ground as it affects the weathering, erosion, transport, and deposition of materials. As such, it provides a valuable indication of possible changes in subsurface ground and water conditions, but also affects the stability of slopes and the direction of surface runoff.

The regional setting is seen to display a **highly undulating surface morphology,** with a pronounced **mountainous terrain** hosting an assortment of variably shaped ridges, spurs and local koppies, separated by either- or a combination of- deeply incised or wide prominent valley landforms.

Moreover, the study area is seen to fall within the eastern limb of the prominent geological phenomenon known as the **Bushveld Igneous Complex**, which is a large-scale igneous body comprised of multiple sequences of igneous intrusions. The individual cycles of lava generally exhibit their own unique traits including varying rates of cooling, density, chemistry and associated resistance to decomposition- further diversified through younger geological processes and relating stresses, such as local intrusions, faulting and folding. The low-lying areas- between alternating ridges- are frequently filled over time with transported sediments of varying shapes and sizes (quaternary aged sediments).

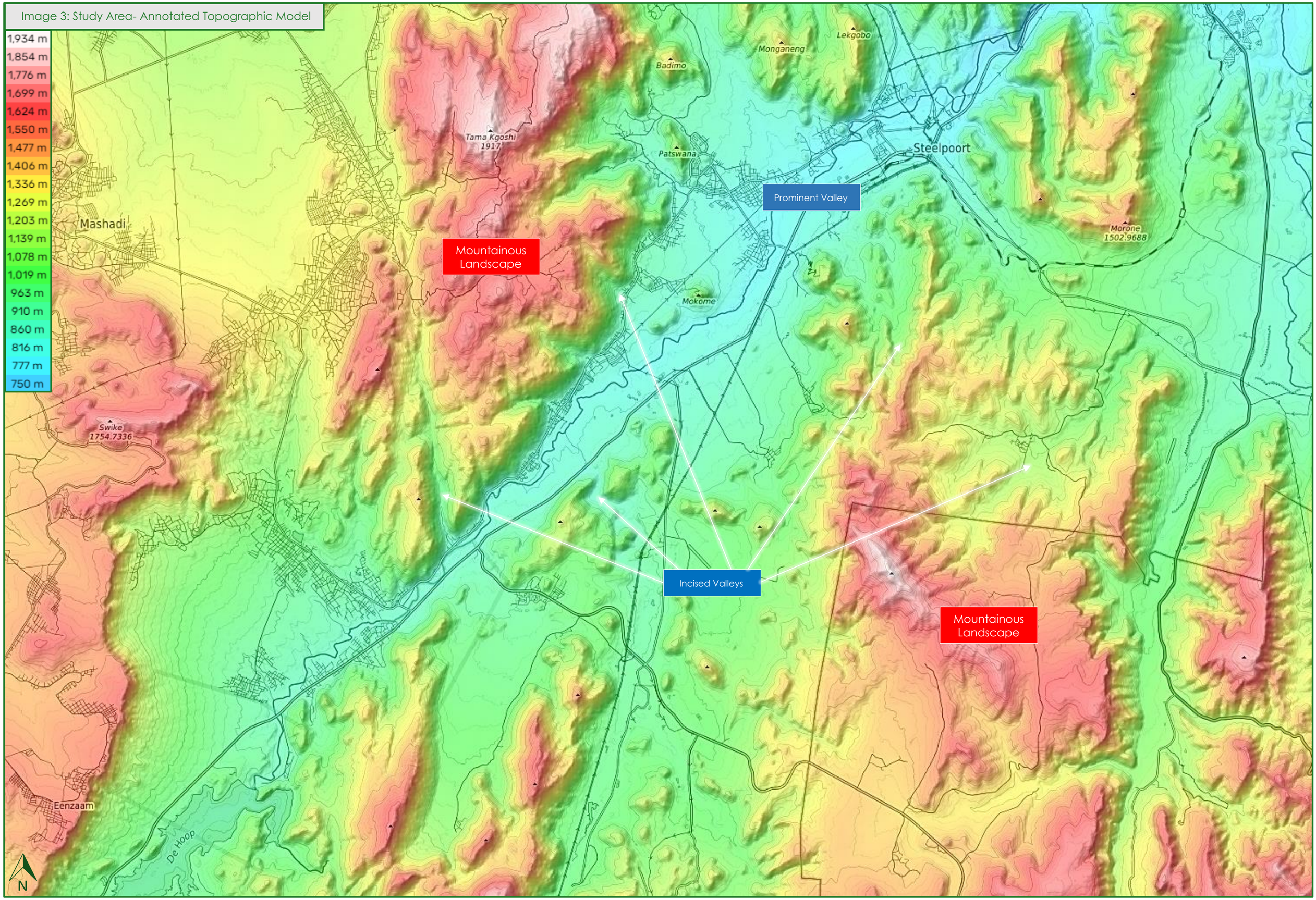
The inherent variability/flaws within the regional lithologies are exposed through erosional processes, with alternating water ways following zones of weakness in the rock mass. The cumulative result of these natural processes has led to the development of a variable landscape, with a sharp contrast in elevation across the study area.

As seen in the annotated topographic map (Image 3 overleaf); the vast majority of the region is dominated by a **mountainous landscape**. This mountainous terrain hosts an accumulation of **variable shaped ridges** (both minor and major), **spurs** and **interlinking saddle landforms** (white, red and orange colours). The immediate side slopes of the various ridges were seen to exhibit a **steep sloping nature**, with the degree of sloping decreasing with an increased distance from their crests. Furthermore, these combined ridges form the **watershed features** for the study area, with the natural slopes **diverging** from their central axes.

Conversely, through the process of **headward erosion**, numerous valley structures have **incised** their way into the high-lying terrain; a few examples of which are pointed out on the image. These incised valleys converge in a dendritic manner upon the **prominent valley landform** which **bisects the study area**. This prominent landform is locally referred to as the **Steelpoort Valley** and is orientated roughly NE/SW. Furthermore, the De Hoop dam is situated within the south western extent of the mapped valley, following which the Steelpoort River meanders its way in a north easterly direction across the study area- confined to the valleys' footprint.

Refer to Image 3 overleaf which graphically depicts the variable topographic nature of the region.

Image 3: Study Area- Annotated Topographic Model



The **complexity** of the study areas' topography is amplified across the mapped mountainous terrain, with a discernible decrease in intricacy with a decrease in surface elevation across the region. Moreover, an **abrupt reduction in declivity** was visible when transitioning from the flanks of the various ridges to the adjoining pediment slopes and finally the extensive basin of the prominent valley landform.

As a result of their primary function, the various **water storage structures** are situated either along the side slopes of the mapped ridges or upon their peaks. For this reason, these targeted sites generally exhibited a notably rocky, **steep to very steep sloping nature**. As a result of these challenging properties, access to- and mobility across- these areas is remarkably challenging, necessitating the design and construction of adequate access roads.

On the contrary, the vast majority of the planned **pipeline routes** traverse the mapped **low-lying terrain**. These portions of the greater study area generally exhibit a **gentle sloping morphology**, with only local variations surrounding anomalies such as stream channels and local ridges.

Additional to the described variable natural landscape- the surface of the study area has been further modified through past and ongoing human activities. These alterations range from large scale mining operations to highly localised small actions such as local infrastructure, dumping etc. The reworking of the surface affects the continuity and degree of natural slopes, impacting its' natural drainage character and resulting in the formation of small-scale anomalies.

3.2. Regional Drainage

The future developments orientation in relation to the natural slopes will impact the rate and associated energy of the overland flow. As a results of the sites complex geomorphological setting, the design and implementation of fit-for-purpose site modification and drainage measures are essential for the stability and longevity of the development.

The drainage nature of the study area will mirror its' topographic nature as described in Section 3.1 of this report. The agglomerate of **ridges** which form the mapped mountainous terrain combine to form the **primary watershed features** for the study area, with the **local spurs and minor ridges** serving as **local divides.**

Steep side slopes: as presented above, the majority of the structures and their access roads are situated along the **steep to very steep** rocky side slopes of the mapped high-lying terrain. Across these areas, the rate of surface water flow is expected to **increase**- with **medium to high energy surface water flow** taking place parallel to the natural slope. Although the catchment area might be limited across some of the sites, medium to high energy channelized flow elevates the risk for erosion and associated instability/scouring/undercutting- especially following the removal of the stabilising vegetation cover.

Gentle slopes: across the low-lying portions of the study area- the natural slopes displayed an overall **gentle sloping nature**. This lowered degree of sloping will result in **low energy surface run-off.** The gentle slopes will aid **surface water infiltration** (where uncompacted natural soils are encountered) into the underlying soils, rather than rapid surface water flow; accentuating **surface water ponding** and **fluctuating moisture conditions** following prolonged precipitation events.

Erosional landforms are prolific across the vast majority of the study area- the shape and extent of which was seen to fluctuate. According to the *Erodibility Potential of Soils in South Africa* map published by the Department of Human Settlements- the site is located within the region of **MEDIUM** (value= 9 to 15) **erodibility potential.** Inadequate erosion/drainage control measures can result in severe damage to infrastructure- both existing and future.

The anthropogenic reworking of the surface across developed portions of the study area will result in local variations of surface water flow- both rate and direction. Topographic anomalies identified/ measured during the professional survey can be addressed individually in the design, and in so doing eliminating their localised effects.

With refence to the Topocadastral Maps 2429 Dd, 2430 Ca and 2430 Cc; scale 1:50 000 (Figure 5)- in combination with the available remote sensing information- **numerous drainage structures** traverse the study area question. The most prominent of these structures is the perennial **Steelpoort River** which meanders its way through the Steelpoort Valley. Furthermore, numerous non-perennial rivers converge from the high-lying areas upon this structure along its voyage to the north east. These secondary drainage structures generally fall within the various incised valley landforms- examples of which are pointed out on Image 3.

These cumulative features are of greater concern across the low-lying portions of the study (i.e. pipeline assessment). Individual occurrences will be highlighted- where applicable- in the site-specific reports to follow.

Across these areas, elevated volumes of surface water flow can be expected following prolonged precipitation events- including elevated degrees of erosion/turbulence and possible localised quicksand conditions. Groundwater flow may occur at shallow depths within- and adjacent to- stream channels. Furthermore, the location, orientation, and nature (stability, undercutting and/or scouring) of these slopes may change periodically because of flooding events.

The flood lines of the mapped drainage structures should be modelled; with the implementation of suitable design measures adhering to the appropriate law of South Africa. Although not favourable, engineering solutions can be applied to these areas to allow for future development- with the actions aligned with the applicable law of South Africa and site specific OHS protocols. Appropriate infrastructure, including scour protection, should be implemented as part of the future developments.

3.3. Regional Climate and Climate Classification

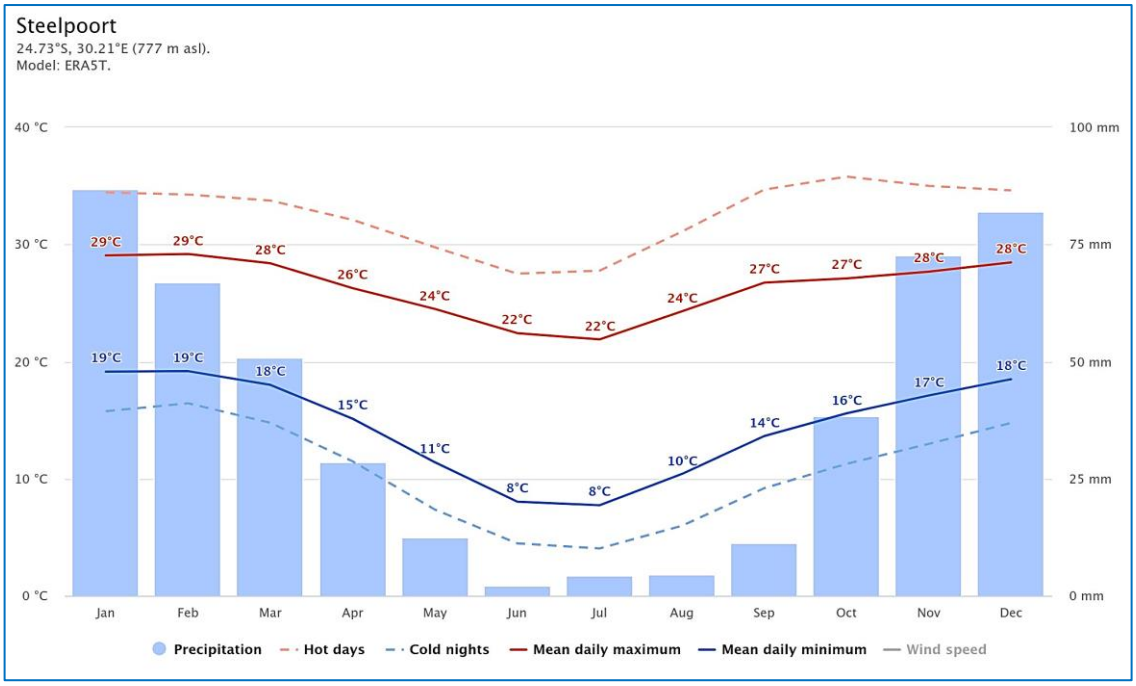
3.3.1. Introduction and Overview

Climate determines the mode and rate of **weathering** of the in-situ materials as well as influences on the **performance** of the asset following construction, including future **maintenance** and **rehabilitation** needs.

Where applicable, the climatic classification systems listed below can be used together with surface temperature indices and the available data on minimum, maximum and mean annual precipitation.

Due to the site's location, it will share the same climatic regime to that of **Steelpoort,** which receives between **600 and 800 mm** of rain per year, with most rainfall occurring during **summer**. Steelpoort receives the lowest rainfall in July and the highest in February. The average midday temperatures for Steelpoort range from ~14°C in June to 24°C in January. The region is the coldest during June when the mercury drops to 5°C on average during the night.

The graphic below depicts the available climatic data for the local setting.



3.3.2. Climate Classification

According to Köppen and Geiger climate classification, the climate is classified as an **Arid Steppe Climate (Bsh/Bsk)** and **Temperate Interior (SANS 204 2).**

Furthermore, the effect of climate on the weathering process (i.e., soil formation) is determined by the **climatic N value** defined by Weinert, 1980. The N-value is calculated as 12 times the January evaporation divided by the annual precipitation and indicates whether an area is predominantly moisture-surplus (N < 5) or moisture-deficit (N > 5).

The **Climatic N-Value** for the area is deemed to be **between 2 and 3**; therefore, **chemical disintegration** of the parent rocks in the regional setting is deemed the principal mode of weathering. This mode of weathering promotes the breakdown of the primary minerals within the parent rock results in the formation of secondary minerals such as clays and sesquioxide's. Consequently, the climatic region favours the development of **fine-grained soils**, rather than an abundance of rocky fragments. Physical/mechanical weathering of the parent rock will take place but on a lower scale.

According to the **Peltier Diagram** (Peltier, 1950), according to average temperature and rainfall stats for Steelpoort, the site within the ***moderate chemical weathering*** category.

Lastly, according to the **Thornthwaite's Moisture Index** the area falls within the *moist sub-humid climatic zone* with moderate rainfall or strong seasonal rainfall, with an overall moisture index of generally $0 < I_m < 20$. These areas all have a small water surplus. This zone is commonly referred to as a **moderate climate**.

3.4. Regional Vegetation and Biotic Activity

The study area is located within the **Central Bushveld Bioregion** of the **Savanna Biome** (Mucina and Rutherford, 2006). This biome is characterised by a grassy ground layer and a distinct upper layer of woody plants. Grasses, shrubs and trees that grow in the savanna have adapted to life with little water and extreme temperatures, and the seasons dictate how each habitat responds to these changes. In years where there is sufficient summer rain, the grasses flourish before turning brown in the dry winter months. After rain, the shrubs and trees flower and some of the bare trees sprout leaves again.

Within and immediately surrounding the **villages** across the study area the **natural vegetation** had been **denuded/altered** to a degree as a result of past and ongoing human activities in the region, specifically relating to township establishment. The resultant vegetation across these developed areas generally includes a sparse grass cover and scattered trees/bushes of varying sizes (both natural and self-sown). Areas subject to high traffic volumes have been scarred- leaving behind bare topsoils.

Conversely, at the time of this investigation, the vegetation across the **undeveloped areas** was moderately dense to dense. Furthermore, although notably rocky, the flanks of the various ridges which form the focal point of the assessments for the various structures and access roads were universally vegetated- hosting grasses, shrubs and varying sized trees. Generally attributed to the occurrence of deeper profiles, large to very large trees were characteristically limited to the low-lying areas.

Many structures are likely to be near trees during their useful life. In some situations, trees can adversely affect structures and induce damage. All trees should be regarded as a potential source of damage. The greatest risk of direct damage occurs close to the tree from the growth of the main trunk and roots and diminishes rapidly with distance. Where adequate distances are not observed, precautions, such as the reinforcement of foundations to resist lateral thrusts/bridging over of roots to allow for future growth, should be adopted.

Where required, the natural vegetation needs to be modified in the early stages of the construction to aid access/terrain mobility. The degree of organic material and biotic activity is expected to decrease with an increase in depth. Varying degrees of decomposed organic matter can be expected at depth across the various sites/pipeline routes, with the decomposition of the organic material resulting in a reduction of volume and the formation of voids.

Moreover, extensive sub-surface vegetation is predicted to occur in areas hosting trees; however, the extent of these root zones is predicted to diminish with an increased distance from the trunk.

The effects of the removal of trees on sites should also be considered, particularly where trees have depressed the water table over a period of time. The removal of large trees can result in the formation of highly **compressible zones** of voided soils and **elevated shallow ground water tables** and may impact **existing slope stability**. Such areas should be treated as zones of possible risk and should be dealt with accordingly in the design.

Many of the medium sized to large flora may be endangered- in which case removal may not be a viable option. This should be kept in mind when defining the location of the future structure. A competent professional- such as a botanist or environmental scientist- can assess the sensitivity of the natural vegetation if required and provide suitable mitigation measures. This attribute is applicable to all greenfield developments in the area.

Lastly, localised biological nests and/or tunnels were encountered across the undeveloped portions of the study area. Although present, it is envisaged that the majority of naturally occurring wildlife has vacated the area due to the significant human presence in the region and related activities (i.e., hunting, deforestation, livestock grazing).

The exact depth of the biological tunnelling is not known, with individual features varying in sizes. Termiticide treatment/pest control can be considered by the design team within the guidelines of the local environmental legislation.

4. Regional Geological Information

4.1. Introduction

The regional geology provides geological context to the anticipated distribution of geological material and how these can affect the distribution of lithologies (rock types) with different chemical, mineralogical, structural, and mechanical properties. Bedrock refers to the rock directly underlying the site and, when exposed to surface, is referred to as outcrop. Bedrock can be underlain by other rock types at shallow depths, and it is usually overlain by residual soils derived of its in-situ weathering and transported soils deposited from other positions.

4.2. Regional Stratigraphic Setting

4.2.1. Geological Sheet 2430 Pilgrim's Rest

According to the available geological information (geological series map: 2430 Pilgrim's Rest); the cumulative study area is underlain by the following geological units (Figure 2):

Young Unconsolidated materials (Quaternary Age)

"Q"- Surficial deposits including **alluvium** and **scree**

Localised Igneous Intrusions (Jurassic Age)

"Jd"- Fine grained dolerite, commonly porphyritic, amygdaloidal in places

Intrusive Rocks Associated with the Rustenburg Layered Suite- Bushveld Complex

"Vr"- Medium- to coarse-grained **magnetite**, localised magnetite layer- *Roossenekal Subsuite*.

"Vdj"- Coarse-grained **gabbro and anorthosite** with localised anorthosite layers, pyroxenite and magnetite plug- *Dsjate Subsuite*.

"Vdr"- Medium-to coarse-grained **norite and anorthosite** (upper part), medium- to coarse-grained pyroxenite (lower-part), localised Merensky Reef, chromitite layer, and pyroxenite layer- *Dwars River Subsuite*.

"Vcr"- Medium- to coarse-grained **pyroxenite** and feldspathic pyroxenite- *Croydon Subsuite*.

"Vsn"- Fine- to medium-grained **norite; pyroxenite**- *Shelter Norite*.

Localised Igneous Intrusions (Vaalian Age)

"Vdi"- Green, fine- to medium-grained diabase.

Sedimentary Rocks of the Pretoria Group- Transvaal Supergroup

"Vs" Undifferentiated lithologies comprised of the Lydenburg, Machadodorp, and Boven members- Silverton Formation of the Pretoria Group

"Vsq"- Clean, fine- to medium-grained quartzite with less pure, purple sandstone and shale with quartz clasts and thin conglomerate layers- Steenkampsberg Formation of the Pretoria Group.

4.2.2. Quaternary Sediments- Colluvium and Alluvium

Quaternary sediment deposits are extensive throughout the study area- the prevalence of which can be linked to the region's geomorphology.

The predominant sediment deposits within the region are seen to comprise of transported material of a **colluvial origin-** mapped on the available geological sheet as scree. Furthermore, **alluvial** deposits can be expected within- and immediately adjacent to- **stream channels** and associated **flood plains** confined to the low-lying areas between the prolific mountainous terrain.

These combined materials have been transported by natural agents during relatively recent geological times and have not undergone lithification into a sedimentary rock. Furthermore, due to their age and shallow occurrence- these deposits may lack essential pre-consolidation characteristics. This may result in additional movement upon saturation and loading.

Alluvium

Alluvium is a general name for sediments which have been deposited by river and stream systems during different depositional times. The properties of the alluvium can vary substantially and are dependent on three dominant factors, including- the geology within the catchment area, the depositional nature of the river system, as well the competence of the river (Chapter 8, Brink, 1979).

Colluvium

Colluvium is a general name for unconsolidated sediments that have been deposited along or at the base of slopes by either rain wash, sheetwash and/or slow downslope creep. Moreover, the colluvial sediments were present as two distinct horizons across the investigated area, namely, **coarse colluvium** and finer **transported sediments** referred to as **fine colluvium** across the study area.

The **coarse colluvium-** also referred to as scree/talus- is dominated by **gravel** to **boulder-sized particles**. These large particles require significant amounts of energy to be transported and are therefore frequently found close to their original source (i.e., local ridges).

Coarse colluvium can generally be found along the side slopes of mountains. Due to the limited distance of transportation, these deposits have not been substantially altered during the erosional process and typically exhibit engineering characteristics **similar** to the **local residual soils/weathered rock**.

As the depositional energy gradually decreases with distance, the particles that can be transported **steadily reduce in size**- to the point where the material transitions to what was deemed to be "fine colluvium".

The profiled **fine colluvium** consists of comparatively **finer material** dominated by **sand-sized particles**. The fine particles that make up these deposits require less energy to be displaced and can therefore be transported greater distances from their original source. As a result of this, these gravity-transported sediments may be frequently found throughout the study area, at great distances from any mountainous areas. During transportation, significant natural modification may occur resulting in considerable changes in engineering characteristics.

4.2.3. Rustenburg Layered Suite- Bushveld Igneous Complex

Background

The study is predominantly mapped to be underlain by the various igneous intrusions which combine to for the eastern limb of the Bushveld Igneous Complex (BIC).

The mafic rocks of the BIC constitute the largest preserved mafic layered intrusion in the world and underly an area of approximately 65000 km^2 with a maximum measure thickness of approaching 8 km (Johnson et al., 2006). Large magma bodies which have intruded into the Earth's crust are generally referred to as plutons or batholiths with the Bushveld Igneous Complex representing one of the largest and best-preserved magmatic bodies in the world. Due to varying magma cooling rates below the surface of the earth, the mineral crystals grow at changing rates, resulting in a variable texture- generally ranging from medium- to coarse- grained.

The Bushveld Complex hosts the words largest ore reserves of chromium, vanadium, and platinum group elements which has been the subject of prolific past and on-going mining activities.

The BIC is subdivided into 4 currently accepted divisions, felsic rocks associated with the BIC, known as the **Rooiberg Group, Rashoop Granophyre Suite**, **Lebowa Granite Suite** as well as a layered mafic/ultra mafic intrusion known as the **Rustenburg Layered Suite**.

With respect to the study area, the local setting generally consists of mafic rocks forming the 200 km long **eastern limb** of the **Rustenburg Layered Suite (RLS),** extending from Stofberg to Chuniespoort. The layered suite is predicted to have formed by a number of magma injections. However, estimates relating to the number and composition of these injections are unresolved.

Although, the Rustenburg Layered Suite can be further subdivided into 5 main zones, the majority of lithologies across the study area are associated with the **Dwars Rivier Subsuite** of the Critical Zone and the **Dsjate Subsuite** of the Main Zone. Lastly, the study area was seen to host pockets of older sedimentary rocks associated the Pretoria Group. Some of these sediments have undergone varying amounts of deformation and metamorphism as a result of the intrusion of the bushveld complex.

Igneous Rocks of the Rustenburg Layered Suite

The majority of lithologies associated with the Rustenburg Layered Suite exhibit a similar physical appearance. However, as a whole, the rocks of the RLS display considerable variation in texture, ranging from medium-to very coarse grained, as well as variation in colour and mineralogical composition.

Some of the common rock types are further described below to highlight notable difference/similarities where applicable.

Gabbro is a coarse grained, mafic, intrusive igneous rock characterised by a salt-and-pepper appearance in hand-specimen. The translucent or "salt-coloured" crystals are generally comprised of calcium-rich plagioclase minerals with the "pepper-coloured" portions of the rock mass mostly comprised of the dark minerals clinopyroxene and olivine. The rock is chemically similar to basalt with both rocks crystalising from iron and magnesium rich magma. However, the fast rate of cooling of basalt results in a fine-grained nature and dark/black appearance.

Norite is a coarse grained, mafic, intrusive igneous rock with an identical appearance to that of gabbro and is also sometimes referred to as orthopyroxene-gabbro. The rock consists of calcium-rich plagioclase and olivine with the main difference to gabbro being the incorporation of orthopyroxene instead of clinopyroxene. Due to this minor difference, gabbro and norite are virtually indistinguishable in hand specimen and are typically referred to as **gabbronorite** where they occur in the same local setting. Accurate identification of these rocks requires petrographic analysis under a microscope or advanced chemical evaluation in a laboratory.

Anorthosite is a coarse grained, intrusive igneous rock characterised by its feldspar-rich composition. Due to the limited amount of mafic minerals (iron and magnesium rich minerals characterised by a dark colour) the rock typically displays a lighter colour, generally described as grey. Moreover, the specific type of felspar forming the majority of the rock is known as plagioclase feldspar which can vary in composition from calcium to sodium rich. However, in anorthosite the plagioclase is predominantly calcium rich.

Pyroxenite is an ultra-mafic (very dark coloured) igneous rock consisting predominantly of pyroxene group minerals such as augite, diopside, and hypersthene. Pyroxenite typically occurs in terrains dominated by gabbronorite and is generally distinguishable from these rocks by the absence of felspar. The rock is generally coarse grained and regularly occurs with accessory minerals such as chromite, magnetite, and garnet.

Magnetite is a black coloured mineral characterised by its ferromagnetic properties and is one of the main iron ores.

Residual Soil Properties

Several distinct soil profiles have been identified beneath different landforms on the Rustenburg Layered Suite- the most problematic of which are heaving black clays (Brink, 1979). The ultra mafic/mafic rocks of which the RLS predominantly consists of contain minerals rich in iron and magnesium which form at high temperatures. These minerals are less stable at surficial atmospheric conditions and are susceptible to decomposition into fine grained soils of high plasticity and heave potential under favourable climatic conditions for chemical reactions to occur (high rainfall areas). Conversely, for a low degree of chemical weathering (low to moderate rainfall area), the residual soils may comprise of gravel/cobbles within a matrix of silt and clay.

A common characteristic of igneous bodies is the development of cooling joints, which develop as the rock contracts during cooling. These discontinuities are relatively prominent throughout the rock mass and subdivide it into a number of intact rock blocks. The subsequent weathering of such a rock mass is focussed on the exposed sides of these rock blocks.

When the rock mass weathers below the surface, the result is the development of **large rock/boulder inclusions** suspended in a **fine-grained soil matrix;** commonly known as **corestones**. Corestones negatively affect the continuity in the excavatability of the residual material and can result in an increased degree of differential settlement for foundations.

Rock Properties- Gabbronorite

The mechanical properties of a rock mass are dependant not only on the properties of the intact rock (Uniaxial Compressive Strength etc.) but also on the properties of the discontinuities (spacing, orientation, continuity, etc.).

The various intact rock and discontinuity properties will each have their own impact on the overall geotechnical properties of the rock mass, such as the permeability and strength.

Ideally the assessment of the underlying rock mass would be undertaken through the implementation of a rotary core drilling regime- with associated rock core logging, photography, sampling and lab testing on the cores (physical and chemical attributes).

Based on the available theoretical data, the fresh igneous rock masses which underlie the study area **display favourable strength characteristics** with regards to the construction of the planned water storage structures.

Refer to Table 2 below which depicts the rock classification by uniaxial compressive strength as presented by De Vallejo, L.G. and Ferrer, M., 2011. In Table 3 overleaf, the strength and deformation properties of **norite** are presented as an example.

Table 2: Rock Classification by Uniaxial Compressive Strength (extract)

Table 3.10 **ROCK CLASSIFICATION BY UNIAXIAL COMPRESSIVE STRENGTH (UCS)**

Uniaxial compressive strength (MPa)	ISRM (1981)	BS 5939 (1999)	Bieniawski (1973)	Examples
<1	Soils			
<1.25	Very weak	Very weak	Very low	Salt, mudstone, silt, marl, tuff, coal
1.25–5		Weak		
5–12.5	Weak	Moderately weak		
12.5–25		Moderately strong		
25–50	Moderately strong		Low	Schist, shale
50–100	Strong	Strong	Medium	Schistose metamorphic rocks, marble, granite, gneiss, sandstone, porous limestone
100–200	Very strong	Very strong	High	Hard igneous and metamorphic rocks, highly cemented sandstone, limestone, dolomite
>200		Extremely strong	Very high	Quartzite, gabbro, basalt
>250	Extremely strong			

Table 3: Strength and Deformation Properties of Norite- Presented in Brink Vol 1 1979

Locality Stone quarry: Belfast district depth: Sample (1) 7,6 m (tested 1966) Sample (2) (tested 1970)	Sample	σ_1/σ_3 ratio	Strength MPa	Number of specimens tested	Standard deviation
	(1)	38,20	479	3	1,63
	(2)	36,60	507	3	2,30
Triaxial compressive	(1)	13,34	771	3	1,71
strength	(2)	20,10	684	3	0,90
	(1)	9,19	993	3	1,53
	(2)	12,90	912	3	2,10
Uniaxial compressive strength	(1)	∞	307	6	0,31
	(2)	∞	277	6	1,60
Uniaxial tensile strength	(1)	−∞	18,4	3	2,10
	(2)	−∞	16,8	3	8,40

Density kg/m³	(1)	2 950	Modulus of elasticity: GPa	(1)	103
	(2)	2 940		(2)	98
Porosity	(1)	0,3%			
	(2)	0,3%			
Moisture	(1)	0,07%	Poisson's ratio	(1)	0,23
content	(2)	0,07%		(2)	0,25

The orientation of the applied load relative to the rock fabric/structure will result in variations in intact rock strength. Rock structure/fabric such as bedding planes in sedimentary rocks, colling joints in igneous rocks and metamorphic banding in gneiss, generally represent pre-existing planes/zones of weakness within the intact rock mass. Loading perpendicular to these inherent features typically results in higher strength estimates while loading parallel to these structures result in reduced strength as the rock mass fails along the pre-existing weaker planes.

Use in Construction and Similar Attributes- Gabbronorite

Fresh/Unweathered gabbro-norite has been widely used in the building industry as natural building stone or coarse aggregate for concrete. When quarried for building stone these rocks have been referred to as "black granite" or "blue granite". Brink (1979) noted that the crushed rock performs brilliantly as base-coarse material in road construction and aggregate in bituminous carpets.

Furthermore, the high relative density of the aggregate is prone to cause segregation and bleeding of the concrete mix. Moreover, the concrete/coarse aggregate/crusher sand derived from the rock is often harsh and difficult to place.

Tables 4 to 6 to follow cover theoretical attributes for the local rock masses, including concrete aggregate properties, ripper performance and typical lab results for these materials relating to road construction.

Table 4: Concrete Aggregate Properties of Gabbro/Norite (After Davis et al, 1978 presented in Brink Vol 1, 1979)

Engineering parameters		Specific gravity	Loose bulk density of coarse aggregate (kg/m³)	Loose bulk density of fine aggregate (kg/m³)	Mortar shrinkage %
Maximum	x_M	3,04	1 470	1 690	0,048
Minimum	x_m	2,81	1 420	1 530	0,041*
Mean	$\bar{x}$	2,94	1 430	1 620	0,044
Number of test data	n	27	23	10	4
Standard deviation	s	0,058	13,16	51,95	0,003
Coefficient of variation	$\frac{s}{\bar{x}}$	0,020	0,009	0,032	0,068

Table 5: Ripper performance relative to seismic wave velocity through some soils and rocks (D9 type Ripper)- Adapted from Weaver, 1975 (TRH 18, 1993)

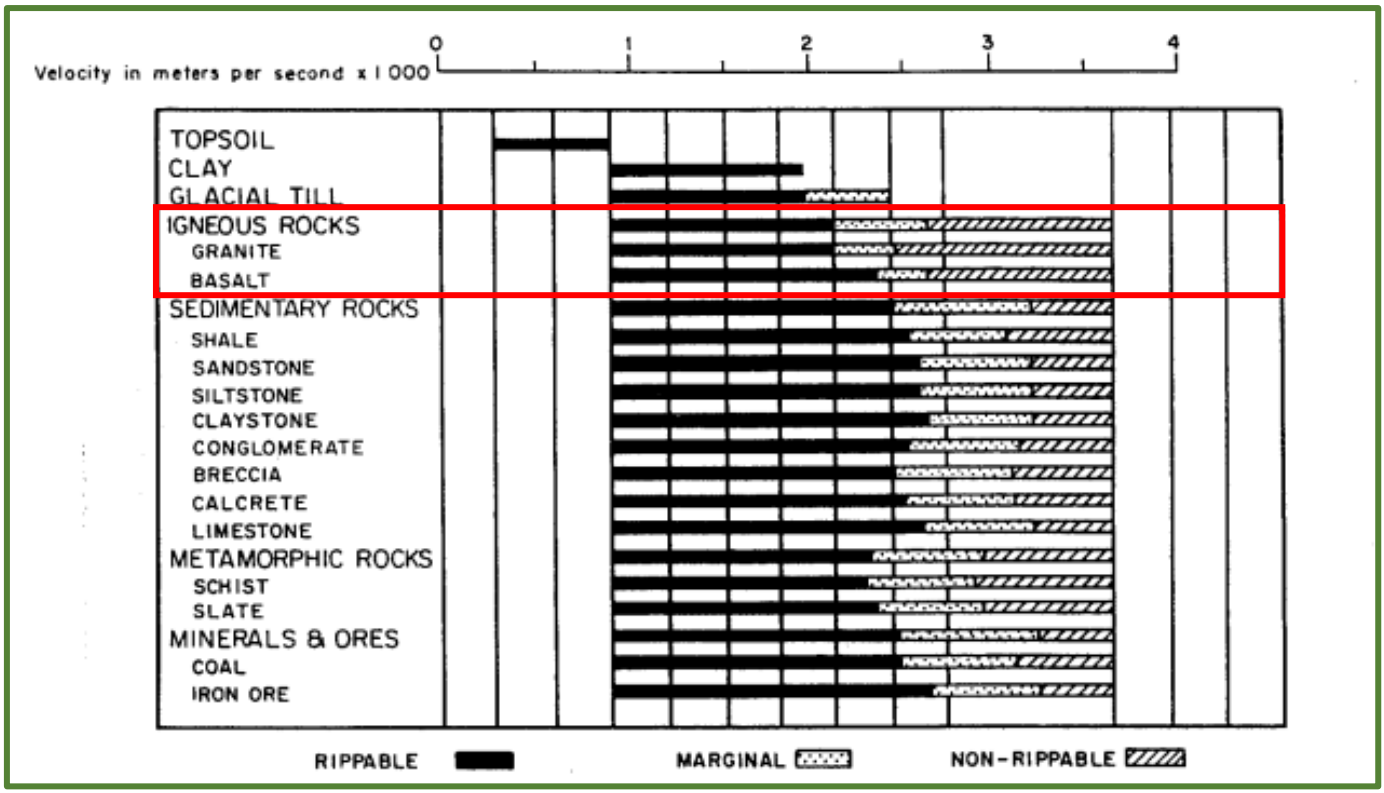


Table 6: Typical Laboratory Test Results of Basic Igneous Rocks for use in Roads (Green, 2007)

Property	Mean	Standard deviation	Maximum	Min
Mineralogical testing				
Smectite content (X-Ray diffraction) (%)	8.833	6.41	21	0
Smectite (petrographic) (%)	6.750	4.97	14	0
Secondary mineral (petrographic) (%)	10.583	9.09	31	0
Abrasion tests				
Los Angeles Abrasion (%)	13.267	5.31	25.1	5.2
Aggregate durability index (coarse and fine)	26.7	17.27	48	10
Durability Mill Index	21.5	50.52	172.7	0
Maximum percentage passing 0.425 mm	14.1	6.82	27.6	2.3
Water Absorption and relative density				
Water absorption (+4.75 mm fraction) (%)	1.796	1.11	4.400	0.399
Water absorption (-4.75 mm fraction) (%)	2.473	1.35	4.309	0.305
Weighted Apparent Relative Density (ARD)	2.944	0.04	2.991	2.860
Weighted Bulk Relative Density (BRD)	2.792	0.09	2.951	2.639
Glycol testing				
Glycol durability index (aggregate)	4.500	2.68	8	1
Glycol index (core)	1.833	1.99	7	1
Modified SATS glycol index	11.7	13.37	35	0
Aggregate Crushing Value (ACV) (%)				
dry	11.3	3.89	19.4	5.3
wet	13.7	4.43	20.3	6.8
4 day glycol soaked	18.4	9.63	34.7	5.6
10%FACT (kN)				
dry	385	100.20	595	236
wet	306	113.58	595	182
24 hour glycol soaked	313	169.59	675	130
4 day glycol soaked	261	181.26	580	0
wet/dry ratio	0.78	0.11	1.00	0.66
4day glycol soaked minus wet				
Aggregate Impact Value (%)				
dry	13.5	3.45	20.6	9.8
wet	14.6	4.53	24.1	8.5
24 hour glycol soaked	15.0	4.74	22.7	8.2
4 day glycol soaked	18.7	10.22	42.8	8.6
7 day glycol soaked	19.9	10.98	45.3	7.9
wet/dry ratio	1.071	0.14	1.31	0.87
4 day glycol soaked minus wet	4.13	9.20	28.1	-4
Mod AIV (%)				
dry	15.6	4.47	24.9	10.9
wet	17.0	5.99	29.9	9.4
24 hour glycol soaked	17.6	6.19	27.9	9.0
4 day glycol soaked	23.1	14.90	60.1	9.5
7 day glycol soaked	24.9	16.12	64.5	8.6
wet/dry ratio	1.08	0.16	1.35	0.86
4 day glycol soaked minus wet	6.12	13.76	43.0	-4.9

4.3. Prominent Geological Structures

Regional maps indicate a **complex geological environment** consisting of multiple lithologies of igneous rock and their associated **contacts** as well as the sporadic occurrence **diabase dykes.** These intrusions are mapped with a general **NNE/SSW orientation**. The localised presence of igneous intrusions can lead to the formation of micro-structures which could traverse the site i.e., feeder dykes and hydrothermal veins.

Furthermore, relevant geological maps indicates that the local area is **highly faulted** with various inferred lineaments and minor fault lines. The orientation of these geological features is variable, with the most prominent of which mapped to bisect the study area- following the general alignment of the major valley. Due to the great age of these features, they are deemed **geologically stable**.

These combined structures can affect the geotechnical properties of the in-situ bedrock at depth. Due to the shallow excavations across the study area, in conjunction with the existing soil cover; these geological features were not modelled in detail. It is recommended that the nature, stability, and extent of these structures should be investigated for sensitive structures.

4.4. Mineral Deposits

The Bushveld Complex hosts the words largest ore reserves of chromium, vanadium, and platinum group elements which has been the subject of prolific past and on-going mining activities.

According to the geological maps and accompanied explanation mineral deposits are present across the region. The exact extent, nature and depth of underground and surface mining operations across the study area is not known. Information of this nature can be acquired from the local mining houses where applicable. Ongoing mining (drill and blast operations) and the local movement of heavy earth moving equipment may induce additional vibrations, which could result in possible instabilities.

As a side note to the mining operations; due to its hard nature and stable chemistry- **slag** is typically a competent **construction material**- suitable for the use in gabions, reno mattresses and engineered fills.

4.5. Dolomitic Land and Sinkhole Formation

Information received from the Council for Geosciences and the available regional geological sheets indicate that the site is <u>not</u> characterised by soluble rocks such as dolomite or limestone. Therefore, the study area does <u>not</u> reflect any risk for the formation of sinkholes or subsidence's caused by the presence of water-soluble rocks, and as such is **<u>not</u> deemed "*dolomitic land*".**

4.6. Seismic Risk

The peak ground acceleration is the maximum acceleration of the ground shaking during an earthquake. According to **Kijko et al (2003)** the regional seismic hazard in the project area can be defined as **LOW**, exhibiting a 10% probability of a seismic event with a peak ground acceleration of **less than 100 cm/s²** within a period of 50 years.

4.7. Liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking/seismic activity or other rapid loading. Liquefaction occurs when loose, cohesionless, water- saturated soils (generally fine-grained sand and silt) are subject to strong seismic ground motion of significant duration. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. These soils essentially behave similar to liquids, losing much of its shear strength.

Liquefaction more often occurs in earthquake prone areas underlain by young sandy sediments where the groundwater table is less than 15 m below the existing ground surface.

According to the *Liquefaction Hazard Map of South Africa* map published by the Department of Human Settlements- the region is not located within a potential liquefaction zone.

4.8. Cemetery Sites

Across the planned water storage sites, o mounds, suggestive of semi-formal graves, or burial sites were observed during the site investigation. Along the routes of the various access roads and pipelines- the risk of this occurring is greatly increased attributed to the position of these structures in relation to the existing villages. The full length of this routes should be examined by an expert, such as an archaeologist, and/or anthropologist in the light of the potential socioenvironmental impact of these sites needing to be moved or protected.

4.9. Palaeontology

Assessment of the palaeontology of the project area is not within the scope of this study. Detailed pre-construction recording and collection within the proposed development footprint should be undertaken by a professional palaeontologist.

5. Regional Hydrogeological Setting

The findings of a detailed hydrological survey- conducted by a competent specialist- overwrites the information presented below (where applicable). No site-specific hydraulic conductivity tests or borehole searches were undertaken, for this reason, the static rest level and chemistry of the ground water cannot be discussed. Based on the SADC Groundwater Information Portal, there are a large number of boreholes across the greater study area. If required, a detailed hydro census can be conducted to determine/model the permanent ground water table depth, location and quality underlying the study area.

5.1. Hydrogeological Information Sheet and Brochure

5.1.1. Introduction

Hydrogeological regions are areas in which the properties of sub-surface water, or groundwater, are broadly similar in geology, climate and topography. Hydrogeology is the branch of geology that deals with the distribution and movement of water beneath the earth's surface. The sections to follow are extracted from the available hydrogeological information sheet for the area- in this case 2330 Phalaborwa 1998- and accompanying explanation brochure presented by *W.H. du Toit and M van Lelyveld (2014)*.

5.1.2. Inter-granular and Fractured Aquifers

According to the available hydrogeological information (2330 Phalaborwa (1998)); the study area is underlain by **Inter-granular and Fractured Aquifers** of moderate yield with **moderate potential (d3/d4)** as a result of extensive chemical weathering of the relatively flat areas of Pre-Cambrian rocks.

The bedrock underlying the study area at depth represents an intergranular and fractured aquifer where groundwater rest level occurs within fractures and in-between the individual grains of the bedrock at depth. Intergranular interstices are secondary of nature. Enhanced groundwater recharge, and related localized seepage, may occur within the fractured bedrock surrounding geological features (e.g.: geological contacts, dyke intrusions and/or faults).

Across the region, ground water occurs in saturated unconsolidated alluvial sediments lining stream channels, basins of weathering in crystalline rocks and along the fractured transitional zone between weathered and unweathered rock.

Regions of higher rainfall having better quality water than areas of lower rainfall. This would imply that poorer quality groundwater is stagnant and gradually increases in salinity, while areas with better quality groundwater are more regularly recharged. The ground water **quality** is deemed to be between **70 and 300 mS/m** and **N**(NO_3 + NO_2)**> 10 mg/l**. The most probable source of high nitrates is from pit latrines in informal settlements as well as agricultural activities.

According to the available map, large scale groundwater abstraction does **not** occur across the study area.

Refer to the map extract at the end of this section which depicts the median borehole yield across the map regional area as well as the mapped aquifer types (*W.H. du Toit and M van Lelyveld (2014)*).

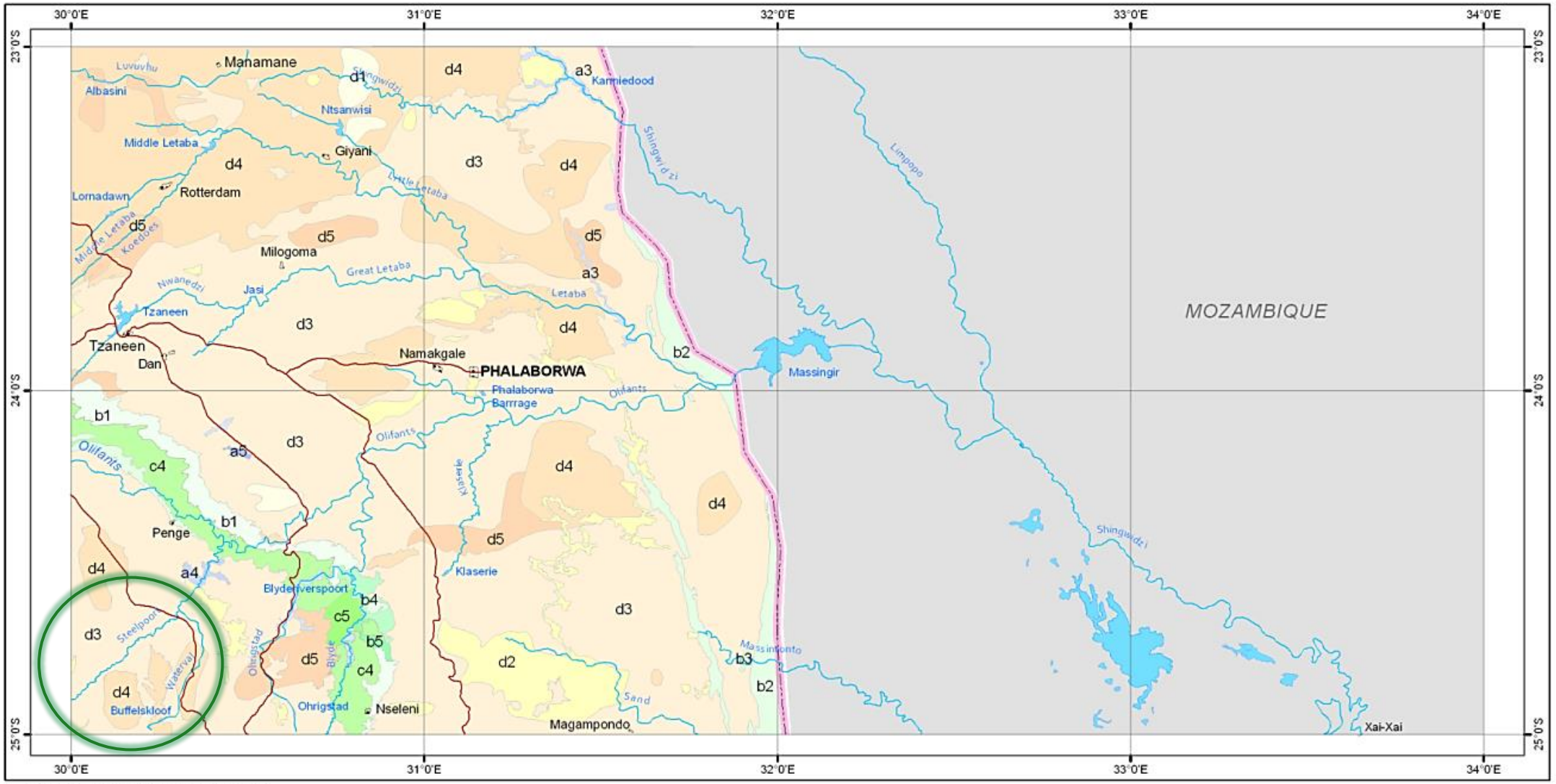
5.1.3. Rustenburg Suite

As discussed in detail in Section 4 of this report, the Rustenburg Layered Suite consists mainly of mafic rocks including norite, gabbro, magnetite gabbro, anorthosite, pyroxenite and others.

The groundwater potential is generally good with water occurring mainly in deeply weathered and fractured mafic rocks. Due to the relative high permeability of the weathered and fractured rock, these basins can be good aquifers. Problems have been experienced in some of the mines outside the map area where large volumes of water are intercepted in fractured anorthosite depths of 300m. Water is also obtained in fault and associated shear or fracture zones, contact zones and dyke contacts.

The borehole yield analysis reveals that approximately 27% of 119 boreholes documented yield between 2 - 5 ℓ/s, 26% yield between 0.5 - 2 ℓ/s, 23% between 0.1 - 0.5 ℓ/s, and 15% are stronger than 5 ℓ/s. The median borehole yield is 1.0 ℓ/s and the maximum encountered was 25 ℓ/s.

Furthermore, the water within this unit is not suitable for domestic use due to the average nitrate level being above the maximum allowable limit for potable water. The water displays a magnesium-bicarbonate-chloride character and appears to be slightly alkaline.



Groundwater Occurrence

Intergranular

a3	Intergranular 0.5 - 2.0 l/s
a4	Intergranular 2.0 - 5.0 l/s
a5	Intergranular > 5.0 l/s

Fractured

b1	Fractured 0.0 - 0.1 l/s
b2	Fractured 0.1 - 0.5 l/s
b3	Fractured 0.5 - 2.0 l/s
b4	Fractured 2.0 - 5.0 l/s
b5	Fractured > 5.0 l/s

Karst

c4	Karst 2.0 - 5.0 l/s
c5	Karst > 5.0 l/s

Intergranular and Fractured

d1	Intergranular and Fractured 0.0 - 0.1 l/s
d2	Intergranular and Fractured 0.1 - 0.5 l/s
d3	Intergranular and Fractured 0.5 - 2.0 l/s
d4	Intergranular and Fractured 2.0 - 5.0 l/s
d5	Intergranular and Fractured > 5.0 l/s

5.2. Groundwater and Shallow Seepage

Without knowledge on the depth to <u>permanent</u> groundwater in the region- it is not possible to comment on the occurrence of permanent groundwater flow within/below the subsurface of the site. Furthermore, the natural seepage and ground water flow characteristics of the area have been modified/altered to varying degrees as a result anthropogenic processes across the site and surrounding developments upslope.

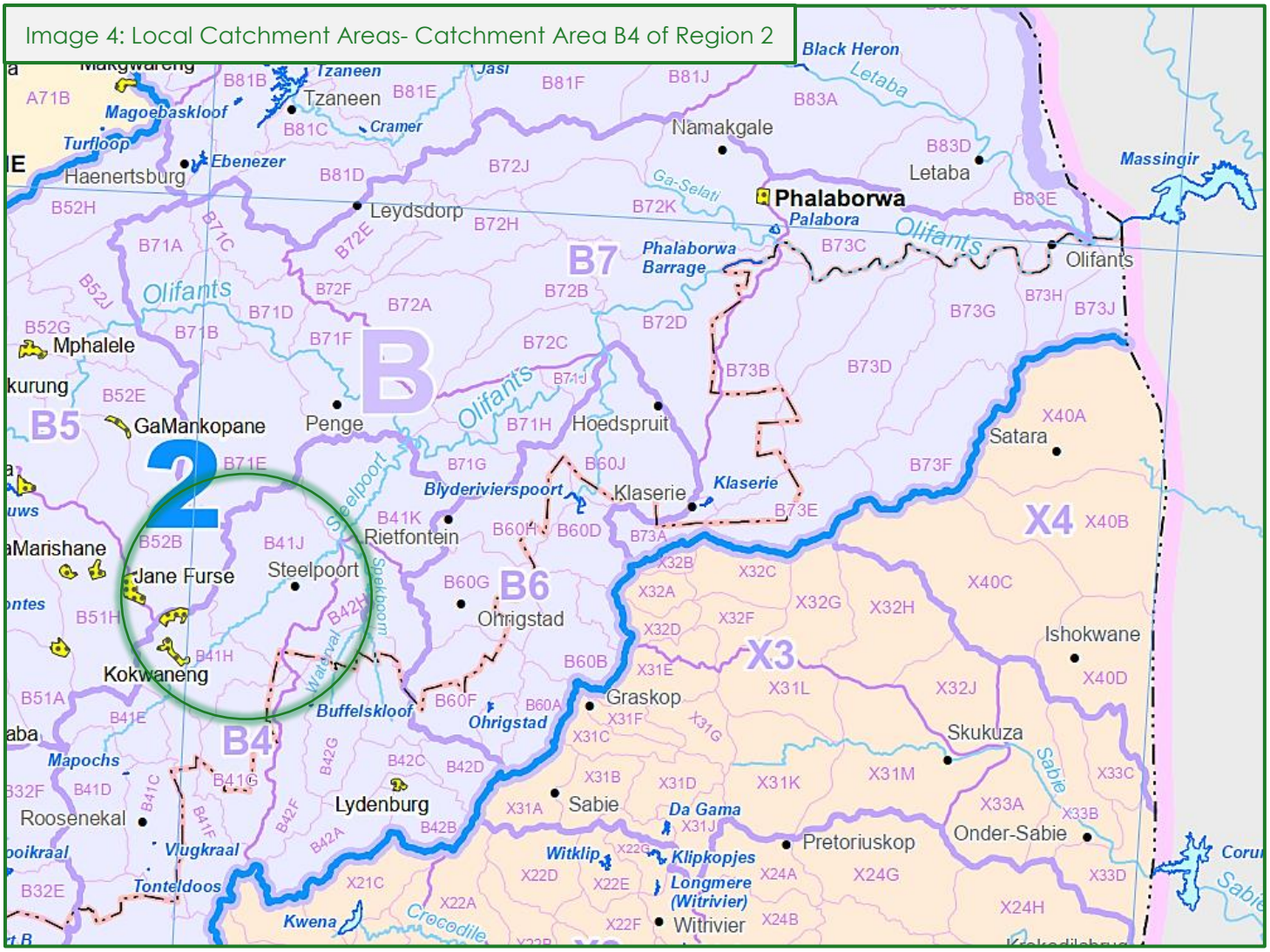
Along the flanks of the mapped high-lying terrain, infiltrating water is predicted to flow/perch along the rock-soil interface at depth, with its flow dynamics dependant on both the rock type and the topography of the rock mass at that point. The predicted undulating topography of the underlying lithologies affects the continuity of the shallow water flow dynamics of the site.

Should excessive infiltration take place in the high-lying areas, it is predicted that elevated volumes of shallow ground water throughflow may occur- converging upon the low-lying terrain and associated drainage features. The rate and volume of the flow is predicted to fluctuate with fluctuations in the intensity of local rainfall events. Groundwater flow may occur at shallow depths within- and adjacent to- known drainage channels (as discussed in Section 3.3).

5.3. Quaternary Catchment Area

The site falls within the Quaternary Catchment Areas **B41H and B41J** which form part of the local **Steelpoort River Catchment Area (B4)** of the greater **Olifants Water Management Area**- Region 2/B as depicted in Image 4 below.

Image 4: Local Catchment Areas- Catchment Area B4 of Region 2



6. Local Cuttings

6.1. Introduction

During the fieldwork operations conducted across the study area, various road cuttings/exposures were observed attributed to the mountainous landscape. Some of these features were inspected by means of basic visual assessment in order to formulate a better understanding of the slope stability properties of the natural materials occurring in the region. It is envisaged that important information regarding possible design measures and engineering solutions can be gathered from analysing the existing cuttings. Lastly, the visual observations have been substantiated by academic data gathered from similar rock-types/soils in order to guide preliminary designs and future projects.

6.2. Local Cuttings/Exposures

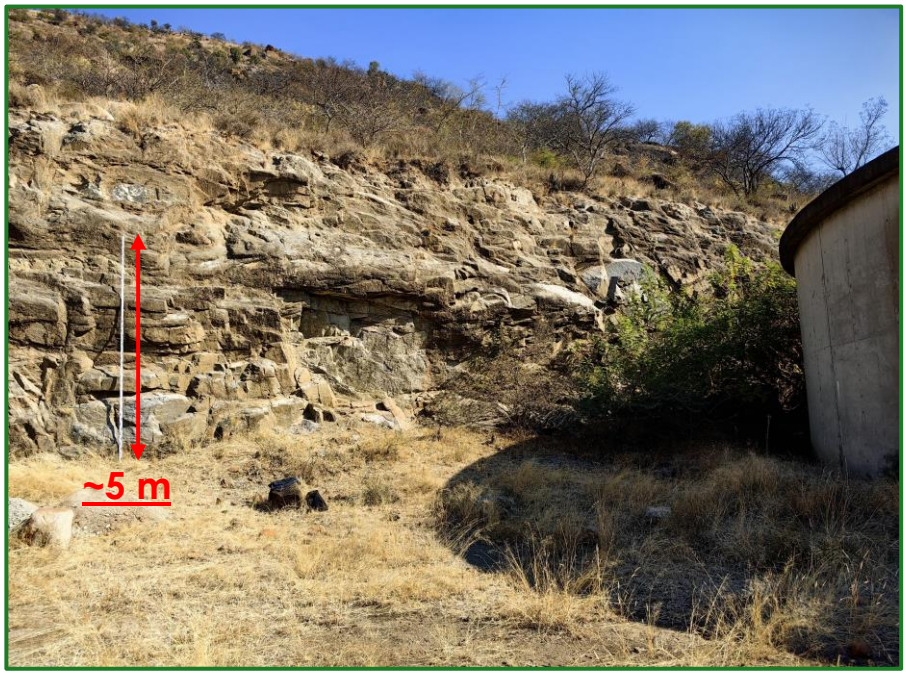
Various road cuttings/exposures were encountered across the study area- with the inclination of the cuts/exposures varying according to multiple factors including ground properties (soil vs varying grades of weathered rock), morphology of the terrain and nature of the road (basic access road vs district road vs regional road) etc. The following basic visual observations were made with respect to the local road cutting/exposures:

- The majority of cuttings were seen to be comprised of residual soil/weathered bedrock overlain by a heterogeneous and variable horizon of transported material consisting of a large assortment of particle sizes.
- Where deep cuts have been implemented- multiple examples encountered along the District Road (D1392)- the inclination of the cut was seen to vary across face of the excavation. At the toe of the excavations- generally comprised of competent weathered bedrock the declivity was the greatest (near vertical cuts)- reducing along the transition into soil.
- The igneous rock mass which the roads are cut into displays an undulating and variable weathering profile- increasing the complexity of slope analysis and associated stable cutting angles, further emphasising the importance of individual cutting/exposure evaluation.
- Furthermore, in deep cuts the degree of weathering was seen to increase towards the top of the excavation with the rock mass at this point resembling soil. At the very top of the cutting, the heterogeneous transported soil represents comparatively less stable/competent material and was seen to have a reduced angle in order to aid slope stability.
- Where the height of the cut face was less severe or the cut material displayed more homogeneous properties, a uniform slope gradient was generally encountered. In general, as the degree of weathering decreased, the gradient of the road cutting/exposure was seen to increase.
- Some road cuttings were modified at the base/toe by the addition of gabion baskets- sometimes stacked as high as 3 visible layers. This increases the weight at the toe of the slope increasing slope stability, mitigates erosion and forms a small catchment area for dislodged debris/rockfalls.

- Where gabions were absent, cuttings for more prominent roads were generally seen to host a small portion of vacant land between the cut and constructed road which is predicted to serve as a catchment area for mobilised/dislodged rock fragments or transported gravels/cobbles/boulders.
- No major slope failures were visible across the cutting inspected. Particles ranging in size from gravels to boulders were sometimes encountered in these catchment areas or at the base of cuttings indicating the occurrence of localised instability in the form of rockfalls. However, the majority of instability is predicted to be confined to the blanketing transported material or upper extent of the residual soil and not the weathered bedrock which form the majority of the cuts face.
- As a side note, the localised rockfall instability may be exacerbated by tremors induced by blasting activities from the numerous mines in the area.

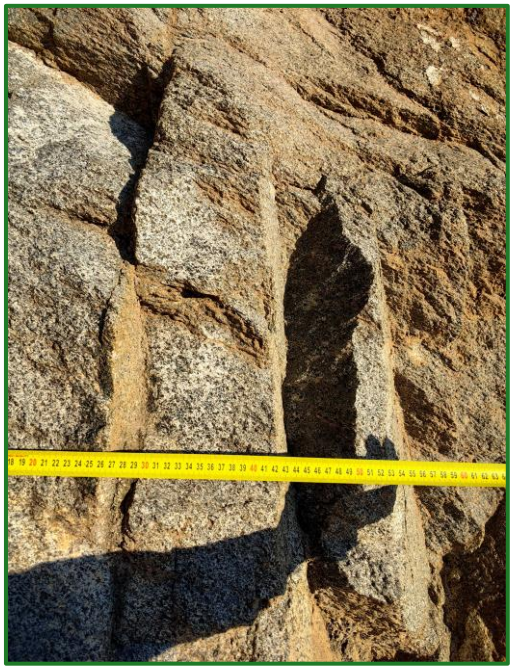
The photo series to follow depicts the nature of the cuttings observed as part of this basic walkover analysis.

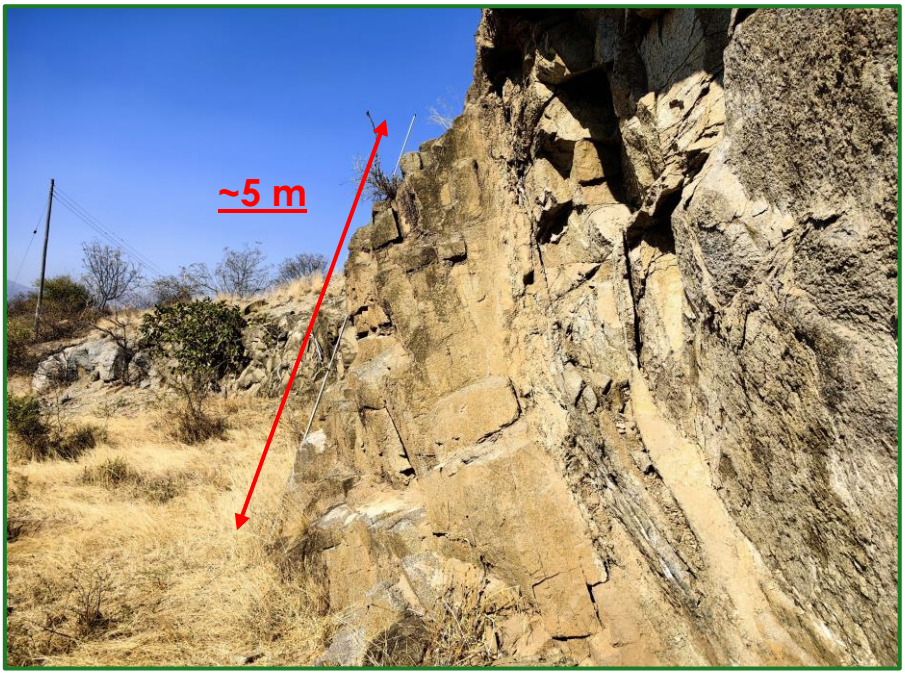
Regional Cuttings/Exposures













Regional Cuttings/Exposures









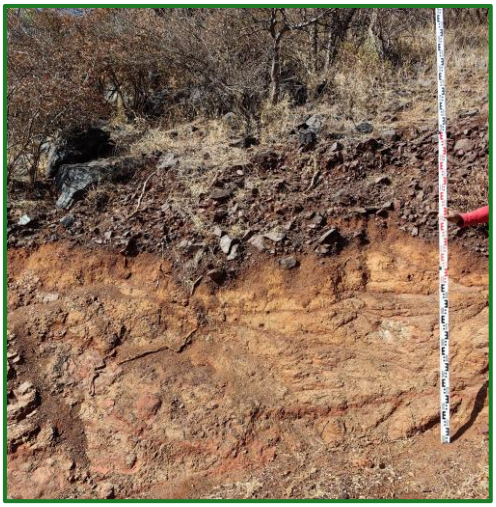


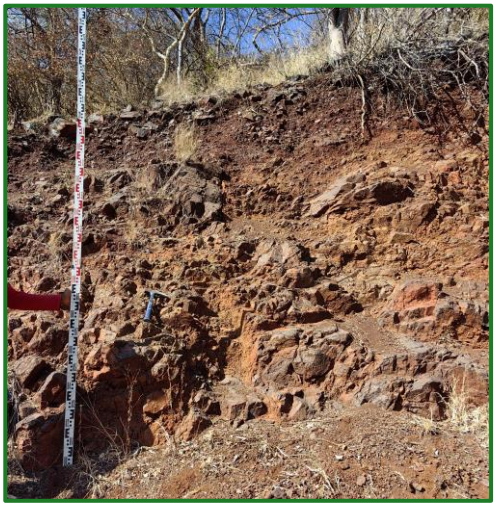


Regional Cuttings/Exposures







6.3. Theoretical Information- Cuttings Into rock

The following tables have been extracted from available/applicable literature and can be used in conjunction with the site observations in order to guide future slope stability/road cutting stability analysis.

Due to the presented data not being site specific, it can only be used as an indication of the expected geotechnical properties of the material and should not be used for final designs. It is advised that additional investigations be conducted specifically evaluating the properties influencing large slope/cutting stability on which appropriate designs can be based.

Table 7: Summary of Rock Types, Weathering Products and Performance of Cut Slopes (TRH 18, 1993)

Summary of rock types, weathering products and performance of cut slopes[43]

	Group	Main parent materials	Weathering products	Stability and possible types of failure*		
				Unweathered/ partly weathered	Weathered	Erodibility
1	Metamorphic rocks	Schist, phyllite, slate	Plastic clays, sands	Poor, rock topples, falls and slides, rock block slides along cleavage, joints etc	Good, if well-drained, earth slump or earth slides if not	Soils may be erodible
2	Acid igneous rocks	Granite, gneiss, syenite, felsite, granodiorite, rhyolite	Sandy to silty materials	Good, 2 or 3-dimensional rock block slides along joints and pseudo bedding	Good, if adequately drained, earth slides or slumps if not	Some decomposed granites are dispersive. Shallow angled cuts will often erode severely
3	Basic igneous rocks	Gabbro, norite, basalt, dolerite, andesite, pyroxenite	Expansive clays	Good, 2 or 3-dimensional rock block slides along joints	Good, if adequately drained, earth slides or slumps if not	Soil may be highly to slightly erodible. Certain rocks weather rapidly
4	Arenaceous and rudaceous rocks	Sandstone, quartzite, conglomerate, arkose	Sands and gravels	Influenced by dip, rock block slides common, wedge failures possible	Good, if adequately drained, rotational/ translational slump if not	Usually not erodible
5	Argillaceous rocks	Mudstone, shale, siltstone, marl	Clay and silt	Poor, rock block sliding along bedding common, small wedge, failures along joints	Earth slides or slumps if not adequately drained.	Usually not erodible but often rapidly slaking
6	Diamictites	Tillite	Silty clays and clayey sands	Poor when strata dips into cut, large block slides along clay filled bedding planes	Good, generally self-draining; possible earth slumping	Soils usually not erodible; some outcrops weather rapidly whereas others display a sort of "piping"
7	Carbonate rocks	Dolomite, limestone	Clay wad, sand and gravel	Stable, depending on attitude of jointing	Occasional earth flows or slumps when wad becomes saturated	Wad may be slightly erodible
8	Other sedimentary rocks	Banded ironstone, chert, pedocretes	Gravel - sands	Generally not very thick, stable	Probably stable; very few exposures	Usually not erodible
9	Residual materials	Clays, sands, silts	-	Unstable if water flow is not controlled (earth slumps)		Depends on parent materials; see above
10	Transported materials	Colluvium, sands	-	Unstable if water flow is not controlled (earth and debris slumps)		Minor problems with erosion
11	Complex areas	Intrusions, faults	Sands, silt, clay gravel	Often unstable, all types of failure, block slide, wedge slides, earth slumps, earth and debris flows etc		Variable

* The stability of any slope depends to a large extent on the ground-water conditions.

Table 8: Probable Steepest Stable Slopes for Various Materials (TRH, 1993)

Probable steepest stable slopes for various materials
Vertical : Horizontal

	Material Type (See Table 3)	Water-surplus area			Rest of South Africa		
		Soil*	Weathered	Unweathered	Soil*	Weathered	Unweathered
1	Metamorphic rocks	1:1,5	1:1,5	1:1,5	1:1,5	1:0,5	1:0,25
2	Acid igneous rocks	1:1	1:0,5	1:0,25	1:1	1:0,25	1:0,25
3	Basic igneous rocks	1:1,5	1:1	1:0,25	1:1,5	1:0,5	1:0,25
4	Arenaceous and rudaceous rock	1:1,5	1:0,5**	1:0,5**	1:1,5	1:0,5**	1:0,25**
5	Argillaceous rock	1:2	1:2**	1:2***	1:2	1:2***	1:2***
6	Diamictites	1:2	1:1,5**	1:0,5**	1:1	1:0,5	1:0,25
7	Carbonate rocks	1:2	1:1,5	1:0,25	1:1,5		1:0,25
8	Other sedimentary rocks	-	1:0,5	1:0,25	-	1:0,5	1:0,25
9	Residual materials	1:1,5	-	-	1:1	-	-
10	Transported materials	1:2	-	-	1:2	-	-

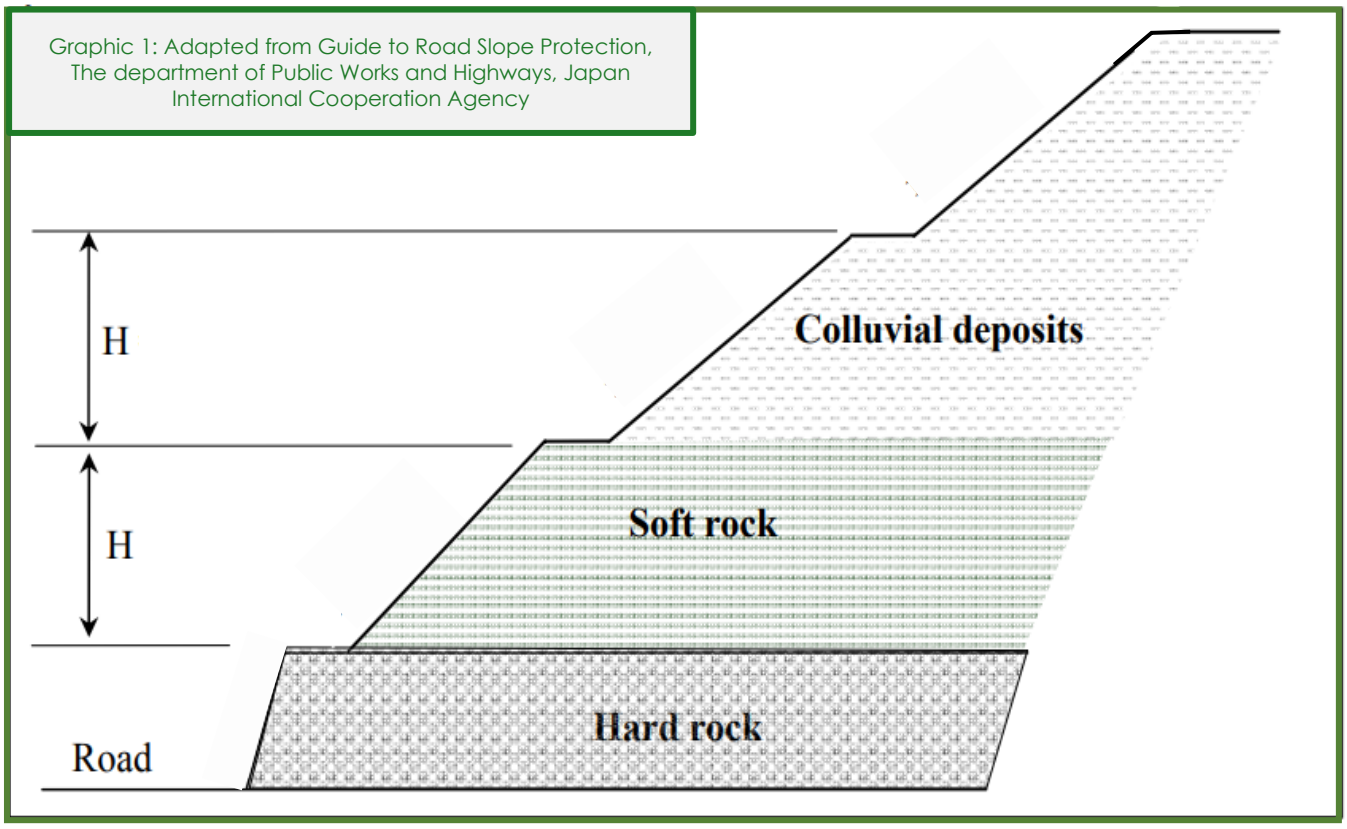
* Recommended not steeper than 1:2 to establish vegetation
** Subject to bedding not dipping into the cut
*** Subject to material not being highly slaking and not dipping into cut

NB: This table should only be used as a rough guide together with local experience, studies of neighbouring slopes and engineering judgement. Weathered materials can be classified as those where weakening of the joints has occurred and their properties are dictated primarily by the joint or gouge strength.

In certain areas it is often useful to cut some granitic soils and argillaceous rocks vertically or at 1:0,25 to reduce erosion of the slopes. However, their stability at these steep batters should be ensured first.

Graphic 1: Basic Cut Slope Gradient in Relation to Different Ground Conditions

Graphic 1: Adapted from Guide to Road Slope Protection, The department of Public Works and Highways, Japan International Cooperation Agency



7. Report Provisions

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The investigation was conducted according to the accepted proposal and the scope of works and literature references provided in this document. Field work and reporting were conducted and/ or overseen by professionally registered scientists with the South African Council for Natural Scientific Professions. Furthermore, GeoCalibre has have employed accepted engineering geologic procedures, and our opinions and conclusions are made in accordance with generally accepted principles and practices in engineering geology.

The presented geotechnical model is based on a data base of available information and available on-site exposures. Parcels of land within the developmental area which are free of excavations are modelled using on-site observations and surrounding exposures. While every effort is made during the fieldwork phase to identify the different soil horizons, areas subject to a perched water table, areas of poor drainage, areas underlain by hard rock and to estimate their distribution, it is impossible to guarantee that variations are excluded over the extent of the site which are the subject of this report.

Variable founding conditions and materials are expected to be encountered. This variability includes soils of different age, composition and associated pre-consolidation pressures. In view of the variability inherent in natural materials, a competent person must inspect all foundation excavations at the time of construction to ensure that the materials are adequate for the proposed structure and that they are in accordance with the recommendations stated in this report.

The design and implementation of the planned engineering fills remains the responsibility of the consulting engineers/competent person- with GeoCalibre and its' employees carrying no liability in this regard. The placement of engineered fill must be controlled with suitable field tests to ensure that the required densities are achieved during compaction, and that the quality of the fill material is within specification to ensure the longevity of the development.

The determination of flood lines and delineation of wetland areas were not part of this investigation scope and should be addressed by suitably competent professionals prior to the final site development plan is compiled, if deemed necessary. If the site or a portion thereof is situated within the 1:100-year flood line, or has been delineated as a wetland, it is the prerogative of the Civil Engineer or other suitably experienced specialist to overwrite the recommendations for such portions.

Although not anticipated at this site, it should be noted that this investigation did not include the assessment of any potential environmental hazards, or groundwater impacts that may be present, or ensue from the construction of the proposed structures.

GeoCalibre is open to ongoing discussions with all the parties involved in order to elaborate on the methodology implemented during this assessment and its associated findings/ground models.

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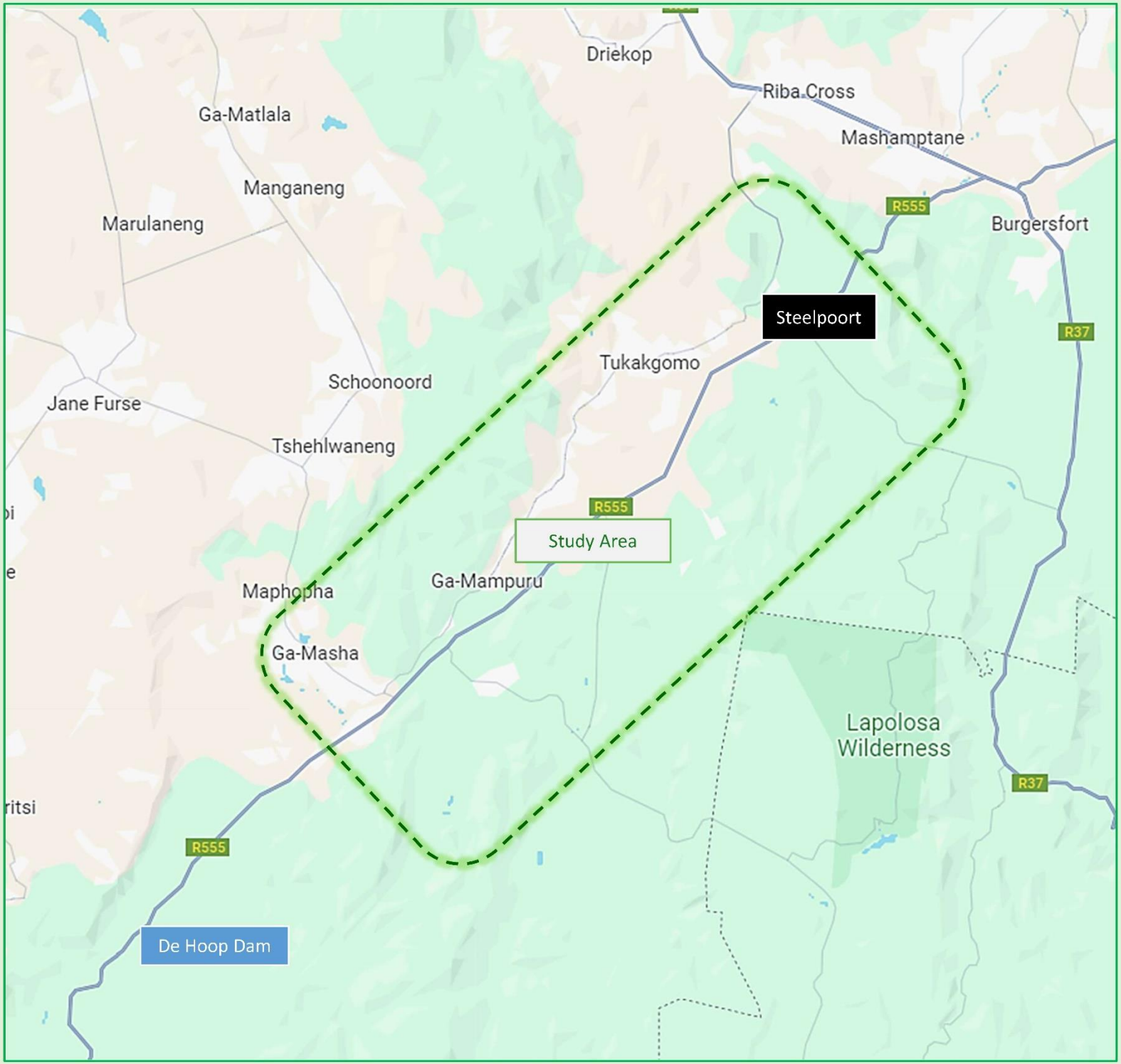
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Layout Maps



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Figure 1

Study Area Location

LEGEND

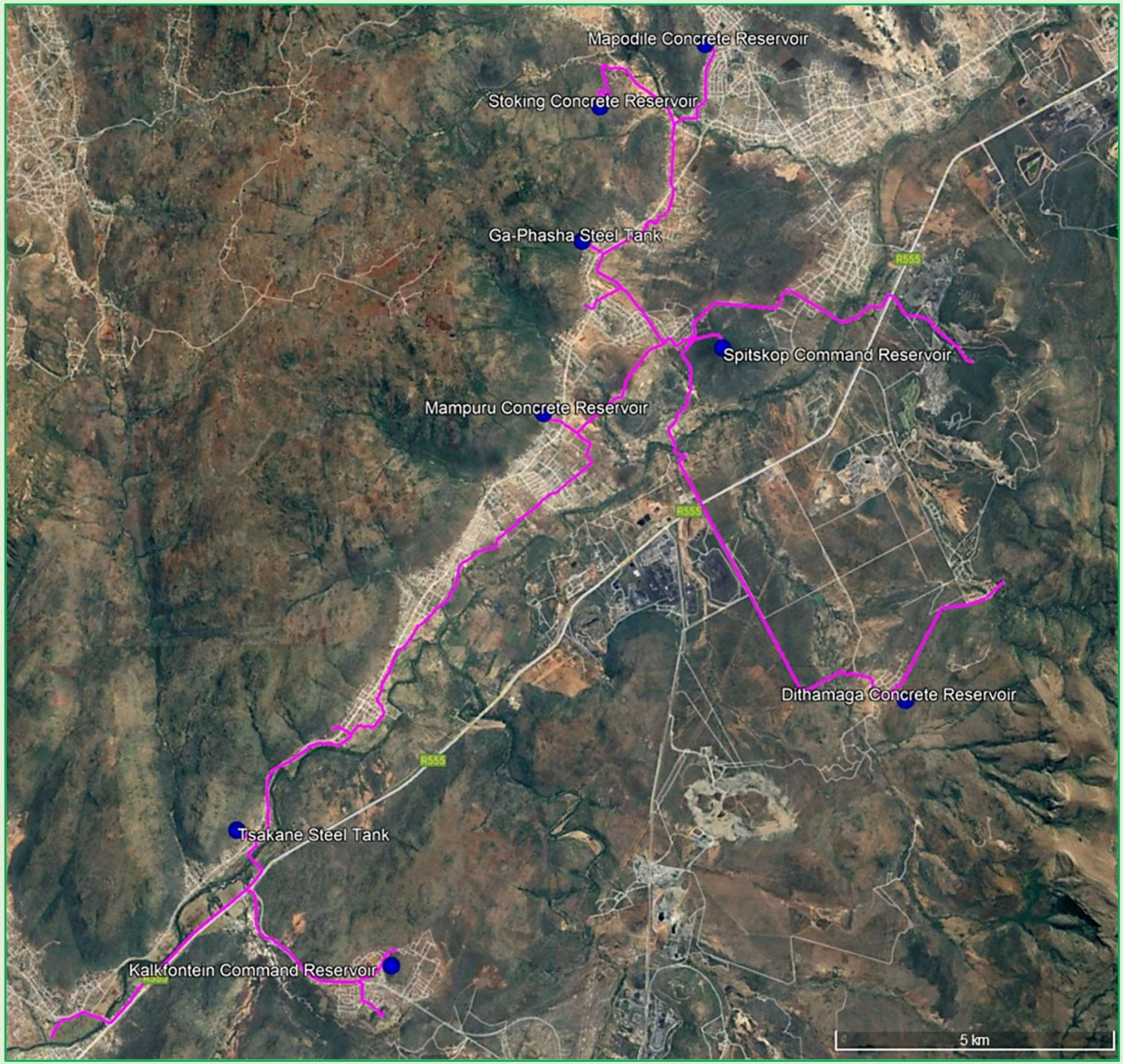
Study Area

N

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Nelspruit
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Figure 2A

Regional Site Location- Aerial View

LEGEND

Planned Pipeline

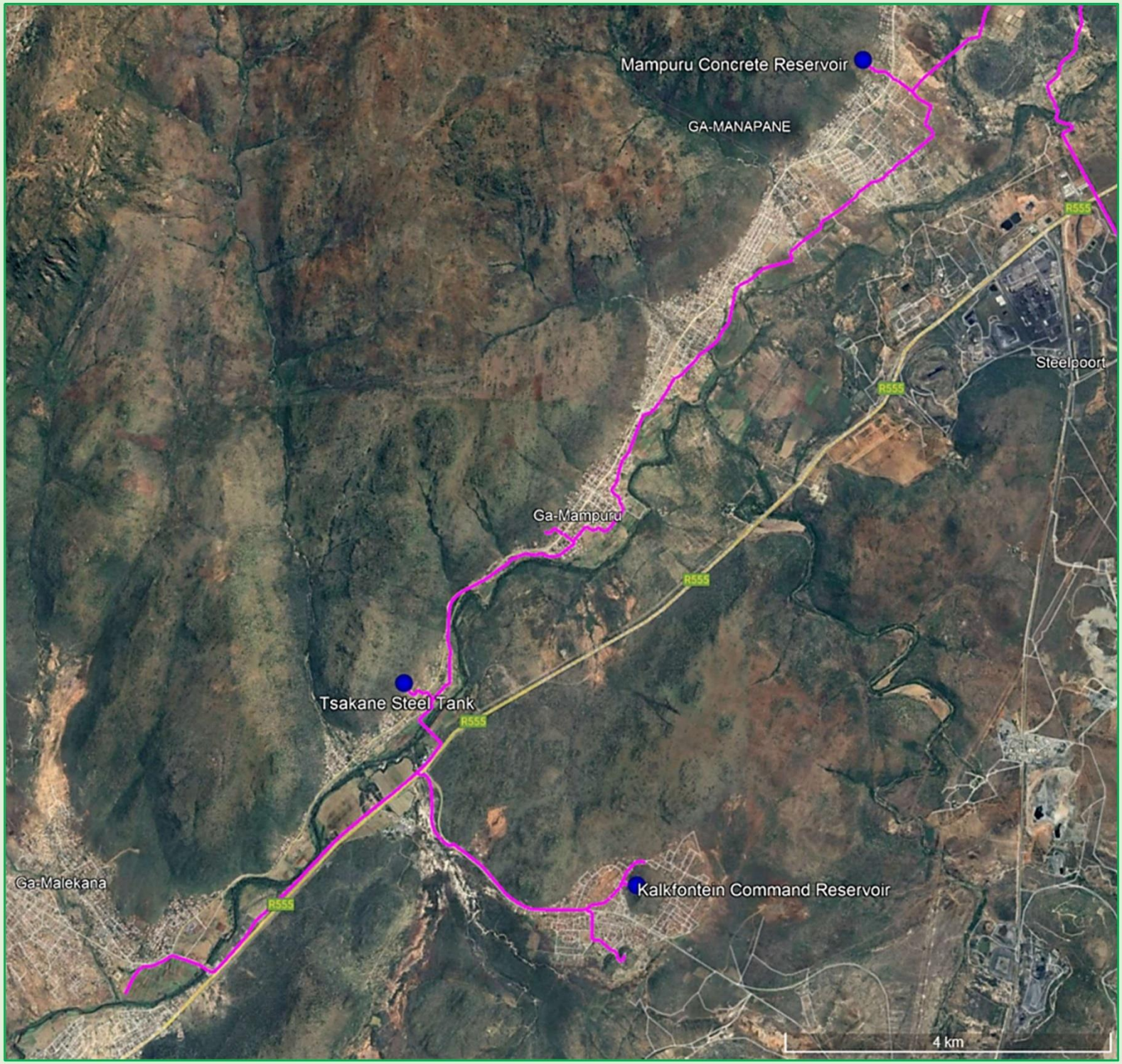
Planned Structure

N

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Figure 2B

Southern Portion- Aerial View

LEGEND

Planned Pipeline

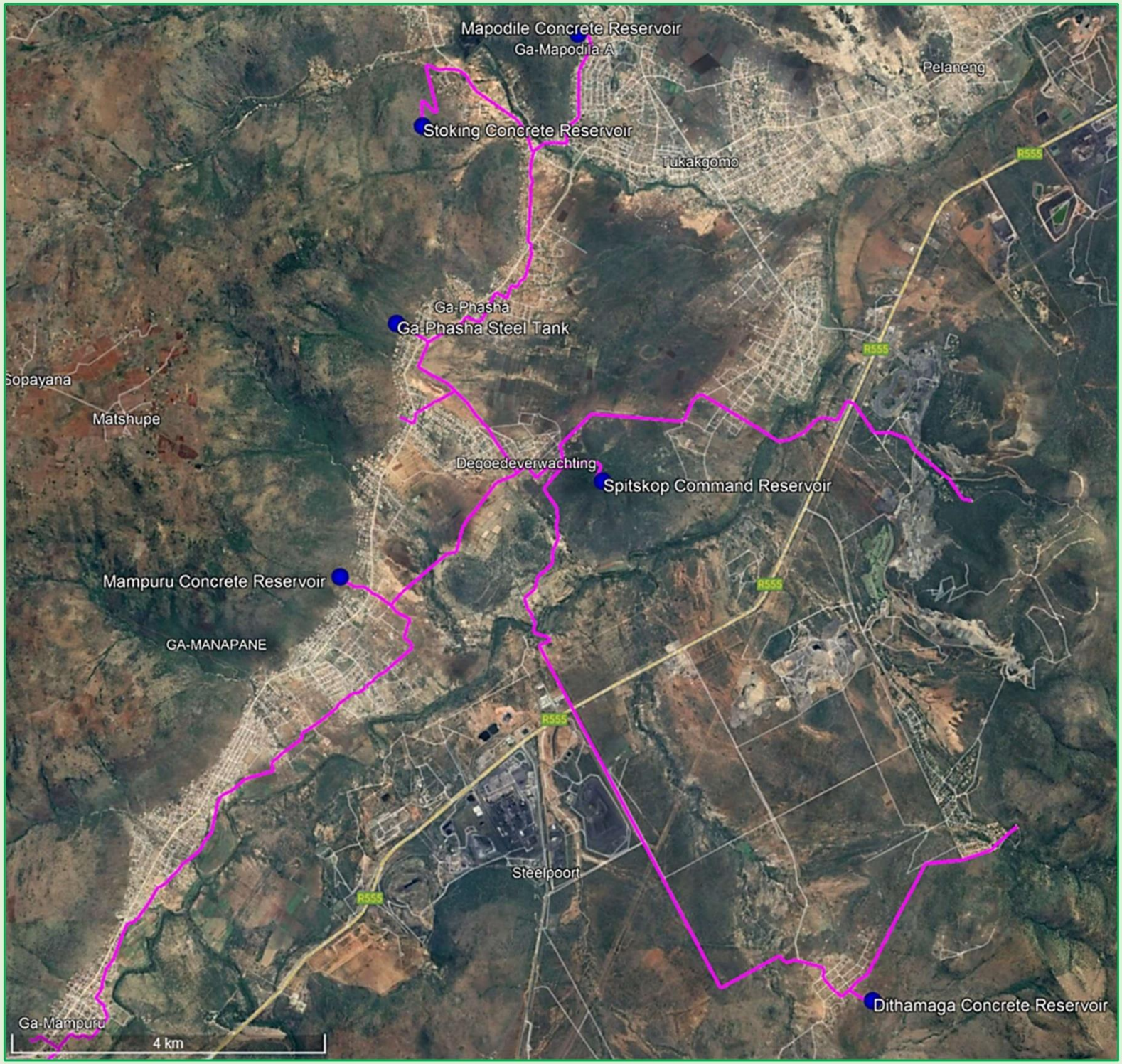
Planned Structure

N

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Figure 2C

Northern Portion- Aerial View

LEGEND

Planned Pipeline

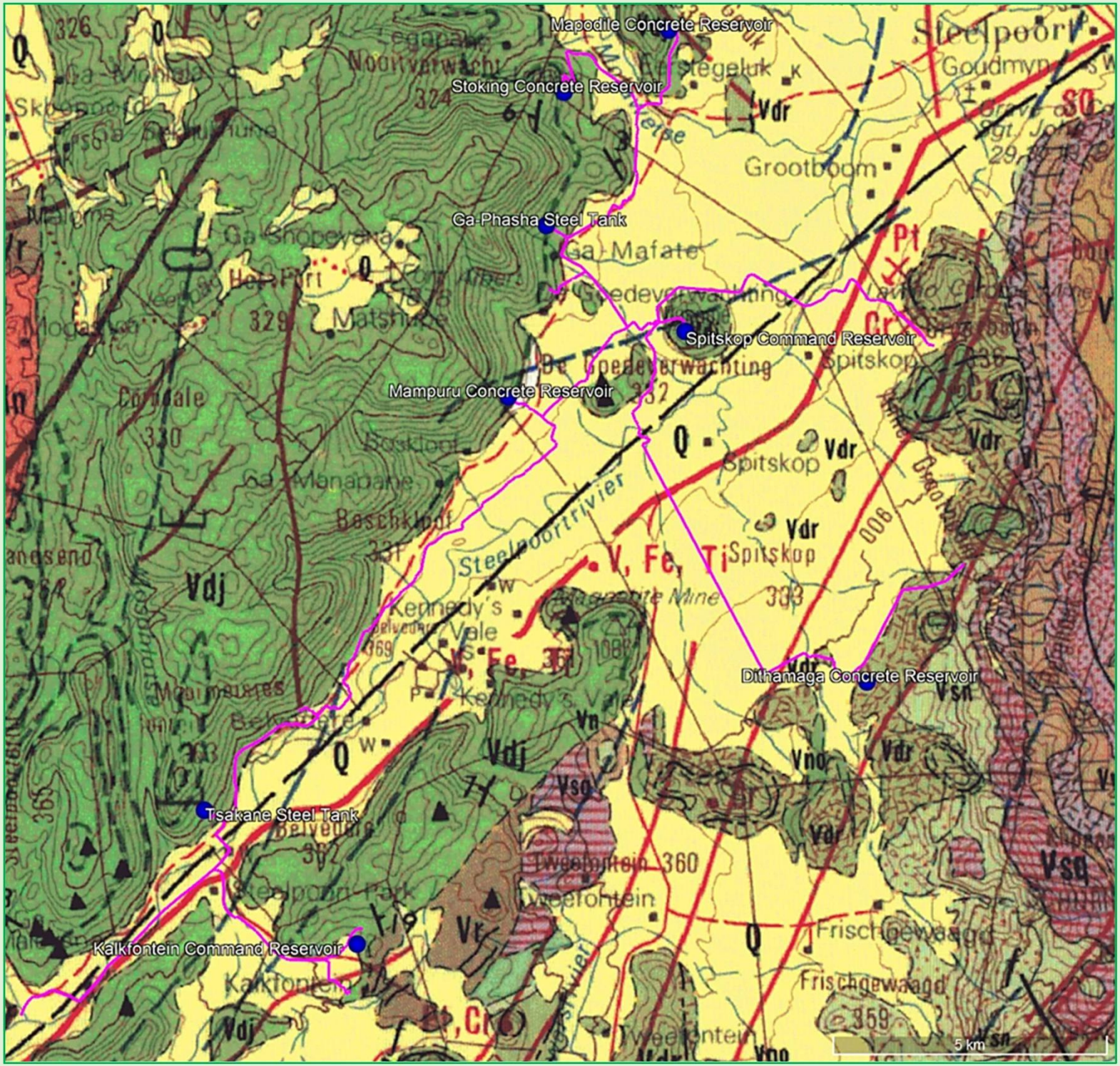
Planned Structure

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Figure 3A

Regional Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.
- Vdr — Medium to coarse-grained norite and anorthosite (upper part)-***Dwars River Subsuite***
- Vsq — Fine to medium-grained quartzite, purple sandstone and shale with quartz clasts and thin conglomerate layers- ***Steenkampsberg Formation*** of the Pretoria Group

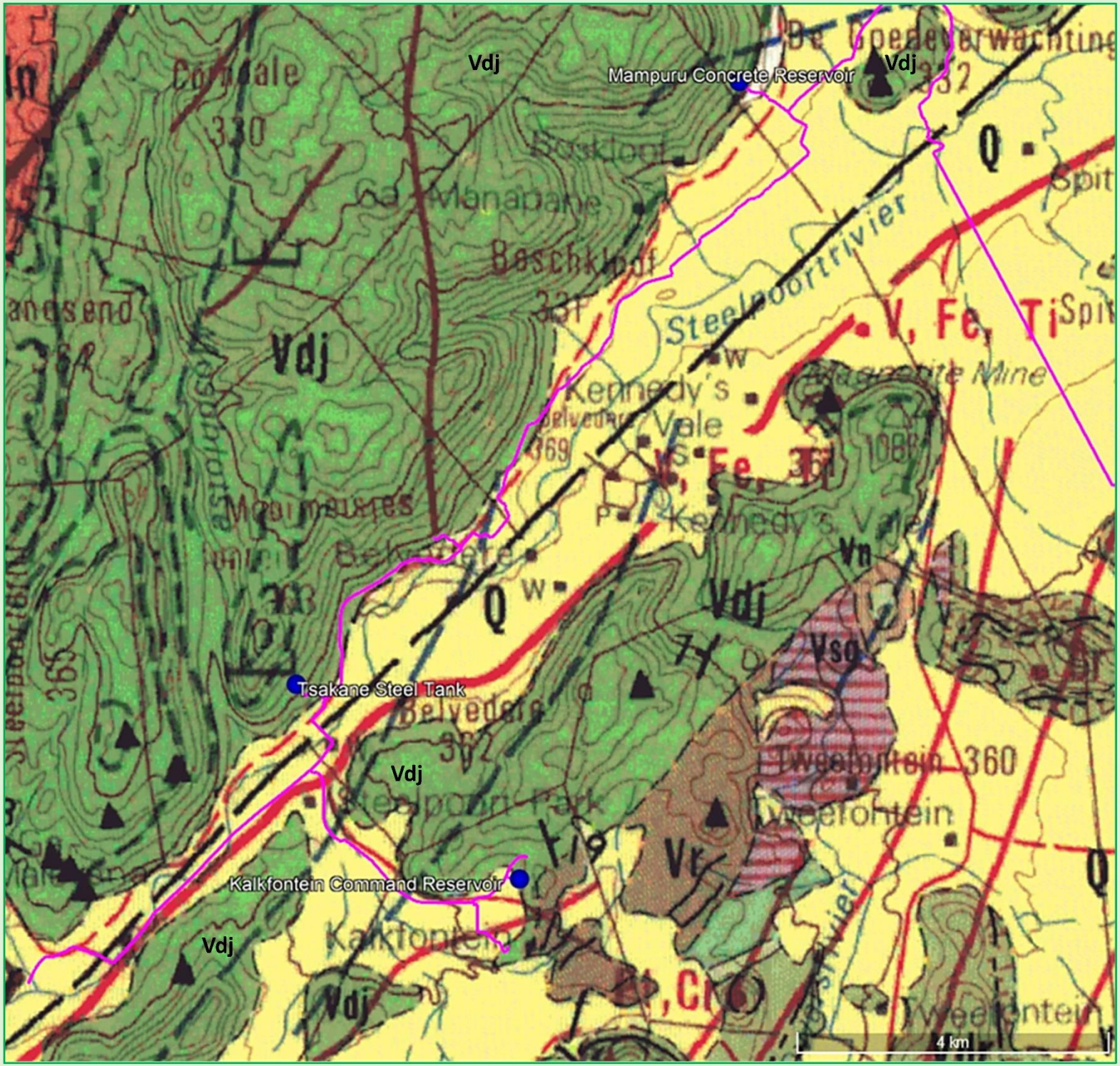
Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

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Figure 3B

Southern Portion- Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.
- Vdr — Medium to coarse-grained norite and anorthosite (upper part)-***Dwars River Subsuite***
- Vsq — Fine to medium-grained quartzite, purple sandstone and shale with quartz clasts and thin conglomerate layers- ***Steenkampsberg Formation*** of the Pretoria Group

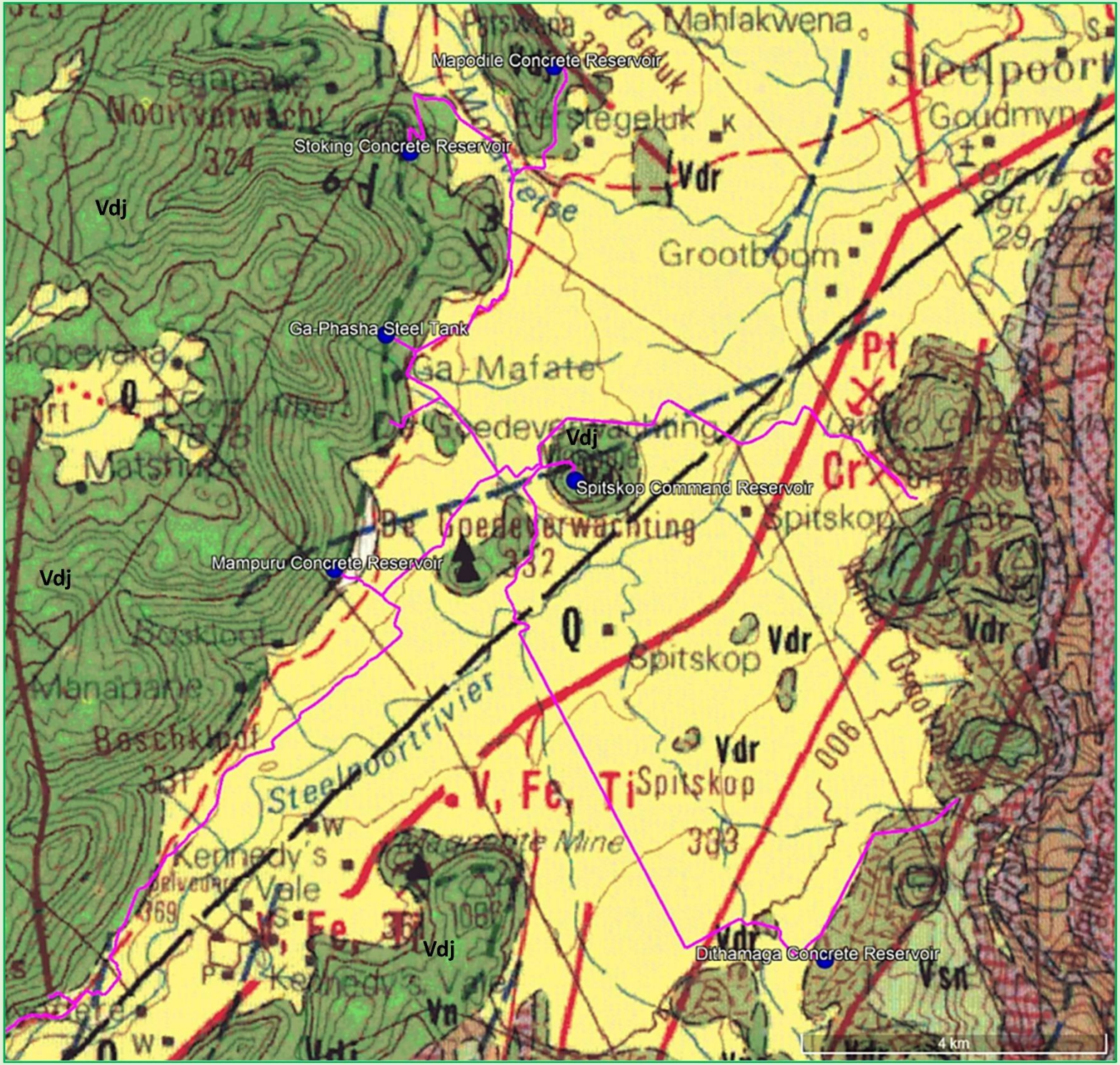
Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

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Figure 3C

Northern Portion- Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.
- Vdr — Medium to coarse-grained norite and anorthosite (upper part)-***Dwars River Subsuite***
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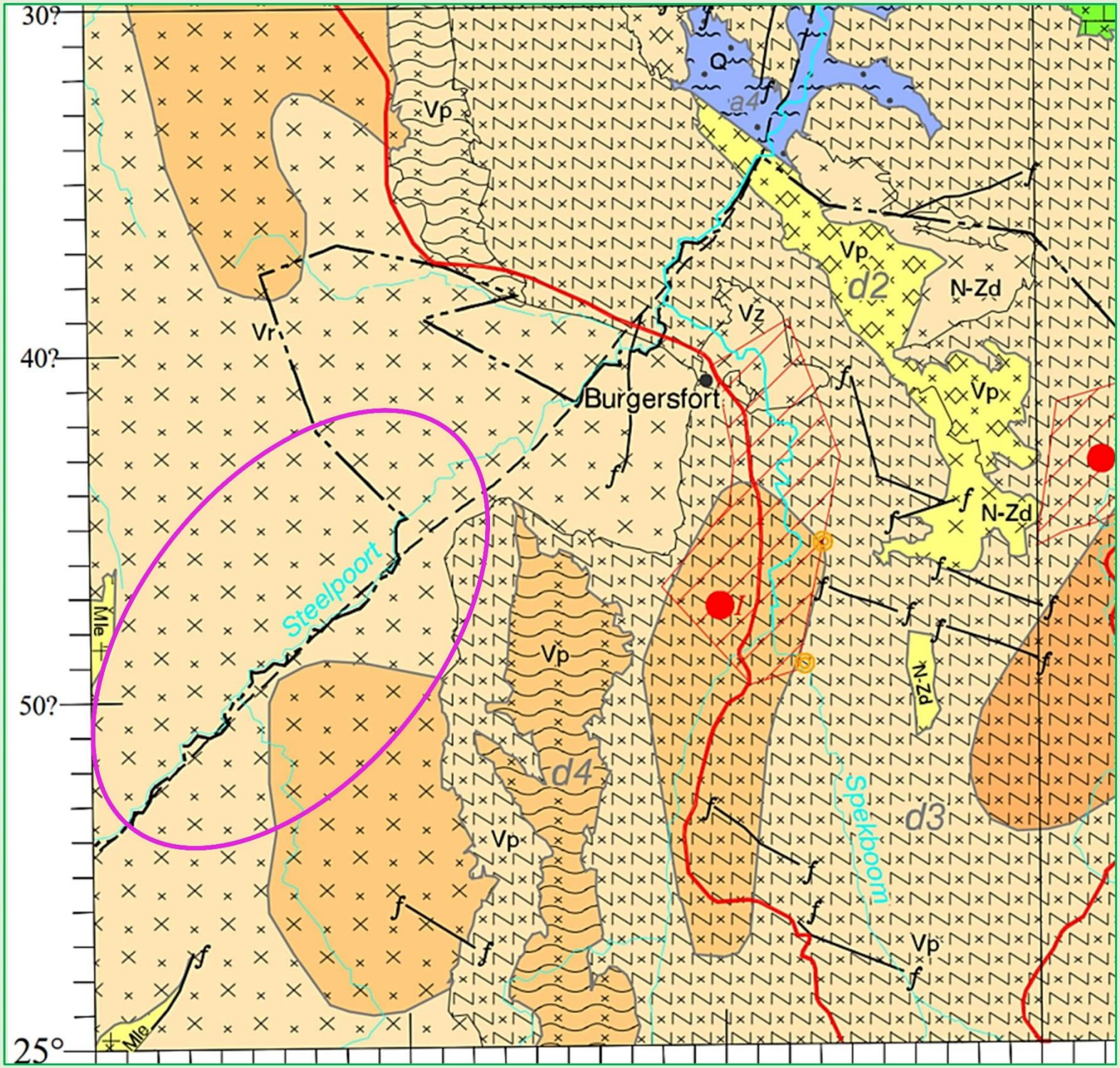
Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

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Figure 4

Regional Hydrogeological Map

LEGEND

Borehole yield class (median l/s) (excluding dry boreholes)

Aquifer type	0.0 - 0.1	0.1 - 0.5	0.5 - 2.0	2.0 - 5.0	> 5.0
Intergranular	*	*	*	a4	a5
Fractured	*	b2	b3	b4	b5
Karst	*	*	*	*	*
Intergranular and fractured	*	d2	d3	d4	d5

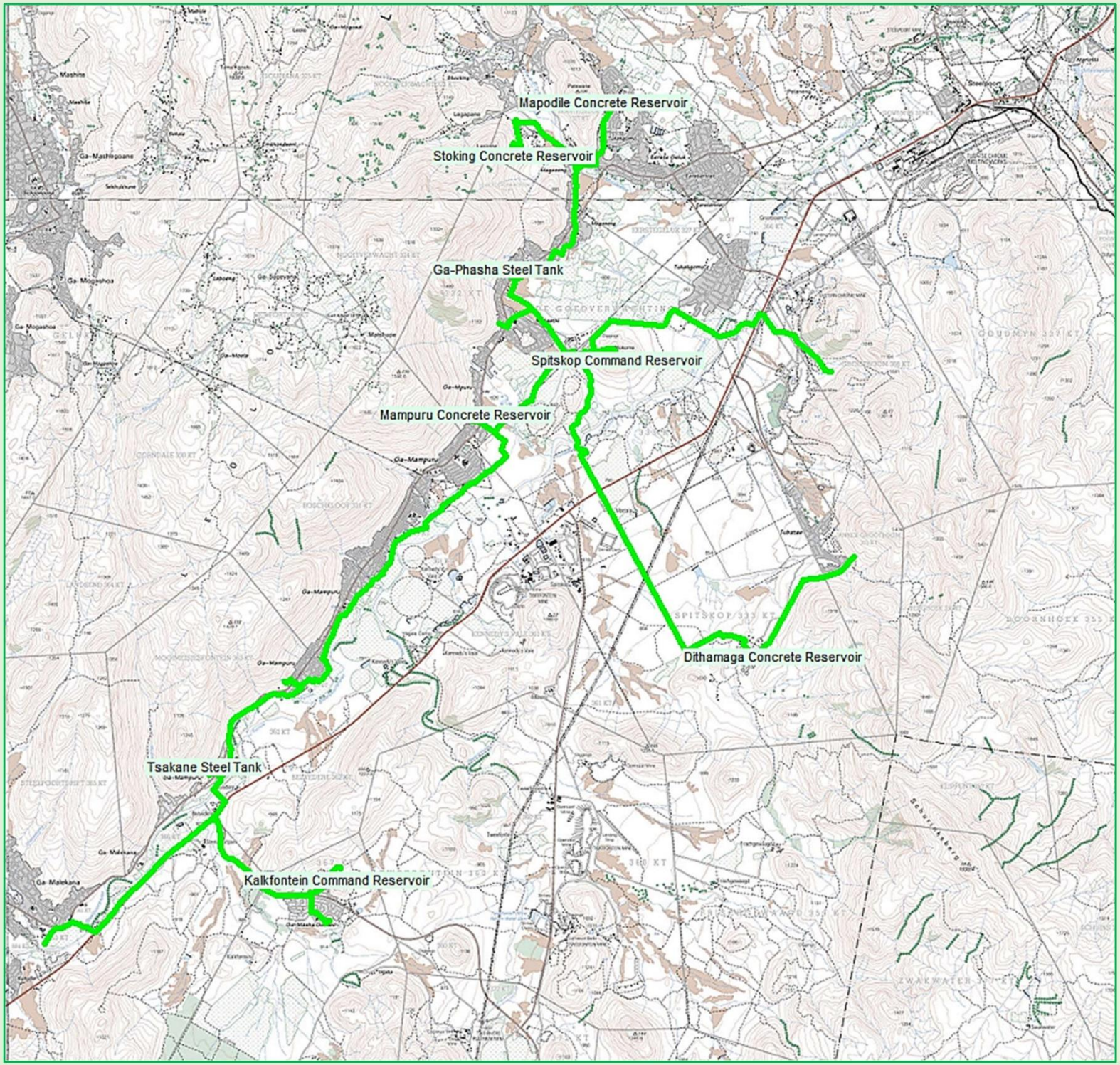
Hydrogeological Series Map:
2330 Phalaborwa (1998); Scale 1 : 500 000

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Figure 5A

Regional Topocadastral Map

LEGEND

Planned Pipeline

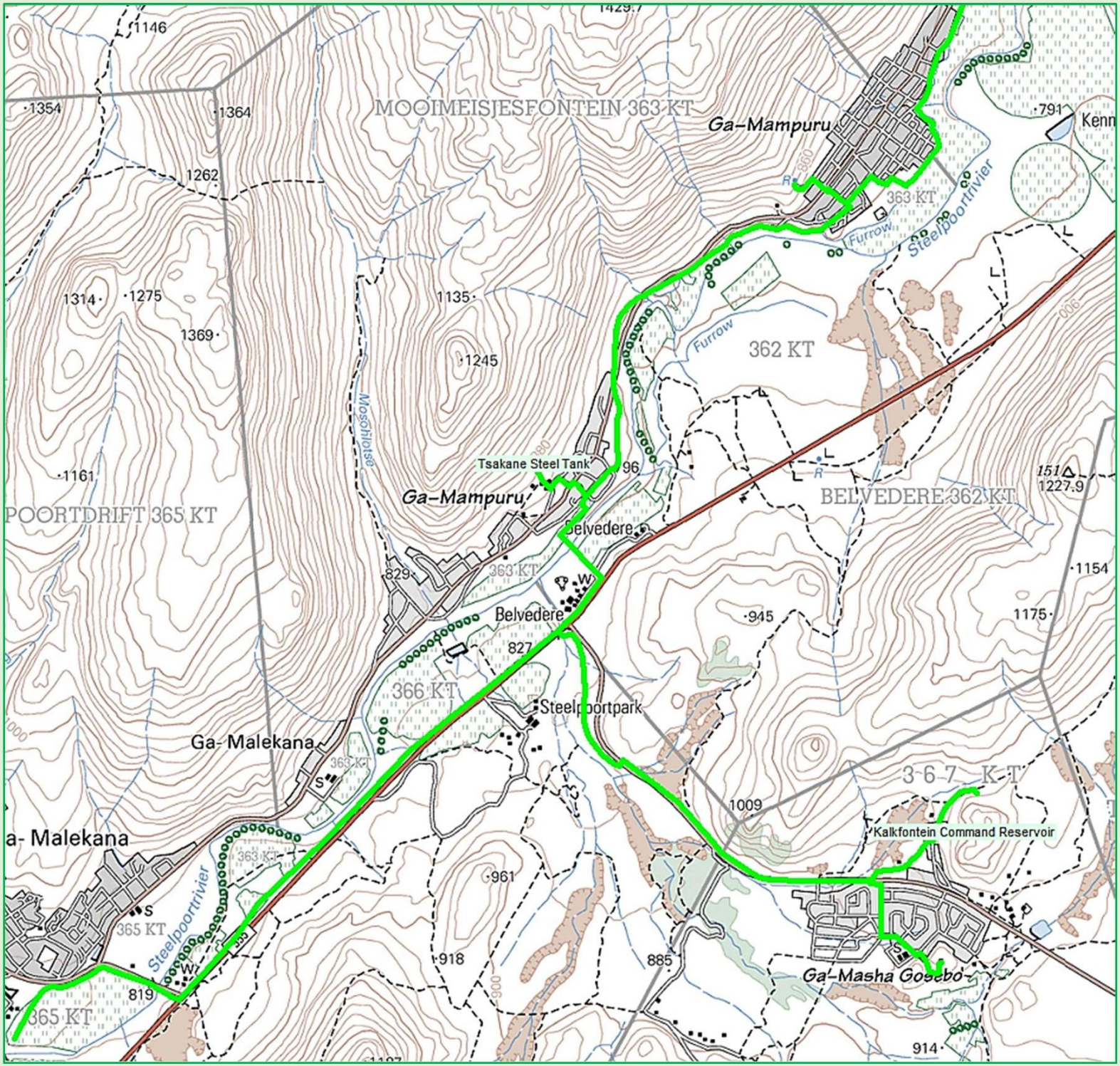
Topocadastral Maps:
2430 Ca and Cc; Scale 1 : 50 000

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Figure 5B

Topocadastral Map- Southern Portion

LEGEND

Planned Pipeline

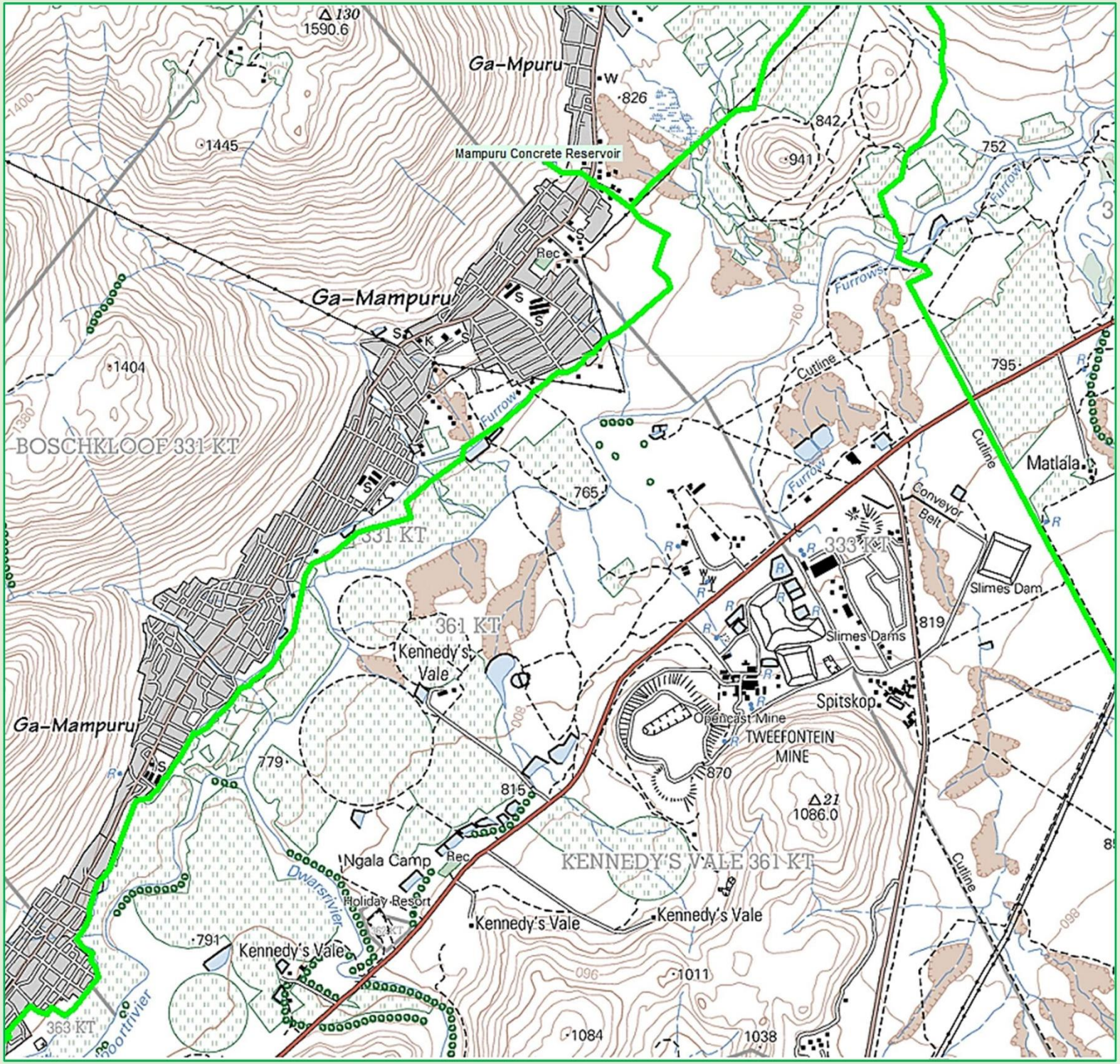
Topocadastral Maps:
2430 Cc; Scale 1 : 50 000

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Figure 5C

Topocadastral Map- Central Portion

LEGEND

Planned Pipeline

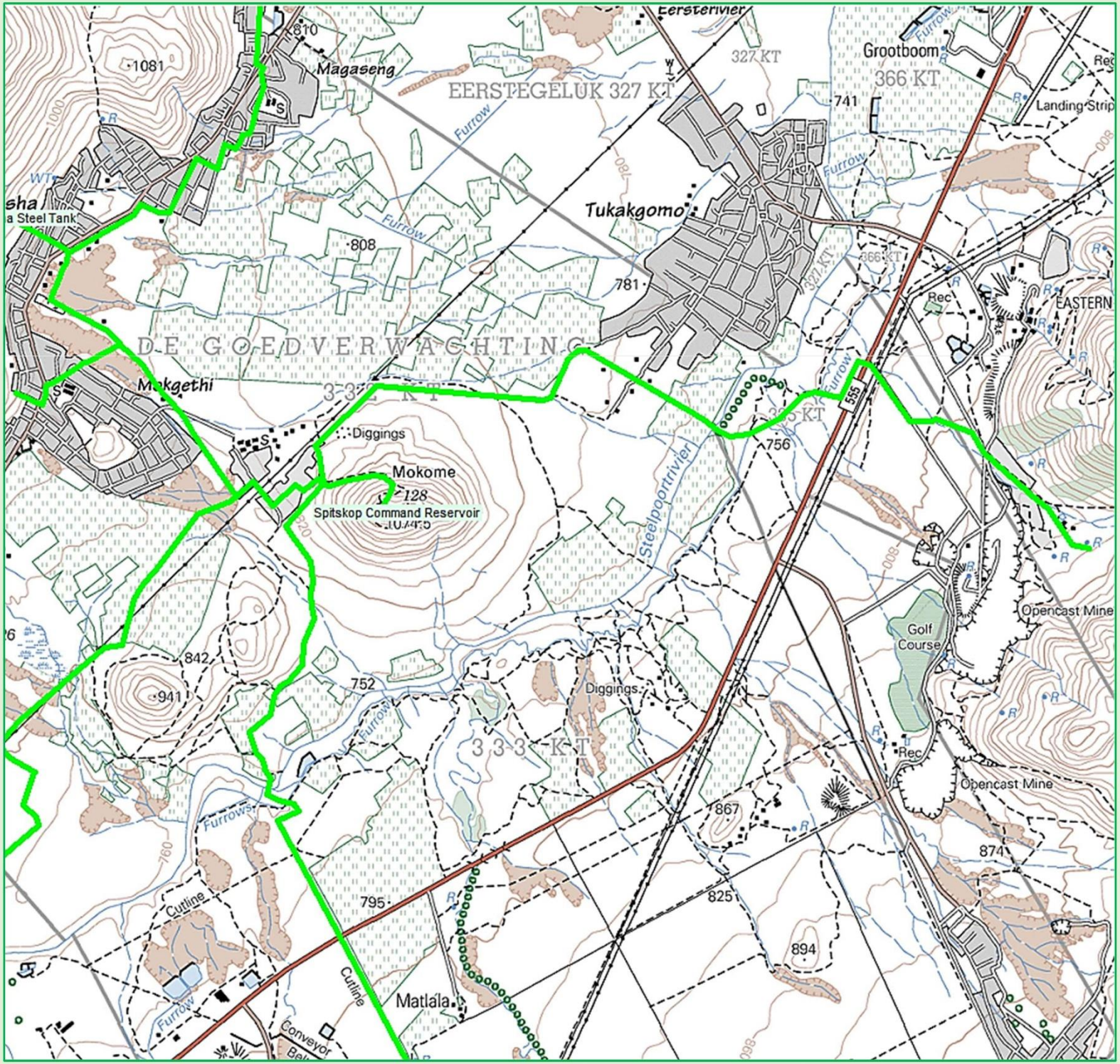
Topocadastral Maps:
2430 Cc; Scale 1 : 50 000

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Figure 5D

Topocadastral Map- Central Portion

LEGEND

Planned Pipeline

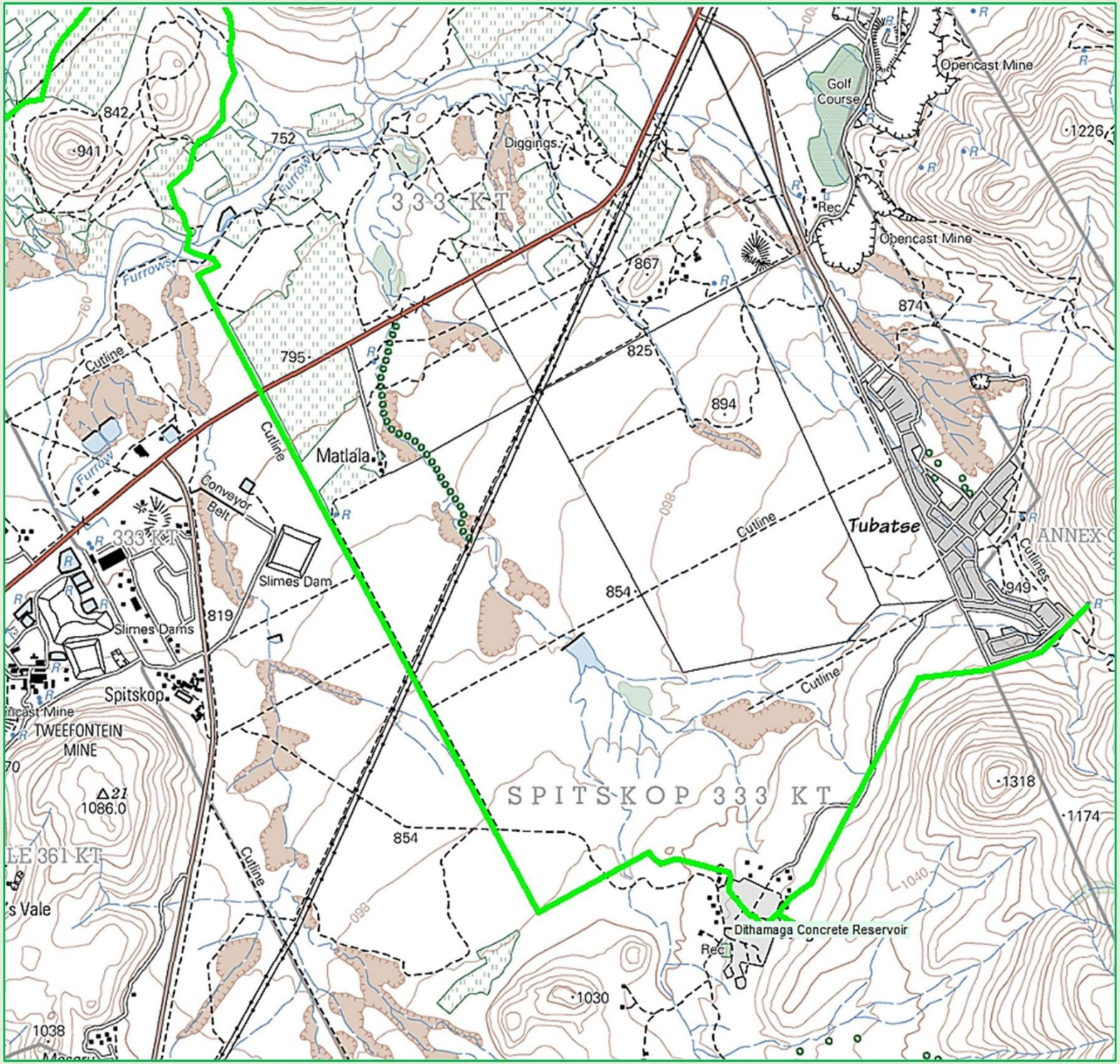
Topocadastral Maps:
2430 Cc and Ca; Scale 1 : 50 000

N

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Figure 5E

Topocadastral Map- South Eastern Portion

LEGEND

Planned Pipeline

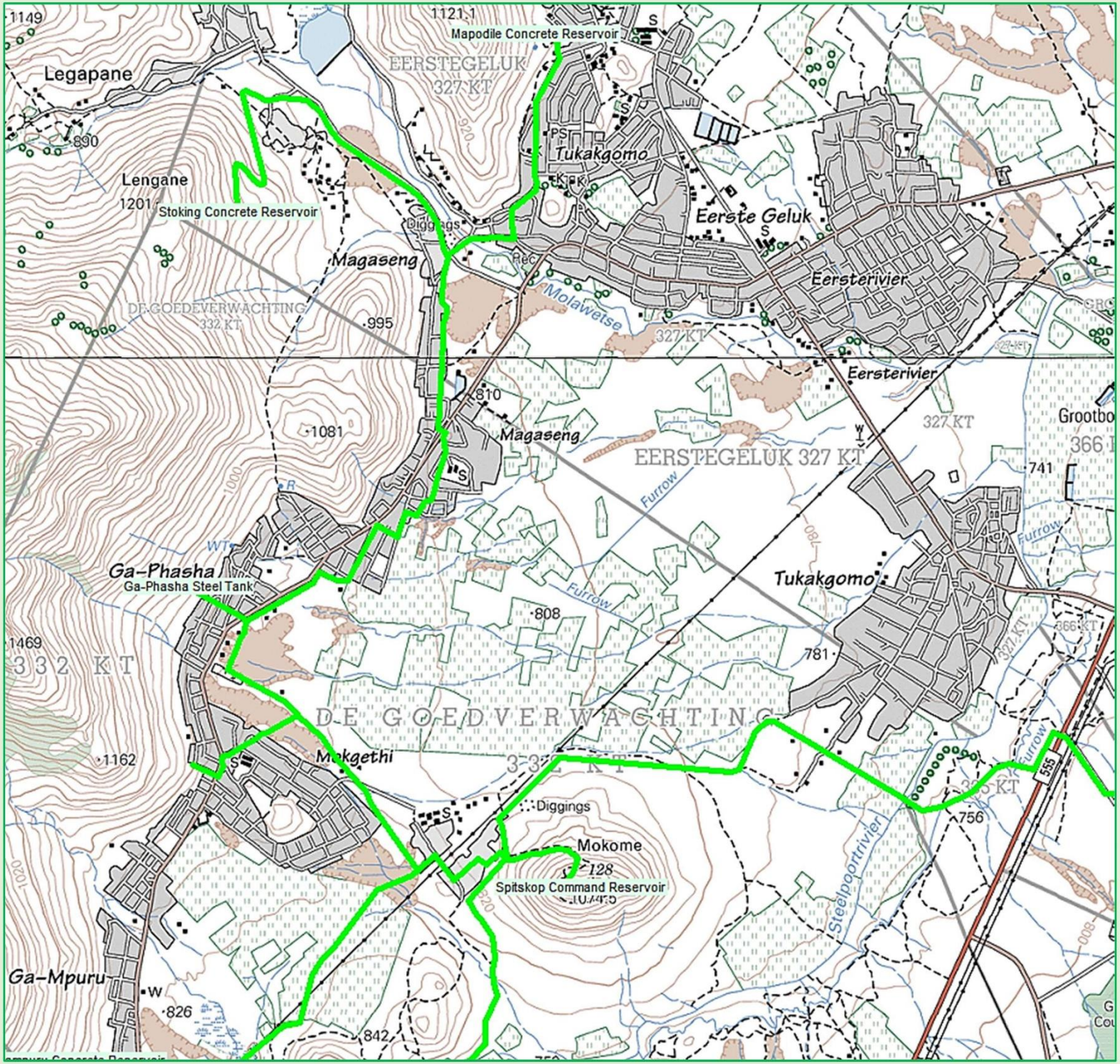
Topocadastral Maps:
2430 Cc; Scale 1 : 50 000

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Figure 5F

Topocadastral Map- Northern Portion

LEGEND

Planned Pipeline

Topocadastral Maps:
2430 Cc and Ca; Scale 1 : 50 000

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TECHNICAL REPORT

Kalkfontein Command Reservoir- 3000 kl

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Geotechnical Site Investigation and Materials Assessment

Prepared for
Zutari (Pty) Ltd.

Date
23/08/2024

Compiled by
Kevin Coertzen (Pr.Sci.Nat)

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Technical Report

GC24/144A

23 August 2024

Kalkfontein Command Reservoir- 3000 kl

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Project Details

Report Title	Kalkfontein Command Reservoir- 3000 kl
Report Reference	GC24/144A
WAS/WSP	Sekhukhune District Municipality (SDM)
Contract Reference	SK08/3/1-30/2017/2018
Project Engineers	Zutari (Pty) Ltd.
Report Description	Geotechnical Site Investigation and Materials Assessment
Report Version	Final Report

Report Compilation and Signatory

GeoCalibre Geotechnical Consultancy (Pty) Ltd.

Kevin Coertzen
Professional Natural Scientist (400011/17)
NHBRC Competent Person (Barcode 3000179078)
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Approved by:

Kevin Coertzen	Digitally signed: 23/08/2024	23/08/2024
Name	Signature	Date

Report Distribution List

Date	Name	Institution	Version	Format
23/08/2024	Mr. Niel Swarts	Zutari (Pty) Ltd.	GC24/144A Kalkfontein Reservoir- 3000 kl	PDF.

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This document is prepared exclusively for the Client and is subject to all confidentiality, copyright and trade secrets, rules, intellectual property law and practices of South Africa.

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1. Project Introduction

1.1. Background

A series of detailed reports have been compiled to shed light on the various phases of the Geotechnical Site Investigation- and associated Materials Assessment- conducted in support of the planned upgrades and additions to the existing **Mampuru Bulk Water Supply Scheme.** The scheme falls under the jurisdiction of the Sekhukhune District Municipality within the Limpopo Province of South Africa.

The formal contract details are as follows:

- **WAS/WSP:** Sekhukhune District Municipality (SDM)
- **Contract Number:** SK08/3/1-30/2017/2018
- **Project Engineers:** Zutari (Pty) Ltd.

Individual reports have been compiled for the planned new **water storage structures** set to form part of the upgrades and additions to the existing bulk water scheme. Separate reports have been created for the planned structures and their access roads, with the various sections in the report referring to specific attributes/routes- for easy reference.

The report breakdown for the project is as follows:

- GC-24-144RS- Regional Setting- Structures and Access Roads
- GC-24-144A- Kalkfontein Command Reservoir- 3000 kl
- GC-24-144B- Tsakane Steel Tank- 250 kl
- GC-24-144C- Dithamaga Concrete Reservoir- 600 kl
- GC-24-144D- Mampuru Concrete Reservoir- 1200 kl
- GC-24-144E- Ga-Phasha Steel Tank- 1300 kl
- GC-24-144F- Spitskop Command Reservoir- 15000 kl
- GC-24-144G- Stoking Concrete Reservoir- 700 kl
- GC-24-144H- Mapodile Concrete Reservoir- 3000 kl

1.2. Terms of Appointment

GeoCalibre Geotechnical Consultancy was appointed by Zutari (Pty) Ltd. (Polokwane Branch) to undertake the required near surface site investigation.

The information presented in this document is based on the information supplied by the Client prior to the commencement of the investigation; therefore, GeoCalibre Geotechnical Consultancy (Pty) Ltd- shall not be held liable for, and is indemnified against all actions, claims, demands, losses, liabilities, costs, damages and expenses prompted by, or in connection with, inaccurately relayed information pertaining to the site and/or the development.

The exact nature and design of the future structures across the greater water scheme were not defined at the time of this study, with this near surface investigation utilising typical attributes of structures of this nature to guide the analysis and corresponding recommendations.

1.3. GeoCalibre- Company Background and Information

GeoCalibre is a specialist geotechnical consulting firm made up of a team of qualified professional geo-practitioners. The firm was established out of a love for the industry and an urge to define a new calibre of professional consulting.

GeoCalibre uses advanced scientific methods to create accurate and reproducible geotechnical models; successfully guiding the implementation of site-specific design precautionary measures/engineering solutions. The methodology followed throughout the investigative process accounts for the nature and location of the development as well as adhering to the standards of our practice (SANS and SAICE).

Investigations undertaken by GeoCalibre are overseen by suitably qualified Engineering Geologists *professionally registered* (Pr.Sci.Nat) with the South African Council of Natural Scientific Professions (SACNASP)- in accordance with all the relevant and required procedures and legislations. GeoCalibres employees are also members of the South African Institute for Engineering and Environmental Geologists (SAIEG).

1.4. Limitations of the Geotechnical Assessment

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an **initial phase near surface geotechnical study**- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The results of this level of assessment provides an overview of the geotechnical character of the site, as well as listing prominent adverse geotechnical characteristics. Once access/mobility has been modified follow-up studies can be conducted, where required.

The presented geotechnical models are based on a data base of available information, on-site soil profiles and the results from soil laboratory tests. Parcels of land within the developmental area which are free of excavations are modelled through interpolation and extrapolation of known testing locations, to identify problem issues of a geotechnical nature on which this report is based.

Geological conditions are seldom uniformly developed and areas and positions where geological and geotechnical conditions on the site might vary locally from those described and assessed in this report.

A centerline and materials assessments primarily focus on near surface attributes along the length of any given linear structure (i.e., access roads and pipelines). The primary aim of such a study is to assess the near surface geotechnical nature of the site in relation to planned development. Shallow and/or basic studies of this nature generally do not include specialist geotechnical studies for attributes such as complex surficial structures, thick fill embankments (existing or future), pipe jacking, natural slope/cutting stability, blasting and/or rock crushing attributes and/or soil/rock mechanics. In depth geotechnical studies across target areas can be undertaken by GeoCalibre as part of follow-up studies.

The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result of either natural processes or human activity. If a substantial lapse of time occurs between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we urge that our report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions.

In addition, advancements in the practice of geotechnical engineering and engineering geology and changes in applicable practice codes may affect the validity of this report. Our investigation did not include the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.

1.5. Development within 1 : 100 year-flood lines

It must be noted that the National Water Act (Act 36 of 1998) states the following regarding development within the 1 : 100 year-flood line of any stream or river (Thompson, 2006): **Section 21(c):** Impeding or diverting the flow of water in watercourses (including alteration of the hydraulic characteristics of flood events) requires licensing according to the Act.

Section 21(i): Any action that may alter the bed, banks, courses or characteristics of watercourses (including flood events) requires licensing according to the Act, including: widening or straightening of the bed or banks of a river to allow for the construction the housing development and altering the course of a river partially or completely (i.e.: river diversion) to be able to use or develop the area where the watercourse originally was.

The National Water Act does not prohibit development within 1 : 100 year-flood lines; however, the Act requires detailed analysis of the effects of the proposed development on the surrounding environment, with special reference to surface and sub-surface water flow. The Act requires that suitable precautionary measures be implemented to limit the effect within and downstream from the proposed development.

1.6. Codes of Practise and Investigative Standard

The investigation was carried according to the following standard practice codes and guidelines:

- Guidelines for Urban Engineering Geological Investigations (SAIEG & SAICE, 1997) for urban development.
- Site Investigation Code of Practice put forward by the Geotechnical Division of SAICE (2010).
- SANS 2001-DP1:2011 Earthworks for buried pipelines and prefabricated culverts.
- SANS 10400.
- Applicable technical specification documents of South Africa (SANS, TRH, TMH, COLTO/COTO and SAPEM).
- The guideline and specification documents by the South African Institute of Engineering and Environmental Geologists (SAIEG) and South African Institution for Civil Engineers (1997), AEG/SAIEG/SAICE (2002).

1.7. Information Sources

- **Geological Map:**
  - Geological Series Map 2430 Pilgrim's Rest; scale 1:250 000 (digital format)
- **Hydrogeological Data:**
  - SADC Groundwater Information Portal (SADC GIP)
  - Hydrogeological Series Map 2330 Phalaborwa (1998); scale 1: 500 000 (digital format)
  - Electronic Maps of the Water Management Areas and Drainage Regions in South Africa- DWAF [Department of Water Affairs and Forestry]- 1996 and 1999 (www.dwa.gov.za).
- **Topocadastral maps:**
  - 2429 Dd; scale 1:50 000 (digital format)
  - 2430 Ca; scale 1:50 000 (digital format)
  - 2430 Cc; scale 1:50 000 (digital format)
- **Provided by the Client:**
  - Structure location and planned access road route
- **Remote Sensing Information:**
  - Google Earth Pro ™
  - Planet GIS Limpopo Cadastral Land Layer (2022)
- **Available geotechnical reports:**
  - Numerous geotechnical reports from the region compiled by Kevin Coertzen (Pri.Sci.Nat and MSAIEG)

1.8. Scope of the Investigation

A near surface geotechnical site investigation was be carried out across each of the areas in question in order to assess the mechanical nature of the underlying strata and model the geomorphological nature of the local setting. Following the assessment, GeoCalibre provides recommendations on the implementation of **site-specific engineering solutions.**

The aim of the overall site investigation can be summarised as follows:

- Establishment of a **regional geological**, **geomorphological** and **geo-technical** model for the site.
- To delineate the **succession of strata** (soil and rock) underlying the site; with the identification of problematic **physical, chemical** and **mechanical** characteristics which may influence the development.
- To quantify the **in-situ mechanical properties** of the soft materials underlying the site; specifically, with regards to the proposed future developments.
- To compute the **excavatability properties** of the materials underlying the site.
- To assess shallow **groundwater** patterns.
- To evaluate the basic **re-usage potential** of the materials underlying the site.
- To aid the development moving forward through the formulation of an **accurate geotechnical model** for the site under investigation.

The near surface site investigation was undertaken in order to assess the basic engineering geological character of the site, focussing on the geotechnical properties which will affect the development potential of the area in question with regards to the **installation of civil engineering services** and the construction **surficial water storage structures** and their associated **gravel access roads**.

The investigation excludes the following aspects, where applicable:

- Geophysical, resistivity, or corrosion studies.
- Dolomite stability or undermining Investigations
- Detailed hydrological, hydropedological, hydrogeological, pedological, flood line, or wetland delineation studies.
- Excavations by means of light/heavy earth moving equipment and associated soil and/or rock sampling.
- Footprint studies along the pipeline routes for the various water treatment works, pump stations, river crossings and pipe jacking sites.
- Borehole drilling and/or rock strength analysis.
- Detailed slope stability assessments.
- Geo-environmental assessments.
- Township establishment/land rezoning (SANS 634).

1.9. Investigative Methodology

The investigation is undertaken in a number of phases in order to achieve the aims discussed above. The investigative phases are as follows:

- **Phase 1: Introduction and Regional Assessment of the Site**
- **Phase 2: Geotechnical Analysis- Structures**
- **Phase 3: Geotechnical Analysis- Access Roads**
- **Phase 4: Data Assessment and Report Compilation**

1.9.1. Phase 1: Introduction and Regional Assessment of the Site

The collation and evaluation of all the available topographic, geo-morphological and geological data across the investigated site and its' surroundings. This assessment is done through the use of available regional maps and remote sensing images.

This section of the report will include a description and summary of the site's nature, based on existing literature, and is supplemented with the compilation of a series of base maps.

1.9.2. Phases 2 and 3: Geotechnical Analysis

Phases 2 through to 4 shared a similar methodology (presented below); with the distribution of testing locations, depth and nature of sampling/testing and footprint specific geotechnical observations at any given portion of the site relating to the nature of the planned structures at said location.

Trenching

The field work phase of the investigation was conducted by GeoCalibre across June and July 2024.

Access to- and mobility- across the target areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by **hand** across the footprints of the planned structures and along the routes of the various access roads.

Across the various sites, between TWO (2) and TEN (10) test pits were excavated by means of **pick-and-shovel** (local labour digging by hand). A total of **50 test pits** were excavated across the greater project area.

Additionally, where applicable, available **exposures/cuttings** situated within close proximity to the various sites were logged and sampled. In many cases, the local cuttings provide greater exposures- both laterally and vertically- of the in-situ materials as compared to the small hand excavated trial pits.

Test pits were distributed across the various sites placed at locations chosen on merit to map and model variances in the underlying strata. Test pit locations were primarily based on the Client's specific outcomes (footprint analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model. Following a detailed site walkover and associated existing services' mapping exercise, planned trial pits were adapted on ground level.

The succession of soil layers exposed within the test pits and exposures were logged by GeoCalibre. The description of soil profiles is done according to SANS 633:2012 which describes the moisture, colour, consistency, structure, (soil) texture and origin. Following detailed logging, a series of detailed photographs were taken of the different soil layers.

Table 1 below presents a breakdown of the trial pits excavated across the various water storage structure and access road sites.

Table 1: Trial Pit Breakdown

Trial Pit Breakdown- Structures and Access Roads			
Description	**Storage Capacity (kl)**	**Access Road Length (m)**	**Combined Quantities**
Kalkfontein Command Reservoir	3000	360	6
Tsakane Steel Tank	250	500	6
Dithamaga Concrete Reservoir	600	-	2
Mampuru Concrete Reservoir	1200	500	7
Ga-Phasha Steel Tank	1300	480	6
Spitskop Command Reservoir	15000	2330	14
Stoking Concrete Reservoir	700	1190	9
Mapodile Concrete Reservoir	3000	500	7

Sampling

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development. Laboratory testing commenced on the samples collected during the field work phase of the investigation.

Undisturbed sample extraction was not possible/feasible across the various sites as a result of the granular nature and elevated consistency of the foundation zone materials. For this reason, the mechanical assessment of subsoils will be based on the available disturbed soil test results and field observations (i.e., structure, composition, and consistency).

Laboratory Testing

Standard foundation/road indicator and soil compaction tests were conducted by Tzaneen Lab (**SANAS Accredited- 17205**) on disturbed and bulk soil samples.

These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the proposed construction. The following tests were conducted:

I. Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage)- (SANS 3001: GR10/11)

II. Particle-size Distribution (SANS 3001: GR1)

III. Maximum Dry Density vs. Optimum Moisture Content (SANS 3001: GR30)

IV. Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method) (SANS 3001: GR40)

V. pH and Electrical Conductivity (chemical testing)

In-situ Testing- DCP Testing

In-situ penetration tests were conducted alongside and between the excavated test pits in order to determine the quantitative soil consistency conditions.

Standardised DCP tests (8 kg hammer falling 575 mm with a tip/cone of 60°) were implemented as to give an indication of the consistency of the in-situ material of the layer house in question. Soil strength and stiffness are correlated with consistency of earthy soil material and penetrometer testing is used to determine the consistency of both cohesive and non-cohesive materials.

In the design of light structures and roadways, the DCP is a practical test used for onsite measuring of material strength. The test results can be correlated with the California Bearing Ratio (CBR) by applying a formula; results of which can be correlated to the laboratory tests conducted on the soils from the same location. Furthermore, an inferred depth to bedrock can be modelled using the DCP refusal depths. Although not exact, these depths aid in formulating a regional excavation model across the development area.

1.9.3. Phase 4: Data Assessment and Report Compilation

The investigation concluded with the compilation of numerous technical reports detailing the methodology utilised during the study and the summarised results obtained. This includes a potential geotechnical evaluation of the site based on the cumulative results of the near surface investigation.

2. Description of the Environment

2.1. Site Location and Description

The **study area** for this investigation is seen to fall within the southern to south eastern portions of the Limpopo Province of South Africa- proximal to provincial border with Mpumalanga. On a more localised scale, the study area is situated approximately 20 km south west of the mining town of Steelpoort (Figure 1). Moreover, the study area is positioned across Portion 11 of the Farm Kalkfontein 367 KT, within the bounds of the Fetakgomo Tubatse Local Municipality of the greater Sekhukhune District Municipality.

The site forms part of the upgrades and additions to the existing **Mampuru Bulk Water Scheme,** which is a strategic water project from SDM that supplies water to the various end users across the Steelpoort Valley. The portion of land forming the focal point of this investigation is located in the south western extent of the cumulative study area.

More specifically, the **site** is situated along the side slope of a radial ridge which falls within the central to northern extent of the village locally known as **Kalkfontein**- bearing the same name as the farm on which it was established. This high-lying terrain is accessible via the District Road 212 (D212) which extends from the Regional Road R555 (R555) to the south east. The D212 bisects the village of Kalkfontein, following which the various gravel roads which combine to form the internal network of the village can be used to access the site.

The **site** was primarily investigated to assist with the design and construction of a **3000 kl concrete command reservoir**. Additional to the planned reservoir, the development includes the construction of a **winding access road**, with a length of approximately **360 m**.

The footprint of the planned development was not defined on ground level attributed to the **undeveloped** nature of the site, with the Client providing a pin location delineating the centre of the proposed reservoir and associated path for the future gravel road set to form its primary access route during construction and subsequent stages.

The planned **starting point (0+000)** of the access road is located at the base of the ridge- creating an intersection with an unnamed gravel road. The access road climbs the steep sloping flanks of the ridge in a meandering fashion on route to the proposed reservoir location to the east. Moreover, the road hosts multiple 180-degree hairpin turns at ~0+087, 0+160 (TP2), and 0+235 resulting from the natural slopes along its length. The **termination point of ~0+360** is achieved as the road approaches the structures' planned **footprint** from the north/north west.

The access road's shape- as presented by the Client- represents an attempted optimisation of the infrastructure across the complex topographic setting, including attributes such as road length/footprint, modification requirements, usability constraints and budget considerations, to name a few.

Refer to Image 1 at the end of this section which graphically depicts the breakdown of the site and its cumulative attributes. The defined points of interest across the site- as received from the Client- are presented in Table 2 overleaf.

Table 2: Points of Interest

Kalkfontein Command Reservoir- 3000 kl - Points of Interest			
Points of Interest		**Co-ordinates**	
Access Road	**0+000**	Latitude 24.883518°S	Longitude 30.069291°E
	0+360	Latitude 24.884050°S	Longitude 30.070895°E
Reservoir Location		Latitude 24.884024°S	Longitude 30.070839°E

The cumulative development across the surface will encompass the subdivision of this land portion into various land-use zones i.e., infrastructural units, roadways, and services etc. Each of these zones may require their own set of unique geotechnical recommendations determined by the properties of the in-situ material. The geotechnical properties of these separate areas/attributes are dealt with individually in the succeeding sections of this report- as follows:

- Section 3: Combined Terrain Analysis
- Section 4: Geotechnical Evaluation- 3000 kl Command Reservoir
- Section 5: Geotechnical Evaluation- Access Road

Report GC-24-144-RS covers the **regional attributes** of the study area, including detailed discussions regarding the topographic setting, regional geology/ hydrogeology, vegetation and local cuttings across the visited villages. Although alluded to, these attributes are not duplicated in this document.

2.2. Site Observations

Numerous observations were made by the field team with regard to the current condition of the investigated site. These observations are graphically depicted in the photo series to follow at the end of the discussion.

The following basic notes were highlighted by the field team:

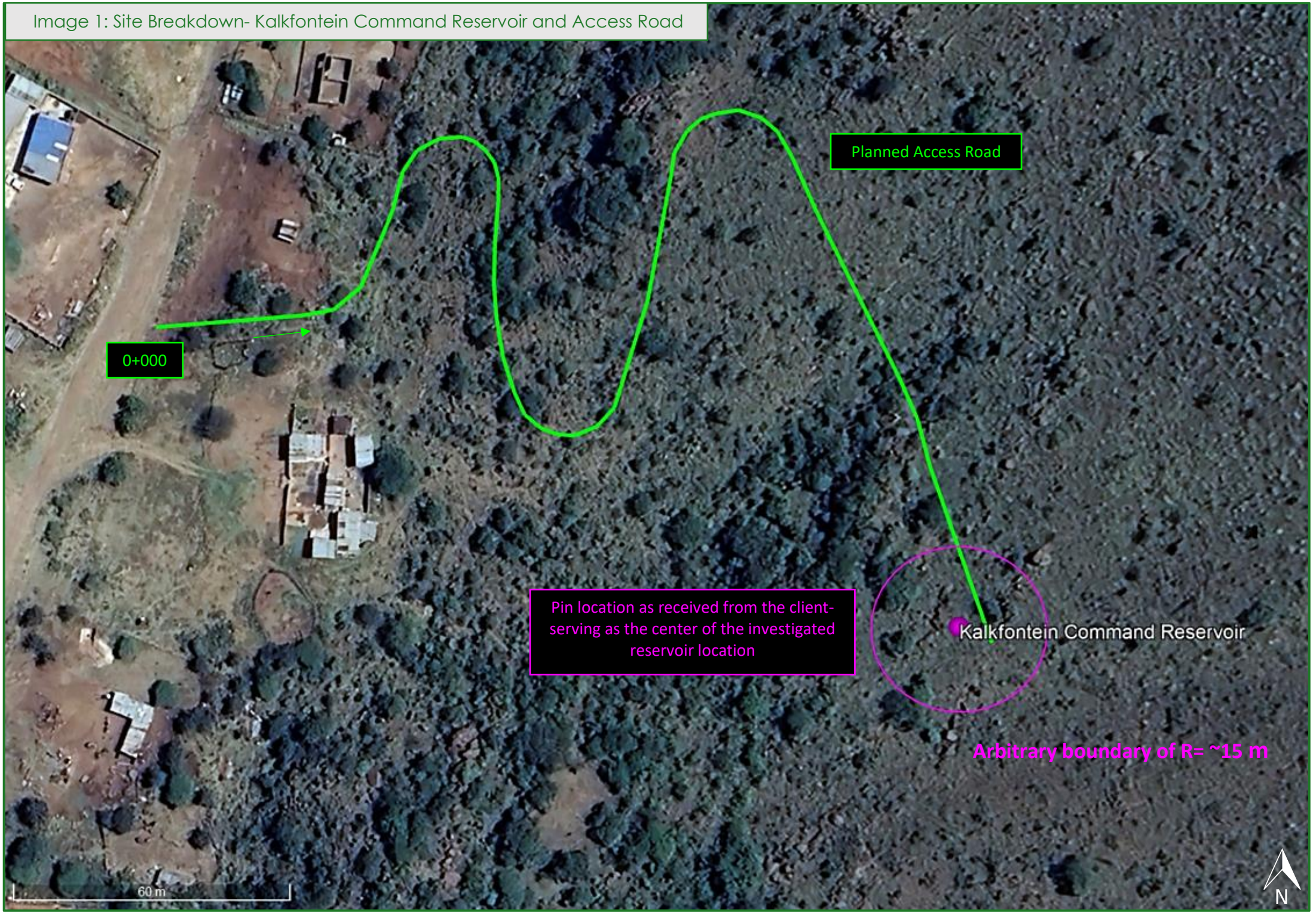
- **Slope:** the site exhibits a complex topographic setting, with its predominant steep sloping morphology limiting mobility.
    - The far western extent of the site was seen to exhibit an initial reduced declivity- just off the foot slope of the radial ridge.
    - Once on the side slope of the high-lying terrain, the declivity rapidly increases, with the majority of the site exhibiting a rocky and steep sloping morphology.
    - A localised portion of the proposed reservoir location was seen to be comprise of a small plateau surrounded by steep sloping terrain upslope as well as downslope from this feature.
    - No erosional landforms were encountered across the surface of the site. The rocky surface in conjunction with the natural vegetation is predicted to retard surface water flow just enough in order to prevent erosion from occurring. Following manipulation of the surface of the site and removal of vegetation, the possibility of erosion/deformation greatly increases.

- **Rocky/Bouldery Surface and Outcrops:** in addition to the steep sloping topography of the site, the surface exhibits a rugged morphology comprised of minor rocky ridges, outcrops and intermittent cobbles and boulders.
    - The rough terrain is anticipated to result in significant mobility/access and excavatability issues across the site, specifically during the initial phases of construction.
    - The possibility of dislodged cobbles/boulders from further upslope following disturbance of the natural conditions should not be overlooked in order to ensure a safe working environment.
- **Vegetation and biotic activity:** the site was primarily seen to be blanketed by fine grass cover with intermittent shrubs/bushes and xerophytes.
    - Small to medium-sized trees were also encountered intermittently, with the majority of these flora species encountered proximal to the previously mentioned secondary ridges.
    - Pockets of dense vegetation may cause localised terrain mobility issues. No significant biological activity was encountered across the site attributed to the steep nature of the area.

Refer to the photo series below which graphically depicts the nature of site and its immediate surrounds at the time of this study.



Image 1: Site Breakdown- Kalkfontein Command Reservoir and Access Road



2.3. Regional Geology

According to the available geological information (geological series map: 2430 Pilgrim's Rest); the proposed reservoir location and access road are underlain by the following geological units (Figure 2):

1. "**Q**"- Surficial deposits including **alluvium** and **scree.**
2. "**Vr**"- Medium- to coarse-grained **magnetite**, localised magnetite layer- **Roossenekal Subsuite** of the *Rustenburg Layered Suite*.
3. "**Vdj**"- Coarse-grained **gabbro** and anorthosite with localised anorthosite layers, pyroxenite and magnetite plug- **Dsjate Subsuite** of the *Rustenburg Layered Suite*.

A detailed discussion regarding the regional geological setting and its associated attributes is presented in report GC-24-144/RS.

Following the excavation of the trial pits, it was noted that the site is blanketed by transported sediments of **colluvial origin**. Moreover, the surface of this horizon was notably rocky with surficial cobbles/boulders frequently encountered along the steep sloping flanks of the radial ridge. The blanketing sediments were generally underlain by weathered bedrock- with the exact classification of the rock mass not possible due to its limited exposure and weathered state. Based on available exposures, the rock mass is predicted to comprise of **gabbro** with possible pockets of anorthosite (Dsjate Subsuite).

2.4. Vegetation and Biotic Activity

At the time of this investigation, the vegetation across the site was comprised of a dense grass cover with intermittent shrubs, xerophytes and varying sized trees scattered between the rocky surface. The natural vegetation will need to be modified in the early stages of the construction to aid access and terrain mobility.

In the exposed profiles, the degree of organic material and biotic activity was seen to decrease with an increase in depth, with the major root system reaching an average depth of approximately **0,33 m** below natural ground level. Fine roots were generally encountered in grassy areas, the extent of which was limited to the organic rich topsoil. Extensive sub-surface vegetation is predicted to occur in areas hosting trees; however, the extent of these root zones is predicted to diminish with an increased distance from the trunk.

Regarding bio-engineering, the natural vegetation cover protects the slope from erosion (run-off and rain splash) and serves as a anchoring mechanism to reduce the possibility of shallow seated instabilities. The effects of the removal of trees on sites should also be considered. The removal of large trees can result in the formation of highly compressible zones of voided soils, elevated moisture conditions and can impact existing slope stability. Such areas should be treated as zones of possible risk and should be dealt with accordingly in the design.

Moreover, many of the large flora may be endangered- in which case removal may not be a viable option. This should be kept in mind when defining the location of the future structures. A competent professional- such as a botanist or environmental scientist- can assess the sensitivity of the natural vegetation if required and provide suitable mitigation measures. This attribute is applicable to all greenfield developments in the area.

3. Basic Terrain Analysis

3.1. Site Topography

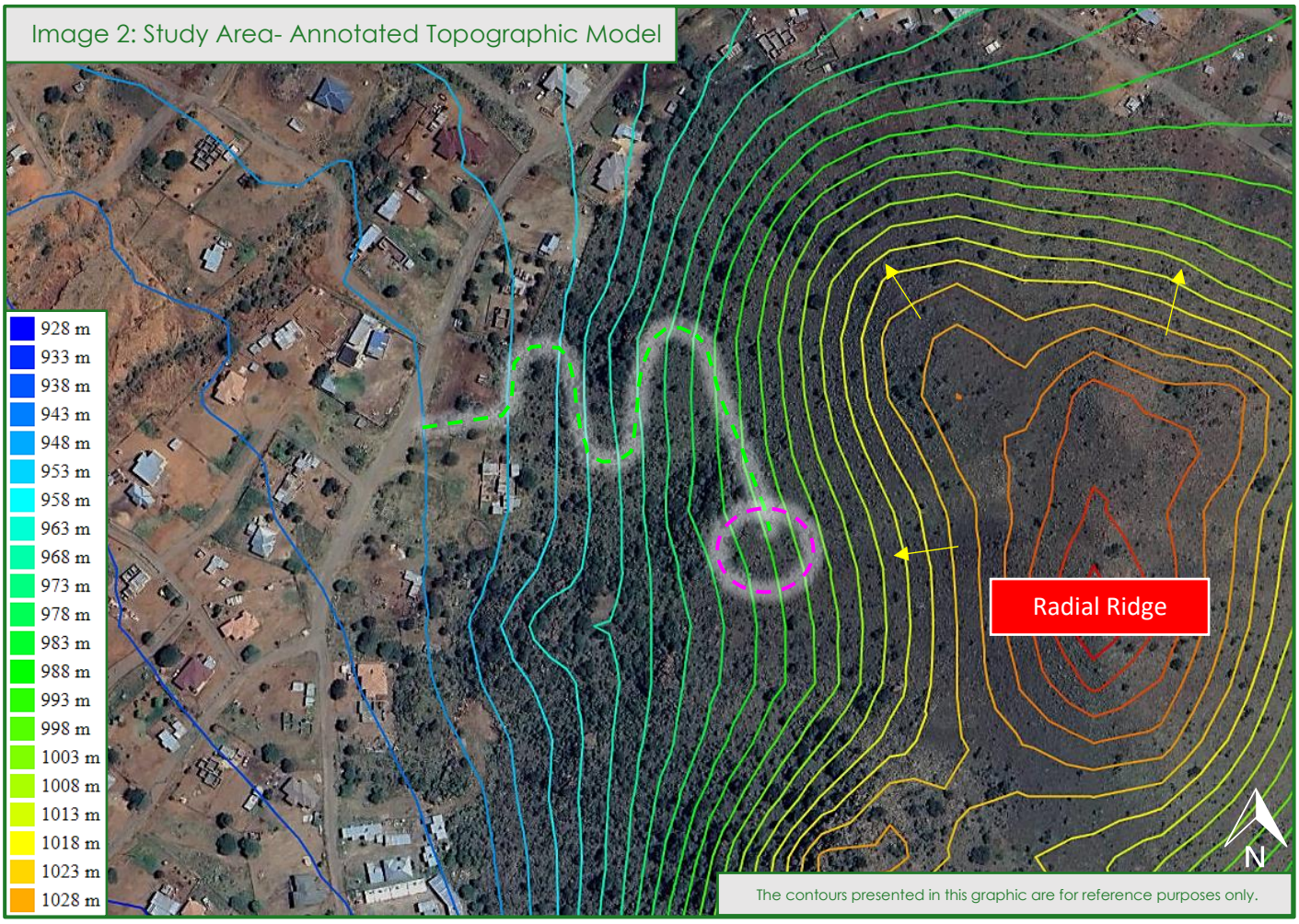
Topography is based on elevation profiles from the available remote sensing information and basic field observations. This does not substitute land survey data. Topography and regional hydrology (e.g., steep slopes, very flat slopes, defined drainage features, and rapid changes in slope) affect the distribution of ground as it affects the weathering, erosion, transport, and deposition of materials. As such, it provides a valuable indication of possible changes in subsurface ground and water conditions, but also affects the stability of slopes and the direction of surface runoff.

As seen in the annotated topographic map below (Image 2); the eastern/south eastern portions of the study area are seen to exhibit a **high-lying** topographic nature, hosting an irregularly shaped **radial ridge**. The radial ridge serves as the **watershed feature** for the study area and its immediate surrounds. The orientation and extent of the watershed feature directly impacts the geomorphological nature of the site in question.

Furthermore, the **natural slopes** (yellow arrows) extend **radially** from the high-lying terrain, towards the surrounding low-lying areas (green and blue contours). Once of the immediate **steep sloping flanks** of the radial ridge, the topography displays an **abrupt reduction** in **declivity**, characterized by uniform and continuous surficial morphology as evident by the **increased spacing** of the **contours** and overall decreased range in elevation.

Refer to Image 2 below which graphically depicts the topographic nature of the study area and its immediate surrounds.

Image 2: Study Area- Annotated Topographic Model



With reference to Image 2, the **planned reservoir- and associated access road-** is located along the steeply sloping western talus slope of the mapped high-lying terrain- immediately west of its crest/watershed. Consequently, the **natural** topographic nature of the site can be largely characterised by **very steep slopes** in **excess of 12 degrees** (natural)- extending from the higher lying areas to the east- towards the low-lying western portions.

Across the low-lying western portions, the planned access road is initially orientated parallel to natural slope and displays a reduced declivity. Once the road encounters the very steep sloping flanks of the radial ridge, the road adopts a **meandering shape** in order to accommodate the abrupt change in surface elevation. From this point, the road exhibits a near continuous increase in elevation with an increase in chainage as the road climbs upward towards the planned reservoir location.

The lowest surface elevation of ~ 943 meters above mean sea level (MAMSL) is recorded at the access road's starting point (far western portions). The surface elevation increases in a general easterly direction towards the routes' termination point- proximal to the reservoir location- with a surface elevation of ~992 MAMSL (calculated using Google Earth PRO ^{tm}).

Localised slope variances were encountered due to the occurrence of small-scale natural anomalies such as local terraces. Once surveyed, topographic anomalies will need to be addressed individually in the engineering design and in so doing eliminating their localised effects. Based on the available information, the development will entail the rehabilitation of the sites surface- within and immediately surrounding the planned future structures and roadways.

3.2. Drainage Attributes

The drainage nature of the study area will mirror its' topographic nature as described in Section 3.1 of this report. The crest of the ridge annotated on Image 2 will serve as the **primary watershed** feature for the site and its immediate surrounds. Due to the proximity of the site to the high-lying terrain, it is predicted that the catchment area for surface water is limited.

Developments of this nature typically include the rehabilitation/remoulding of the site's surface. As a results of the sites complex topography and geographic location, the design and implementation of **fit-for-purpose site modification and drainage measures** are essential for the stability and longevity of the development. Future anthropogenic attributes will influence natural infiltration, shallow throughflow and run-off rates. Importance should be placed on surface drainage and storm water control measures to avoid instabilities, focused infiltration, surface water ponding and erosion.

Addressing the concerns surrounding the **convergence** of surface water upon the site- originating from the bordering crest of the ridge- is key to the stability and longevity of the development as a whole. Convergent high-energy flow upon the site from the surrounding high-lying terrain elevates the rate/energy of surface water flow- increasing the risk of erosion and instability of future cuts.

The cumulative **developments orientation** in relation to the natural slopes- specifically with regards to the meandering access road- will impact the rate and associated energy of the overland flow. Topographic anomalies identified during the professional survey can be addressed individually in the design.

Across most of the sites' footprint, due to the **very steep sloping nature**, it will drain mainly by means of **high energy surface run-off (sheet-flow);** with storm water flowing from the high lying eastern portions of the site, in a general westerly direction. Most of the access roads' route was seen to traverse the natural slopes at an **obtuse angle**, with **medium to high energy surface water flow** expected to take place **along the length of the road**. The anticipated high energy run-off across the sites' footprint elevates the risk of erosion as well as the instability of slopes following modification.

Conversely, across the low-lying western portions and where cuts/platforms or terracing are implemented to modify the sites surface, these **artificially induced very gentle/gentle sloping** portions will drain mainly by means of **low energy surface run-off (sheet-flow).** These portions of the site will be subjected to elevated degrees of **surface water infiltration** into the underlying soils, rather than rapid surface water flow, accentuating **surface water ponding** and **fluctuating moisture conditions** after precipitation events. Furthermore, the sudden decreased rate of surface water flow from the steep portions and cuttings to anthropogenically induced flat slopes/platforms may result in a combination of focused infiltration and piping/erosion.

The planned infrastructure is located downslope of currently undeveloped land. Although generally steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of shallow ground water throughflow may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

According to the available information (Topocadastral Maps 2430 Cc- Figure 3), **no** natural drainage structures are seen to traverse the site.

3.3. Erosion

As a result of the sites' natural slope, erosion will be a concern, however no erosional landforms were visible at the time of the investigation- predicted to be as a result of the stabilising effect of the natural vegetation and retarding effect of the rocky/bouldery surface on flow. Once the vegetation and surficial cobbles/boulders are removed following site preparation, the risk for erosion will greatly increase.

According to the TRH20, the ability of the material to resist/avoid erosion depends on the shear strength of the material which is equal to the cohesion of the material as no normal stress is applied to the blanketing materials. If the attractive force of the water is greater than the shear strength of the material, then erosion will occur.

The following are generally accepted findings on the relationships between different properties and erodibility parameters of soil:

- An increase in percentage clay, accompanied with an elevated cohesion, leads to an increase in erosion resistance.
- In general, an increase in PI leads to an increase in erosion resistance.
- Fine, poorly graded material with limited coarse particles (grading coefficient of less than 16) are highly susceptible to erosion.
- High energy channelized flow surface water flow will elevate the risk for erosion and scouring/undercutting across the footprint.
- Steep/converging slopes increase flow velocities/volumes and as such decrease erosion resistance.
- Dispersive soils tend to be less erosion resistant.
- Erosion may cause changes in the properties of the material over the design life as certain fractions are removed.

Inadequate temporary erosion and drainage control measures can result in severe damage to infrastructure. The following can be done to **minimize erosion** of problematic soils during and following the planned construction:

- Erosion can be reduced by elevating the shear strength of the material by increasing its compaction and ensuring a well-graded mixture of material resulting in increased particle interlock. The improved interlocking increases suction forces within the material and decreases permeability/penetrability.
- Intercept or minimise surface wash towards the future infrastructure from upslope areas. The energy of the water can be decreased by retarding the rate of flow using good drainage measures.
- Drainage measures at regular intervals along newly constructed roads, with these drainage systems designed in such a way so as to reduce erosion across the outflow/discharge areas.
- Depressions created along the steep sloping routes may act as preferential flow paths following precipitation- with the channelised flow inevitably resulting in the formation of erosional landforms.
- Trench backfills and shoulder materials should be modified to an equivalent compaction/density of surrounding soil- in so doing controlling the natural infiltration/through flow characteristics of the regional materials (i.e., eliminating irregularities).
- Consider treating dispersive subsoils with gypsum prior to compaction and/or backfilling to minimise risk of tunnel erosion- along the road shoulder and back filled pipeline routes.

Lastly, a maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.

3.4. Natural Slope and Future Cutting Stability

Detailed stability assessments of existing- and future- deep cuttings did not form part of the scope of this initial phase investigation. With this said, **no natural** slope instabilities or inherent ground instability signs such as tension cracks etc. were evident during the site walkover and basic visual inspection.

Across most of the site, excluding the localised mobilisation of cobbles and gravels, it is envisaged that temporary shallow trenches and/or cuttings to depths of up to 1 m will remain stable- the stability of which can be assessed periodically. Where thick successions of the heterogeneous colluvium are encountered, minor collapse in the form of dislodged particles may occur.

The final layout of the development is not known but based on the natural slopes prior to modification, specialised methods for the stabilisation of cuts into the existing slopes are deemed necessary. It is recommended that specialist geotechnical investigations for major cuts be undertaken by a competent person as part of design level studies. Where possible, detailed face mapping and joint line surveys can be undertaken along freshly created cuttings.

In contrary to the problematic colluvial sediments, the local igneous rock masses are not generally prone to major instabilities based on the available theoretical databases and as seen in local cuttings. Although it is predicted that fresh exposures in bedrock exhibit stable conditions in near vertical cuts (depending on orientation), it is recommended that the permanent cuttings be adequately sloped (approximately 60 to 75 degrees) or stabilised to reduce the risk of instabilities. Instability in these igneous bodies is predicted to be in the form of localised rock block failure, necessitating the removal or stabilisation of unstable rock blocks. Though rare, problematic joint sets/features can be present especially surrounding geological structures.

As a guide, where deep cuts/thick fills are implemented to modify the sites surface, cut/fill embankments will need to be adequately sloped, modified or stabilised- and vegetated where possible- to ensure long-term stability in saturated conditions. Soil slope modification methods/considerations may include- but are not limited to- the following:

- Visually identifying and alleviating local boulders/debris in the vicinity of the planned cuttings. Caution taken during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/infrastructure or life.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.
- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability. Therefore, adequate drainage measures need to be implemented for major cuttings.
- Modifying the slope geometry by reducing the slope angle, removing weight from the slope head, increasing weight at the slope toe and/or constructing of benches or berms.
- Constructing walls or other retaining elements (reinforced earth walls, gabion walls, loffelstein walls).

- Surface protection measures including wire meshes, geotextiles and using plant cover to help reinforce the ground surface of soil slopes.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the road/reservoir shoulder.
- All cuttings should be periodically assessed by a geo-professional or competent engineer.
- No loading of the temporary slopes by machinery, equipment, excavated soil or materials shall be allowed.

Due to the site gradient- cut to fill site preparation is expected. A carefully engineered fill embankment should not settle more than 0.5% of its height due to self-weight. Density control of placed fill material should be undertaken at regular intervals during fill construction. Engineered fill slopes should be over constructed and thereafter trimmed back to the required position.

4. Geotechnical Evaluation- 3000 kl Command Reservoir

4.1. Introduction and Description

This section of the report focusses on the geotechnical attributes within proximity to the predetermined footprint of the planned **reservoir**- hereafter referred to as the **site.** Attributes surrounding the planned access road route will be addressed in the subsequent section (Section 5).

A pin location defining the centre of the planned structure was provided by the Client prior to the field work phase of the investigation. The final working levels/layout of the development is not known at this stage, with this study utilising typical attributes of structures of this nature to guide discussions.

Access to- and mobility- across the target areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by **hand** across the footprint of the planned structure. The presented geotechnical model is based on a data base of available information and available on-site exposures.

4.2. Trenching

The field work phase of the investigation was conducted by GeoCalibre in June 2024. Across the reservoir site, a total of THREE (3) test pits (TP4 to TP6) were excavated using labours digging by **hand** (pick-and-shovel method), to a depth of approximately 1.0 meters below the existing ground level, or refusal.

Trial pit placements were undertaken in such a way so as to create an accurate and reproducible site-specific geotechnical model. Test pit locations were primarily based on the Client's specific outcomes (foot print analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model.

An *Engineering Geologist* supervised the excavation of the trial pits. The description of the exposed ground profile is done according to SANS 633:2012 and describes the moisture, colour, consistency, structure, (soil) texture and origin. The soil profile is described according to the following parameters:

- **Moisture** dictates the colour and consistency of soils and indicates how and where water moves and the depth to perched water systems.
- **Colour** indicates the oxidizing or reducing state of soils and assist in the identification of minerals in completely weathered to fresh rock.
- **Consistency** is separated between cohesive and granular as the drainage and permeability affects the soil's shear strength.
- **Structure** describes any relict features from rock or soil and those that form through packing, soil and rock structures, seepage, reworking/biotic action.
- **Texture** is the abundance of different grain sizes in soils and is described by means of field test.
- **Origin** is the formation of the soil by means of transport of weathering.

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development.

4.3. Generalized Ground Profile

Note: this description is based on field observations and does **not** reflect the results of any laboratory tests.

4.3.1. Introduction

During the trenching phase of the investigation, it was noted that the investigated area is generally blanketed by an organic-rich horizon of gravity transported material- profiled as **colluvium**. The blanketing sediments were underlain by **varying degrees of weathered gabbro bedrock** deemed to be in the late stages of rock decomposition/early stages of soil formation. The formation of residual soil is generally limited across the steep sloping flanks of the ridge/site due to the reduced amounts of infiltrating water- with the majority of the overland flow converging downslope towards the low-lying areas.

The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock. Moreover, based on the limited exposures, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material. Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and continuity.

Based on the available exposures of the weathered bedrock, the rock mass underlying the site is deemed to be **gabbro**. Lastly, pedogenic inclusions in the form of calcification staining and calcrete nodules were encountered within the weathered material. These pedogenic inclusions can be attributed to infiltrating water and subsequent alteration/weathering of the calcium-rich minerals in the rock mass.

In depth soil profile descriptions for each test pit location are presented in **Appendix A.**

The information presented in the sections to follow is based on point data. Every effort was made during the site investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. Variances in soil quality and quantity from those predicted may be encountered during construction and these should be recorded.

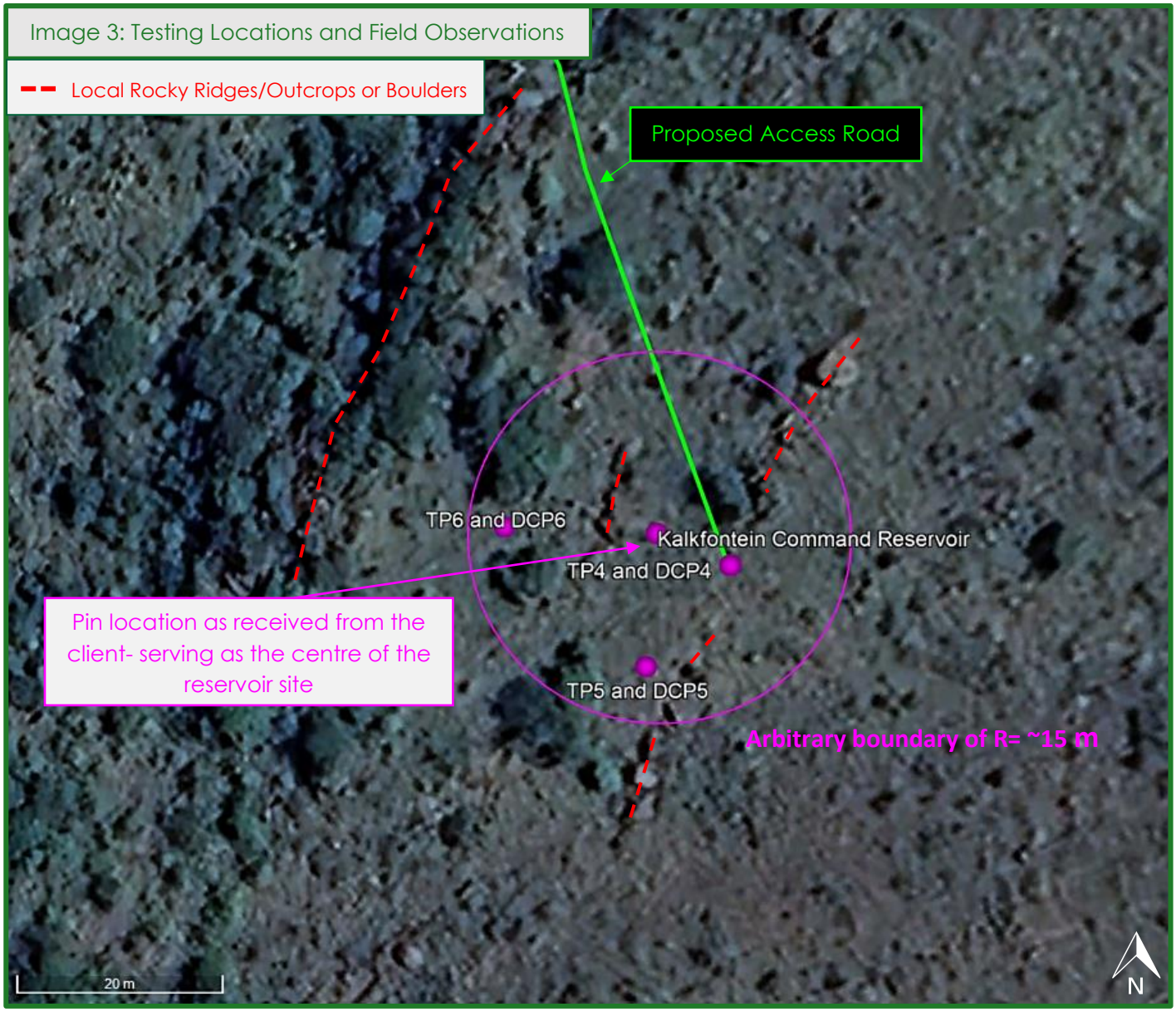
Although the section below presents a summary of the generalised soil profile exposed across the site- it should be noted that variability was encountered in numerous individual excavations, amplifying geotechnical variability.

Refer to Table 3 overleaf which depicts the summarised ground profile of the site. Following this table, Image 3 depicts the testing locations and basic field observations across the site.

Table 3: Summarised Ground Profile for the Site

Summarised Ground Profile									
Test Pit	Colluvium			Weathered Gabbro Bedrock			Excavation Character		
	From	To	Thickness (m)	From	To	Thickness (m)	Test pit depth (m)	Termination Conditions	Termination Material
TP4	0,00	0,49	0,49	0,49	1,10	0,61	1,10	ES	WGB
TP5	0,00	0,36	0,36	0,36	1,16	0,80	1,16	R	WGB
TP6	0,00	0,50	0,50	0,50	1,06	0,56	1,06	ES	WGB
Data Summary	**Minimum**		0,36	0,36	1,06	0,56	1,06		
	Max		0,50	0,50	1,16	0,80	1,16		
	Average		**0,45**	0,45	1,11	**0,66**	**1,11**		
Notes:	Thickness refers to the exposed thickness of each soil horizon (meters) All depths displayed in meters (m) Horizon depths displayed in the table are average measured values Excavation conditions: R-Refusal; DE - Difficult Excavation; ES- Excavation Stopped Materials: WGB- Weathered Gabbro Bedrock								

Image 3: Testing Locations and Field Observations



The ground profiles across the site can be **generally summarised** as follows:

4.3.2. Transported Sediments- Colluvium

The site is blanketed by organic rich and granular transported material profiled as **colluvium.** These transported materials have been transported by a natural agent during relatively recent geological times and have not undergone lithification into a sedimentary rock. Furthermore, due to their age and shallow occurrence- these deposits may lack essential pre-consolidation characteristics. This may result in additional movement upon saturation and loading.

The colluvium was seen to host the major **root systems** and associated biotic activity across the site. In areas proximal to large flora species, the roots zone is anticipated to extend to significant depths.

The colluvium is dominated by **sand** but hosts a variable assortment of gravels, cobbles and boulders which have been transported downslope and gradually incorporated into the horizon over time. The larger granular materials are generally concentrated at- or near- the surface of the horizon as can be seen by the rocky nature of the site.

The exposed successions of colluvium were seen to be slightly variable, with fluctuations in composition and colour across the investigated area. Overall, the colluvium exhibited a **low in-situ density**, **heterogeneous composition** and voided nature.

The **colluvium** was described by the field team as; *slightly moist; light brown, light orangey brown, blotched cream, mottled white;* ***medium dense; pinholed; silty or clayey sand with minor or traces of sub-angular gravels and cobbles****;* ***surficial gravels, cobbles and boulders****; gravels and boulders decreasing with depth; biological activity;* ***abundant fine roots.***

This organic rich transported material was generally seen to extend from the surface to depths of between **0.36 and 0.50 m** below the existing ground level (E.G.L.)- with an **average exposed thickness of ~0,45 m.**

4.3.3. Weathered Gabbro- *Dsjate Subsuite*- Rustenburg Layered Suite

Across the proposed reservoir location, the organic-rich transported sediments were underlain by **varying grades of weathered rock** formed from the decomposition of the regionally abundant **gabbro** bedrock.

Moreover, the exposed protolith was seen to display an irregular degree of weathering with pockets of less weathered material frequently encountered within the soil-like completely weathered gabbro- representing an irregular and undulating weathering profile characteristic of igneous rock masses.

The calcium-rich minerals within the exposed upper extent of the rock mass have been significantly altered by infiltrating water and associated processes over time- resulting in the formation of pedogenic inclusions in the form of calcification staining/calcrete nodules. The calcification and degree of weathered is anticipated to decrease with an increased depth from natural ground level (where weathering is most concentrated).

The **weathered gabbro** was generally described by the field team as: *slightly moist; **light greyish white**, **mottled/speckled black**, **or yellow; coarse grained; relict joint planes; highly weathered; soft rock; gabbro of the Dsjate Subsuite-Rustenburg Layered Suite**; traces of fine roots in the upper extent; **pockets of less weathered bedrock at the base**; gradual transition to less weathered bedrock with depth; **minor calcification.***

Weathered gabbro was profiled to extend to depths of between **1.06 and 1.16 m** below E.G.L; displaying an **average exposed thickness** of **0.66 m**. In both test pits TP4 and TP6 excavations were stopped within the weathered rock mass, whereas TP5 underwent refusal to pick-and-shovel on less weathered bedrock at depth.

4.4. Groundwater and Shallow Seepage

4.4.1. Introduction and Discussion

A detailed hydrocensus was not undertaken across the study area. For this reason, the static rest level and chemistry of the ground water cannot be discussed. Without knowledge on the depth to permanent groundwater in the region- it is not possible to comment on the occurrence of permanent groundwater flow within/below the subsurface of the site.

If required, a detailed hydro census can be conducted across the site to determine/model the permanent ground water table depth, location and quality underlying the site. Additional to this process, monitoring boreholes/ piezometers can be installed across the development area to examine ground water patterns seasonally.

Managing surface water across the development area will play a pivotal role in reducing ponding, erosion as well as limiting the volumes of sub-surface flow. Additional to the considerations listed above, a **maintenance regime** and ongoing performance testing should be put in place to monitor the nature of the system over its useful life.

4.4.2. Measured Ground Water Occurrences

No ground water seepage or permanent water table was encountered during the fieldwork phase of the investigation.

As a side note, if the constructed water bearing structures (pipelines and reservoirs) are not properly constructed/maintained resulting in leakages, the additional influx of water into the subterrain will impact their associated mechanical properties.

4.4.3. Fluctuating Moisture Conditions

The predominant runoff will occur as high energy overland-flow following the topography. As discussed in Section 3.2, the planned infrastructure is located downslope of currently undeveloped land. Although generally steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of **shallow ground water throughflow** may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

Altering the soil profile in areas underlain by shallow bedrock commonly affects the subsurface seepage.

Following site modification practises (cut-to-fill), the upper transported materials will allow **infiltration**. Infiltrating water is predicted to temporarily flow/perch along the **rock-soil interface**, with its flow dynamics dependant on the topography of the rock mass at that point. This typically manifests as a weak, relatively **short-lived perched water** table associated with slight groundwater seepage present directly after a precipitation event. Furthermore, the **undulating topography** of the bedrock affects the continuity of the **shallow water flow dynamics** of the site.

The completely weathered gabbro bedrock was seen to host variable amounts of **pedogenic** materials in the form of calcification staining and calcrete nodules. These pedogenic materials are not predicted to have formed due to excessive amounts of infiltrating/perching of water but are likely amplified by the mineralogy of the rock and susceptibility of the mafic minerals to decomposition. Nonetheless, these pedogenic inclusions indicate the periodic occurrence of **fluctuating moisture conditions** after prolonged precipitation events.

Good site drainage measures, on surface and subsurface, must be implemented to prevent moisture changes, which may add to the development of temporary perched groundwater tables. During construction and after development, shallow perched water systems may develop yet further due to stormwater management practices, localised infiltration and site modification practices**.** The implementation of a sub-surface drainage system is deemed necessary should foundation configurations result in the damming up of ground water flow.

Foundations and installed services will cause soil density and texture changes which may lead to variations in soil moisture across the site with flow changes and build-up of moisture that may differ from the natural conditions. The weight of the structures on the surface may result in an increased ground water rest level. As good construction practice, adequate damp-proofing measures should be implemented beneath individual structures.

Excavations may need to be dewatered following prolonged precipitation events- to be undertaken in line with the prescribed HSE protocols. Furthermore, the influx of water- both surface and sub-surface- into the trenches may drastically impact their stability.

4.5. Bedrock Outcrops/Boulders

Boulders/outcrops were intermittently encountered across the site- some of which are indicated on Image 3. Surficial occurrences were inspected and photographed by the field team- examples of which are included in the photo series below. The exact nature and extent of these anomalies is not known generally as a result of the shallow soil cover and existing vegetation. In large scale unrestricted cuttings, the impact of these features is reduced.

It is recommended that the exact location of these anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the structures location- and adjoining access roads/pipelines- can be partially adjusted on ground level to avoid major anomalies exposed in the initial earthworks.

Boulders/outcrops will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development. Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.

The photo series below depicts examples of these anomalies.





4.6. Site Excavatability

4.6.1. Introduction and Discussion

Excavatability is a measure of material to be excavated/dug/mined with conventional excavation equipment such as a bulldozer with rippers, mechanical excavator, or other grading equipment.

Profiles were described in trenches excavated by means of labourers digging by hand (**pick-and-shovel method**). End of hole conditions were due to either **refusal** or maximum reach at depths of between **1.06 and 1.16 m** below E.G.L.

As was seen in exposed ground profiles, the weathered bedrock typically hosts irregular pockets of more and less intact material. Based on the variable weathering profile exposed in the excavations and intermittent occurrence of outcrops across the site- the weathered gabbro bedrock is anticipated to display an **undulating bedrock topography** which is characteristic of igneous rock masses/terrains.

The **average** excavation depth across the site was approximately **1.11 m.** The excavation type to an **average** depth of **1.11 m** below the existing ground level is deemed to be **SOFT Excavation** (SANS 10400G/SANS1200D).

Excluding known outcrops and intermittent surficial boulder locations, **no significant problems** are foreseen during the excavation of **shallow foundation** trenches to a depth of approximately **1.11 m** below E.G.L. Following this depth, **significant problems** are foreseen in the excavation of **deep service trenches/bulk excavations** though the use of light excavation methods (i.e., hand excavation, TLBs etc.)- due to the shallow and undulating occurrence of weathered gabbro bedrock.

4.6.2. Excavation Notes- Gabbro Bedrock

In rock masses, excavatability is governed by the shear strength of both the intact rock and the discontinuities separating them. Fluctuating excavation conditions correlate to the depth, spacing and degree of fracturing of the underlying rock mass. In a closely jointed rock mass, the excavatability is mostly controlled by failures along joint planes, whereas in widely jointed rock masses, the failure of the intact rock is required before the material can be ripped.

Where deep excavations are undertaken for structures, services, foundations or to modify the sites surface- the excavation properties of the gabbro rock mass need to be considered. The inherent excavatability is predicted to fluctuate over short distances as a result of varying degrees of weathering and spacing of discontinuities.

The physical and mineralogical nature of **gabbro** has led to the formation of a **highly undulating bedrock topography**. These sub-surface features are expected to have an impact on the overall **continuity of the excavatability** across the site, with pockets of deeper less weathered bedrock being present within the soil-like completely weathered bedrock. This variability can take place over a **very short distance**.

The rock mass at depth will require **hard rock excavation** to unearth. Cognisance should be taken of the fact that the depth to bedrock might vary between the trial pits (known points).

The final layout of the development is not known (including associated earthworks); however, allowance should be made for HARD Excavation, typically requiring blasting, wedge and split, chemical fracturing and/or heavy pecking -the exact method of which is dependent on the required final working levels, available equipment and the local environment.

Blasting shallow holes in bedrock or other hard material with no overburden to act as a damping blanket will create fly rock which could be problematic.

If blasting is to be undertaken, it should be designed by and conducted under the supervision of a blasting specialist and advice should be sought as to whether or not it is best to drill and blast through the overburden or whether small areas of this pedocrete can be blasted post-stripping of the overburden provided that appropriate measures such as the use of blast mats are adopted.

A provisional volume of material can be determined using the information from the trial pits and the final earthworks model. The calculated volume should also include excavation for sumps and deep services.

4.6.3. Excavation Safety

The following general notes should be considered regarding workings within and surrounding bulk excavations (SANS 10400 Part G and Section 11 of the OHS Act Construction Regulations):

- The provisions of the Occupational Health and Safety Act of 1993, SANS 10400 and Construction Regulations (most recent edition) must be followed in the excavations and workings therein.

- In terms of Section 11 of the Construction Regulations the contractor must appoint an excavation supervisor. All excavations should be inspected by a competent person (engineer or geo-professional with relevant training and experience) at least once a day and following any periods of rain or any long periods where no work has taken place.
- Where the excavation work involves the use of explosives, a method statement is developed in accordance with the applicable explosive's legislation, by an appointed person who is competent in the use of explosives for excavation work and that the procedures therein are followed.
- No load, material, plant or equipment is placed or moved near the edge of any excavation where it is likely to cause its collapse and thereby endangering the safety of, any person, unless precautions such as the provision of sufficient and suitable shoring or bracing are taken to prevent the sides from collapsing.
- Sheet wash from stormwater or other waters shall be prevented from running over the trench/cutting flanks. Trenches/box-cuts may need to be dewatered between and following prolonged precipitation events because of water temporarily perching upon the underlaying less permeable materials at depth.

4.7. Engineering and Material Characteristics

4.7.1. Sampling

The engineering material properties of the various sampled soil horizons were measured in laboratory conditions as per accredited testing procedures.

Standard foundation indicator, compaction tests and soil chemistry tests were conducted by Tzaneen Lab (**SANAS Accredited**) on disturbed and bulk soil samples. These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the construction.

Full lab test results are presented in **Appendix B**.

The sampling which took place during this investigation was based on both the in-situ geotechnical properties of the exposed soil horizons as well as the nature of the development. Problem soil horizons were accurately sampled where encountered (i.e., collapsible/expansive soils).

This section focuses on the identification and assessment of the soil properties which will influence the proposed construction.

The sampling process **excluded** the following inclusions:

- Oversized particles
- Organic materials
- Anthropogenic contamination

4.7.2. Bulk and Disturbed Samples- Laboratory Test Results

The soil testing which was conducted across the site can be subdivided into three broad categories, as follows:

- **Foundation Indictor Tests**

  Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage) and Particle-size Distribution

- **Compaction Tests**

  Maximum Dry Density versus Optimum Moisture Content and Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)

- **Soil Chemistry Tests**

  pH and EC analysis (corrosivity) as well as double hydrometers as an indication of material dispersivity.

The results presented in the summaries to follow are as received from the accredited testing facility. Although the summaries have been annotated **no** amendments have been made to the results themselves.

The tables to follow summarise the results of the soil tests conducted on the various sampled materials.

Table 4: Foundation Indictor Test Results

Foundation Indictor Test Results																				
Sample Number	Test Pit	Depth (m)	Sampled Material	Particle Size Distribution: Standard Sieves (Cumulative percentage passing)					Particle Size Distribution: Hydrometer Analysis (SANS 3001-GR3)			Atterberg Limits (SANS 3001-GR10) (%)			Grading Modulus	Gravel Wearing Course			Material Classification		Heave
				37,5 mm	20 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm	0,005 mm	0,002 mm	LL	PI	LS		Grading Coefficient	Shinkjage Product	TRH20	TRB	USC	
T03345/4	TP4	0,49-1,10	Weathered Gabbro Bedrock	100	100	78	33	9	5.9	1.9	1.4	-	NP	0.0	1.8	21	0	Ravels and corrugates	A-1-b	SW-SM	**LOW**
T03345/5	TP5	0,00-0,36	Colluvium	84	74	46	30	18	10.7	3.7	3.2	38	15	6.6	2.1	18	196	Good	A-2-6	SC	**LOW**
T03345/6	TP6	0,50-1,06	Weathered Gabbro Bedrock	100	100	95	52	18	13.5	5	4.3	22	5	2.3	1.4	35	116	Ravels	A-2-4	SM-SC	**LOW**

Notes:
1. Atterberg Limits undertaken on material passing the <0,425 mm sieve
2. Atterberg Limits: Liquid Limit (LL), Plasticity Index weighted (PI), Linear Shrinkage (LS).
3. Heave: Potential expansiveness (acc. Van Der Merwe, 1964).

Table 5: Compaction Test Results

Compaction Test Results												
Sample Number	Test Pit	Depth (m)	Sampled Material	Compaction Test Results					Material Classification		
				MDD (kg/m^3)	OMC (%)	Interpreted CBR Values SANS 3001-GR40 Mod AASHTO Method			COLTO	Material re-usage potential	
						90%	93%	100%			
T03345/4	TP4	0,49-1,10	Weathered Gabbro Bedrock	2155	10.1	11	15	32	G7	FAIR	Does not meet G6 requirements due to: CBR @ 95%<25
T03345/5	TP5	0,00-0,36	Colluvium	2304	9.9	11	15	30	G7	FAIR	Does not meet G6 requirements due to: PI>14,12, LS>5, CBR @ 95%<25
T03345/6	TP6	0,50-1,06	Weathered Gabbro Bedrock	2233	9.7	10	15	40	G7	FAIR	Does not meet G6 requirements due to: CBR @ 95%<25
Notes:	1. Compaction Test Results; percentage compaction of MDD (MOD AASTHO Method); CBR of 13.344 kN 2. MDD- Maximum Dry Density; OMC- Optimum Moisture Content 3. Material classification and re-usage potential based on the COLTO classification system										

4.7.3. Laboratory Test Results- Summary and Discussion

Due to their interlinking nature and overall similar measured engineering properties, the **Colluvium** and **Weathered Gabbro Bedrock** can be grouped together. Minor variations in material characteristics have been highlighted were applicable. The material discussion is summarised as follows:

- The samples grade as granular materials ranging between **sand** and/or **gravel** with a **grading modulus (GM)** of between **1.4** and **2.1.**
  - The sampled colluvium displays an increased grading modulus with respect to the weathered bedrock- attributed to its heterogeneous composition. Moreover, the colluvium is anticipated to display variable properties including varying textures and associated GM due to its transported nature.
  - The GM of the weathered bedrock is anticipated to varying with fluctuations in degree of weathering.
- The **weathered bedrock** exhibits a **low plasticity**, low linear shrinkage values and an overall **LOW potential for heave** (acc. Van Der Merwe, 1964).
  - Measured PI values range from **NP** (Non-plastic) **to 5.**
- The **colluvium** exhibits a **medium plasticity**, low linear shrinkage values and an overall **LOW potential for heave** (acc. Van Der Merwe, 1964).
  - Measured PI value of **15.**
- Typical Unified Soil Classes (USC) are **SC, SM-SC and SW-SM.**
- Based on USCS class (SM and SC), drainage will range from poor to impervious, and a low compressibility can be expected once compacted. Moreover, these materials typically display good/fair compaction characteristics and classify as reasonably stable embankment material.
- Typical TRB Class are **A-2-4, A-2-6** and **A-1-b.**

- The **combined granular materials** typically displayed a **FAIR reaction** to **compaction:**
    - The **colluvium and weathered gabbro bedrock** classified as **G7- type** material according to the COLTO classification system. The compacted samples displayed a calculated **remoulded bearing capacity** of approximately **105 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5.
- Based on the available double hydrometer readings the sampled colluvial materials are deemed to be **slightly dispersive**. Measures to reduce the susceptibility of the material to dispersion are recommended. These methods my include suitable compaction/improving the structure of the soil and blanketing/covering of the material by use of vegetation (where applicable), manage sodium levels within the material by replacement/addition of calcium (gypsum) and importantly managing water across the contract.

4.7.4. Combined Re-usage Summary and Discussion

The sampled **colluvium and weathered gabbro bedrock** were seen to display a **FAIR** quality- typically classifying as **G7-** type material (COLTO 1998). These materials are therefore deemed **suitable** for the use in the **selected layers (G7/G8)** in the proposed construction and associated engineered fill/road layer works (suitability based on the engineer's design).

The organic-rich nature of the blanketing colluvium may pose a risk to the proposed development. Caution should be taken in the **zones of poor-quality material** (i.e., organic rich materials and/or anthropogenic contamination). Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.

The extent of **cut-to-spoil** is dependent on the layout of the development coupled with the design of the planned structures.

Where deep/bulk excavations are undertaken across the reservoir site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction. This material generally serves as good material for the use in engineered fills.

Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction.

4.7.5. Soil Corrosion Discussion

As a brief introduction soil corrosion is an electrochemical process whereby complex chemical reactions between the soil and the contacting metal result in the formation of corrosion products and deterioration of the metal. The severity of corrosion that can be caused by a particular soil type is dependent on a variety of factors, including the soil's chemical properties, environmental conditions and the properties of the metal in contact with the soil.

Corrosion is a natural redox (reduction-oxidation) reaction that converts a refined metal to its more chemically stable state. Three components must be present for corrosion to occur: an anode (the buried metal in contact with the soil), a cathode (oxygen) and an electrolyte (the moisture found in the soil).

The degree of corrosiveness and the rate of corrosion differ between different soil types and properties (K. Nanan., 2018).

As part of this analysis, some of the soil samples were tested for pH and electrical conductivity (EC). These results and other indicators of aggressiveness to stee l and concrete (corrosivity) are shown in Table 6 below.

Table 6: Soil Chemistry Test Results

Soil Chemistry Test Results								
Sample Number	Test Pit	Depth (m)	Sampled Material	Corrosivity Indicators				Dispersivity Indicators
				Profiled In-Situ Moisture	% Clay	pH	EC (mS/m)	Double Hydrometer Results (%)
T03345/5	TP5	0,00-0,36	Colluvium	Slightly Moist	3,2	7,3	51	29,7
T03345/6	TP6	0,50-1,06	Weathered Gabbro Bedrock	Slightly Moist	4,3	7,4	28	16,0
Notes:	1. Material as per soil profile description. 2. Moisture as per soil profile description or natural moisture content. 3. Percentage clay, pH, EC (Electrical Conductivity) and double hydrometer as per laboratory results.							

Table 7: Reference Table- Influences of the Corrosiveness of Soils to Steel and Concrete

PARAMETER	→ INCREASING AGGRESSIVENESS OR CORROSIVENESS OF SOILS →					
EC (S/m)	**<0.0050: Essentially non-corrosive**	**<0.0100: Mildly corrosive**	**<0.0200: Moderately corrosive**	**<0.0333: Corrosive**	**<0.1000: Highly corrosive**	**>0.1000: Extremely corrosive**
Soil type	**Sand and gravel generally have lower EC: Generally less corrosive**			Clay generally has higher EC: Generally more corrosive		
Saturation	**<40% or 100%: Generally not aggressive to mildly corrosive**				60-85%: Maximum expected corrosion rates	
pH	**Soils with neutral pH are generally not very corrosive**			Very acidic or alkaline: corrosive to steel Acidic (pH < 5.5): likely corrosive to concrete		

Based on the combined results presented in Table 6- when compared to the applicable references (Table 7)- all materials which underlie the site are deemed to be **corrosive**. It is advisable not to use steel pipes and engineering measures must be implemented to protect portions of the structure which will come into prolonged contact with soil. These methods may include but are not limited to the following:

- Barrier coatings, sealers and membrane-type coatings (resins, epoxies, emulsions) applied to the concrete surface.
- Concrete reinforcement/steel coatings including nickel, stainless steel and zinc (i.e. galvanisation).
- Cathodic protection or other electro-chemical means.
- Overlays including Portland cement, latex-modified concrete and polymer concrete.
- Addition of corrosion inhibitors and admixtures to the concrete.
- Adequate site drainage measures to avoid soil saturation.

4.8. In-Situ Mechanical Assessment

4.8.1. Introduction

The soils underlying the site have been examined and tested to determine their suitability as founding horizons for the proposed development (light structures) according to the following criteria:

- **Bearing capacities** of the founding materials determined from estimated field consistencies and inferred from tabulated strength values.
- **Compressibility,** where applicable.
- **Collapse potential**, where applicable.
- Potential **heave**, where applicable.
- Predicted **displacements** (settlement/collapse/heave) from the above factors.

Undisturbed sample extraction was not possible/feasible in the exposed granular materials. For this reason, the mechanical assessment of subsoils will be based on the available disturbed soil test results and field observations (i.e., structure, composition, and consistency).

For **light structures** and road ways, the variable successions of **soft materials** including **colluvium and upper weathered material** form the primary materials of concern across the site. Caution must be taken when dealing with these potentially **collapsible/compressible** soils.

During the design of the **planned large reservoir structure**, the mechanical properties of the underlying rock mass- beyond the depth of the exposed soft materials- needs to be considered.

4.8.2. Inferred Material Properties Unified Soil Classification System

As part of this assessment a number of engineering material properties can be **inferred**- to be confirmed/measured in follow-up studies where required. Inferred figures are extracted from the data base available on geotechdata.info.

The Unified Soil Classification System (USCS) is a soil classification system used in engineering and geology to describe the texture and grain size of a soil. The classification system can be applied to most unconsolidated materials and is represented by a two-letter symbol. The demarcated result can be used to infer a wide range of soil properties and characteristics.

The **soils** sampled across the site classified as: **SC, SM-SC and SW-SM.**

The following inferred paraments/attributes can be used in **preliminary designs**:

1. Typical values of **soil friction angle (degrees)**
    a. SC Soils: 30 to 40
    b. SM Soils: 27 to 34
    c. SW Soils: 33 to 43
2. Typical values of **soil cohesion (kPa)**
    a. SC Soils: 5
    b. SM Soil: 20 to 50
    c. SW/SP Soils: 0

3. Typical values of **soil permeability (m/s)**
    a. SC Soils: $5.5x10^{-9}$ to $5.5x10^{-6}$
    b. SM Soils: 1x10-8 to $5x10^{-6}$
    c. SW Soils: 1x10-8 to $1x10^{-6}$

Numerous additional inferences can be made based on the available laboratory test results and associated data bank of information. Additional properties can be presented on the request of the project team.

4.8.3. Bearing Capacity and Soil Shear Strength (Light Structures)

1. **Introduction**

Bearing capacity is defined as the pressure which would cause **shear failure** of the supporting soil immediately below and adjacent to a foundation. The estimated allowable bearing capacity of a soil material is a function of the angle of internal friction (reflected in the grading), consistency/cohesion (reflected in the soil grading and density) and degree of saturation (moisture content).

The allowable bearing pressures imposed on the material is a function of both the soils shear strength (ultimate limit state) and its' settlement characteristics (serviceability limit state). The presumptive bearing capacity figures disregard the effect of soil moisture changes that may induce settlement/collapse.

2. **Estimated Allowable Bearing Capacity- Field Estimates**

The estimated presumed bearing values of the foundation materials are only an empirical guide to the maximum load that can be placed on the soil/weathered rock particular to this site without shear failure, and as such are not an indicator of the possible settlement/collapse that may occur at foundation pressures up to the bearing capacity of the soil.

Taking the additional movements due to soil movement into account will imply that foundation improvements will be necessary for structures.

The presumed bearing values below are based on the materials exposed in situ in the test pits and ignore any improvement, which may be obtained by compacting, or treating the site soils. The bearing capacity will increase with an increase in depth due to the increase in grain size and in-situ consistency.

The on-site materials are all deemed to be granular material. Preliminary estimates of bearing capacity for granular material are as follows (Look, 2014):

- **Loose** consistencies in these materials may be roughly correlated to a presumed bearing value of between **30 - 80 kPa.**
- **Medium dense** consistencies may be roughly correlated to a presumed bearing value of between **80 - 225 kPa.**
- **Dense** consistencies in these materials may be roughly correlated to a presumed bearing value of between **225 - 375 kPa**.

- **Colluvium**

  The **colluvium** was profiled to exhibit an **overall medium dense** consistency. **Medium dense** consistencies in the granular soils can be roughly correlated to a presumed bearing value of between **80 - 225 kPa** (Look, 2014). Other sources list presumptive bearing capacity of sandy/gravelly soils to 95 – 150 kPa (Alemdag et al, 2017; BS8004-1986; Builders Engineer 27 October 2012).

  During CBR testing, the colluvium displayed a **FAIR reaction** to compaction, classifying as **G7-** type material according to the COLTO classification system. Furthermore, the material displayed a calculated **remoulded bearing capacity** of approximately **105 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5 (following destruction of its collapsible fabric and controlled compaction).

  However, the intrinsic variability of the blanketing transported sediments should be considered. The in-situ consistency, soil texture and structure are anticipated to fluctuate spatially across the flanks of the ridge. Therefore, the bearing capacity of the upper soil layer may not be adequate for light structures and will require additional detailed evaluation depending on location. Nevertheless, following excavation, removal of organics, sorting and re-compaction- the material displays suitable characteristics, as indicated above.

- **Weathered Gabbro Bedrock**

  As mentioned, the exposed weathered constituent of the rock mass typically represents the transition between the late stages of rock disintegration/ decomposition and early stages of soil formation. It is therefore envisaged that the exposed upper weathered extent of the rock mass will display properties- including bearing capacity attributes- in line with a **dense granular soil**.

  Dense consistencies in the granular soils can be roughly correlated to a presumed bearing value of between **225 - 375 kPa** (Look, 2014). The rock mass at depth is anticipated to serve as a good founding medium for planned structures (Section 4.8.7 of this report).

  Furthermore, as for the granular colluvial sediments, the weathered bedrock displayed a **FAIR** reaction to compaction, classifying as G7- type material according to the COLTO classification system. During CBR testing, the material displayed a calculated **remoulded bearing capacity** of between approximately **105 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5.

4.8.4. Heave Characteristics

Expansive soils are soils that undergo changes in volume due to changes in moisture content, swelling when the moisture content increases and shrinking when the moisture content decreases.

Based on the results from the various **disturbed samples** from the on-site materials it was noted that these soils exhibit a low to medium plasticity, low linear shrinkage values and an overall **LOW potential for heave** (according to Van Der Merwe, 1964).

These results indicate that soil heave will not be a dominant factor during the design of the planned structures.

4.8.5. Settlement Characteristics of the In-Situ Soils

Compressible soils are soils of low stiffness that settle significantly when loaded. In free-draining soils (e.g., sands), this settlement occurs during and shortly after loading. In low permeability soils (e.g., clays), this settlement occurs over a period of time as the pore pressures set up during loading dissipate.

Considering the material characteristics measured in lab conditions and observed within the soil profiles; the soft materials exposed in the excavations underlying the site are deemed to display a **slightly compressible nature** at light foundation loads.

The compressibility is predicted be greater in the blanketing colluvial deposits. Furthermore, the upper extent of the weathered gabbro is deemed to display a slightly compressible nature but is anticipated to drastically reduce with depth as the degree of weathering reduces and associated increase intact rock strength.

4.8.6. Collapse Settlement Characteristics of the In-Situ Soils

Collapsible soils are open-textured (high void ratio) soils that are stiff when dry but lose their stiffness when they become wet. This can lead to sudden, large settlements taking place when the moisture content of the soils below a foundation increase, even many years after construction.

The exposed materials displayed a low-insitu density (colluvium), voided fabric, low liquid limits with low clay percentages which may be sufficient to form clay bridges between grains that are typical of a collapsible grain texture. These attributes are typically associated with **collapsible fabrics**.

Based on the available information, the transported materials are deemed to have a potentially **collapsible nature**, with the inherent variability of the transported material amplifying the predicted degree of **differential settlement**.

Differential settlement at depth is amplified across the site due to the variable weathering profile of the residual material (pockets of soil-like material vs less weathered rock particles.

4.8.7. Basic Rock Mechanics- Large Structures

Discussion

As discussed in the preceding sections of this report, the site is underlain by shallow undulating gabbro bedrock. Due to the limited exposures of the rock mass- coupled with its weathered state- the exact composition of the gabbro rock mass could not be defined, as well as its geotechnical nature at depth.

The mechanical properties of a rock mass are dependant not only on the properties of the intact rock (Uniaxial Compressive Strength etc.) but also on the properties of the discontinuities (spacing, orientation, continuity, etc.). The various intact rock and discontinuity properties will each have their own impact on the overall geotechnical properties of the rock mass, such as the permeability and strength.

Ideally the assessment of the underlying rock mass would be undertaken through the implementation of a rotary core drilling regime- with associated rock core logging, photography, sampling and lab testing on the cores (physical and chemical attributes).

Possible Follow-up Actions

In gabbro rock masses, due to the relatively high strength and low permeability of the intact rock, the rock mass properties are predominantly a function of the **discontinuity properties.** As such, the properties of a jointed rock mass are generally best determined through the use of rock mass classification systems such as the Rock Mass Rating by Bieniawski (1989) (Appendix D), and the Norwegian Q-Index, presented by Barton et al (1974). These rock mass properties are generally determined from exposures allowing for the classification of the foundation rock.

Based on the available theoretical data, the fresh igneous rock masses which underlie the study area **display favourable strength characteristics** with regards to the construction of the planned water storage structures. However, should more detailed information be required- one or more of the following actions can be implemented to model the rock mass as a whole:

1. Joint line surveys and/or window mapping of the bulk excavations created in the early stages of the construction.
2. Geophysical surveys to model the extent of the weathered zone of the rock mass, mapped geological anomalies and indicate the excavatability of the rock mass at depth (i.e. seismic velocities).
3. Hydrological studies to model the movement of ground water across the development's footprint, including possible chemical assessments.
4. Borehole drilling with associated core logging, sampling and rock core laboratory testing. The rock core samples should be submitted for testing in order to determine the physical and chemical properties of the rock material. The drilling results will shed light on the extent and quality of the gabbro bedrock underlying the site- which will further aid the design of the proposed infrastructure.

4.9. Foundation Design Options- Large Structures

4.9.1. Introduction

The diverse geotechnical attributes of the site have been discussed at length in the preceding sections of this report. There are geotechnical attributes of the site which are not ideally suited for the planned development (delineated in this report)- for this reason, **advanced engineering solutions** will be required to ensure the stability and longevity of the development.

Soil/rock mechanics calculations are based on the geometry of the foundation and measured parameters. During the design of the **planned large reservoir structure**, the mechanical properties of the underlying rock mass- beyond the depth of the exposed soft materials- needs to be considered. The allowable bearing pressures imposed on the material is a function of both the shear strength (ultimate limit state) and its' settlement/deformation characteristics (serviceability limit state).

Structural solutions shall improve the flexibility and strength of the structure to enable the building to tolerate potential movements so that the resulting response to actions is within the limits specified in SANS 10400-B. The structure must be strengthened to allow for the predicted differential settlement.

Please consult a competent engineer for additional options and final designs.

It is recommended that the structural engineers calculate the best economical foundation option for the proposed development based on the type of structure and the different available construction methods/materials to remedy the negative effects of the measured geotechnical constraints.

The final layout of the development is not known at this stage, with the discussion points to follow using typical attributes for structures of this nature.

Additional to the proposed foundation configurations, an important factor in the promotion of a stable site is the control and removal of both surface and ground water from the site. The implementation of a sub-surface drainage system is deemed necessary should foundation configurations result in the damming up of ground water flow.

4.9.2. Deep Foundation Discussion

Considering the **complex terrain** and **mechanical properties** of the in-situ materials- in conjunction with the nature of the development- it is recommended that the foundations for the planned **reservoir structure** be taken down to **sound bedrock** beyond the depth of the exposed soft materials, including the variable colluvial sediments and upper weathered extent of the rock mass.

Considerations surrounding general **deep foundation configurations** are presented below. GeoCalibre is open to future discussions with the design team should other foundation options be explored once final structural configurations are defined.

- This option entails foundations founded upon **intact bedrock** below problematic soft materials, with the reinforcement of the foundations to the point at which they can withstand the expected differential movements resulting from site modification practises.
- Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand across the footprint of the planned structure. Once access/mobility has been modified follow-up studies can be conducted, where required.
- Deep excavations should be inspected once created to confirm exact geotechnical conditions in the exposures- for both cutting stability and foundations- with the adaption of the ground model where required.
- Based on the available theoretical data, the fresh igneous rock masses which underlies the site displays favourable strength characteristics with regards to the construction of the planned water storage structure. Although not defined at this stage due to the limited exposures- at the refusal point, a conservative field estimated allowable bearing capacity of >300 kPa can be inferred for the rock mass. Once exposures are logged, the overall quality can be defined using available Rock Mass Rating (RMR) systems or similar indices.
- As addressed in detail in Section 3 of this report, due to the site gradient- cut to fill site preparation is expected, with cuts primarily extending into the weathered gabbro bedrock which occurs from shallow depths.
    - In contrary to the problematic colluvial sediments, the local igneous rock masses are not generally prone to major instabilities based on the available theoretical databases and as seen in local cuttings.

- Although it is predicted that fresh exposures in bedrock exhibit stable conditions in near vertical cuts (depending on orientation), it is recommended that the permanent cuttings be adequately sloped (approximately 60 to 75 degrees) or stabilised to reduce the risk of instabilities.
- Instability in these igneous bodies is predicted to be in the form of localised rock block failure, necessitating the removal or stabilisation of unstable rock blocks. Though rare, problematic joint sets/features can be present especially surrounding geological structures.
- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the reservoir.
- Drainage measures required across the constructed platforms so as to limit ponding and infiltration which may lead to perching in these areas.

- It is recommended that foundation be place on a uniform founding medium (i.e., bedrock across the cut portion of the platform) so as to limit the degree of differential settlement. Where possible, foundations should not span across the cut/fill interface or from soil to rock so as to limit differential settlement.
- The force of the proposed structure should be applied horizontally uniform across the exposed jointed rock surface; this will allow for the spanning of the various joint sets and the avoidance of point loads on individual unstable rock blocks. Boulders are to be avoided wherever possible.
- The depth to bedrock is expected to fluctuate, attributed to the characteristic undulating nature of the regional extrusive igneous rock (gabbro). The final profile of the excavation will be undulating, over break and over excavation will occur in both the base and sidewalls of the excavations and provision made in the pricing, and quantities in the relevant contract documentation.
  - Jackhammer trimming of the base and sidewalls of excavations in bedrock must be expected and allowed for in the contract documentation.
  - Provision should be made for additional mass concrete in the foundation trenches to ensure that the TOC is always at the specified level.
  - Provision should be made for blinding particularly where the footings are founded in bedrock. A decision can be made on site during construction as to whether or not blinding is actually necessary.
  - Emphasis must be placed on the final cleaning of the excavation, with the complete removal of loose debris prior to the injection of mass concrete or blinding layers.
- The sampled soft materials are deemed to be corrosive. Engineering measures must be implemented to protect portions of the structure which will come into prolonged contact with the soft material.

- It is recommended that earthworks be carried out along the guidelines given in SABS 1200/SANS 10400 (current version).
- Areas subjected to extensive fills need to be adequately modified/ compacted to limit soil movement over time (i.e., fill creep).
- Where implemented, it is essential that backfilled materials are of sufficient quality and compacted in controlled layers (material quality/required density as per engineer's design).
    - The combined materials sampled across the site displayed a POOR quality with regards to the planned construction- classifying as worse than G9- type material according to the COLTO classification system (resulting from its elevated PI). For this reason, these materials are only deemed suitable for use as subgrade layers (G9/<G9) in the proposed construction and associated engineered fill/road layer works. This material is not suitable for the use in controlled fills in final engineered layers.
    - Based on the available USCS classification, the granular materials are reasonably stable embankment materials.
    - Caution should be taken in the zones of poor-quality material (i.e., organic rich materials). Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.
    - Where deep/bulk excavations are undertaken across the reservoir site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction. This material generally serves as good material for the use in engineered fills.
    - Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction.
- Across the fill portion of the platforms, placement of imported layers should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve 93% Modified AASHTO maximum dry density at ±2% optimum moisture content.
- Density control of placed fill material should be undertaken at regular intervals during fill construction.
- Quality control testing should be undertaken by an accredited laboratory where possible (Tzaneen Lab can assist in this regard).
- Deep excavations may need to be dewatered during construction- especially during the summer months of the year (rainy season).
- Lastly, a maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.

5. Geotechnical Evaluation- Access Road

5.1. Introduction and Description

This section of the report summarises the cumulative findings of the **centreline** and **materials investigation** conducted in support of the design and construction of the new access road to the proposed Kalkfontein Command Reservoir. Numerous geotechnical attributes which were discussed at length in the preceding section of this report are duplicated in this section. These sections are included where deemed applicable to assist the design team in their processes.

As discussed in the preceding sections of this report, the development includes the construction of a **sinuous access road**, with a length of approximately **360 m**.

The planned **starting point (0+000)** of the access road is located at the base of the ridge- creating an intersection with an unnamed gravel road. The access road climbs the steep sloping flanks of the ridge in a meandering fashion on route to the proposed reservoir location to the east. Moreover, the road hosts multiple 180-degree hairpin turns at ~0+087, 0+160 (TP2), and 0+235 resulting from the natural slopes along its length. The **termination point of ~0+360** is achieved as the road approaches the structures' planned **footprint** from the north/north west.

A **basic materials assessment** was conducted along the route of the planned new access road. The footprint of the planned development was not defined on ground level attributed to the **undeveloped** nature of the site, with the Client providing a path for the future gravel road. The planned access road's shape represents an attempted optimisation of the infrastructure across the complex topographic setting, including attributes such as road length/footprint, modification requirements, usability constraints and budget considerations, to name a few.

The access road is located at the following coordinates:

Start- 0+000	**Latitude:** 24.883518° S	**Longitude:** 30.069291° E
End- 0+360	**Latitude:** 24.884050° S	**Longitude:** 30.070895° E

The results of this geotechnical analysis models that the whole site exhibits geotechnical characteristics that may require the implementation of design and/or precautionary measures to reduce the risk of structural damage due to adverse geotechnical characteristics. However, these characteristics do not disqualify the site from being used for the development, but rather require the implementation of **site-specific precautionary engineering measures**.

The exact design and configurations of the planned structures was not known at the time of compiling this report. GeoCalibre is open to ongoing discussions regarding site specific engineering solutions once final configurations are known.

GeoCalibre has compiled a **simplified summary** including field observations, summarised ground profiles, laboratory and DCP test results for the road, in order to guide the design phase of the development (presented at the end of this section). The purpose of this summary is to eliminate data complexity. During the detailed design phase of the development, local areas of concern can be extracted from the summary and can be dealt with individually.

5.2. Trenching

The field work phase of the investigation was conducted by GeoCalibre in June 2024. As a result of the limited access, along the route of the planned access road, test pits were excavated using labours digging by **hand** (pick-and-shovel method), to a depth of approximately 1.0 meters below the existing ground level, or refusal. Where available, local cuttings/exposures along the route were mapped for the amalgamation into the sites geotechnical model.

Excavations were conducted as to accurately describe the general near surface conditions occurring across the target areas. Trial pit placements were undertaken in such a way so as to create an accurate and reproducible site-specific geotechnical model. Test pit locations were primarily based on the Client's specific outcomes (foot print analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model.

An *Engineering Geologist* supervised the excavation of the trial pits. The description of the exposed ground profile is done according to SANS 633:2012 and describes the moisture, colour, consistency, structure, texture and origin.

The soil profile is described according to the following parameters:

- **Moisture** dictates the colour and consistency of soils and indicates how and where water moves and the depth to perched water systems.
- **Colour** indicates the oxidizing or reducing state of soils and assist in the identification of minerals in completely weathered to fresh rock.
- **Consistency** is separated between cohesive and granular as the drainage and permeability affects the soil's shear strength.
- **Structure** describes any relict features from rock or soil and those that form through packing, soil and rock structures, seepage, reworking and biotic action.
- **Texture** is the abundance of different grain sizes in soils and is described by means of field test.
- **Origin** is the formation of the soil by means of transport of weathering.

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development. Laboratory testing commenced on the samples collected during the field work phase of the investigation.

5.3. Ground Profile Discussion

Note: this description is based on field observations and does **not** reflect the results of any laboratory tests.

5.3.1. Introduction

The proposed footprint of the access road traverses undeveloped land and is not defined by any existing pathways/roadways on ground level. Due to the undisturbed nature of the soil profile, the upper extent of the exposed soil layers was seen to be **organic rich**. Although predicted to be more influential surrounding trees, the degree of organic material was noted to gradually decrease with depth- generally limited to the blanketing colluvial sediments.

The footprint of the planned road is underlain by a similar sequence of materials as the proposed reservoir- discussed in length in the preceding sections of this report. The access road is blanketed by **transported materials** deemed to be of a **colluvial origin**.

The transported materials thinly blanket **weathered gabbro bedrock-** with the exposed upper extent of the protolith deemed to be in the late stages of rock decomposition/early stages of soil formation. The formation of residual soil is generally limited across the steep sloping flanks of the ridge/site due to the reduced amounts of infiltrating water- with the majority of the overland flow converging downslope towards the low-lying areas.

The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock. Moreover, based on the limited exposures, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material. Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and continuity.

Each soil horizon present in the study area displays its own unique gradual change in material properties, both laterally and vertically.

The information presented below is based on point data. Every effort was made during the site investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. Variances in soil and rock quality and quantity from those predicted may be encountered during construction and these should be recorded.

In depth soil profile descriptions for each test pit location are presented in **Appendix A.** The extent of each material along the proposed road is graphically depicted in the **cross section** which forms part of the summaries in **Section 5.10**.

The following predominant material horizons were encountered across the site:

- **Colluvium**
- **Weathered Gabbro Bedrock**

The **combined general characteristics** of the various materials encountered across the site can be **summarised** as follows:

5.3.2. Transported Sediments

Based on available exposures, the side slope of the ridge which the proposed access road climbs is blanketed by a **heterogeneous deposit** of transported material profiled as **colluvium**. Due to the limited distance of transportation, these deposits have not been substantially altered during the erosional process. Furthermore, these transported materials have been transported by a natural agent during relatively recent geological times and have not undergone lithification into a sedimentary rock.

The colluvium was seen to host the major root systems and associated biotic activity across the site. The organics were seen to gradual decrease with an increase in depth. In areas proximal to large flora species, the roots zone is anticipated to extend to significant depths below the surface of the site.

The blanketing gravity transported material display an **overall granular nature** with a large range in particles sizes varying from sand to boulders. The larger particles are generally concentrated at or near the surface of the slope resulting in the **rock/bouldery surface of the site**. The size of surficial cobbles/boulders is anticipated to gradually decrease with an increased distance from the crest of the ridge. Larger particles require significant amounts of energy to be transported and are therefore frequently found close to their original source.

Coarse transported deposits can generally be found along the side slopes of mountains. As the depositional energy gradually decreases with distance, the particles that can be transported **steadily reduce in size**. These comparatively finer deposits are anticipated along the foot slopes or across major valleys which separate the various ridges across the study area of this investigation

The exposed successions of colluvium were seen to be variable, with fluctuations in composition and colour across the investigated area. Overall, the colluvium exhibited a low in-situ density, heterogeneous composition and voided nature.

The colluvium was profiled by the field team as a: *slightly moist; light brown/ orangey brown, mottled cream or white;* ***medium dense****;* ***pinholed; silty sand with traces of gravels and cobbles****;* ***abundant fine roots; surficial gravels, cobbles and boulders****, gravels/boulders decreasing with depth, biological activity.*

Across the combined excavated test pits, the colluvium is present from surface and extends to depths of between **0.17** and **0.50 m** below the existing ground level (E.G.L.)- displaying an **average exposed thickness of 0.33 m.** The colluvium can be regarded as a **FAIR quality material** with respect to the planned development. Fluctuations in material quality are anticipated due to its inherent heterogeneous composition resulting from its transported nature.

5.3.3. Weathered Gabbro- *Dsjate Subsuite*- Rustenburg Layered Suite

As alluded to in the introductory discussions, the formation of residual soil is generally limited along the steep sloping flanks of the ridge/site due to the reduced amounts of infiltrating water- with the majority of the overland flow converging downslope towards the low-lying areas.

For this reason, the blanketing sediments along the route were generally underlain by **weathered gabbro bedrock**. As a result of the limited exposures in hand excavated test pits, varying degrees of protolith weathering and alteration/calcification- classification of the exact rock mass properties was not possible. Accurate rock mass characterization/mapping can be undertaken across cuttings/exposures resulting from the planned bulk earthworks.

The calcium-rich minerals within the exposed upper extent of the rock mass have been significantly altered by infiltrating water and associated processes over time- resulting in the formation of pedogenic inclusions in the form of calcification staining/calcrete nodules. The calcification and degree of weathering is anticipated to decrease with an increased depth.

The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock. Moreover, based on the limited exposures, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material.

Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and rock mass continuity.

The **weathered gabbro** was generally described by the field team as: *slightly moist; light creamy or light greyish white, speckled black, mottled black or yellow;* ***coarse grained; closely jointed or relict joint planes; completely/highly weathered; very soft rock or soft rock; gabbro of the Dsjate Subsuite- Rustenburg Layered Suite****; traces of fine roots in the upper extent; gradual transition to less weathered bedrock with depth; irregular pockets of less weathered bedrock at the base; minor calcification; traces of calcrete nodules.*

In test pit TP2, the weathered rock was seen to display elevated strength characteristics and an overall reduced weathering intensity compared to other exposures- profiled as highly weathered medium hard rock gabbro. The **weathered gabbro** in TP2 was generally described by the field team as: *slightly moist; dark grey mottled white;* ***coarse grained; closely jointed; highly weathered; soft rock; gabbro****; traces of fine roots in the upper extent; pockets of completely weathered bedrock decreasing with depth.*

The varying grades of weathered bedrock were encountered from below the blanketing colluvium, extending to depths of between **0.48 and 1.16 m** below the E.G.L.- displaying an **exposed average thickness of 0.64 m**.

The various grades of weathered bedrock exposed in the excavations displayed a **FAIR quality**- with pockets of GOOD quality material- with respect to the planned access road construction. Although the quality of the material is anticipated to be partially variable across the contract due to its inherent **variable weathering profile**, it is predicted to **increase in quality and overall continuity with an increase in depth**.

5.4. Groundwater and Shallow Seepage

5.4.1. Introduction and Discussion

A detailed hydrocensus was not undertaken across the study area. For this reason, the static rest level and chemistry of the ground water cannot be discussed. Without knowledge on the depth to permanent groundwater in the region- it is not possible to comment on the occurrence of permanent groundwater flow within/below the subsurface of the site.

If required, a detailed hydro census can be conducted across the site to determine/model the permanent ground water table depth, location and quality underlying the site. Additional to this process, monitoring boreholes/ piezometers can be installed across the development area to examine ground water patterns seasonally.

Managing surface water across the contract will play a pivotal role in reducing ponding, erosion as well as limiting the volumes of shallow sub-surface through flow. Future roadways can be targeted for the use in the drainage network and in so doing limiting the disturbance to the local road users.

Additional to the considerations listed above, a **maintenance regime** and performance testing should be put in place to monitor the nature of the system over its design life.

5.4.2. Measured Ground Water Occurrences

No ground water seepage or permanent water table was encountered during the fieldwork phase of the investigation.

5.4.3. Fluctuating Moisture Conditions

The predominant runoff will occur as high energy overland-flow following the topography. As discussed in Section 3.2, the planned infrastructure is located downslope of currently undeveloped land. Although generally steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of **shallow ground water throughflow** may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

Altering the soil profile in areas underlain by shallow bedrock commonly affects the subsurface seepage.

Following site modification practises (cut-to-fill), the upper transported materials will allow **infiltration**. Infiltrating water is predicted to temporarily flow/perch along the **rock-soil interface**, with its flow dynamics dependant on the topography of the rock mass at that point. This typically manifests as a weak, relatively **short-lived perched water** table associated with slight groundwater seepage present directly after a precipitation event. Furthermore, the **undulating topography** of the bedrock affects the continuity of the **shallow water flow dynamics** of the site.

The weathered gabbro bedrock was seen to host variable amounts of **pedogenic** materials in the form of calcification staining and calcrete nodules. These pedogenic materials are not predicted to have formed due to excessive amounts of infiltrating/perching of water but are likely amplified by the mineralogy of the rock and susceptibility of the mafic minerals to decomposition. Nonetheless, these pedogenic inclusions indicate the periodic occurrence of **fluctuating moisture conditions** after prolonged precipitation events.

The evidence for fluctuating moisture conditions was encountered within the **upper 1.0 meter** of the profile. This attribute will become a greater concern in the **lower-lying sections** of the roads- due to the predicted convergent shallow ground water through flow.

Good site drainage measures, on surface and subsurface, must be implemented to prevent moisture changes, which may add to the development of temporary perched groundwater tables. During construction and after development, shallow perched water systems may develop yet further due to stormwater management practices, localised infiltration and site modification practices.

Cuttings and installed services will cause soil density and texture changes which may lead to variations in soil moisture across the site with flow changes and build-up of moisture that may differ from the natural conditions.

Excavations may need to be dewatered following prolonged precipitation events- to be undertaken in line with the prescribed HSE protocols.

5.5. Bedrock Outcrops/Boulders

A combination of both **boulders and outcrops** were visible along the entire route of the planned access road. Surficial occurrences were inspected and photographed by the field team- examples of which are included in the summaries (Section 5.10). The exact nature and extent of these anomalies is not known generally as a result of the shallow soil cover and existing vegetation. In large scale unrestricted cuttings, the impact of these features is reduced.

It is recommended that the exact location of these anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the route of the planned access road can be partially adjusted on ground level to avoid major anomalies exposed in the initial earthworks.

Boulders/outcrops will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development. Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.

5.6. Site Excavatability

Excavatability is a measure of material to be excavated/dug/mined with conventional excavation equipment such as a bulldozer with rippers, mechanical excavator, or other grading equipment. In rock masses, this characteristic is governed by the shear strength of both the intact rock and the discontinuities separating them. Fluctuating excavation conditions correlate to the depth, spacing and degree of fracturing of the underlying rock mass.

Profiles were described in trenches excavated by means of labourers digging by hand (pick-and-shovel method). End of hole conditions were due to either **refusal** or maximum reach at depths of between **0.48 and 1.10 m** below E.G.L.

As was seen in exposed ground profiles, the weathered bedrock typically hosts irregular pockets of more and less intact material. Based on the variable weathering profile exposed in the excavations and dominant occurrence of outcrops across the site- the weathered gabbro bedrock is anticipated to display an **undulating bedrock topography** which is characteristic of igneous rock masses/terrains. Cognisance should be taken of the fact that the depth to bedrock might vary between the trial pits.

The average depth of excavation along the **entire length of road** was **0,97 m**. For this reason, the excavation type to an **average depth of 0.97 m** is deemed to be SOFT Excavation (SANS 10400G/ SANS1200D).

Due to the implemented mode of excavation, the excavatability properties of the less weathered gabbro bedrock at depth could not be determined. Excavations problems relating to shallow boulders, outcrops and undulating bedrock can be expected in deep/bulk excavations. It is anticipated that the rock mass at depth will require **hard rock excavation** to unearth. Where deep cuts into the natural steep slopes are implemented to modify the surface of the site, the excavation properties of the gabbro rock mass need to be considered as discussed in section 4.6.2.

5.7. Engineering and Material Characteristics

5.7.1. Introduction and Sampling

The engineering material properties of the various sampled soil horizons were measured in laboratory conditions as per accredited testing procedures.

Standard foundation/road indicator, compaction tests and soil chemistry tests were conducted by Tzaneen Lab (**SANAS Accredited**) on disturbed and bulk soil samples. These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the proposed construction.

The sampling which took place during this investigation was based on both the in-situ geotechnical properties of the exposed soil horizons as well as the nature of the development (gravel road assessment).

This section focuses on the identification and assessment of the soil properties which will have an effect on the proposed **access road construction**.

Full laboratory test results are included in **Appendix B**.

The sampling process **excluded** the following inclusions:

- Oversized particles
- Organic materials
- Anthropogenic contamination

5.7.2. Bulk and Disturbed Samples- Laboratory Test Results

The soil testing for the site can be subdivided into two categories, as follows:

- **Road Indictor Tests**

  Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage) and Particle-size Distribution

- **Compaction Tests**

  Maximum Dry Density versus Optimum Moisture Content and Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)

The results presented in the summaries to follow (Section 5.10) are as received from the accredited testing facility.

5.8. On-site Material Suitability Discussion

5.8.1. Introduction

Detailed annotated summaries are presented in the sections to follow (Section 5.10). The succession of materials encountered across the site each display their own variability- impacting the overall **continuity** of the expected material quality with regards to the planned construction.

5.8.2. TRH20/COTO- Unsealed Roads

The nomenclature to follow is used in the technical recommendations for the design, construction and maintenance of unsealed roads (TRH20).

Corrugations are one of the most disturbing functional defects of unsealed roads and cause significant roughness and poor vehicle directional stability. Corrugations consist of parallel pinnacles of sandy materials which form perpendicular to the flow of traffic.

Moreover, corrugations are typically characterized as loose of fixed depending on the degree of compaction of the crests/pinnacles. Loose corrugations are easily remediated by blading, whereas fixed corrugations may require cutting or even light ripping with a grader in order to spread the material. The wavelength of the corrugations is proportional to the speed of the traffic using the road.

Ravelling refers to the degradation of the road surface by the generation of loose gravel under traffic and represents a significant economic, safety and maintenance problem. The loose gravel may be distributed across the entire surface of the road or concentrated between wheel tracks forming dangerous zones of debris which frequently cause damage to vehicles.

Erosion can simply be described as the loss of surfacing material caused by the flow of water over the road. According to the TRH20, the ability of the material to resist/avoid erosion depends on the shear strength of the material which is equal to the cohesion of the material as no normal stress is applied to the blanketing materials across the surface of the road. If the attractive force of the water is greater than the shear strength of the material than erosion will occur.

Fine, poorly graded material with limited coarse particles (grading coefficient less than 16) are highly susceptible to erosion. Erosion results in the formation of run off channels-sometimes referred to as runnels- which may form across the surface of the road resulting in an extremely rough surface along the footprint of the road resulting in the formation of deep ruts.

Slipperiness is caused by the migration of plastic/clayey materials to the surface of the road under the impact of rain or tires of vehicles. A road with sufficient coarse fraction may become slippery if fine clay/silt become concentrated on the surface of the unsealed road. The saturated clay/fine materials on the surface of the road may have a similar effect to aquaplaning on sealed roads. In dry weather conditions, a roadway may become slippery if there is an accumulation of fine particles on the road reducing the skid-resistance of the surface.

5.8.3. On-site Material Classification

Colluvium

The blanketing **colluvium** displayed a **slightly variable quality** with regards to the planned road construction.

This horizon tested as **FAIR quality (G7/G8)** material according to COLTO 1998. The marginal fluctuations in material quality can be attributed to the heterogeneous composition relating to transported nature of the material. According to COLTO 1998- the colluvium is suitable for the use in **selected layers (G7/G8)** in the planned road construction.

Furthermore, the **colluvium** exhibits measured **CBR values of 14 and 18 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the colluvium falls within subgrade class **SG2** and may therefore not be adequate subgrade material for flexible pavements due its CBR at 93% not consistently **exceeding 15.**

According to the **TRH20**, the colluvium classifies as **Class A** (erodible) and/or **Class E** (good) in terms of **gravel wearing course performance**.

The variability of the colluvium and its organic-rich nature should be addressed during the design of the planned road structure- with allowance for adequate site supervision and ongoing quality control testing during the construction phase of the development.

Varying Grades of Weathered Gabbro Bedrock

The underlying varying grades of weathered gabbro displayed an overall similar quality as compared to that of the blanketing sediments, with minor fluctuations in re-use potential.

Although the quality of the material is anticipated to be partially variable across the contract due to its inherent **variable weathering profile**, it is predicted to **increase in quality and overall continuity with an increase in depth**.

The samples tested as **FAIR (G7) quality** material with localised pockets of **GOOD (G6)** quality. According to COLTO 1998, the weathered gabbro bedrock is generally suitable for the use in **selected layers (G7/G8) with pockets of better-quality bedrock** suitable for use as **subbase (G5/G6) layers** in the planned road construction.

Furthermore, the **weathered gabbro** exhibits **measured CBR values** ranging from **18 to 33 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the weathered material falls within subgrade class **SG1-** with adequate CBR values at 93% (>15) to be deemed suitable subgrade material for flexible pavements.

According to the **TRH20,** the weathered bedrock classifies as **Class B** (ravels and corrugates) or localized **Class A** (erodible) in terms of performance as a gravel wearing course.

Conclusion

The organic-rich nature of the blanketing colluvium may pose a risk to the proposed development. Caution should be taken in the **zones of poor-quality material** (i.e., organic rich materials). Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.

According to COLTO 1998- the colluvium and weathered gabbro bedrock is generally suitable for the use in **selected layers (G7/G8) with pockets of better-quality bedrock** suitable for use as **subbase (G6) layers** in the planned road construction.

Based on the cumulative **TRH20 classes**, the materials are deemed to be susceptible to corrugating, ravelling and erosion (Class B and Class A) when used as gravel wearing coarse. **Regular road maintenance** will be required in order to mitigate the formation of **corrugations** and to **inhibit loose corrugations** from transition to **fixed corrugation** over time. Similarly, good compaction, adequate amounts of fine material, and good particle size distribution will reduce ravelling on the road surface. Moreover, increasing compaction, and ensuring a well graded mixture of material resulting in increased particle interlock will reduce the susceptibility of the material to erosion.

The energy of the water can be decreased by retarding the rate of flow using good drainage measures and adjusting camber angles of the road. Erosion may cause changes in the properties of the material as certain fractions are removed.

Where deep/bulk excavations are undertaken across the site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction. This material generally serves as good material for the use in engineered fills.

Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction.

5.9. DCP Testing- Centerline Investigation

A total of **SIX (6)** Dynamic Cone Penetrometer (DCP) tests were performed across the site so as to give an indication of the consistency of the in-situ material.

DCP test results are presented in the graphics to follow (Section 5.10)- with full detailed results included in **Appendix C.**

In the design of roads, the DCP is a practical test used for onsite measuring of road material strength. The test results can be correlated with the California Bearing Ratio (CBR) by applying a formula; results of which can be correlated to the laboratory tests conducted on the soils from the same location.

DCP tests were performed at **natural moisture conditions** and thus the values vary greatly from the CBR results measured under controlled conditions within the laboratory. This variation is mainly due to the lab specimens being analysed under saturated conditions. It should be noted that the strength of the in-situ soil changes greatly with change in moisture conditions.

Fluctuations of the in-situ moisture content within the exposed soil horizons may have had a detrimental effect on the accuracy of the DCP results. DCP test should therefore only be used as indicative statistics for the site.

Summarised DCP results discussion

With reference to the CBR readings with depth (graphic in Section 5.10):

- The DCP tests conducted across the site displayed a **variable penetration resistance with depth** and associated in-situ consistency.
- All DCP tests conducted across the site refused at depths of between **105 and 470 mm** with average penetration depth across the proposed footprint of **332 mm**.
- Based on the soil profiles, the colluvium extends to an average depth of 0,33 m below E.G.L, indicating that the DCP tests were only able to penetrate the blanketing colluvium and **refused on the underlying weathered rock**.
- As seen in the various annotated graphics, the in-situ CBR values inferred for the entire soil profile were notably high- in fact, considerably higher than that of the attributes measured in saturated conditions in the lab.
- Using this depth, an average in-situ CBR of greater than 60 can be inferred for the transported material. From these excessive values it is clear that the accuracy of the DCP probe has been negatively affected by the granular nature and low in-situ moisture content of the blanketing horizon.
- The presence of sand/ gravel and/or cobble sized rock fragments, in conjunction with fluctuations of the in-situ moisture content within the exposed soil horizons may have had a detrimental effect on the accuracy of the DCP results.
- Once the area has been rehabilitated and final starting levels have been created on site- DCP testing can be conducted at regular intervals in order to determine the in-situ CBR of the road bed at any given point/location.

5.10. Combined Geotechnical Summaries

GeoCalibre has compiled a simplified site summary, including laboratory and DCP test results in order to guide the design phase of the development.

The purpose of this summary is to eliminate data complexity, for this reason, extensive/in-depth soil profile discussions have been omitted from this exercise.

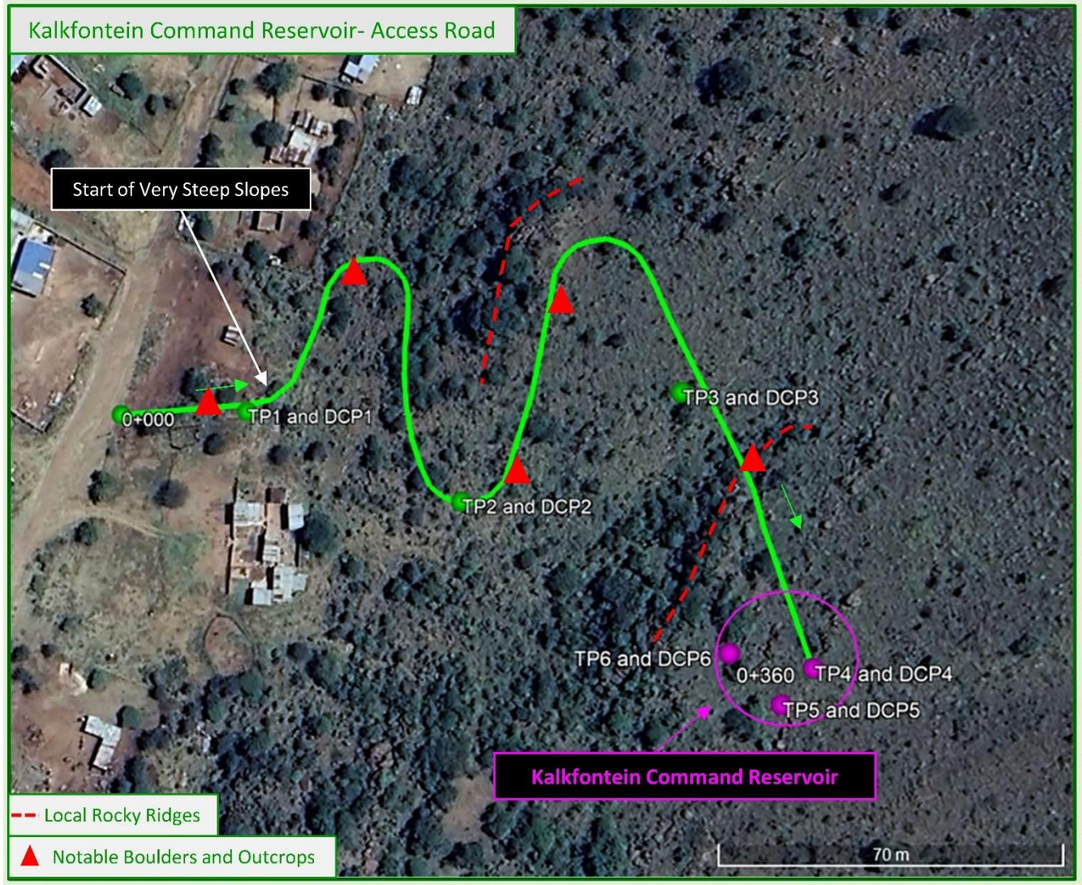
Major geotechnical attributes are highlighted and listed where applicable.

The follow legend guides the understanding of the tables/graphics to follow:

- Discussions points presented in the summaries are based on the information presented by the field team (observations and photography), available remote sensing information and the cumulative results of the study.
- All depths displayed in **meters** (m).
- Thickness refers to the **exposed thickness** of the soil horizon (meters).
- The field observations annotated on the graphics serve as an indication.

- Horizon depths displayed in the tables are **average measured values**.
- Excavation conditions:
  - **ES-** Excavation **stopped**.
  - **DE-** Difficult Excavation
  - **R- Refusal**.
- Material codes used in the summary:
  - **C-** Colluvium
  - **WGB-** Weathered Gabbro Bedrock
- Presented chainages are inferred from the available remote sensing information- adjustments can be made where required.
- CBR graphs make use of the **combined materials sampled** across the access road in question- irrespective of depth.
- Oversized particles: **Cobbles** refer to particles with an average diameter of between 0.06 - 0.20 m; particles larger than this are deemed to be boulders.
- The provided **cross sections** serve as a practical **graphical depiction** of the various layers underlying the various roads. These graphics are not to scale.
- Lab results are presented as received from **Tzaneen Lab.** Although the summaries have been annotated- no amendments have been made to the results themselves.

The combined graphics to follow depict the **summarised findings** from the **fieldwork** and **laboratory testing phases** of the investigation.





Summarized Discussion

- Sinuous access road- start at the base of ridge (0+000) extending to reservoir located along the very steep side slope of the high-lying terrain 0+360.
- Road exhibits a constant increase in elevation with chainage.
- The road executes multiple hair pin-like turns at 0+087, 0+160 (TP2), and 0+235 in order to navigate the complex and steep terrain.
- The footprint of the planned development was not defined on ground level attributed to the undeveloped nature of the site.
- The slopes of the ridge display a rocky morphology with boulders and outcrops along its length. Outcrops separated by zones of soft materials.
- The slopes are densely vegetated. No erosion encountered due to existing vegetation and rocky surface.
- The surface of the site to be remolded to improve access and mobility.
- Varying degrees of cut-to-fill site preparation expected across the road.
- Slope, outcrops, boulders and undulating bedrock topography anticipated to significantly hamper excavatability especially during cut-to-fill site preparation.
- No natural slope instabilities were visible in these areas at the time of the investigation (basic visual inspection).
- Removal of vegetation from blanketing soils may promote slope/cutting instability.
- Addressing the concerns surrounding the convergence of surface water upon the future road is key to the stability/longevity of the development.
- High energy channelized flow and converging surface water flow elevates the risk for erosion and associated scouring/undercutting.
- The roads' orientation in relation to the natural slopes will impact the rate and associated energy of the overland flow.
- Typically traverse the natural steep slopes at an obtuse angle- medium to high energy surface water flow taking place along the footprint of the road.
- Emphasis should be placed on surface drainage and storm water control measures across the developments footprint in order to avoid instabilities associated with concentrated flow, infiltration and surface water ponding.
- The construction will influence natural infiltration and run-off rates and precautions should therefore be implemented as part of the design.
- Due to the meandering shape of the road, localised sections traverse the natural slopes at an acute angle- decreasing the associated run-off. Similar drainage expected where cut-to-fill operations are implemented.
- The undulating topography of the bedrock affects the continuity of the shallow water flow dynamics of the site. Water is predicted to flow/perch along the weathered bedrock-soil interface, with its flow dynamics dependent on the topography of the rock mass at that point.

Summarized Ground Profile:

The side slope of the ridge is blanketed by a variable and heterogeneous deposit of colluvium. These deposits thinly blanket varying grades of shallow weathered bedrock. The formation of residual soil is limited across the steep sloping flanks.

- **Colluvium**: the blanketing sediments display a large range in particles sizes (gravels to boulders) and hosts the major roots across the undeveloped site.
  - Profiled as: medium dense; pinholed; **silty/clayey sand with minor/ traces of gravels/cobbles; abundant roots; surficial cobbles/boulders**
  - Variable thickness ranging from **0,17** to **0,50 m**.
  - Average thickness of **0,33 m**.
  - Overall **FAIR** quality material (COLTO, 1998).
  - Heterogeneous and organic-rich nature may pose a risk to the construction.
- **Varying Grades of Weathered Gabbro:** The rock mass displayed a variable weathering profile with fluctuating pockets of less weathered/better preserved bedrock. No discernable change in quality was measured between the exposed varying degrees of weathered rock. Overall, the quality is predicted to increase with an increase in depth.
  - Profiled as: **coarse grained; closely/moderately jointed; highly/moderately weathered; very soft rock/medium hard rock** Undulating bedrock topography, encountered from between **0,17 to 0,50m** below E.G.L.
  - Average thickness of **0,64 m**.
  - Overall **FAIR** quality material with localised **GOOD** quality (COLTO, 1998).
  - Variability expected due to variable weathering.
- **Final excavation depths** range between **0,48** and **1,16 m** below the natural ground level- **average excavation depth across the access road 0,98 m**.

Summarised Ground Profile- Kalkfontein Command Reservoir- 3000 kl

Area	Chainage	Test Pit	Colluvium From	Colluvium To	Colluvium Thickness (m)	Weathered Gabbro Bedrock From	Weathered Gabbro Bedrock To	Weathered Gabbro Bedrock Thickness (m)	Excavation Character Test pit depth (m)	Excavation Character Termination Conditions	Excavation Character Termination Material
Access Road	0+030	TP1	0,00	0,17	0,17	0,17	0,48	0,31	0,48	R	WGB
Access Road	0+160	TP2	0,00	0,30	0,30	0,30	0,97	0,68	0,97	R	WGB
Access Road	0+290	TP3	0,00	0,19	0,19	0,19	1,10	0,91	1,10	ES	WGB
Access Road	0+350	TP4	0,00	0,49	0,49	0,49	1,10	0,61	1,10	ES	WGB
Reservoir Location	0+360	TP5	0,00	0,36	0,36	0,36	1,16	0,80	1,16	R	WGB
Reservoir Location	0+360	TP6	0,00	0,50	0,50	0,50	1,06	0,56	1,06	ES	WGB
Data Summary			**Minimum**	0,17	0,17	0,48	0,31	0,48			
			Max	0,50	0,50	1,16	0,91	1,16			
			Average	**0,33**	**0,33**	**0,98**	**0,64**	**0,98**			

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Road Description

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Access Road

Test Pits TP1 to TP6

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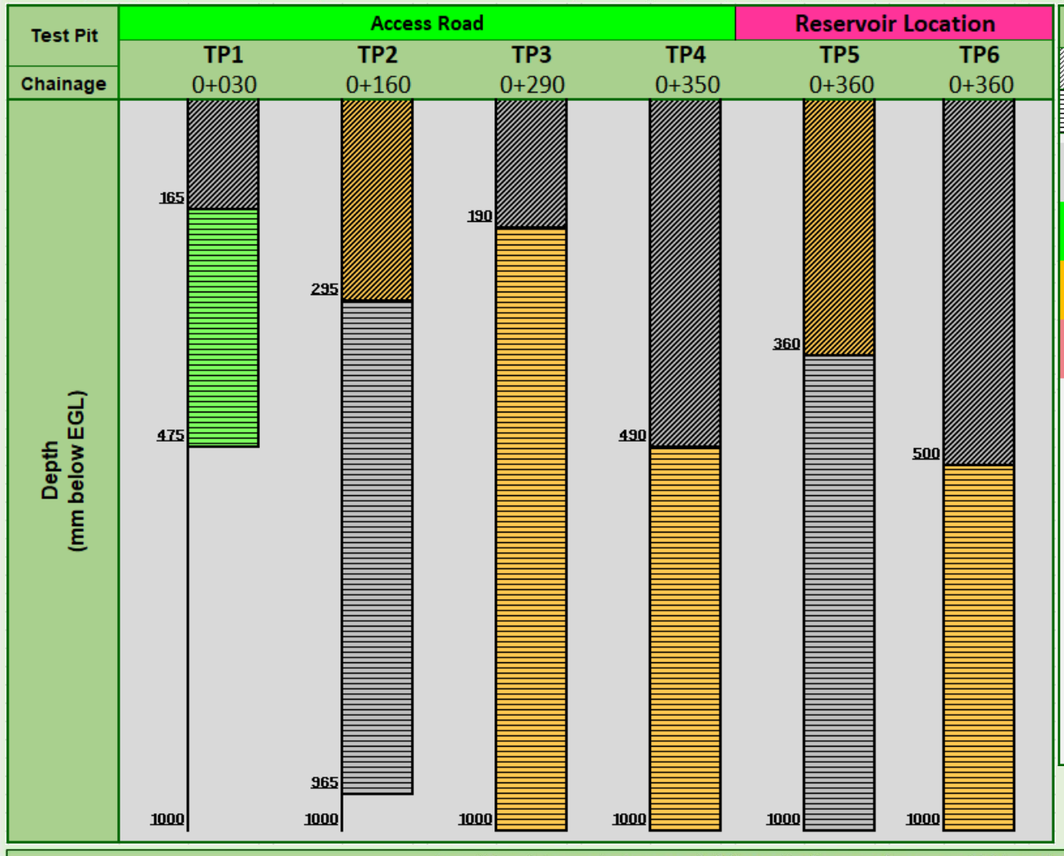
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Kevin Coertzen

Pri.Sci.Nat and MSAIEG

Combined Laboratory Test Results Summary

Sample Description						Particle Size Distribution									Dispersivity Indicator	Atterberg Limits			Compaction Test Results Mod AASHTO Method					Material Classification			Performance as Gravel Wearing Course		
						Sieve Analysis (Cumulative Percentage Passing)										Atterberg Limits			Mod AASHTO		Interpreted CBR Values								
Sample No.	Area	Test Pit	Sample Depth (m)	Chainage	Material	37.5	28.0	20.0	14.0	5.0	2.0	0.425	0.075	GM	Double Hydrometer Results (%)	LL	PI	LS	MDD (Kg/m³)	OMC (%)	100%	95%	93%	COLTO CLASS.	US Highway	Unified Soil Classification	Grading Coefficient (Gc)	Shrinkage Product (Sp)	TRH20 Classification
T03345/1	Access Road	TP1	0,17-0,49	0+030	**Weathered Gabbro Bedrock**	93	90	86	81	79	71	32	8	**1,9**	-	-	**NP**	0,0	2233	9,6	73	33	24	**G6**	A-1-b(0)	SW-SM	15	0	Class B Ravels and Corrugates
T03345/2		TP2	0,00-0,30	0+160	**Colluvium**	83	77	72	70	62	57	37	20	**1,9**	-	34	**15**	7,2	2065	10,2	24	14	11	**G8**	A-2-6(0)	SC	12	265	Class A Erodible
T03345/3		TP3	0,19-1,10	0+290	**Weathered Gabbro Bedrock**	100	100	99	97	85	66	34	10	**1,9**	-	26	**6**	2,9	2236	11,5	46	23	17	**G7**	A-2-4(0)	SP-SC	29	97	Class B Ravels and Corrugates
T03345/4		TP4	0,49-1,10	0+350	**Weathered Gabbro Bedrock**	100	100	100	97	96	78	33	9	**1,8**	-	-	**NP**	0,0	2155	10,1	32	18	15	**G7**	A-1-b(0)	SW-SM	21	0	Class B Ravels and Corrugates
T03345/5	Reservoir Location	TP5	0,00-0,36	0+360	**Colluvium**	84	78	74	69	57	46	30	18	**2,1**	**29,7**	38	**15**	6,6	2304	9,9	30	18	15	**G7**	A-2-6(0)	SC	18	196	Class E Good
T03345/6		TP6	0,50-1,06	0+360	**Weathered Gabbro Bedrock**	100	100	100	100	100	95	52	18	**1,4**	**16,0**	22	**5**	2,3	2233	9,7	40	20	15	**G7**	A-2-4(0)	SM-SC	5	116	Class A Erodible



Graphic Legend

- Colluvium
- Weathered Gabbro Bedrock
- Not Sampled
- G5/G6- type Material Suitable for use in Subbase Layers
- G7-G8- type Material Suitable for use in Selected Layers
- G9/<G9- type Material Suitable for use in Subgrade Layers

The presented lab results are in accordance with those provided by Tzaneen Lab

The material types are extrapolated from the presented soil profiles.

The soil profile results are presented up to a depth of 1 m below the existing wearing course.

The material quality as presented is in accordance with the COLTO Classification System (1998).

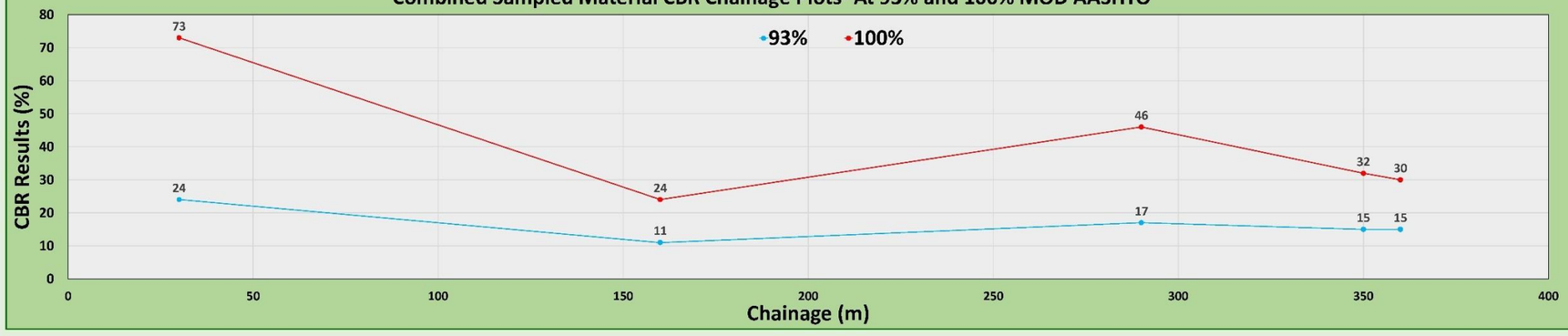
The graphics are not to scale

Summarized Laboratory Test Results

The laboratory testing can be summarized as follows:

- The blanketing colluvium and underlying varying grades of bedrock classified as **FAIR (G7/G8)** quality material with localised pockets of bedrock classifying as **GOOD (G6) quality.**
- According to the South African Pavement Manual, the weathered material falls within subgrade class **SG1-** with adequate CBR values at 93% (>15) to be deemed **suitable subgrade material** for flexible pavements.
- Moreover, the **bedrock** typically classifies as **Class B** (ravels and corrugates) or localized **Class A** (erodible) TRH20.
- The colluvium exhibits measured CBR values of **14 and 18** at 93% Mod AASHTO density. According to the South African Pavement Manual, the colluvium falls within subgrade class **SG2** and may therefore not be adequate subgrade material for flexible pavements due its CBR at 93% not consistently exceeding 15.
- The **colluvium** typically classified as **Class A** (erodible) and **Class E** (good) TRH20.
- Lastly, caution must be taken when using the **colluvial deposits** in the planned construction due to their heterogeneous composition and organic-rich nature.

Combined Sampled Material CBR Chainage Plots- At 93% and 100% MOD AASHTO



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Laboratory Summary

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Access Road

Test Pits TP1 to TP6

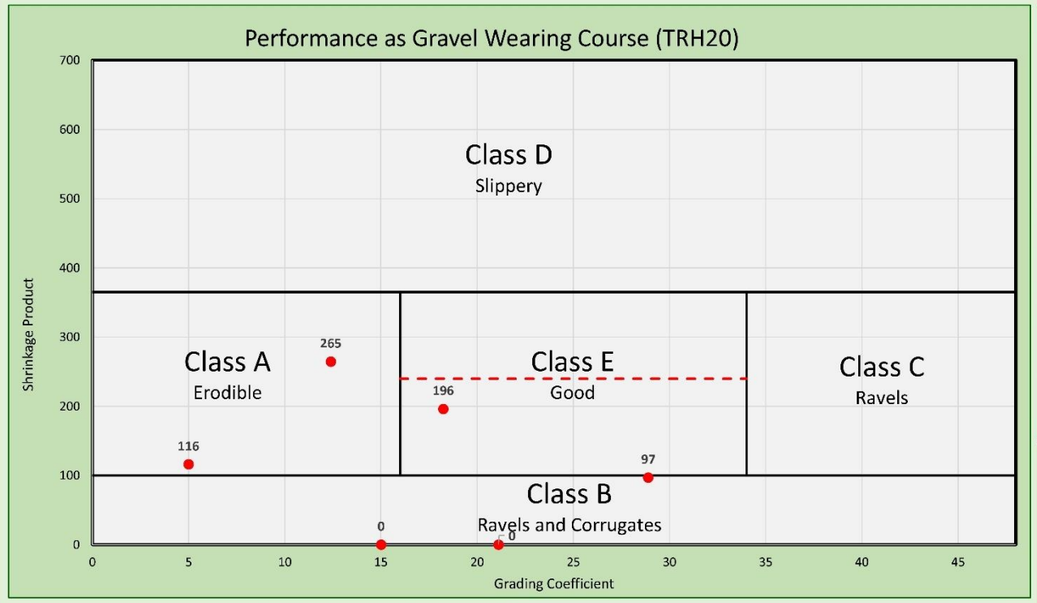
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Kevin Coertzen

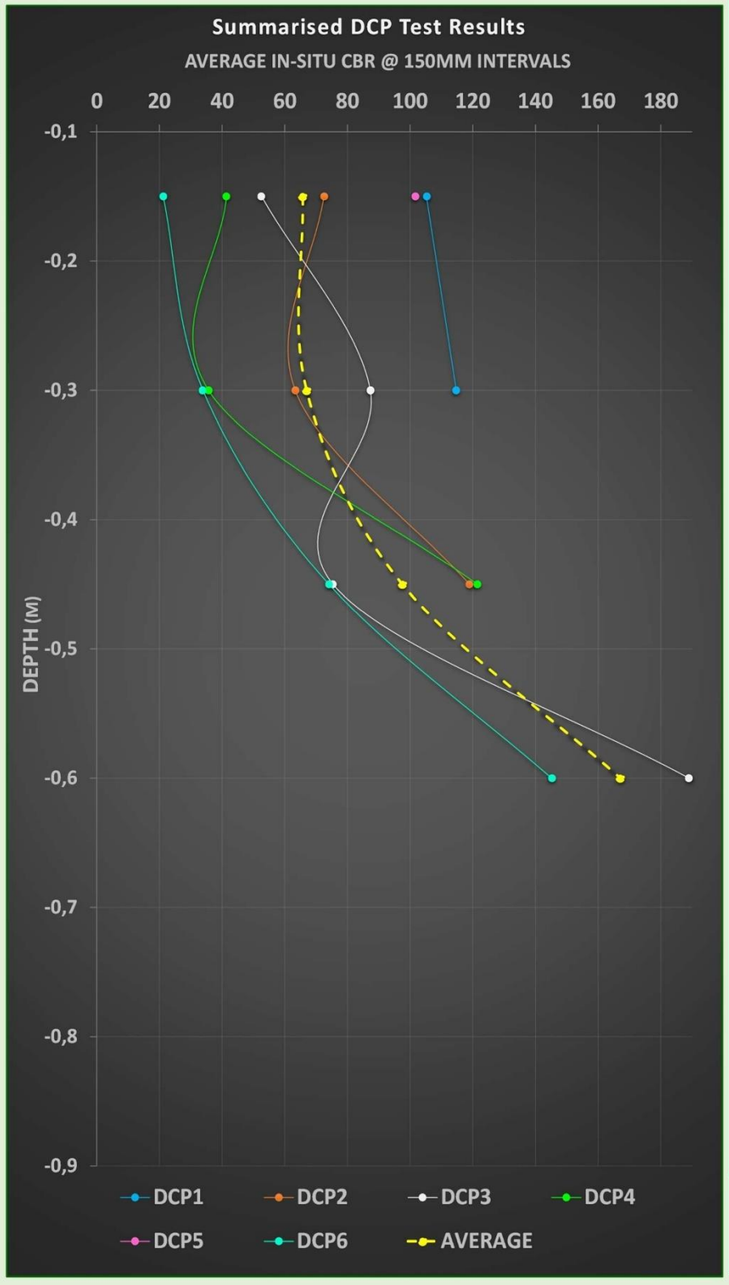
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Summarised DCP Test Results

Depth (m)	Average In-Situ **CBR** Values						AVERAGE
	Access Road				Reservoir Location		
	DCP1 0+030	DCP2 0+160	DCP3 0+290	DCP4 0+350	DCP5 0+360	DCP6 0+360	
0,00	-	-	-	-	-	-	-
-0,15	105	73	53	41	102	21	66
-0,30	115	63	87	36	-	34	67
-0,45	-	119	75	122	-	74	98
-0,60	-	-	189	-	-	145	167
-0,75	-	-	-	-	-	-	-
-0,90	-	-	-	-	-	-	-
Termination Depth (mm)	228	319	470	374	105	496	332



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Gravel Wearing Coarse

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Access Road

DCP Tests DCP1 to DCP6

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Photographs

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Access Road

Test Pits TP1 to TP6

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5.11. Design Considerations- Access Road

The diverse geotechnical attributes of the site have been discussed at length in the preceding sections of this report. There are geotechnical attributes of the site which are not ideally suited for the planned development (delineated in this report)- for this reason, **engineering solutions** will be required to ensure the stability and longevity of the development.

The following considerations and generally accepted standards of practise should be contemplated during the design and construction of the planned new access road:

- All future actions across the site should be aligned with the most recent applicable standards of practise/technical specification documents of South Africa (SANS, TRH, TMH, COLTO/COTO and SAPEM).
- Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand along the route of the planned access road structure.
    - Access to- and terrain mobility across- the site will need to be modified in the early stages of the development, the extent of which should be sufficient to allow for long term access to ensure smooth daily operations, ongoing maintenance and possible future upgrades.
    - Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/infrastructure or life.
    - Once access/mobility has been modified follow-up studies can be conducted, where required.
- The full route of the planned access road was vegetated at the time of this study. The natural vegetation will need to be modified in the early stages of the construction to aid access and terrain mobility. Regarding bio-engineering, the natural vegetation cover protects the slope from erosion (run-off and rain splash) and serves as a anchoring mechanism to reduce the possibility of shallow seated instabilities. The effects of the removal of trees on sites should also be considered.
- Developments of this nature typically include the rehabilitation/remoulding of the site's surface including major cut-to-fill site preparation in order to create the prescribed working levels as well as the construction of the associated infrastructure including basic drainage measures.
- As a results of the sites complex topography and geographic location, the design and implementation of fit-for-purpose site modification and drainage measures are essential for the stability and longevity of the development.
- Importance should be placed on drainage/storm water control measures to avoid instabilities, focused infiltration, surface water ponding and erosion.
- Future anthropogenic attributes will influence natural infiltration, shallow throughflow and run-off rates.
- Inadequate temporary erosion and drainage control measures can result in severe damage to infrastructure.

- A maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.
- As a result of the roads shape in relation to the very steep natural slopes, site modification practises are required. Where cuts/thick embankment fills are implemented to modify the sites surface, cut/fill embankments will need to be adequately sloped, modified or stabilised- and vegetated where possible- to ensure long-term stability in saturated conditions.
- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the road cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the roads' flank.
- Areas subjected to extensive fills need to be adequately modified/ compacted to limit soil movement over time (i.e., fill creep).
    - Where implemented, it is essential that backfilled materials are of sufficient quality and compacted in controlled layers (material quality/required density as per engineers' design).
    - Ensure the removal of topsoil within the footprint of planned fill areas.
    - A carefully engineered fill embankment should not settle more than 0.5% of its height due to self-weight.
    - Engineered fill slopes should be over constructed and thereafter trimmed back to the required position.
    - Cut and fill heights greater than 2 metres should be inspected and approved by a competent person.
- A combination of both boulders and outcrops were visible along the entire route of the planned access road. It is recommended that the location of these anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the route of the planned access road can be partially adjusted on ground level to avoid major anomalies exposed in the initial earthworks.
    - Boulders/outcrops will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development. Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.
- A key pavement design principle is that the subgrade provides an adequate foundation. A minimum CBR of 15% (G7-type compaction) is generally required for flexible pavements (SAPEM, 2014).

- Special attention must be given to the selection of the correct material to be used for the fill material and the general backfill in the construction of pavement layers/gravel wearing course.
    - The exposed colluvium and underling bedrock in the excavated test pits display an overall FAIR quality (COLTO, 1998) and are deemed suitable for use as selected layers (G7/G8) in the proposed access road construction. Localised pockets of weathered bedrock exhibit a GOOD quality and are suitable for subbase layers (G6).
    - Caution should be taken in the zones of poor-quality material highlighted in the study.
    - Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.
    - Should additional materials be required, it is recommended that material be imported from a local borrow area or registered commercial source for the use in controlled layers.
- All earthworks should be carried out in a manner to promote stable development of the site.
    - It is recommended that earthworks be carried out along the guidelines given in SABS 1200/SANS 10400 (current version).
    - Placement of fill layers should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve 93% Modified AASHTO maximum dry density at ±2% optimum moisture content.
    - Density control of placed fill material should be undertaken at regular intervals during fill construction.
- All bulk excavations should be inspected by a competent person (engineer or geo-professional with relevant training and experience) at least once a day and following any periods of rain or any long periods where no work has taken place.
- With reference to the exposed soil profiles and accompanying lab results, the materials exposed across the site were seen to display a variable composition and in-situ geotechnical nature.
    - With this said, an adequate quality control system should be implemented during the construction phase of the development to ensure that pockets of poorer quality soils be removed/treated.
    - Due to their intimate knowledge of the site and its conditions- ongoing laboratory testing can be conducted by Tzaneen Lab during the construction phase of the development.

6. Report Provisions

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The investigation was conducted according to the accepted proposal and the scope of works and literature references provided in this document. Field work and reporting were conducted and/ or overseen by professionally registered scientists with the South African Council for Natural Scientific Professions. Furthermore, GeoCalibre has have employed accepted engineering geologic procedures, and our opinions and conclusions are made in accordance with generally accepted principles and practices in engineering geology.

The presented geotechnical model is based on a data base of available information and available on-site exposures. Parcels of land within the developmental area which are free of excavations are modelled using on-site observations and surrounding exposures. While every effort is made during the fieldwork phase to identify the different soil horizons, areas subject to a perched water table, areas of poor drainage, areas underlain by hard rock and to estimate their distribution, it is impossible to guarantee that variations are excluded over the extent of the site which are the subject of this report.

Variable founding conditions and materials are expected to be encountered. This variability includes soils of different age, composition and associated pre-consolidation pressures. In view of the variability inherent in natural materials, a competent person must inspect all foundation excavations at the time of construction to ensure that the materials are adequate for the proposed structure and that they are in accordance with the recommendations stated in this report.

The design and implementation of the planned engineering fills remains the responsibility of the consulting engineers/competent person- with GeoCalibre and its' employees carrying no liability in this regard. The placement of engineered fill must be controlled with suitable field tests to ensure that the required densities are achieved during compaction, and that the quality of the fill material is within specification to ensure the longevity of the development.

The determination of flood lines and delineation of wetland areas were not part of this investigation scope and should be addressed by suitably competent professionals prior to the final site development plan is compiled, if deemed necessary. If the site or a portion thereof is situated within the 1:100-year flood line, or has been delineated as a wetland, it is the prerogative of the Civil Engineer or other suitably experienced specialist to overwrite the recommendations for such portions.

Although not anticipated at this site, it should be noted that this investigation did not include the assessment of any potential environmental hazards, or groundwater impacts that may be present, or ensue from the construction of the proposed structures.

GeoCalibre is open to ongoing discussions with all the parties involved in order to elaborate on the methodology implemented during this assessment and its associated findings/ground models.

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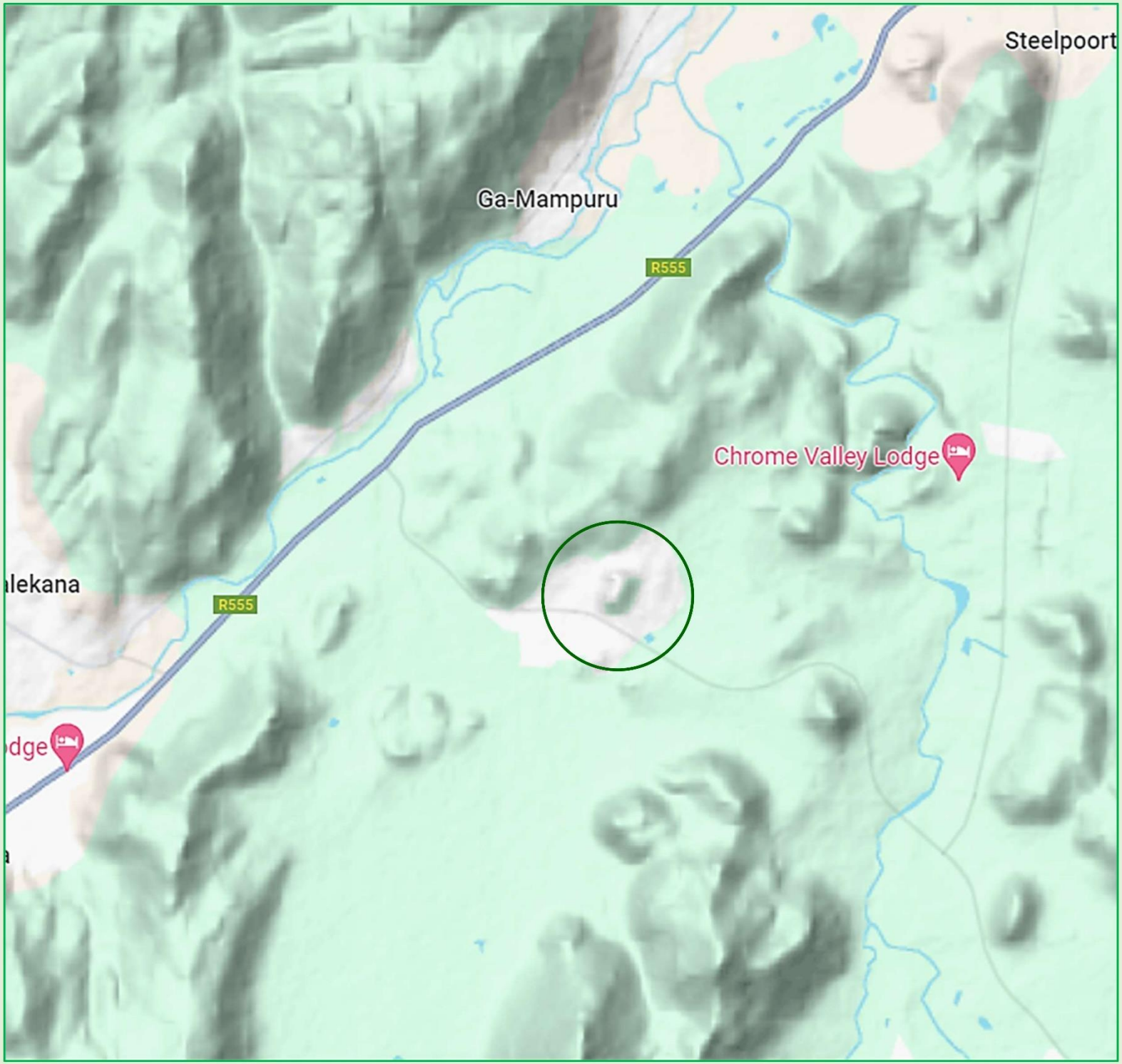
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Layout Maps



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Figure 1

Study Area Location

LEGEND

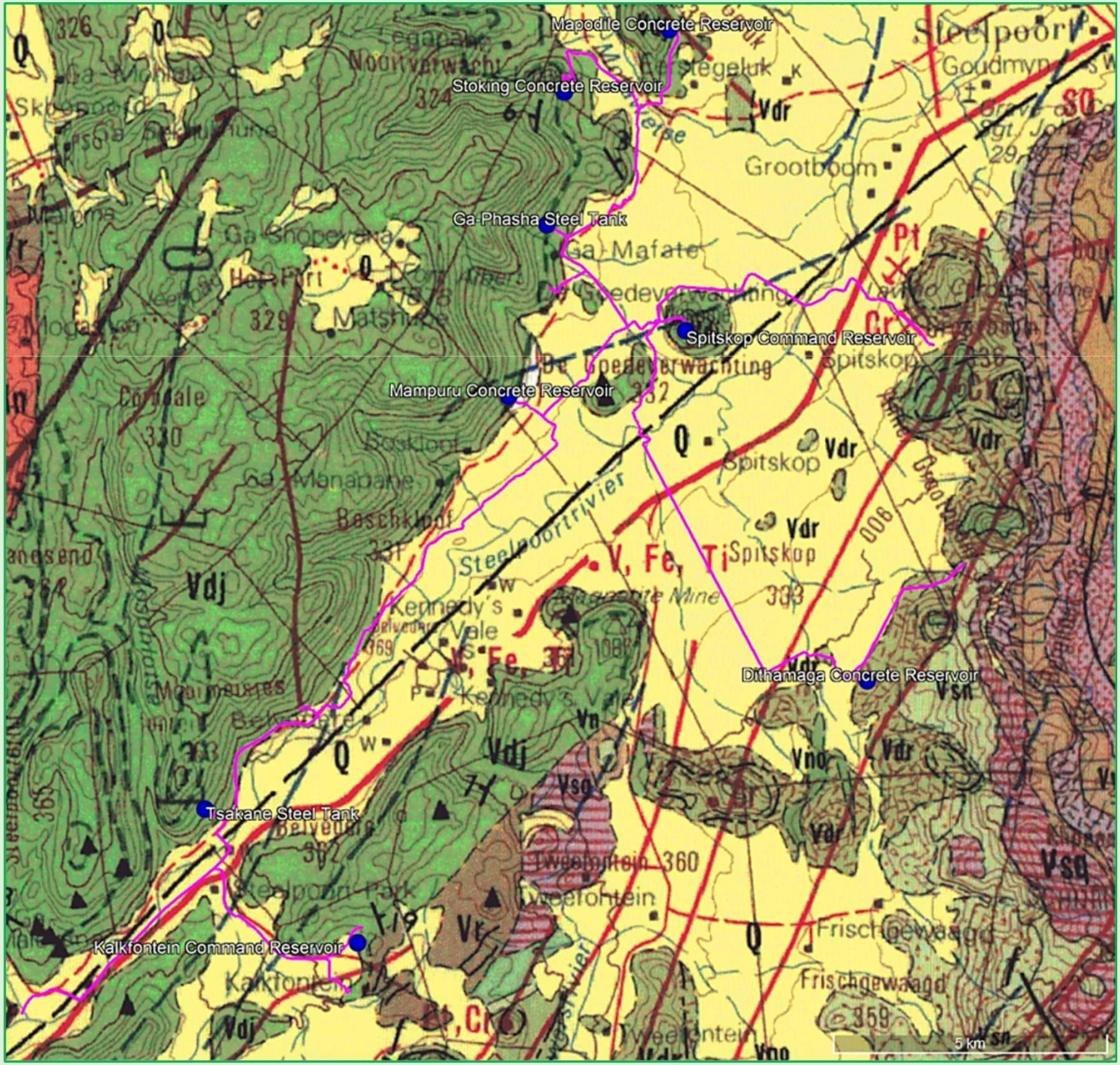
Study Area

N

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Figure 2A

Regional Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.
- Vdr — Medium to coarse-grained norite and anorthosite (upper part)-***Dwars River Subsuite***
- Vsq — Fine to medium-grained quartzite, purple sandstone and shale with quartz clasts and thin conglomerate layers- ***Steenkampsberg Formation*** of the Pretoria Group

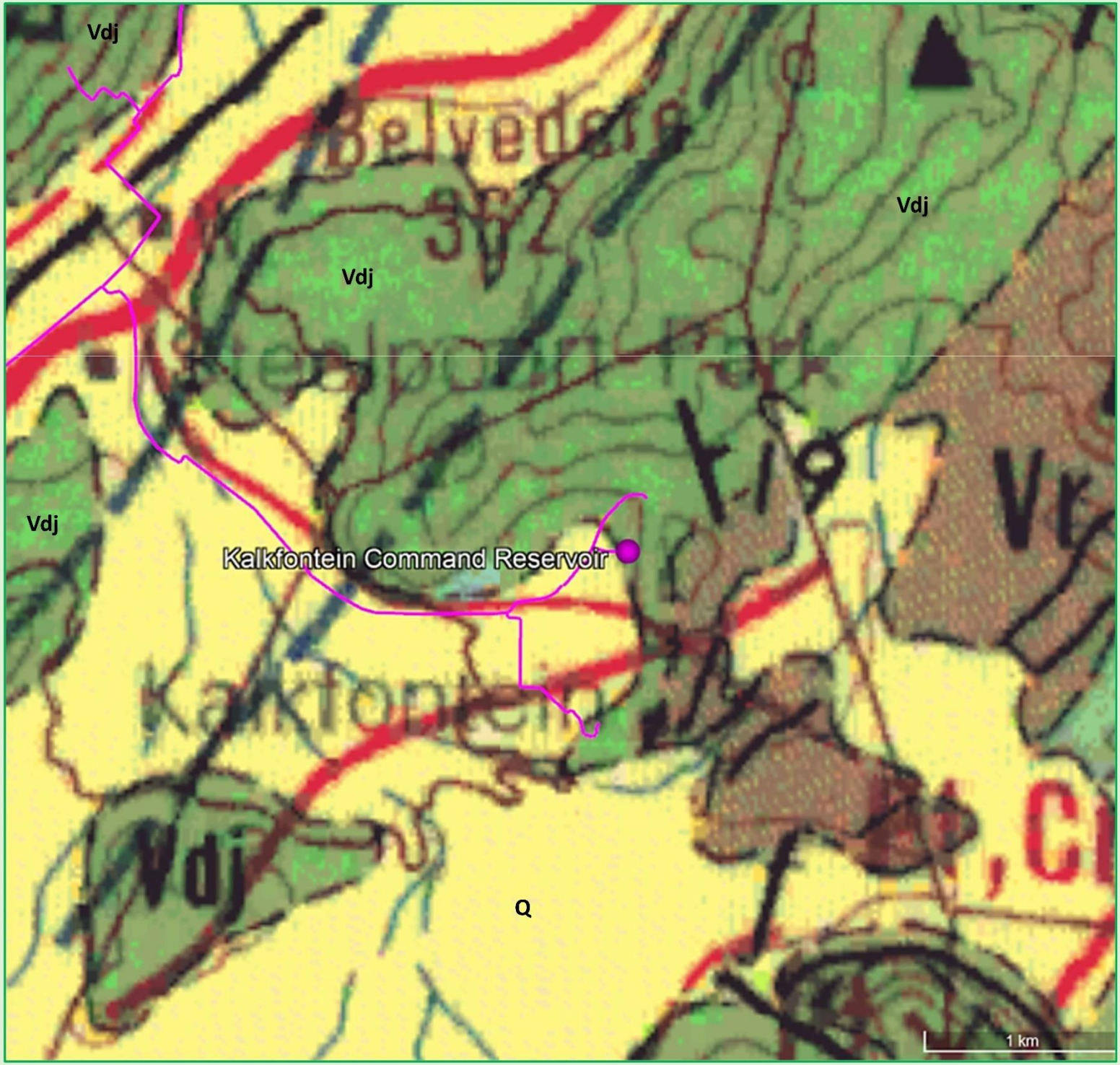
Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

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Figure 2B

Southern Portion- Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.

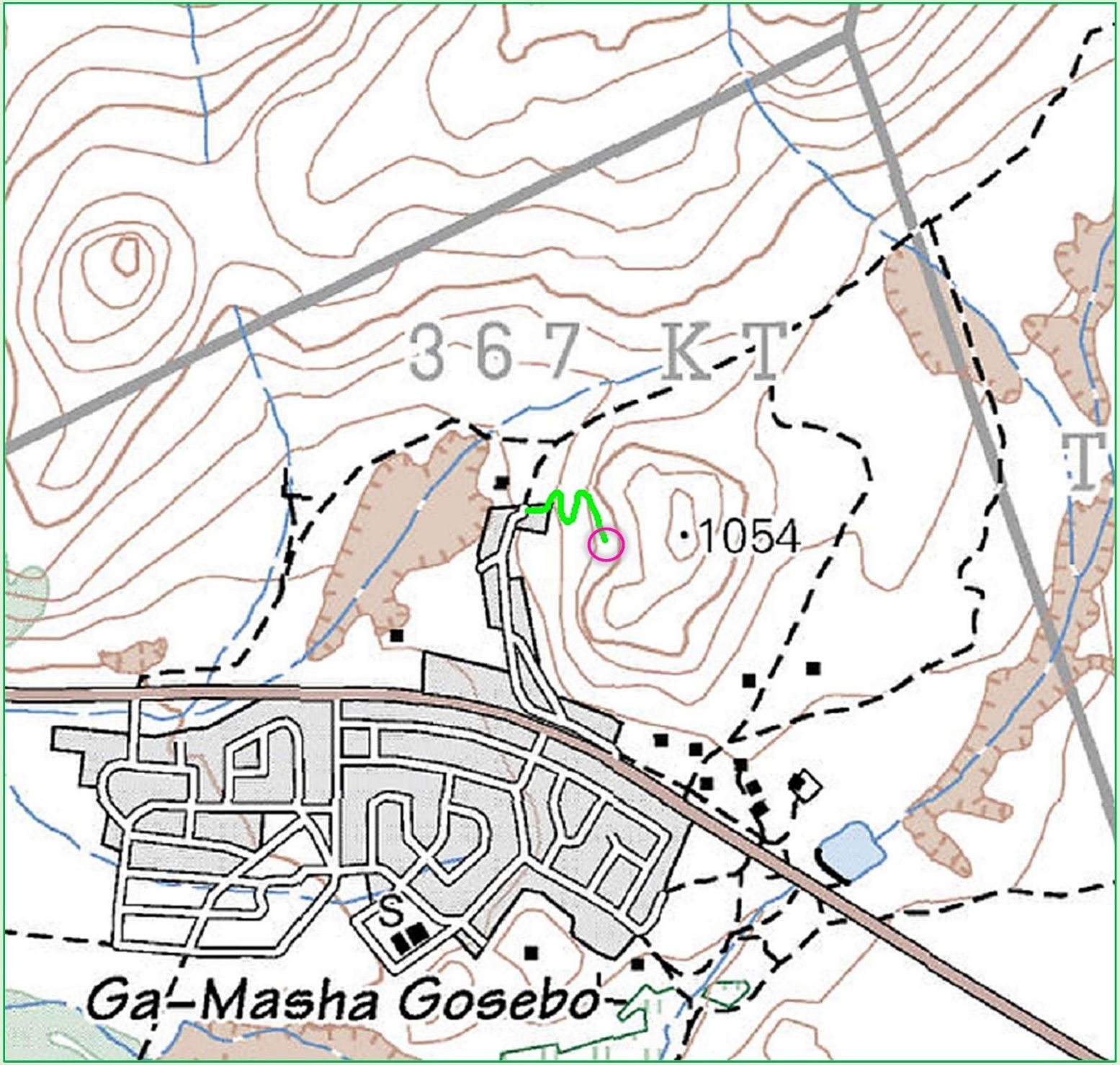
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Figure 3

Topocadastral Map- Kalkfontein Reservoir

LEGEND

Planned Access Road

Reservoir Site

Topocadastral Maps:
2430 Cc; Scale 1 : 50 000

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Figure 4

Site Location- Aerial View

LEGEND

Reservoir Location

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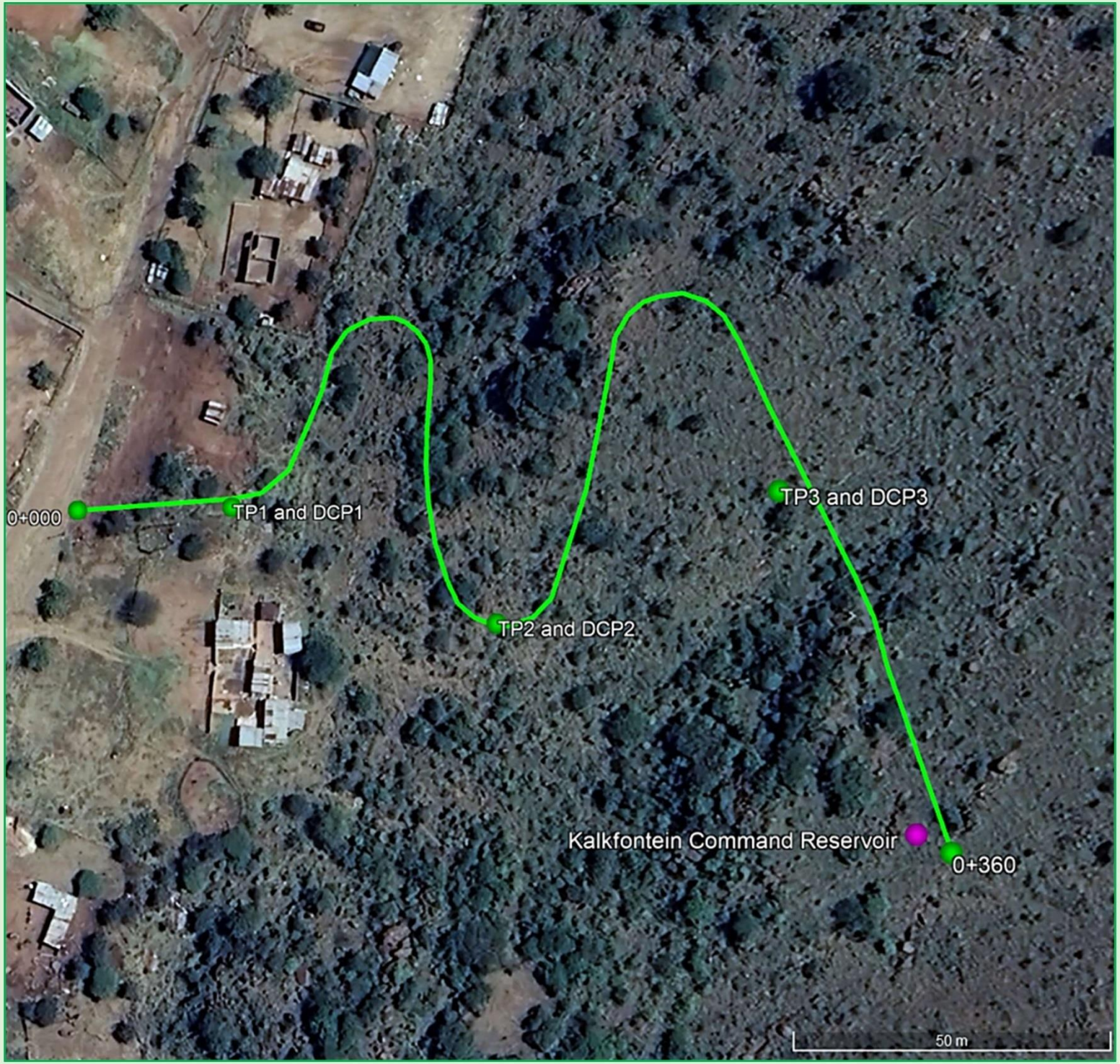
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Figure 5A

Testing Locations- Access Road

LEGEND

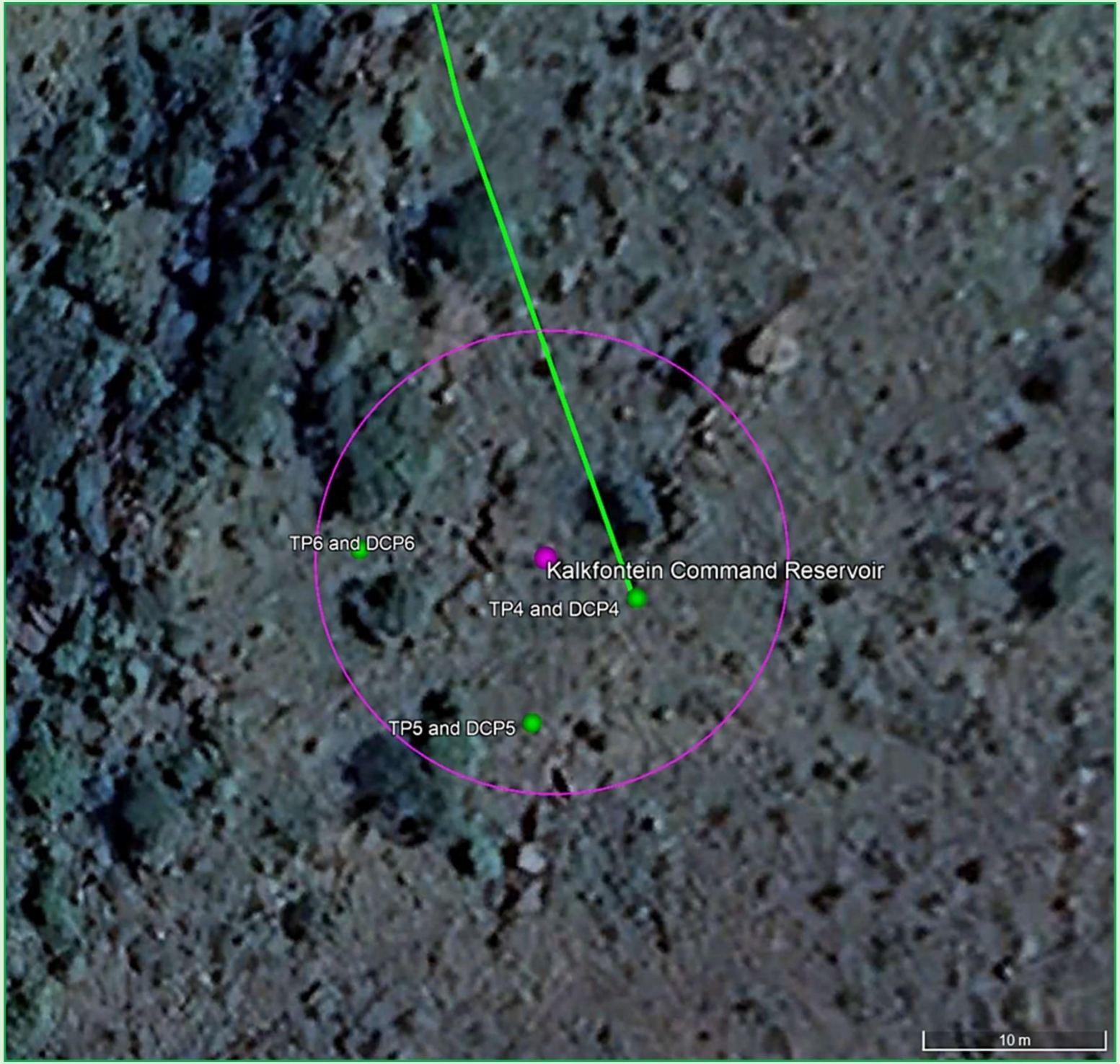
- Test Pit and DCP
- Access Road
- Reservoir Location Received from Client

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Figure 5B

Testing Locations- Planned Reservoir

LEGEND

- Test Pit and DCP
- Access Road
- Reservoir Location Received from Client
- Arbitrary Boundary R= ~15 m

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Testing Locations

GC-24-144A

Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

Test Pit Locations

Test Pit Number	Chainage	Location		Elevation (meters above mean sea level)	Final Excavation Depth by Hand (m)
		Latitude (South)	Longitude (East)		
TP1	0+030	24.883513	30.069602	947	0,48
TP2	0+160	24.883712	30.070122	961	0,97
TP3	0+290	24.883494	30.070615	981	1,10
TP4	0+350	24.884047	30.070896	988	1,10
TP5	0+360	24.884122	30.070831	985	1,16
TP6	0+360	24.884020	30.070718	984	1,06

Please note that all GPS co-ordinates are extracted from a handheld GPS and elevation data from Google Earth PRO

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DCP Testing Locations

GC-24-144A

Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

DCP Test Locations

DCP Number	Chainage	Location		Elevation (meters above mean sea level)	Final Penetration Depth with DCP (mm)
		Latitude (South)	Longitude (East)		
DCP1	0+030	24.883513	30.069602	947	228
DCP2	0+160	24.883712	30.070122	961	319
DCP3	0+290	24.883494	30.070615	981	470
DCP4	0+350	24.884047	30.070896	988	374
DCP5	0+360	24.884122	30.070831	985	105
DCP6	0+360	24.884020	30.070718	984	496

Please note that all GPS co-ordinates are extracted from a handheld GPS and elevation data from Google Earth PRO

Appendix Index

Kalkfontein Command Reservoir- 3000 kl

Appendix A: Soil Profiles

Appendix B: Laboratory Test Results- Bulk and Disturbed Samples

Appendix C: DCP Test Results

Appendix D: Site Classification Reference Tables

Appendix A

Soil Profiles

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Test Pit TP1

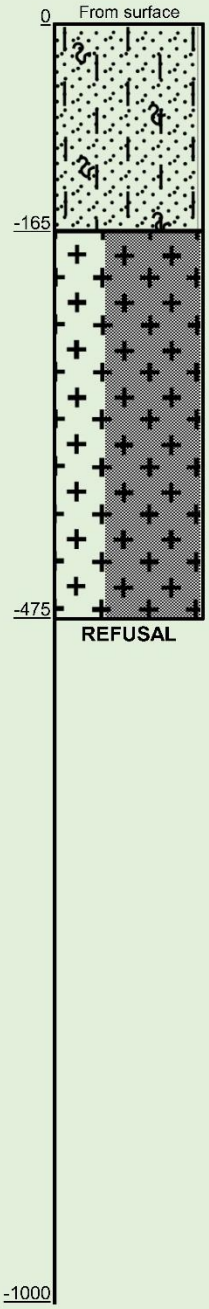
GC-24-144A

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP1



slightly MOIST; light BROWN, mottled cream; medium DENSE; PINHOLED; silty SAND with traces of gravels and cobbles; COLLUVIUM; abundant fine roots; surficial cobbles and boulders; Not Sampled.

~Undulating contact (100 to 230)

slightly MOIST; light creamy WHITE, speckled black; COARSE grained; CLOSELY JOINTED; COMPLETELY weathered; very soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; traces of fine roots in the upper extent; irregular pockets of less weathered bedrock; traces of calcrete nodules; Bulk Sample No. K1.

~Undulating excavation depth (380 to 570)

Profile Notes		Excavation Description	
Profiled by:	CJ Herbig (Engineering Geologist)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	947	**Coordinates:**	24.883513°S 30.069602°E

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GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Profile Photo: TP1



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GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Material Present in Test Pit: TP1







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GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Surroundings of Test Pit: TP1





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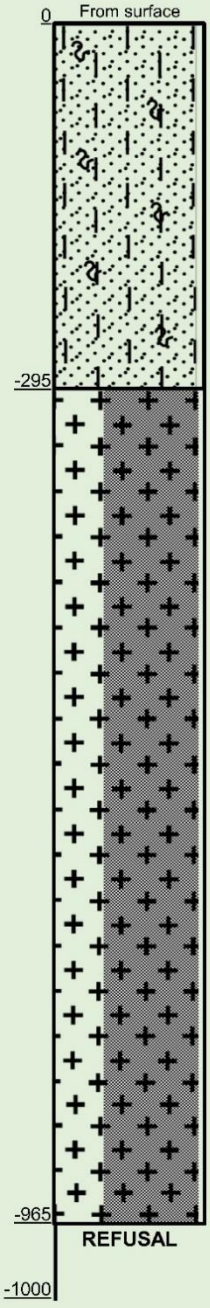
Test Pit TP2

GC-24-144A

Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP2



slightly MOIST; light BROWN, mottled white; medium DENSE; PINHOLED; silty SAND with minor gravels and cobbles; COLLUVIUM; abundant fine roots; surficial cobbles; Bulk Sample No. K2.

~Undulating contact (240 to 350)

slightly MOIST; dark grey, mottled white; COARSE grained; MODERATELY JOINTED; HIGHLY weathered; medium hard rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; traces of fine roots in the upper extent; pockets of completely weathered bedrock decreasing with depth; Not Sampled.

~Undulating excavation depth (1080 to 850)

Profile Notes		Excavation Description	
Profiled by:	CJ Herbig (Engineering Geologist)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	961	**Coordinates:**	24.883712°S 30.070122°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Profile Photo: TP2



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Material Present in Test Pit: TP2







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Surroundings of Test Pit: TP2





GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Test Pit TP3

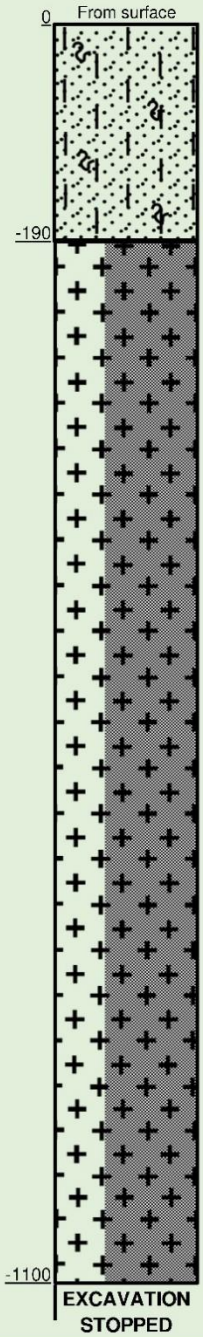
GC-24-144A

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP3



slightly MOIST; light orangey BROWN, mottled white; medium DENSE; PINHOLED; silty SAND with traces of gravels and cobbles; COLLUVIUM; abundant fine roots; Not Sampled.

~Undulating contact (160 to 220)

slightly MOIST; light greyish WHITE, speckled black; COARSE grained; CLOSELY JOINTED; HIGHLY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; traces of fine roots in the upper extent; irregular pockets of less weathered bedrock; minor calcification; joints stained and filled with residual soil; Bulk Sample No. K3.

Profile Notes		Excavation Description	
Profiled by:	CJ Herbig (Engineering Geologist)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Excavation stopped in weathered Gabbro
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	981	**Coordinates:**	24.883494°S 30.070615°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Profile Photo: TP3



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Material Present in Test Pit: TP3







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Surroundings of Test Pit: TP3





GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Test Pit TP4

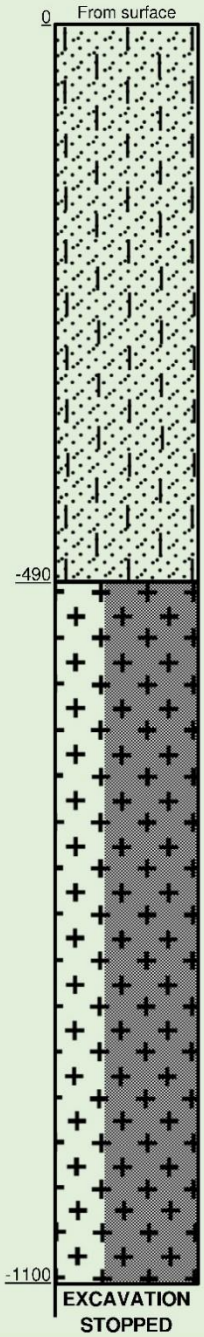
GC-24-144A

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP4



slightly MOIST; light BROWN, blotched cream, mottled white; medium DENSE; PINHOLED; silty SAND with minor gravels and cobbles; COLLUVIUM; gravels and boulders decreasing with depth; surficial gravels, cobbles and boulders; Not Sampled.

~Undulating contact (340 to 640)

slightly MOIST; light GREY, speckled black and white; COARSE grained; CLOSELY JOINTED; HIGHLY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; traces of fine roots; open joint planes stained and filled with granular residual soil; Bulk Sample No. K4.

Profile Notes		Excavation Description	
Profiled by:	CJ Herbig (Engineering Geologist)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Excavation stopped in weathered Gabbro
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	988	**Coordinates:**	24.884047°S 30.070896°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Profile Photo: TP4



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Material Present in Test Pit: TP4







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

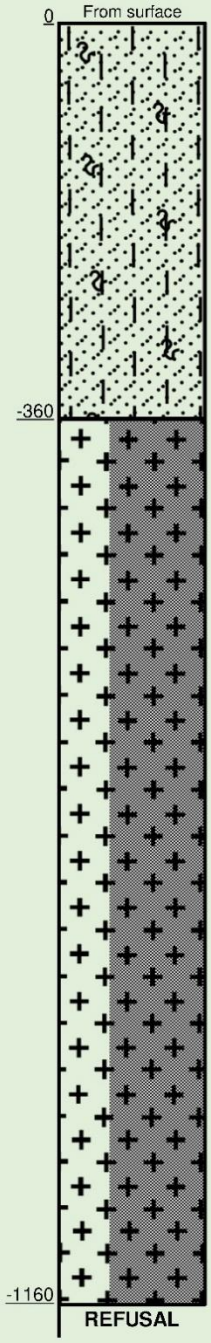
Test Pit TP5

GC-24-144A

Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP5



slightly MOIST; light orangey BROWN, mottled white; medium DENSE; PINHOLED; silty SAND with traces of sub-angular gravels and cobbles; COLLUVIUM; biological activity; abundant fine roots; surficial cobbles and boulders; Bulk Sample No. K5.

~Undulating contact (320 to 400)

slightly MOIST; light greyish WHITE, mottled black; COARSE grained; CLOSELY JOINTED; HIGHLY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; traces of fine roots in the upper extent; gradual transition to less weathered bedrock with depth; traces of calcrete nodules; infiltration zones in the upper extent; open joints filled with granular residual soil; Not Sampled.

Profile Notes		Excavation Description	
Profiled by:	CJ Herbig (Engineering Geologist)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered Gabbro
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	985	**Coordinates:**	24.884122°S 30.070831°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Profile Photo: TP5



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Material Present in Test Pit: TP5







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Surroundings of Test Pit: TP5





GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Test Pit TP6

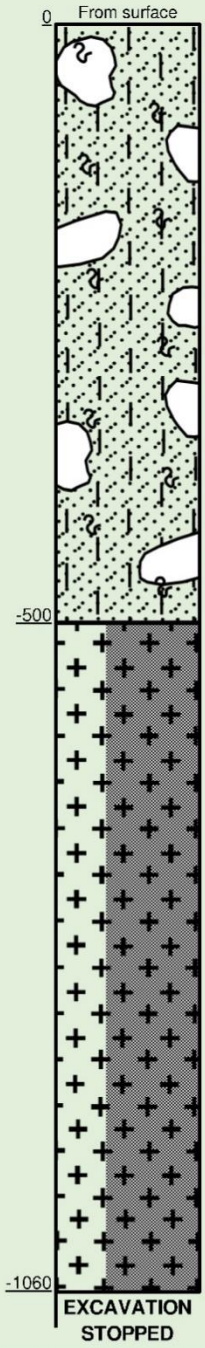
GC-24-144A

Mampuru Bulk Water Scheme

Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP6



slightly MOIST; light BROWN, blotched cream; medium DENSE; PINHOLED; clayey SAND with minor sub-angular gravels and cobbles; COLLUVIUM; abundant fine roots; surficial cobbles and boulders; Not Sampled.

Gradual contact

slightly MOIST; light greyish WHITE, speckled black, mottled yellow; COARSE grained; CLOSELY JOINTED; HIGHLY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; traces of fine roots in the upper extent; irregular pockets of less weathered bedrock; infiltration zones; Bulk Sample No. K6.

Profile Notes		Excavation Description	
Profiled by:	CJ Herbig (Engineering Geologist)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Excavation stopped in weathered Gabbro
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	984	**Coordinates:**	24.884020°S 30.070718°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Profile Photo: TP6



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Material Present in Test Pit: TP6







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144A
Kalkfontein Command Reservoir- 3000kl

Surroundings of Test Pit: TP6





GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Appendix B

Laboratory Test Results

Bulk and Disturbed Samples

Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

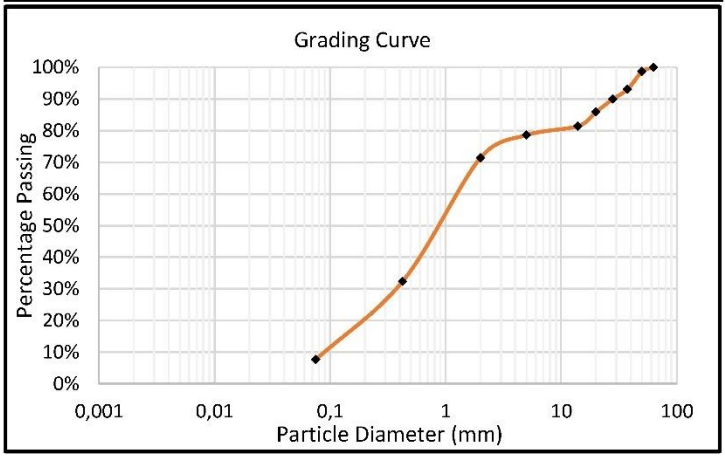
Hanko Investments T/A Tzaneen Lab | P.O. Box 3784, Tzaneen, 0850 |1992 Industria Road, Tzaneen | www.tzaneenlab.co.za | admin@tzaneenlab.co.za | 015 307 1661

Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/1
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description	Test Pit 1 from 0,17 to 0,49m below E.G.L (K1)	Date Reported:	2024/07/10

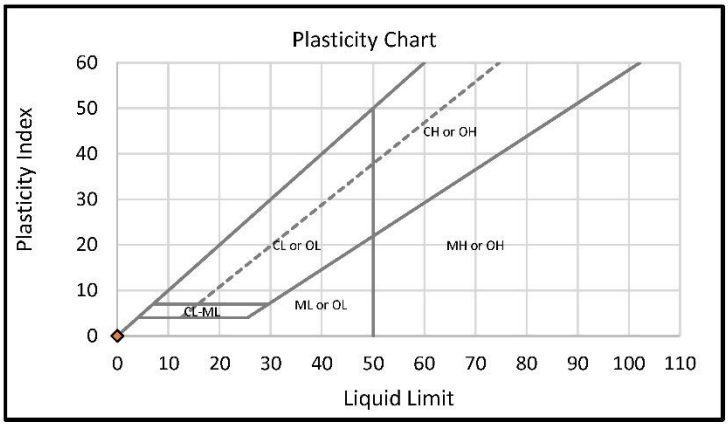
Road Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	99%
37,5	93%
28,0	90%
20,0	86%
14,0	81%
5,0	79%
2,0	71%
0,425	32,4%
0,075	7,6%

Description: Dark Yellowish Orange well-graded silty Sand



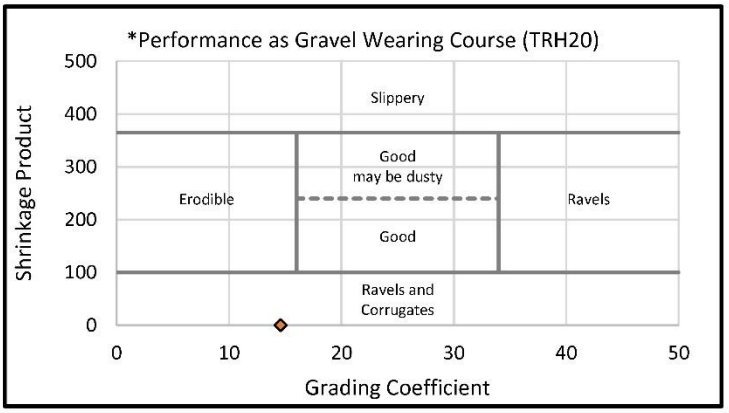
*Grading Characteristics		
Grading Modulus	GM	1,89
Effective Size	D_{10}	0,09
Uniformity Coef.	C_u	14,37
Curvature Coef.	C_c	1,15



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	55%
Fine Sand	0.425 - 0.075 mm	35%
Silt and Clay	<0.075 mm	11%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	-
Plasticity Index	PI	NP
Linear Shrinkage	LS	0,00%

Grading Coefficient	Gc	14,6
Shrinkage Product	Sp	0



*Classifications		
	Unified Soil Classification- USCS	**SW-SM**
	COLTO Classification	**G6**
	US Highway	**A-1-b (0)**



Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G5 requirements due to: % Passing 2mm>70%, CBR @ 95%<45

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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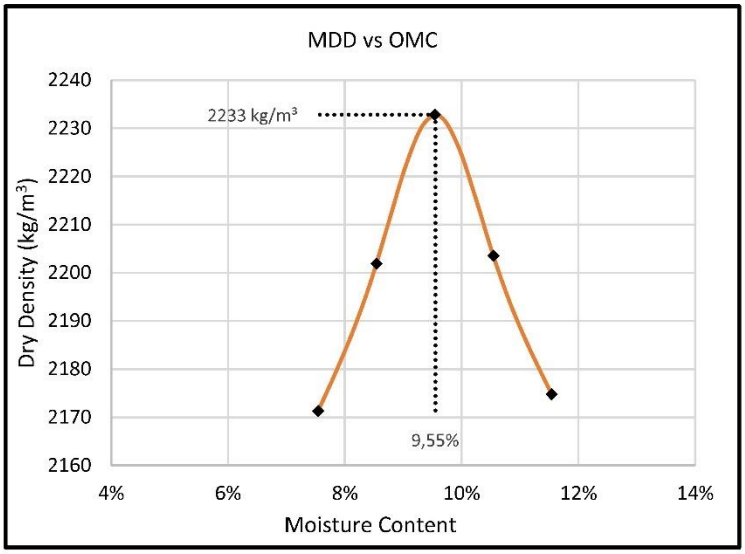
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/1
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description	Test Pit 1 from 0,17 to 0,49m below E.G.L (K1)	Date Reported:	2024/07/10

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	7,5%	2171
2	8,5%	2202
3	9,5%	2233
4	10,5%	2204
5	11,5%	2175

Optimum Moisture Content (OMC):	**9,6%**
Maximum Dry Density (MDD):	**2233 kg/m³**

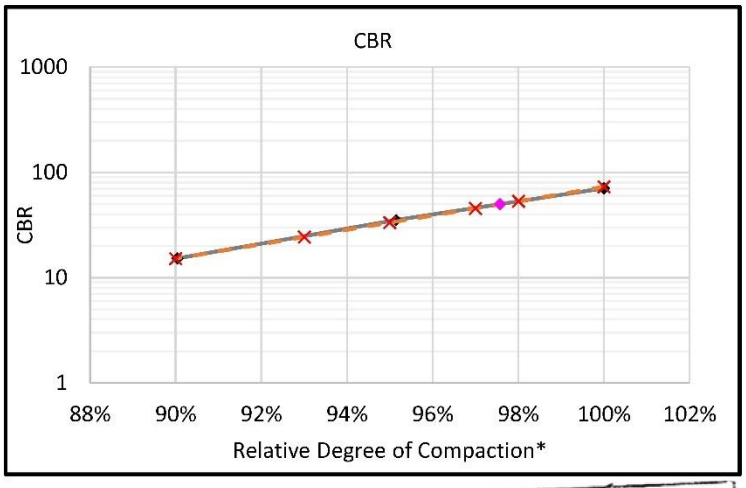


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	9,4%		
Dry Density (kg/m³)	2238 kg/m³	2129 kg/m³	2015 kg/m³
Relative compaction (%)	100,0%	95,1%	90,0%
Measured CBR	71	35	15
% Swell	0,03	0,04	0,05

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	73
98%	53
97%	45
95%	33
93%	24
90%	15



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Box 3784 TZANEEN
CHECKED
Tel: 015 307 1661
Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G5 requirements due to: % Passing 2mm>70%, CBR @ 95%<45

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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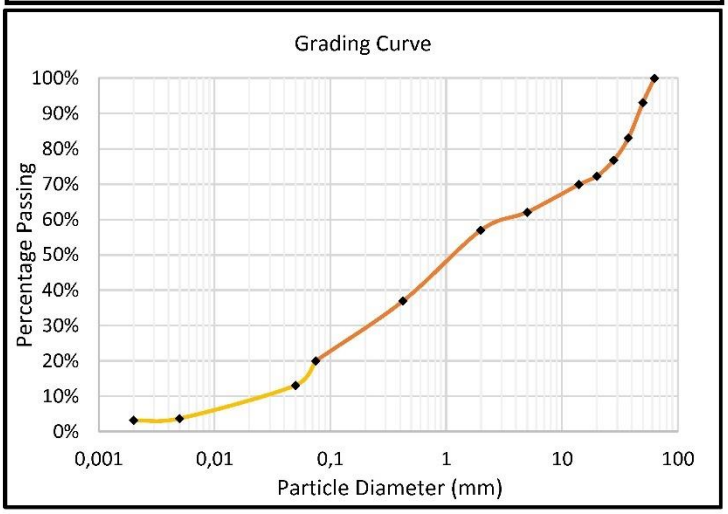
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/2
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description:	Test Pit 2 from 0,00 to 0,30m below E.G.L (K2)	Date Reported:	2024/07/10

Foundation Indicator Test Report: SANS 3001

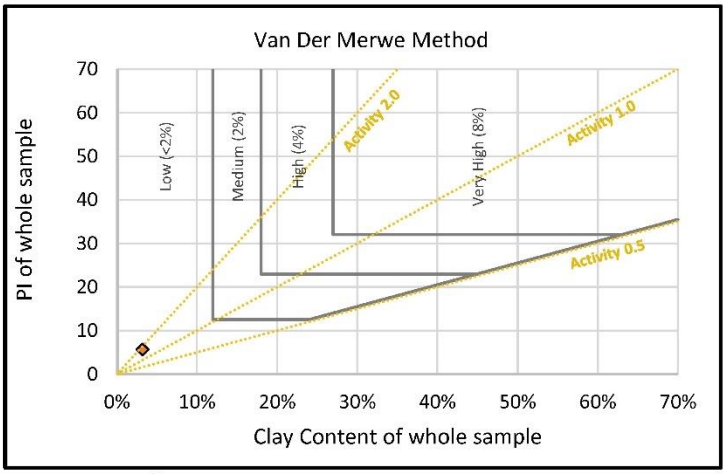
Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	93%
37,5	83%
28,0	77%
20,0	72%
14,0	70%
5,0	62%
2,0	57%
0,425	37,0%
0,075	20,0%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	13,1%
0,005	3,7%
0,002	3,2%

Description: Dusky Red clayey Sand

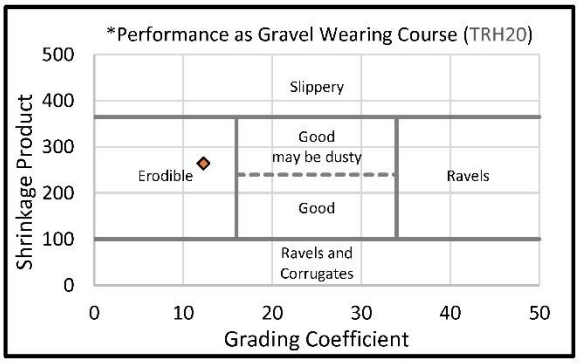


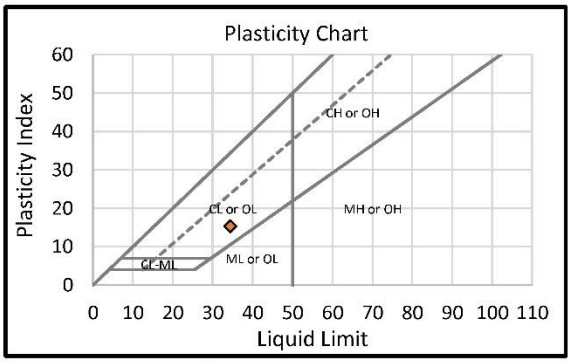
*Grading Characteristics		
Grading Modulus	GM	1,86
Effective Size	D_{10}	0,02
Uniformity Coef.	C_u	147,57
Curvature Coef.	C_c	0,54



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	35%
Fine Sand	0.425 - 0.075 mm	30%
Silt	0.075 - 0.002 mm	29%
Clay	<0.002	7%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	34%
Plasticity Index	PI	15%
Linear Shrinkage	LS	7,15%





*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**G8**
	US Highway	**A-2-6 (0)**

TZANEEN LAB P.O.Box 3784 TZANEEN 2024 CHECKED Technical Signatory Tel: 015 307 1661

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G7 requirements due to: CBR @ 93%<15

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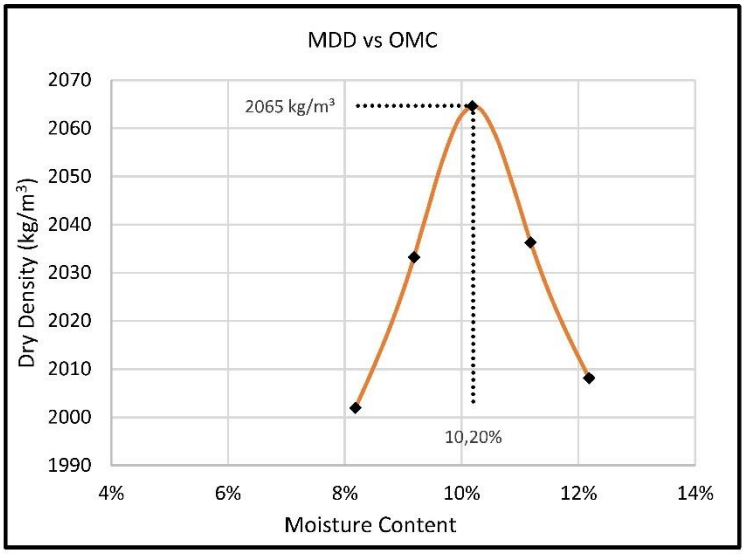
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/2
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description	Test Pit 2 from 0,00 to 0,30m below E.G.L (K2)	Date Reported:	2024/07/10

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	8,2%	2002
2	9,2%	2033
3	10,2%	2065
4	11,2%	2036
5	12,2%	2008

Optimum Moisture Content (OMC):	**10,2%**
Maximum Dry Density (MDD):	**2065 kg/m³**

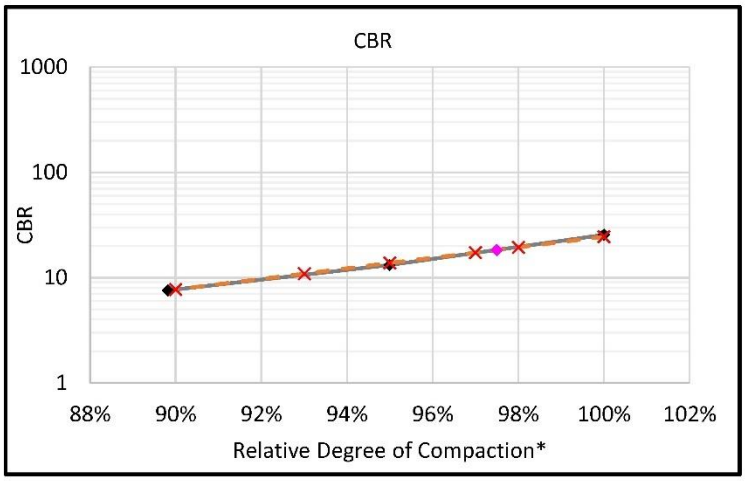


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	10,0%		
Dry Density (kg/m³)	2072 kg/m³	1968 kg/m³	1861 kg/m³
Relative compaction (%)	100,0%	95,0%	89,8%
Measured CBR	25	13	8
% Swell	0,05	0,06	0,08

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	24
98%	19
97%	17
95%	14
93%	11
90%	8



TZANEEN LAB P.O. Box 3784 TZANEEN 2024 CHECKED Tel: 015 307 1661 Technical signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G7 requirements due to: CBR @ 93%<15

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/3
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description:	Test Pit 3 from 0,19 to 1,10m below E.G.L (K3)	Date Reported:	2024/07/10

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	-
50,0	-
37,5	100%
28,0	100%
20,0	99%
14,0	97%
5,0	85%
2,0	66%
0,425	33,9%
0,075	9,5%

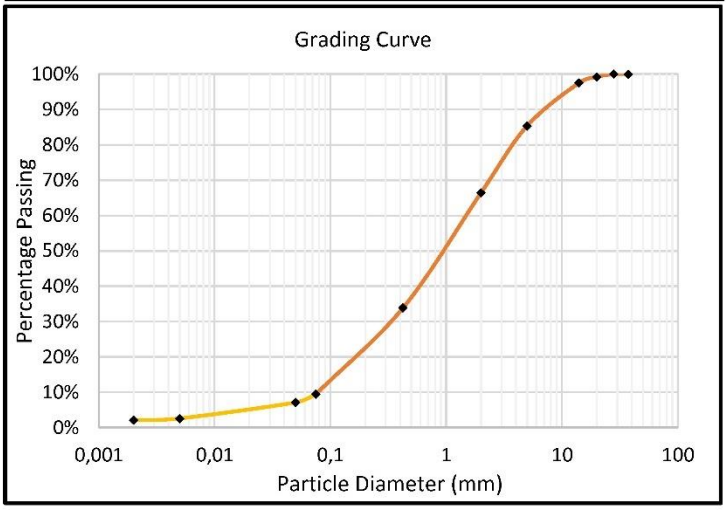
*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	7,1%
0,005	2,6%
0,002	2,1%

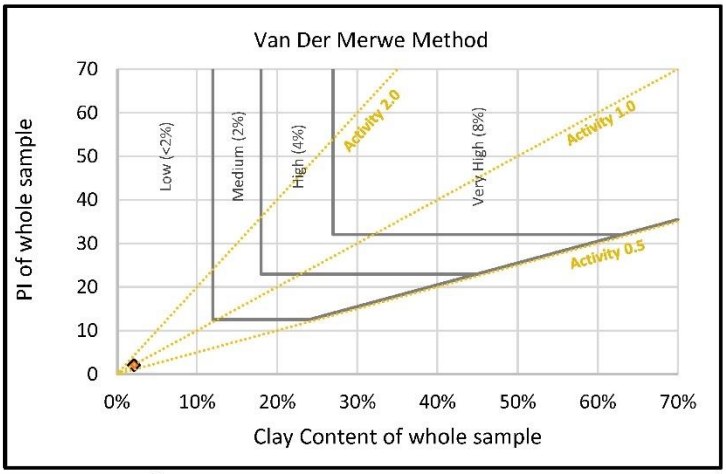
*Grading Characteristics		
Grading Modulus	GM	1,90
Effective Size	D_{10}	0,08
Uniformity Coef.	C_u	18,91
Curvature Coef.	C_c	0,91

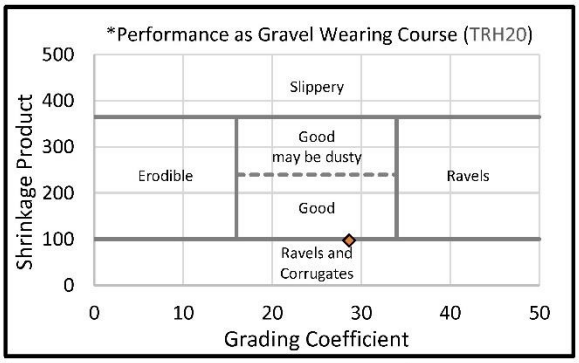
*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	49%
Fine Sand	0.425 - 0.075 mm	37%
Silt	0.075 - 0.002 mm	10%
Clay	<0.002	4%

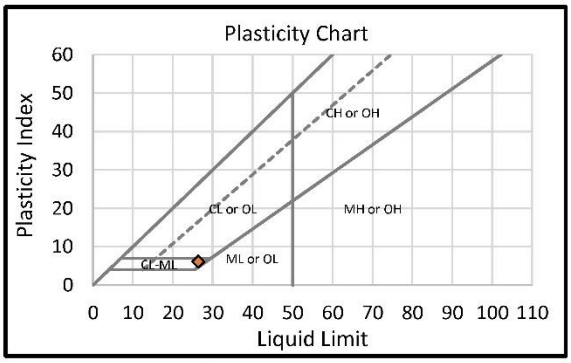
Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	26%
Plasticity Index	PI	6%
Linear Shrinkage	LS	2,86%

Description: Light Brown poorly-graded clayey Sand









*Classifications		
	Unified Soil Classification- USCS	**SP-SC**
	COLTO Classification	**G7**
	US Highway	**A-2-4 (0)**

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

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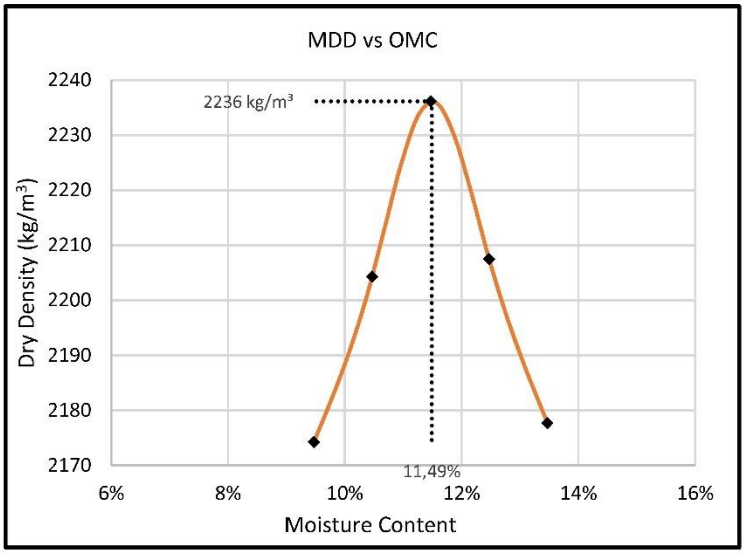
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/3
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description	Test Pit 3 from 0,19 to 1,10m below E.G.L (K3)	Date Reported:	2024/07/10

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	9,5%	2174
2	10,5%	2204
3	11,5%	2236
4	12,5%	2208
5	13,5%	2178

Optimum Moisture Content (OMC):	**11,5%**
Maximum Dry Density (MDD):	**2236 kg/m³**

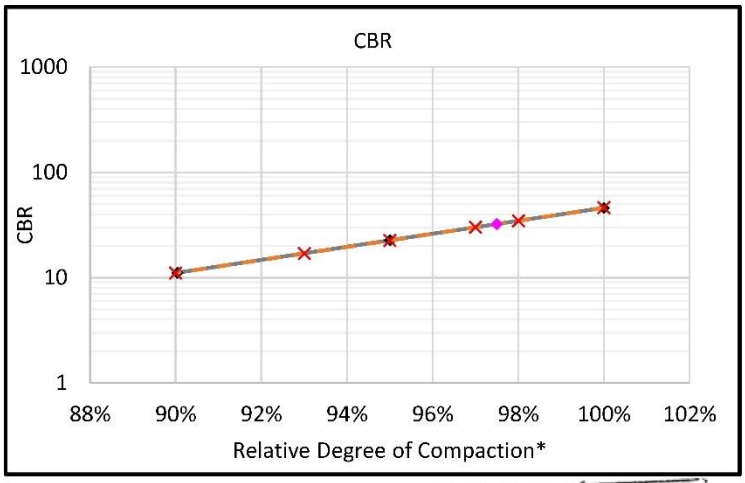


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	11,6%		
Dry Density (kg/m³)	2239 kg/m³	2127 kg/m³	2016 kg/m³
Relative compaction (%)	100,0%	95,0%	90,0%
Measured CBR	46	23	11
% Swell	0,02	0,03	0,04

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	46
98%	35
97%	30
95%	23
93%	17
90%	11



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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

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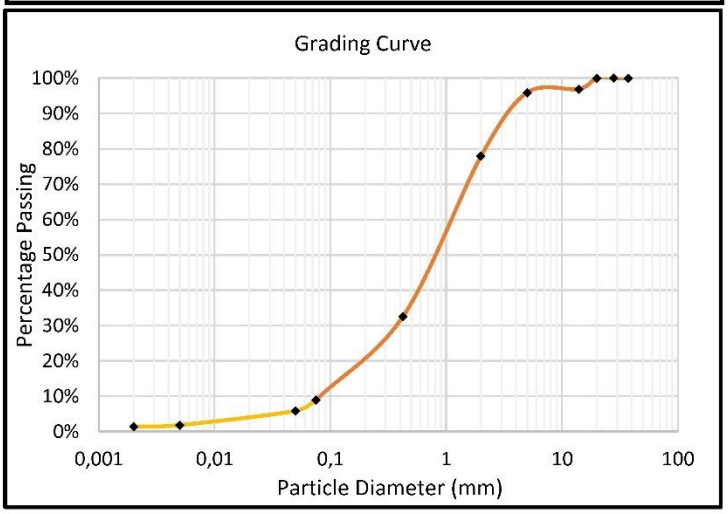
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/4
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description:	Test Pit 4 from 0,49 to 1,10m below E.G.L (K4)	Date Reported:	2024/07/10

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	-
50,0	-
37,5	100%
28,0	100%
20,0	100%
14,0	97%
5,0	96%
2,0	78%
0,425	32,6%
0,075	9,0%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	5,9%
0,005	1,9%
0,002	1,4%

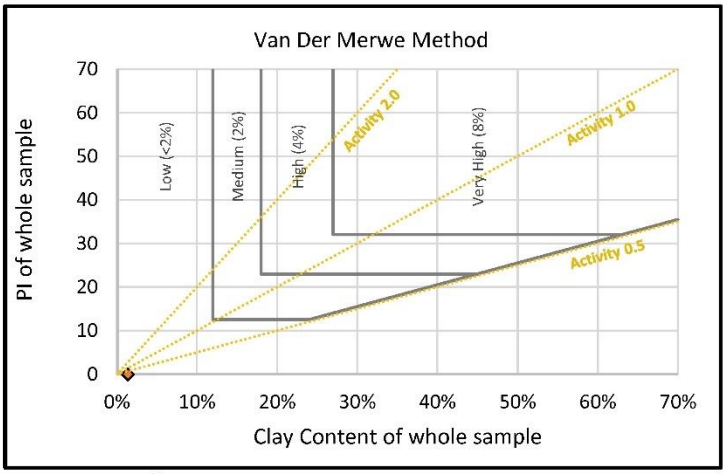
Description: Light Reddish Brown well-graded silty Sand

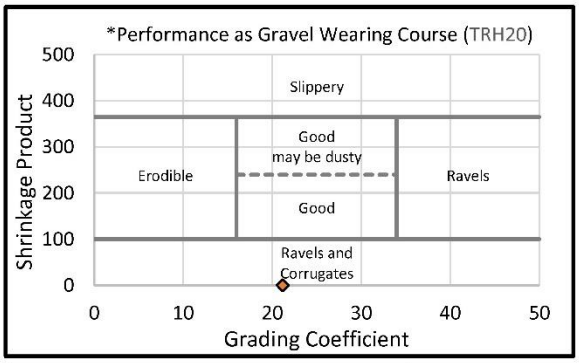


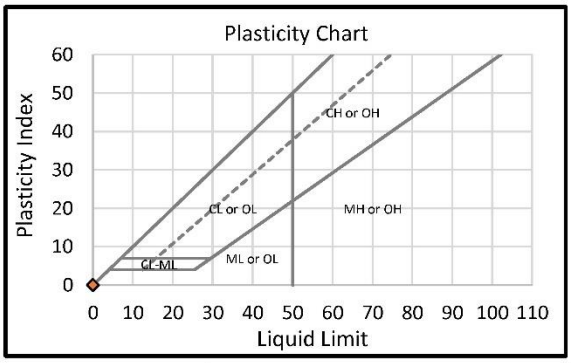
*Grading Characteristics		
Grading Modulus	GM	1,80
Effective Size	D_{10}	0,08
Uniformity Coef.	C_u	13,37
Curvature Coef.	C_c	1,40

*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	58%
Fine Sand	0.425 - 0.075 mm	30%
Silt	0.075 - 0.002 mm	9%
Clay	<0.002	2%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	-
Plasticity Index	PI	NP
Linear Shrinkage	LS	0,00%







*Classifications		
	Unified Soil Classification- USCS	**SW-SM**
	COLTO Classification	**G7**
	US Highway	**A-1-b (0)**

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

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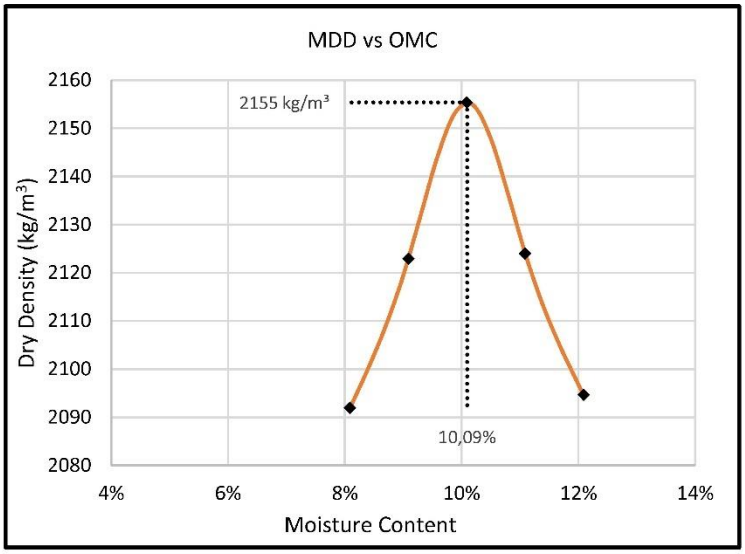
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/4
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description	Test Pit 4 from 0,49 to 1,10m below E.G.L (K4)	Date Reported:	2024/07/10

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	8,1%	2092
2	9,1%	2123
3	10,1%	2155
4	11,1%	2124
5	12,1%	2095

Optimum Moisture Content (OMC):	10,1%
Maximum Dry Density (MDD):	2155 kg/m³

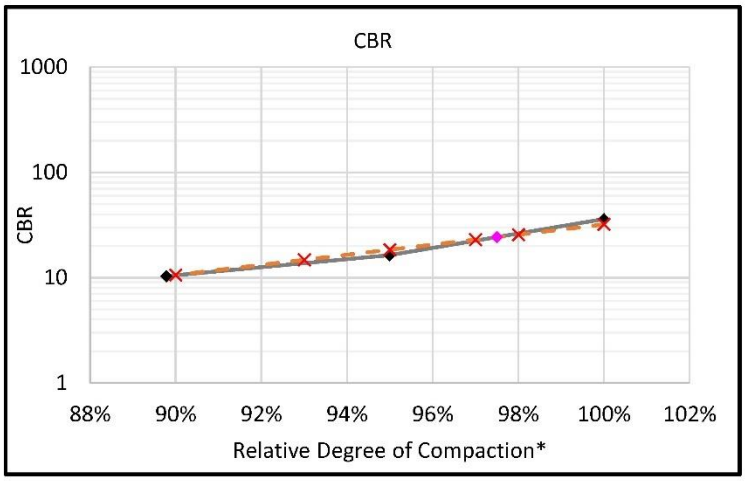


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	10,0%		
Dry Density (kg/m³)	2161 kg/m³	2053 kg/m³	1941 kg/m³
Relative compaction (%)	100,0%	95,0%	89,8%
Measured CBR	36	16	10
% Swell	0,02	0,03	0,05

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	32
98%	26
97%	23
95%	18
93%	15
90%	11





Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

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Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/5
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description:	Test Pit 5 from 0,00 to 0,36m below E.G.L (K5)	Date Reported:	2024/07/10

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	97%
37,5	84%
28,0	78%
20,0	74%
14,0	69%
5,0	57%
2,0	46%
0,425	29,7%
0,075	18,2%

*Hydrometer Analysis (SANS 3001-GR3)		
Diameter (mm)	**% Passing** **	
0,05	10,7%	7,3%
0,005	3,7%	1,1%
0,002	3,2%	0,7%

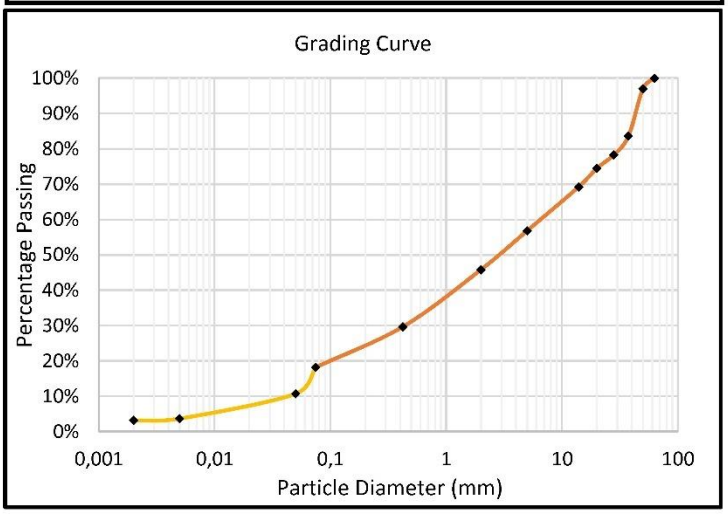
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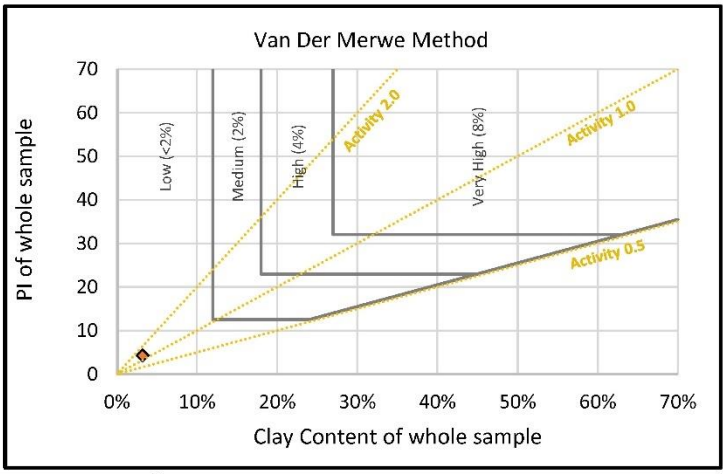
*Grading Characteristics		
Grading Modulus	GM	2,06
Effective Size	D_{10}	0,04
Uniformity Coef.	C_u	163,73
Curvature Coef.	C_c	0,74

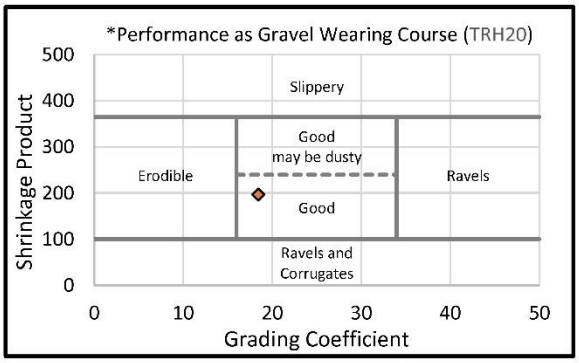
*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	35%
Fine Sand	0.425 - 0.075 mm	25%
Silt	0.075 - 0.002 mm	32%
Clay	<0.002	8%

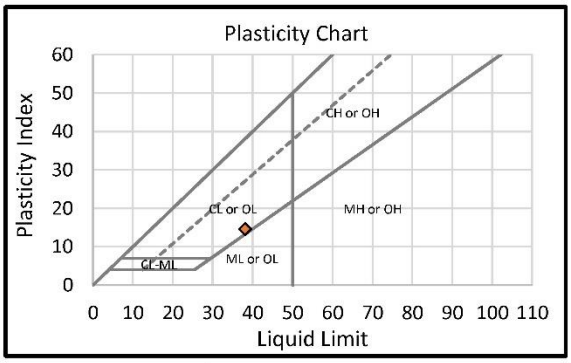
Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	38%
Plasticity Index	PI	15%
Linear Shrinkage	LS	6,61%

Description: Dusky Red clayey Sand









*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**G7**
	US Highway	**A-2-6 (0)**

*pH: 7,3	*Electrical Conductivity: 51 mS/m	*Double Hydrometer: 29,7%

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: PI>14,12, LS>5, CBR @ 95%<25

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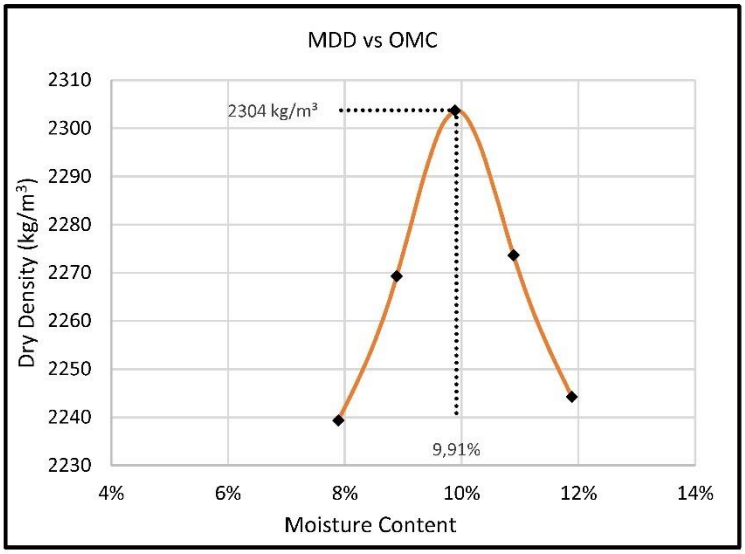
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/5
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description	Test Pit 5 from 0,00 to 0,36m below E.G.L (K5)	Date Reported:	2024/07/10

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	7,9%	2239
2	8,9%	2269
3	9,9%	2304
4	10,9%	2274
5	11,9%	2244

Optimum Moisture Content (OMC):	**9,9%**
Maximum Dry Density (MDD):	**2304 kg/m³**

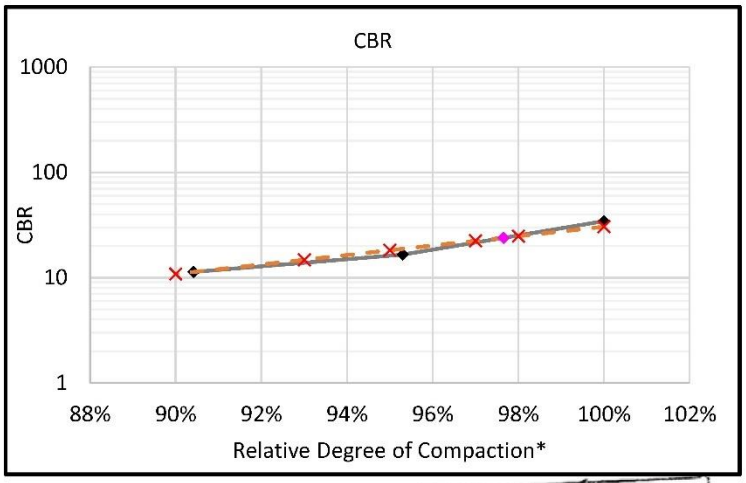


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	9,6%		
Dry Density (kg/m³)	2312 kg/m³	2204 kg/m³	2091 kg/m³
Relative compaction (%)	100,0%	95,3%	90,4%
Measured CBR	34	17	11
% Swell	0,05	0,06	0,08

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	30
98%	25
97%	22
95%	18
93%	15
90%	11



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Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: PI>14,12, LS>5, CBR @ 95%<25

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Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/6
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description:	Test Pit 6 from 0,50 to 1,06m below E.G.L (K6)	Date Reported:	2024/07/10

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	-
50,0	-
37,5	100%
28,0	100%
20,0	100%
14,0	100%
5,0	100%
2,0	95%
0,425	51,6%
0,075	17,6%

*Hydrometer Analysis (SANS 3001-GR3)		
Diameter (mm)	**% Passing** **	
0,05	13,5%	9,5%
0,005	5,0%	0,8%
0,002	4,3%	0,1%

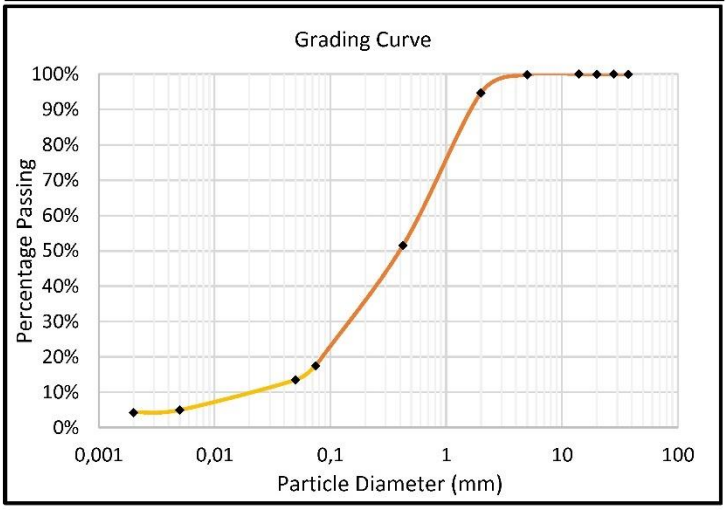
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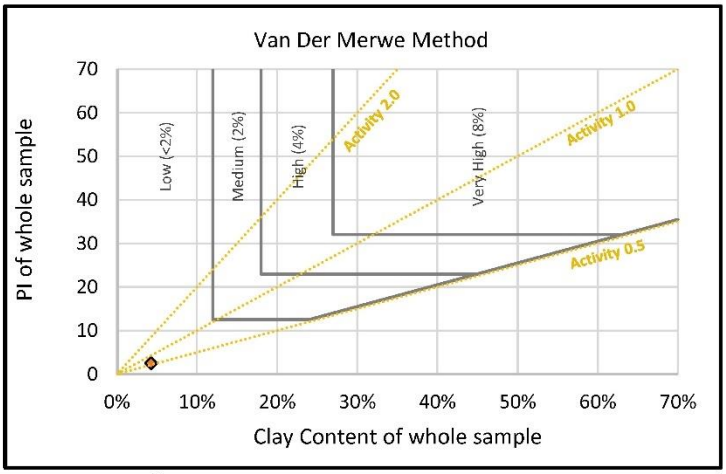
*Grading Characteristics		
Grading Modulus	GM	1,36
Effective Size	D_{10}	0,02
Uniformity Coef.	C_u	29,76
Curvature Coef.	C_c	1,80

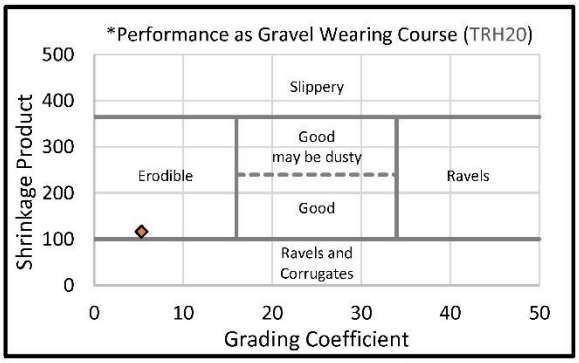
*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	45%
Fine Sand	0.425 - 0.075 mm	36%
Silt	0.075 - 0.002 mm	13%
Clay	<0.002	5%

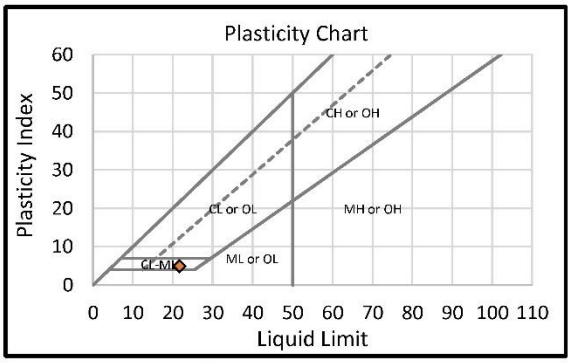
Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	22%
Plasticity Index	PI	5%
Linear Shrinkage	LS	2,25%

Description: Dark Yellowish Orange silty/clayey Sand









*Classifications		
	Unified Soil Classification- USCS	**SM-SC**
	COLTO Classification	**G7**
	US Highway	**A-2-4 (0)**

*pH: 7,4	*Electrical Conductivity: 28 mS/m	*Double Hydrometer: 16,0%

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

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ilac-MRA sanas Testing Laboratory T0906

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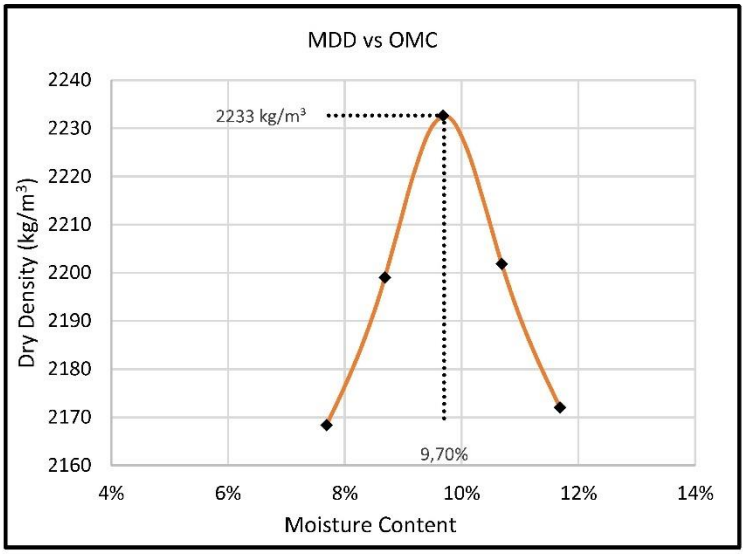
Client:	Geo Calibre Geotechnical Consultancy	Sample No.	T03345/6
Project:	Kalkfontein Command Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/04
Description	Test Pit 6 from 0,50 to 1,06m below E.G.L (K6)	Date Reported:	2024/07/10

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	7,7%	2168
2	8,7%	2199
3	9,7%	2233
4	10,7%	2202
5	11,7%	2172

Optimum Moisture Content (OMC):	**9,7%**
Maximum Dry Density (MDD):	**2233 kg/m³**

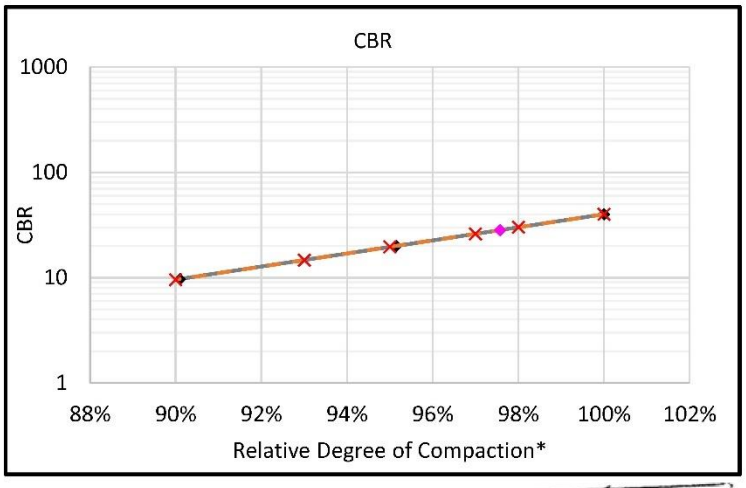


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	9,8%		
Dry Density (kg/m³)	2234 kg/m³	2126 kg/m³	2013 kg/m³
Relative compaction (%)	100,0%	95,2%	90,1%
Measured CBR	40	20	10
% Swell	0,02	0,03	0,04

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	40
98%	30
97%	26
95%	20
93%	15
90%	10





Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

Results in this report only relate to the item(s) tested by Tzaneen Civil Lab. Results and advice are subject to correct sampling being followed. Tzaneen Lab does not accept responsibility for any matters arising from the further use of these results. This report is confidential and is only intended for the use of the individual or entity to which it is addressed.

Appendix C

DCP Test Results

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144A

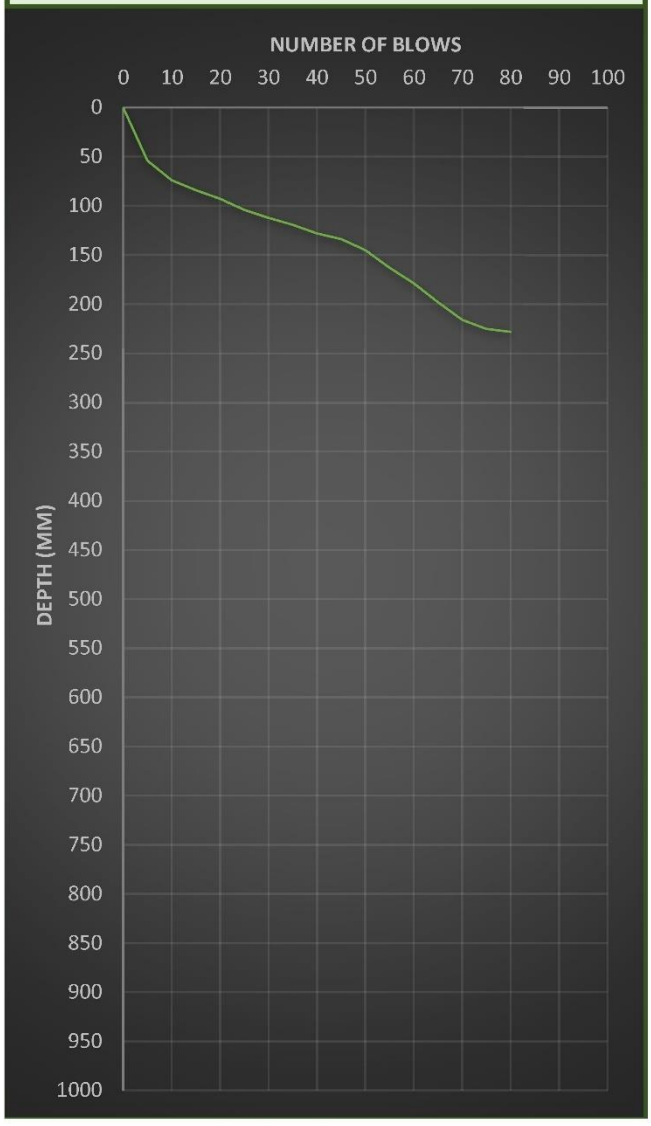
Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd.

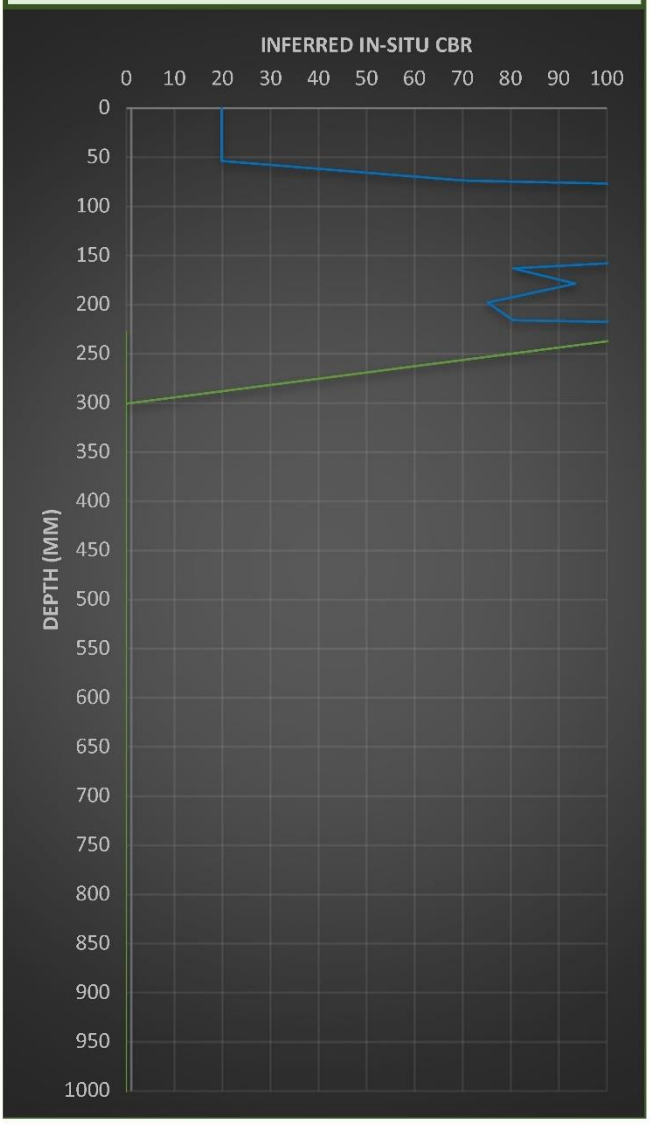
DCP 1 at TP1

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
2,9	**2,7**		
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
105,2	**114,7**		
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 228 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144A

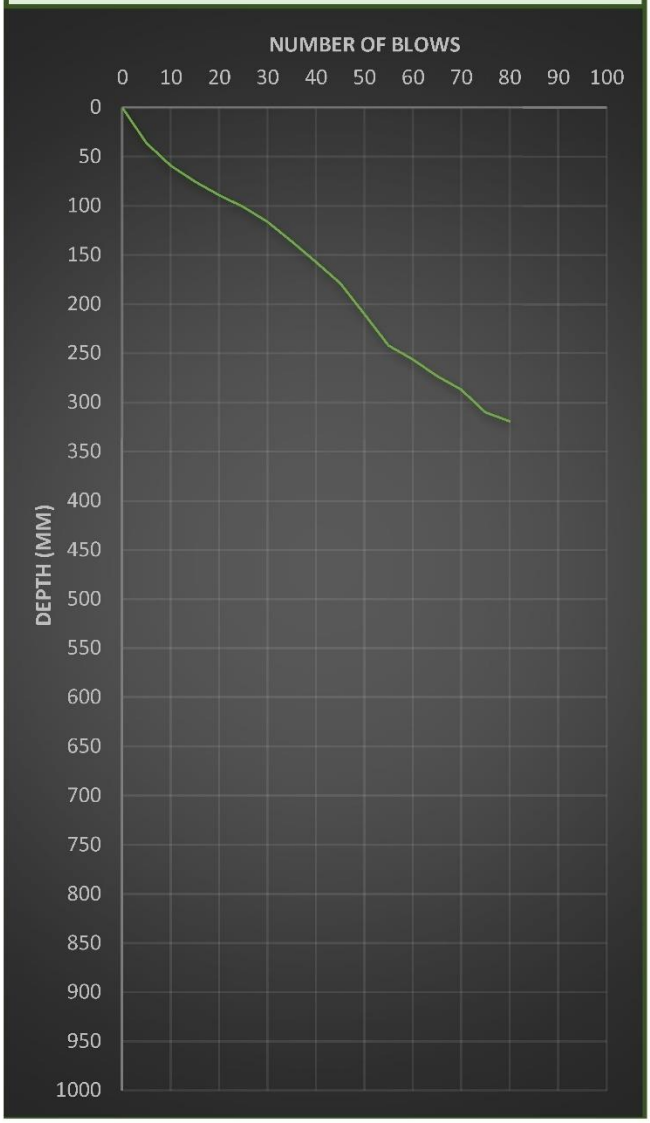
Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd.

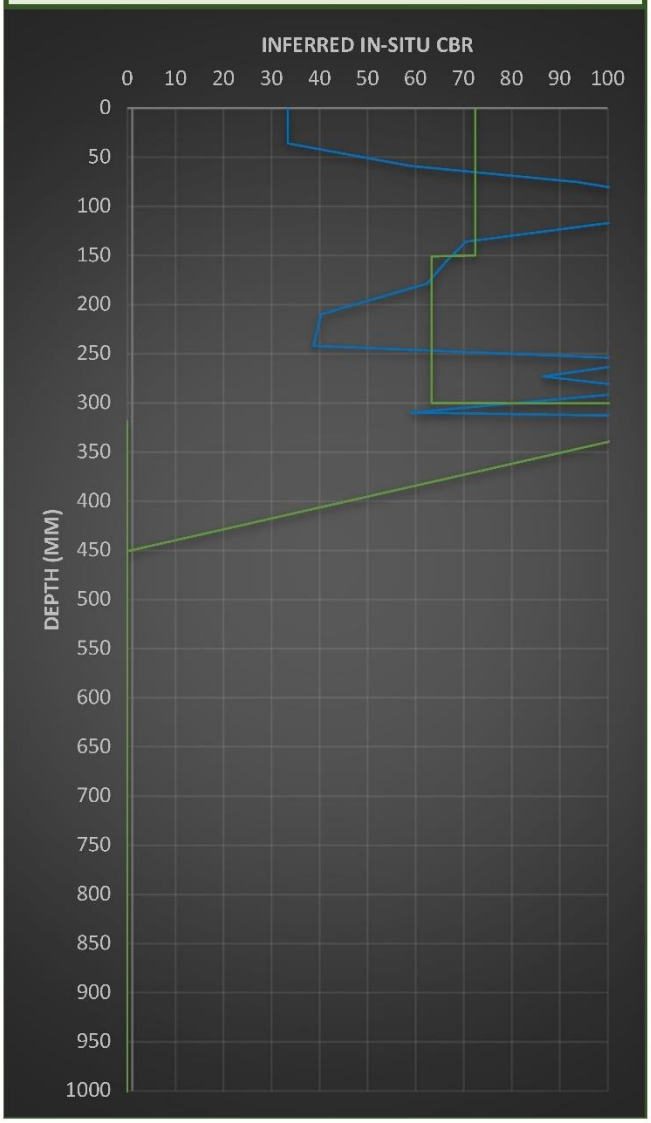
DCP 2 at TP2

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
3,9	**4,3**	**2,6**	
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
72,5	**63,4**	**119,0**	
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 319 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144A

Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd.

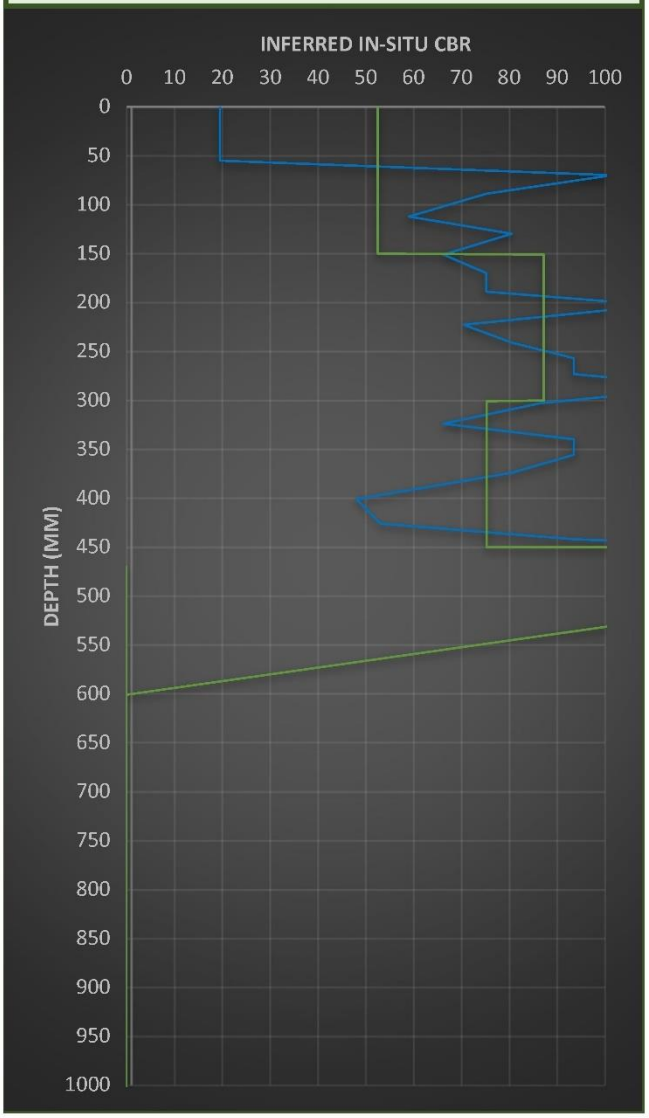
DCP 3 at TP3

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
5,0	**3,4**	**3,8**	**1,8**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
52,6	**87,3**	**75,4**	**189,0**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 470 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144A

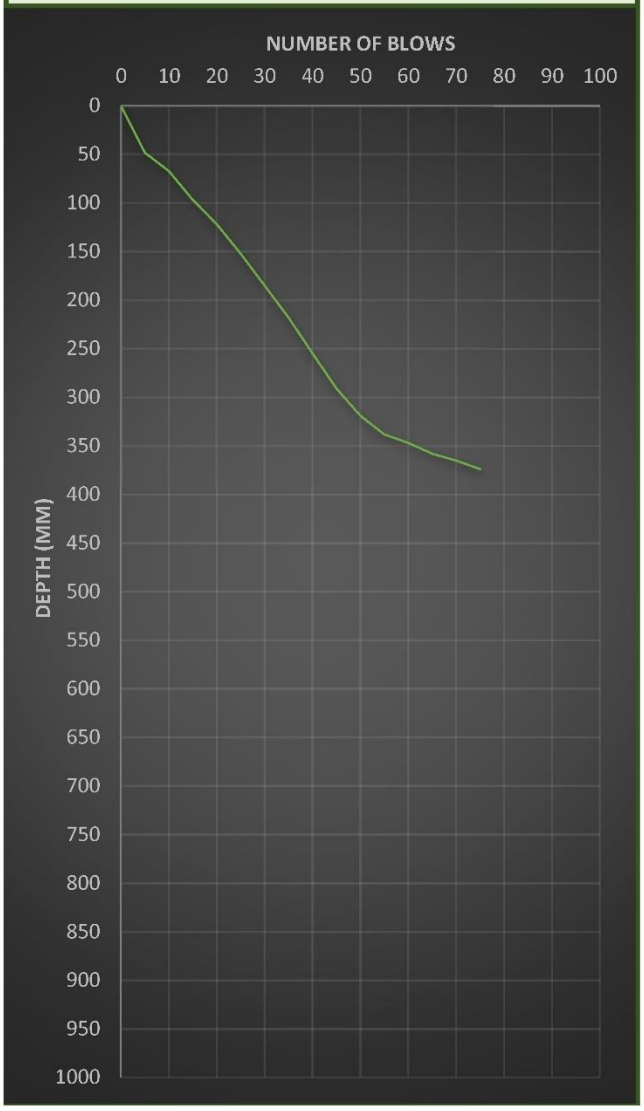
Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd.

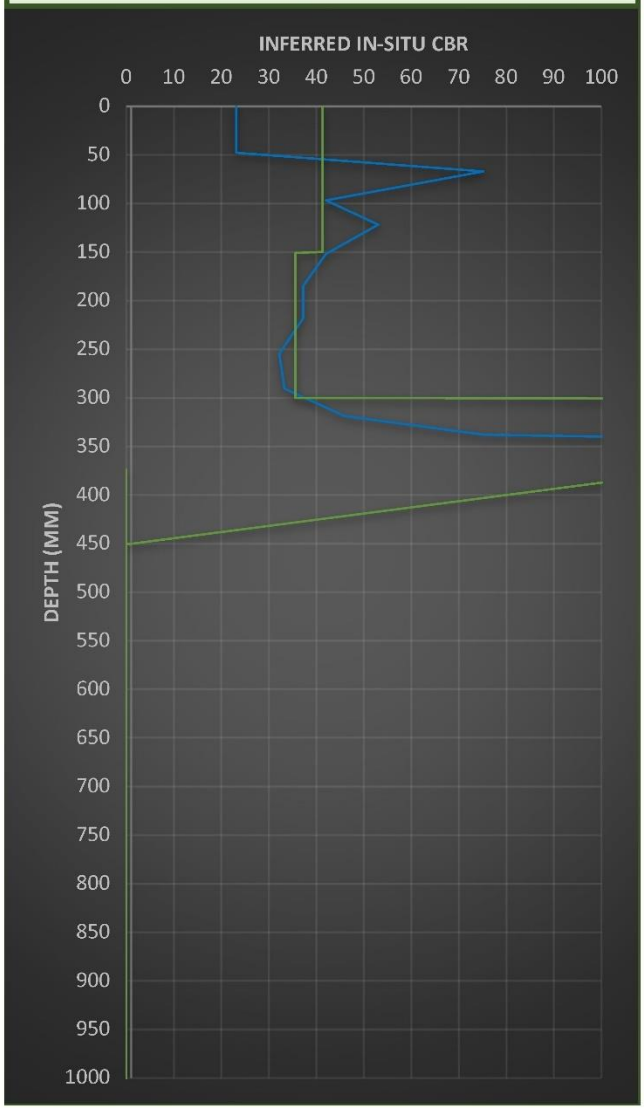
DCP 4 at TP4

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
6,1	**6,8**	**2,6**	
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
41,4	**35,7**	**121,5**	
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 374 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144A

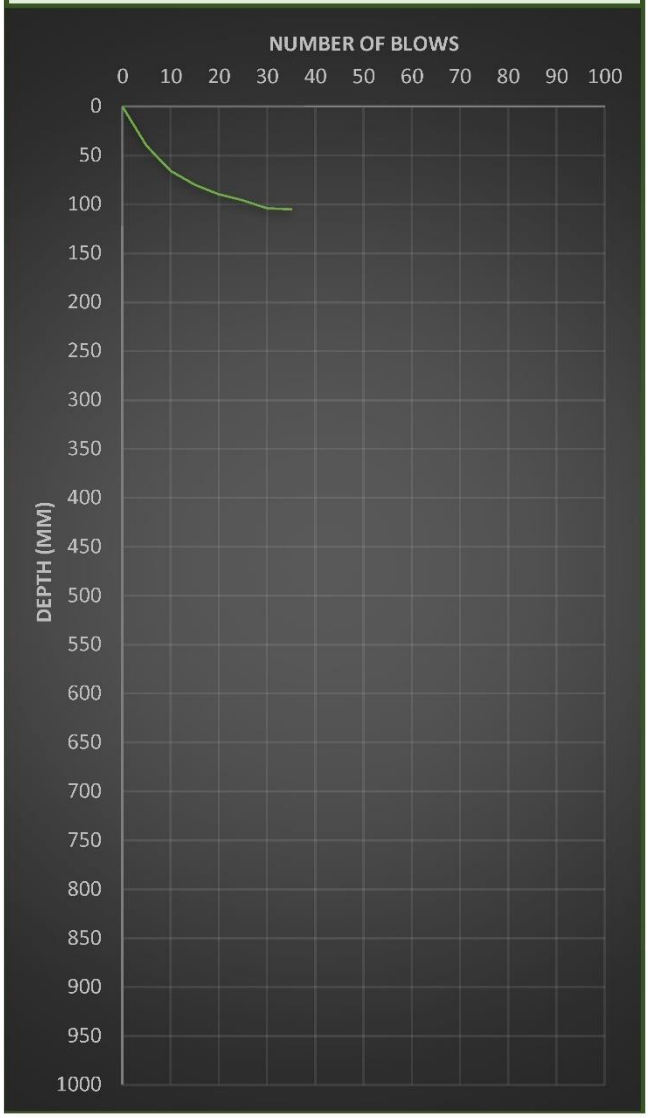
Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd.

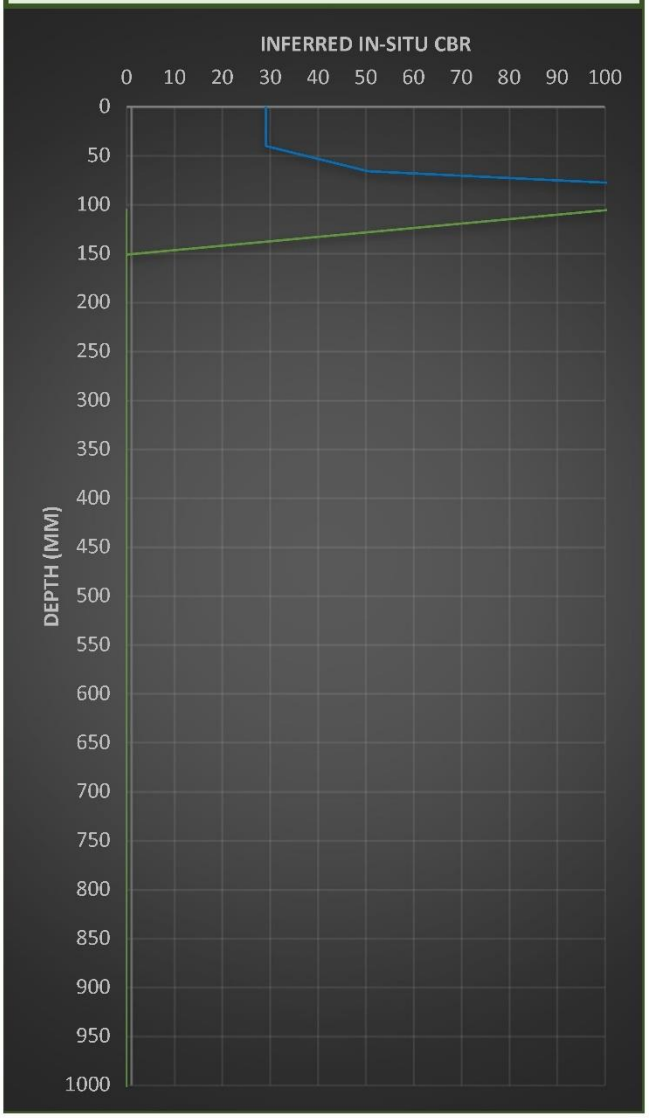
DCP 5 at TP5

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
3,0			
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
101,6			
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 105 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144A

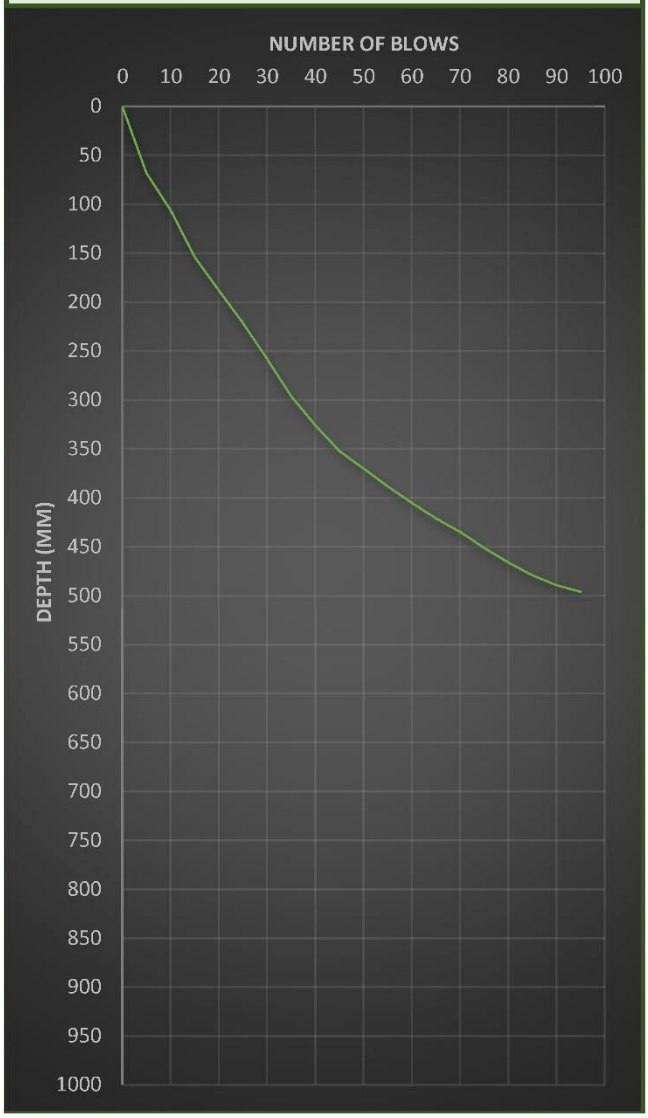
Mampuru Bulk Water Scheme
Kalkfontein Command Reservoir- 3000 kl

Zutari (Pty) Ltd.

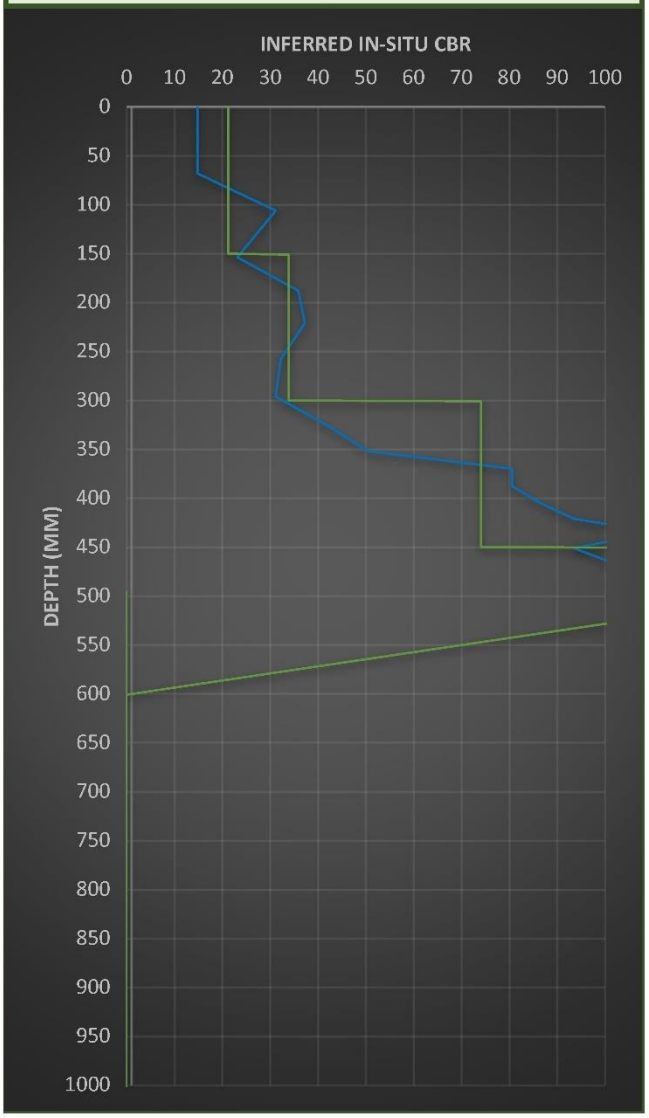
DCP 6 at TP6

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
10,3	**7,1**	**3,8**	**2,3**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
21,2	**33,9**	**74,1**	**145,2**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 496 mm

Termination Character: Refusal

Appendix D

Development Reference Tables

Table 8: Geotechnical Constraints in Urban Development (SANS 634:2012)

CONSTRAINT		DESCRIPTOR		
DESCRIPTION		**1 (most favourable)**	**2 (intermediate)**	**3 (least favourable)**
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling depth of less than 750 mm in thickness	Any collapsible horizon or consecutive horizons totalling depth of more than 750 mm in thickness	n/a
B	Seepage	Permanent or perched water table more than 1.5 m below ground surface	Permanent or perched water table less than 1.5 m below ground surface	Swamps and marshes
C	Active soil	Low soil-heave potential anticipated	Moderate soil-heave potential anticipated	High soil-heave potential anticipated
D	Highly compressible soil	Low soil compressibility anticipated	Moderate soil compressibility anticipated	High soil compressibility anticipated
E	Erodibility of soil	Low	Intermediate	High
F	Difficulty of excavation to 1.5 m depth	Scattered or occasional boulders less than 10% of total volume	Rock or hardpan pedocretes between 10% and 40% of total volume	Rock or hardpan pedocretes more than 40% of total volume
G	Undermined ground	Undermining at a depth greater than 200 m below surface	Old, undermined areas to a depth of 200 m below surface	Mining within less than 200 m of surface with total extraction
H	Stability (dolomite land)	Possibly stable	Potentially instable	Known sinkholes and dolines
I	Steep slopes	2-6 degrees	< 2 degrees or 6-18 degrees	> 18 degrees
J	Unstable natural slopes	Low risk	Intermediate risk	High risk
K	Seismic activity	10% probability of an event less than 100 cm/s^2 in 50 years	Mining-induced seismicity > 100 cm/s^2	Natural seismicity > 100 cm/s^2
L	Flooding	n/a	Adjacent to known drainage or channel with slope < 1%	Areas within drainage channel or floodplain

(After Partridge, Wood & Brink, 1993)

Table 9: Rock Mass Rating System as presented by Bieniawski, 1989

A. CLASSIFICATION –PARAMETERS AND THEIR RATINGS									
Parameter			Range of values						
1	Strength of intact rock material	Point-load strength index	>10 MPa	4 - 10 MPa	2 - 4 MPa	1 - 2 MPa	For this low range - uniaxial compressive test is preferred		
		Uniaxial comp. strength	>250 MPa	100 - 250 MPa	50 - 100 MPa	25 - 50 MPa	5 - 25 MPa	1 - 5 MPa	< 1 MPa
	Rating		15	12	7	4	2	1	0
2	Drill core *Quality RQD*		90% - –100%	75% - –90%	50% - 75%	25% - 50%	< 25%		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		> 2 m	0.6 - 2 . m	200 - 600 mm	60 - 200 mm	< 60 mm		
	Rating		20	15	10	8	5		
4	Condition of –discontinuities (See E)		Very rough –surfaces Not continuous No separation Unweathered wall rock	Slightly rough surfaces Separation < 1 mm Slightly weathered walls	Slightly rough surfaces Separation < 1 mm Highly weathered walls	Slickensided surfaces or Gouge < 5 mm thick or Separation 1-5 mm Continuous	Soft gouge >5 mm thick or Separation –> 5 mm Continuous		
	Rating		30	25	20	10	0		
–5	Ground water	Inflow per 10 m tunnel length (l/m)	None	< 10	10 - 25	25 - 125	> 125		
		(Joint water press)/ (Major principal σ)	0	< 0.1	0.1, - 0.2	0.2 - 0.5	> 0.5		
		General conditions	Completely dry	Damp	Wet	Dripping	Flowing		
	Rating		15	10	7	4	0		

B. RATING ADJUSTMENT FOR DISCONTINUITY ORIENTATIONS (See F)						
Strike –and dip orientations		Very favourable	Favourable	Fair	Unfavourable	Very Unfavourable
Ratings	Tunnels & mines	0	-2	-5	-10	-12
	Foundations	0	-2	-7	-15	-25
	Slopes	0	-5	-25	-50	

C. ROCK MASS CLASSES DETERMINED FROM TOTAL RATINGS					
Rating	100 ← 81	80 ← 61	60 ← 41	40 ← 21	< 21
Class number	I	II	III	IV	V
Description	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock

D. MEANING OF ROCK CLASSES					
Class number	I	II	III	IV	V
Average stand-up time	20 yrs for 15 m span	1 year for 10 m span	1 week for 5 m span	10 hrs for 2.5 m span	30 min for 1 m span
Cohesion of rock mass (kPa)	> 400	300 - 400	200 - 300	100 - 200	< 100
Friction angle of rock mass (deg)	> 45	35 - 45	25 - 35	15 - 25	< 15

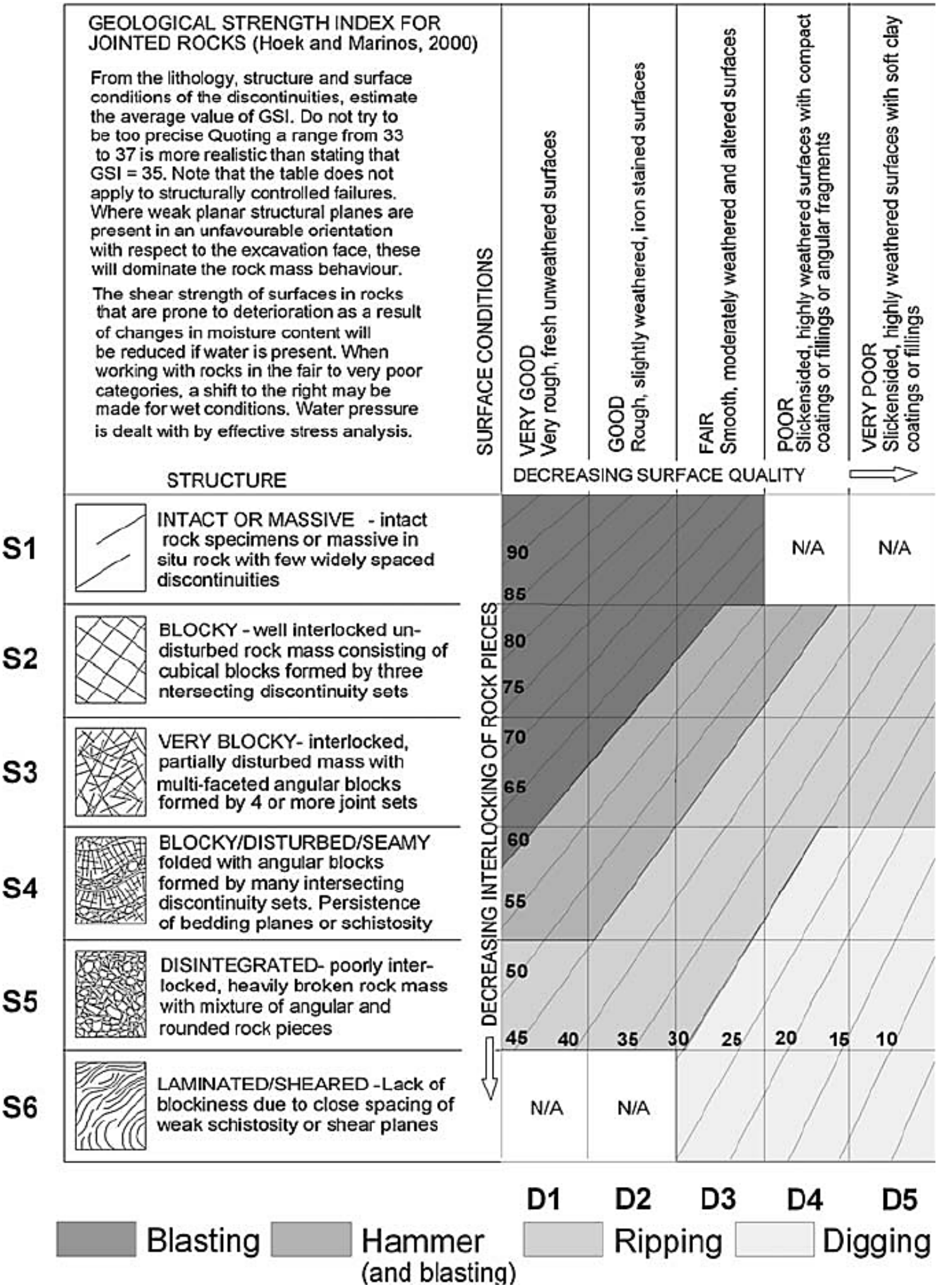
E. GUIDELINES FOR CLASSIFICATION OF DISCONTINUITY conditions					
Discontinuity length (persistence)	< 1 m	1 - 3 m	3 - 10 m	10 - 20 m	> 20 m
Rating	6	4	2	1	0
Separation (aperture)	None	< 0.1 mm	0.1 - 1.0 mm	1 - 5 mm	> 5 mm
Rating	6	5	4	1	0
Roughness	Very rough	Rough	Slightly rough	Smooth	Slickensided
Rating	6	5	3	1	0
Infilling (gouge)	None	Hard filling < 5 mm	Hard filling > 5 mm	Soft filling < 5 mm	Soft filling > 5 mm
Rating	6	4	2	2	0
Weathering	Unweathered	Slightly weathered	Moderately weathered	Highly weathered	Decomposed
Ratings	6	5	3	1	0

F. EFFECT OF DISCONTINUITY STRIKE AND DIP ORIENTATION IN TUNNELLING**			
Strike perpendicular to tunnel axis		Strike parallel to tunnel axis	
Drive with dip - Dip 45 - 90*	Drive with dip - Dip 20 - 45*	Dip 45 - 90*	Dip 20 - 45*
Very favourable	Favourable	Very favourable	Fair
Drive against –dip - Dip 45-90*	Drive against –dip - –Dip 20-45*	–Dip 0-20 - Irrespective of strike*	
Fair	Unfavourable	Fair	

* Some conditions are mutually exclusive . –For example, if infilling is present, the roughness of the surface will be overshadowed by the influence of the gouge. –In such cases use A.4 directly.

** Modified after Wickham et al (1972).

Table 10: Geological Strength Index for Jointed Rocks (Hoek and Marinos, 2000)



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

TECHNICAL REPORT

Tsakane Steel Tank Reservoir- 250 kl

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Geotechnical Site Investigation and Materials Assessment

Prepared for
Zutari (Pty) Ltd.

Date
23/08/2024

Compiled by
Kevin Coertzen (Pr.Sci.Nat)

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Technical Report

GC24/144B

23 August 2024

Tsakane Steel Tank Reservoir- 250 kl

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Project Details

Report Title	Tsakane Steel Tank Reservoir- 250 kl
Report Reference	GC24/144B
WAS/WSP	Sekhukhune District Municipality (SDM)
Contract Reference	SK08/3/1-30/2017/2018
Project Engineers	Zutari (Pty) Ltd.
Report Description	Geotechnical Site Investigation and Materials Assessment
Report Version	Final Report

Report Compilation and Signatory

GeoCalibre Geotechnical Consultancy (Pty) Ltd.

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Professional Natural Scientist (400011/17)
NHBRC Competent Person (Barcode 3000179078)
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Approved by:

Kevin Coertzen	Digitally signed: 23/08/2024	23/08/2024
Name	Signature	Date

Report Distribution List

Date	Name	Institution	Version	Format
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1. Project Introduction

1.1. Background

A series of detailed reports have been compiled to shed light on the various phases of the Geotechnical Site Investigation- and associated Materials Assessment- conducted in support of the planned upgrades and additions to the existing **Mampuru Bulk Water Supply Scheme.** The scheme falls under the jurisdiction of the Sekhukhune District Municipality within the Limpopo Province of South Africa.

The formal contract details are as follows:

- **WAS/WSP:** Sekhukhune District Municipality (SDM)
- **Contract Number:** SK08/3/1-30/2017/2018
- **Project Engineers:** Zutari (Pty) Ltd.

Individual reports have been compiled for the planned new **water storage structures** set to form part of the upgrades and additions to the existing bulk water scheme. Separate reports have been created for the planned structures and their access roads, with the various sections in the report referring to specific attributes/routes- for easy reference.

The report breakdown for the project is as follows:

- GC-24-144RS- Regional Setting- Structures and Access Roads
- GC-24-144A- Kalkfontein Command Reservoir- 3000 kl
- GC-24-144B- Tsakane Steel Tank- 250 kl
- GC-24-144C- Dithamaga Concrete Reservoir- 600 kl
- GC-24-144D- Mampuru Concrete Reservoir- 1200 kl
- GC-24-144E- Ga-Phasha Steel Tank- 1300 kl
- GC-24-144F- Spitskop Command Reservoir- 15000 kl
- GC-24-144G- Stoking Concrete Reservoir- 700 kl
- GC-24-144H- Mapodile Concrete Reservoir- 3000 kl

1.2. Terms of Appointment

GeoCalibre Geotechnical Consultancy was appointed by Zutari (Pty) Ltd. (Polokwane Branch) to undertake the required near surface site investigation.

The information presented in this document is based on the information supplied by the Client prior to the commencement of the investigation; therefore, GeoCalibre Geotechnical Consultancy (Pty) Ltd- shall not be held liable for, and is indemnified against all actions, claims, demands, losses, liabilities, costs, damages and expenses prompted by, or in connection with, inaccurately relayed information pertaining to the site and/or the development.

The exact nature and design of the future structures across the greater water scheme were not defined at the time of this study, with this near surface investigation utilising typical attributes of structures of this nature to guide the analysis and corresponding recommendations.

1.3. GeoCalibre- Company Background and Information

GeoCalibre is a specialist geotechnical consulting firm made up of a team of qualified professional geo-practitioners. The firm was established out of a love for the industry and an urge to define a new calibre of professional consulting.

GeoCalibre uses advanced scientific methods to create accurate and reproducible geotechnical models; successfully guiding the implementation of site-specific design precautionary measures/engineering solutions. The methodology followed throughout the investigative process accounts for the nature and location of the development as well as adhering to the standards of our practice (SANS and SAICE).

Investigations undertaken by GeoCalibre are overseen by suitably qualified Engineering Geologists *professionally registered* (Pr.Sci.Nat) with the South African Council of Natural Scientific Professions (SACNASP)- in accordance with all the relevant and required procedures and legislations. GeoCalibres employees are also members of the South African Institute for Engineering and Environmental Geologists (SAIEG).

1.4. Limitations of the Geotechnical Assessment

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an **initial phase near surface geotechnical study**- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The results of this level of assessment provides an overview of the geotechnical character of the site, as well as listing prominent adverse geotechnical characteristics. Once access/mobility has been modified follow-up studies can be conducted, where required.

The presented geotechnical models are based on a data base of available information, on-site soil profiles and the results from soil laboratory tests. Parcels of land within the developmental area which are free of excavations are modelled through interpolation and extrapolation of known testing locations, to identify problem issues of a geotechnical nature on which this report is based.

Geological conditions are seldom uniformly developed and areas and positions where geological and geotechnical conditions on the site might vary locally from those described and assessed in this report.

A centerline and materials assessments primarily focus on near surface attributes along the length of any given linear structure (i.e., access roads and pipelines). The primary aim of such a study is to assess the near surface geotechnical nature of the site in relation to planned development. Shallow and/or basic studies of this nature generally do not include specialist geotechnical studies for attributes such as complex surficial structures, thick fill embankments (existing or future), pipe jacking, natural slope/cutting stability, blasting and/or rock crushing attributes and/or soil/rock mechanics. In depth geotechnical studies across target areas can be undertaken by GeoCalibre as part of follow-up studies.

The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result of either natural processes or human activity. If a substantial lapse of time occurs between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we urge that our report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions.

In addition, advancements in the practice of geotechnical engineering and engineering geology and changes in applicable practice codes may affect the validity of this report. Our investigation did not include the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.

1.5. Development within 1 : 100 year-flood lines

It must be noted that the National Water Act (Act 36 of 1998) states the following regarding development within the 1 : 100 year-flood line of any stream or river (Thompson, 2006): **Section 21(c):** Impeding or diverting the flow of water in watercourses (including alteration of the hydraulic characteristics of flood events) requires licensing according to the Act.

Section 21(i): Any action that may alter the bed, banks, courses or characteristics of watercourses (including flood events) requires licensing according to the Act, including: widening or straightening of the bed or banks of a river to allow for the construction the housing development and altering the course of a river partially or completely (i.e.: river diversion) to be able to use or develop the area where the watercourse originally was.

The National Water Act does not prohibit development within 1 : 100 year-flood lines; however, the Act requires detailed analysis of the effects of the proposed development on the surrounding environment, with special reference to surface and sub-surface water flow. The Act requires that suitable precautionary measures be implemented to limit the effect within and downstream from the proposed development.

1.6. Codes of Practise and Investigative Standard

The investigation was carried according to the following standard practice codes and guidelines:

- Guidelines for Urban Engineering Geological Investigations (SAIEG & SAICE, 1997) for urban development.
- Site Investigation Code of Practice put forward by the Geotechnical Division of SAICE (2010).
- SANS 2001-DP1:2011 Earthworks for buried pipelines and prefabricated culverts.
- SANS 10400.
- Applicable technical specification documents of South Africa (SANS, TRH, TMH, COLTO/COTO and SAPEM).
- The guideline and specification documents by the South African Institute of Engineering and Environmental Geologists (SAIEG) and South African Institution for Civil Engineers (1997), AEG/SAIEG/SAICE (2002).

1.7. Information Sources

- **Geological Map:**
  - Geological Series Map 2430 Pilgrim's Rest; scale 1:250 000 (digital format)
- **Hydrogeological Data:**
  - SADC Groundwater Information Portal (SADC GIP)
  - Hydrogeological Series Map 2330 Phalaborwa (1998); scale 1: 500 000 (digital format)
  - Electronic Maps of the Water Management Areas and Drainage Regions in South Africa- DWAF [Department of Water Affairs and Forestry]- 1996 and 1999 (www.dwa.gov.za).
- **Topocadastral maps:**
  - 2429 Dd; scale 1:50 000 (digital format)
  - 2430 Ca; scale 1:50 000 (digital format)
  - 2430 Cc; scale 1:50 000 (digital format)
- **Provided by the Client:**
  - Structure location and planned access road route
- **Remote Sensing Information:**
  - Google Earth Pro ™
  - Planet GIS Limpopo Cadastral Land Layer (2022)
- **Available geotechnical reports:**
  - Numerous geotechnical reports from the region compiled by Kevin Coertzen (Pri.Sci.Nat and MSAIEG)

1.8. Scope of the Investigation

A near surface geotechnical site investigation was carried out across each of the areas in question in order to assess the mechanical nature of the underlying strata and model the geomorphological nature of the local setting. Following the assessment, GeoCalibre provides recommendations on the implementation of **site-specific engineering solutions.**

The aim of the overall site investigation can be summarised as follows:

- Establishment of a **regional geological**, **geomorphological** and **geo-technical** model for the site.
- To delineate the **succession of strata** (soil and rock) underlying the site; with the identification of problematic **physical, chemical** and **mechanical** characteristics which may influence the development.
- To quantify the **in-situ mechanical properties** of the soft materials underlying the site; specifically, with regards to the proposed future developments.
- To compute the **excavatability properties** of the materials underlying the site.
- To assess shallow **groundwater** patterns.
- To evaluate the basic **re-usage potential** of the materials underlying the site.
- To aid the development moving forward through the formulation of an **accurate geotechnical model** for the site under investigation.

The near surface site investigation was undertaken in order to assess the basic engineering geological character of the site, focussing on the geotechnical properties which will affect the development potential of the area in question with regards to the **installation of civil engineering services** and the construction **surficial water storage structures** and their associated **gravel access roads**.

The investigation excludes the following aspects, where applicable:

- Geophysical, resistivity, or corrosion studies.
- Dolomite stability or undermining Investigations
- Detailed hydrological, hydropedological, hydrogeological, pedological, flood line, or wetland delineation studies.
- Excavations by means of light/heavy earth moving equipment and associated soil and/or rock sampling.
- Footprint studies along the pipeline routes for the various water treatment works, pump stations, river crossings and pipe jacking sites.
- Borehole drilling and/or rock strength analysis.
- Detailed slope stability assessments.
- Geo-environmental assessments.
- Township establishment/land rezoning (SANS 634).

1.9. Investigative Methodology

The investigation is undertaken in a number of phases in order to achieve the aims discussed above. The investigative phases are as follows:

- **Phase 1: Introduction and Regional Assessment of the Site**
- **Phase 2: Geotechnical Analysis- Structures**
- **Phase 3: Geotechnical Analysis- Access Roads**
- **Phase 4: Data Assessment and Report Compilation**

1.9.1. Phase 1: Introduction and Regional Assessment of the Site

The collation and evaluation of all the available topographic, geo-morphological and geological data across the investigated site and its' surroundings. This assessment is done through the use of available regional maps and remote sensing images.

This section of the report will include a description and summary of the site's nature, based on existing literature, and is supplemented with the compilation of a series of base maps.

1.9.2. Phases 2 and 3: Geotechnical Analysis

Phases 2 through to 4 shared a similar methodology (presented below); with the distribution of testing locations, depth and nature of sampling/testing and footprint specific geotechnical observations at any given portion of the site relating to the nature of the planned structures at said location.

Trenching

The field work phase of the investigation was conducted by GeoCalibre across June and July 2024.

Access to- and mobility- across the target areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by **hand** across the footprints of the planned structures and along the routes of the various access roads.

Across the various sites, between TWO (2) and TEN (10) test pits were excavated by means of **pick-and-shovel** (local labour digging by hand). A total of **50 test pits** were excavated across the greater project area.

Additionally, where applicable, available **exposures/cuttings** situated within close proximity to the various sites were logged and sampled. In many cases, the local cuttings provide greater exposures- both laterally and vertically- of the in-situ materials as compared to the small hand excavated trial pits.

Test pits were distributed across the various sites placed at locations chosen on merit to map and model variances in the underlying strata. Test pit locations were primarily based on the Client's specific outcomes (footprint analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model. Following a detailed site walkover and associated existing services' mapping exercise, planned trial pits were adapted on ground level.

The succession of soil layers exposed within the test pits and exposures were logged by GeoCalibre. The description of soil profiles is done according to SANS 633:2012 which describes the moisture, colour, consistency, structure, (soil) texture and origin. Following detailed logging, a series of detailed photographs were taken of the different soil layers.

Table 1 below presents a breakdown of the trial pits excavated across the various water storage structure and access road sites.

Table 1: Trial Pit Breakdown

Trial Pit Breakdown- Structures and Access Roads			
Description	**Storage Capacity (kl)**	**Access Road Length (m)**	**Combined Quantities**
Kalkfontein Command Reservoir	3000	360	6
Tsakane Steel Tank	250	500	6
Dithamaga Concrete Reservoir	600	-	2
Mampuru Concrete Reservoir	1200	500	7
Ga-Phasha Steel Tank	1300	480	6
Spitskop Command Reservoir	15000	2330	14
Stoking Concrete Reservoir	700	1190	9
Mapodile Concrete Reservoir	3000	500	7

Sampling

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development. Laboratory testing commenced on the samples collected during the field work phase of the investigation.

Undisturbed sample extraction was not possible/feasible across the various sites as a result of the granular nature and elevated consistency of the foundation zone materials. For this reason, the mechanical assessment of subsoils will be based on the available disturbed soil test results and field observations (i.e., structure, composition, and consistency).

Laboratory Testing

Standard foundation/road indicator and soil compaction tests were conducted by Tzaneen Lab (**SANAS Accredited- 17205**) on disturbed and bulk soil samples.

These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the proposed construction. The following tests were conducted:

I. Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage)- (SANS 3001: GR10/11)

II. Particle-size Distribution (SANS 3001: GR1)

III. Maximum Dry Density vs. Optimum Moisture Content (SANS 3001: GR30)

IV. Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method) (SANS 3001: GR40)

V. pH and Electrical Conductivity (chemical testing)

In-situ Testing- DCP Testing

In-situ penetration tests were conducted alongside and between the excavated test pits in order to determine the quantitative soil consistency conditions.

Standardised DCP tests (8 kg hammer falling 575 mm with a tip/cone of 60°) were implemented as to give an indication of the consistency of the in-situ material of the layer house in question. Soil strength and stiffness are correlated with consistency of earthy soil material and penetrometer testing is used to determine the consistency of both cohesive and non-cohesive materials.

In the design of light structures and roadways, the DCP is a practical test used for onsite measuring of material strength. The test results can be correlated with the California Bearing Ratio (CBR) by applying a formula; results of which can be correlated to the laboratory tests conducted on the soils from the same location. Furthermore, an inferred depth to bedrock can be modelled using the DCP refusal depths. Although not exact, these depths aid in formulating a regional excavation model across the development area.

1.9.3. Phase 4: Data Assessment and Report Compilation

The investigation concluded with the compilation of numerous technical reports detailing the methodology utilised during the study and the summarised results obtained. This includes a potential geotechnical evaluation of the site based on the cumulative results of the near surface investigation.

2. Description of the Environment

2.1. Site Location and Description

The **study area** for this investigation is seen to fall within the southern to south eastern portions of the Limpopo Province of South Africa- proximal to provincial border with Mpumalanga. On a more localised scale, the study area is situated approximately 20 km south west of the mining town of Steelpoort (Figure 1). Moreover, the study area is located across the far south eastern portion of the Remaining Extent of the Farm Mooimeisjesfontein 363 KT, within the bounds of the Fetakgomo Tubatse Local Municipality of the Sekhukhune District Municipality.

The site forms part of the planned upgrades and additions to the existing **Mampuru Bulk Water Scheme,** which is a strategic water project from SDM that supplies water to the various end users across the Steelpoort Valley. The portion of land forming the focal point of this investigation is located in the south western extent of the cumulative study area.

More specifically, the **site** is situated within an unnamed village (predicted to be Tsakane) which forms the approximate **midpoint** between Ga-Malekana- to the south west- and Ga-Mampuru to the north east. This focal area is situated immediately north west of the regionally prominent Steelpoort River, accessible via the District Road 1392 (D1392) followed by the various gravel roads which combine to form the internal network of the village- one of which is set to be upgraded to serve as the main access road to the new structure.

The **site** was primarily investigated to assist with the design and construction of a **250 kl ground steel tank reservoir**. The footprint of the planned structure was not defined on ground level attributed to the **undeveloped** nature of the terrain, with the Client providing a pin delineating the centre of the proposed reservoir. Additional to the planned reservoir, the development includes the upgrading/ construction of a **gravel road**- with a length of approximately **500 m-** set to form its primary access route during construction and subsequent stages.

The planned **starting point (0+000)** of the access road is located within the central extent of the village- at the **intersection** between the existing gravel road in question and the **D1392**. From this point, the gravel road forks off in a general north easterly direction- cresting a local ridge. At ~0+170, the existing road makes a 90 degree turn to the north west- following this bearing to ~0+300- traversing developed land, confined by residential properties and their associated services.

Furthermore, from **~0+300**, the existing gravel road ends- with the planned route entering **undeveloped land** along the villages' north western permitter. Following this transition, the access road meanders its way up the very steep sloping flanks of a major ridge, on-route to the proposed reservoir location to the north. The **termination point of ~0+500** is achieved as the road approaches the structures' planned **footprint** from the south west.

Across the **developed areas** the access roads' footprint/shape is limited to **existing attributes**. Across the undeveloped areas to the north west of the village, the access road's shape- as presented by the Client- represents an attempted optimisation of the infrastructure across the complex topographic setting, including attributes such as road length/footprint, modification requirements, usability constraints and budget considerations, to name a few.

Refer to Image 1 at the end of this section which graphically depicts the breakdown of the site and its cumulative attributes. The defined points of interest across the site- as received from the Client- are presented in Table 2A and 2B.

Table 2A: Points of Interest

Tsakane Steel Tank- 250kl - Points of Interest			
Points of Interest		**Co-ordinates**	
Access Road	**0+000**	Latitude 24.864903°S	Longitude 30.043238°E
	0+500	Latitude 24.861717°S	Longitude 30.042349°E
Reservoir Location		Latitude 24.861762°S	Longitude 30.042354°E

Table 2B: Test Pit Breakdown

Tsakane Steel Tank- 250kl - Test Pit Breakdown		
Description	Test Pits	Chainage
Access Road	Start	0+000
	EXP1	0+060
	TP1	0+160
	TP2	0+280
	TP3	0+400
Reservoir Location	TP4	0+480
	TP5	0+500
	End	0+500

The cumulative development across the surface will encompass the subdivision of this land portion into various land-use zones i.e., infrastructural units, roadways, and services etc. Each of these zones may require their own set of unique geotechnical recommendations determined by the properties of the in-situ material. The geotechnical properties of these separate areas/attributes are dealt with individually in the succeeding sections of this report- as follows:

- Section 3: Combined Terrain Analysis
- Section 4: Geotechnical Evaluation- 250 kl Steel Tank Reservoir
- Section 5: Geotechnical Evaluation- Access Road

Report GC-24-144-RS covers the **regional attributes** of the study area, including detailed discussions regarding the topographic setting, regional geology/ hydrogeology, vegetation and local cuttings across the visited villages. Although alluded to, these attributes are not duplicated in this document.

2.2. Site Observations

Numerous observations were made by the field team with regard to the current condition of the investigated site. These observations are graphically depicted in the photo series to follow at the end of the discussion.

The following basic notes were highlighted by the field team:

- **Developed land:** the initial stretch of the access road traverses the central portion of the village and associated developed land (varying degrees).
    - Human activities/processes in these areas have resulted in the reworking of the natural surface- with the frequent occurrence of anthropogenic anomalies- including varying degrees of fill materials, structures etc. The exact extent of the surface and subsurface infrastructure in this region is not known.
    - The existing gravel road is planned to be upgraded.
    - The footprint of the road structure was seen to fluctuate, generally confined by residential property boundaries in its central extent, prior to the transition into the undeveloped land to the north west.
- **Slope:** the site exhibits a complex topographic setting.
    - Excluding local anomalies, across the developments footprint the degree of sloping was generally seen to decrease with a decrease in surface elevation.
    - The undeveloped areas to the north west of the village were generally seen to exhibit a very steep sloping rocky surface, generally decreasing to a steep declivity across the developed areas.
    - As a result of the existing gravel roads orientation in relation to the natural slope, its initial ~100 m was very steep- followed by an abrupt decrease in slope prior to its 90 degree turn to the north west. Erosional features were visible along the flanks of the existing gravel road, considerably worse across its initial segment.
    - Across the very steeply sloping undeveloped areas to the north west, no erosional landforms were encountered. The rocky surface in conjunction with the natural vegetation is predicted to retard surface water flow just enough in order to prevent erosion from occurring.
- **Rocky/Bouldery Surface:** in addition to the steep sloping topography of the site, the surface exhibits a rugged/rocky morphology.
    - The occurrence of boulders was seen to suddenly increase across the high-lying portions of the site, generally along the transition between developed and undeveloped land.
    - Surficial boulders ranged in size sporadically.
    - The rough terrain across the undeveloped areas is anticipated to result in significant mobility/access and excavatability issues across the site, specifically during the initial phases of construction.
    - The possibility of dislodged cobbles/boulders from further upslope following disturbance of the natural conditions should not be overlooked in order to ensure a safe working environment.

- **Vegetation and biotic activity:** the vegetation across the footprint was seen to fluctuate in relation to the degree of anthropogenic alternation.
    - The natural vegetation was denuded across the developed portions of the site- limited to a sparse grass cover and scattered small trees. Roots and biotic activity can be expected when extending the existing gravel road into its vegetated flanks.
    - Across the undeveloped portions, the natural vegetation was considerably more prolific, comprised of a continuous grass cover with intermittent shrubs, xerophytes and isolated small trees scattered between the rocky surface. Abundant organic matter in the topsoil, with a gradual decrease in root occurrence with an increase in depth. The natural vegetation will need to be modified in the early stages of the construction to aid access and terrain mobility.
    - No significant biological activity was visible across the site.

Refer to the photo series below which graphically depicts the nature of site and its immediate surrounds at the time of this study.



Image 1: Site Breakdown- Tsakane Steel Tank Reservoir and Access Road



2.3. Regional Geology

According to the available geological information (geological series map: 2430 Pilgrim's Rest); the proposed reservoir location and access road are underlain by the following geological units (Figure 2):

1. "**Q**"- Surficial deposits including **alluvium** and **scree.**
2. "**Vdj**"- Coarse-grained **gabbro** and anorthosite with localised anorthosite layers, pyroxenite and magnetite plug- **Dsjate Subsuite** of the *Rustenburg Layered Suite*.

A detailed discussion regarding the regional geological setting and its associated attributes is presented in report GC-24-144/RS.

During the trenching phase of the investigation, it was noted that the investigated area is generally blanketed by an organic-rich horizon of gravity transported material- profiled as **colluvium**. The blanketing sediments were underlain by **varying degrees of weathered gabbro bedrock** deemed to be in the late stages of rock decomposition/early stages of soil formation. Thin exposures of upper weathered portion of the gabbro rock mass where visible in the hand excavated test pits.

2.4. Vegetation and Biotic Activity

The natural vegetation was denuded across the developed portions of the site, with the cover in these areas limited to sparse grasses and scattered small trees. Roots and biotic activity can be expected when extending the existing gravel road into its vegetated flanks.

Across the undeveloped portions, the natural vegetation was considerably more prolific, comprised of a continuous grass cover with intermittent shrubs, xerophytes and isolated small trees scattered between the rocky surface. Abundant organic matter in the topsoil, with a gradual decrease in root occurrence with an increase in depth. The natural vegetation will need to be modified in the early stages of the construction to aid access and terrain mobility.

In the exposed profiles, the degree of organic material and biotic activity was seen to decrease with an increase in depth, with the major root system reaching an average depth of approximately **0,33 m** below natural ground level.

Fine roots were generally encountered in grassy areas, the extent of which was limited to the organic rich topsoil. Extensive sub-surface vegetation is predicted to occur in areas hosting trees; however, the extent of these root zones is predicted to diminish with an increased distance from the trunk.

Regarding bio-engineering, the natural vegetation cover protects the slope from erosion (run-off and rain splash) and serves as a anchoring mechanism to reduce the possibility of shallow seated instabilities. The effects of the removal of trees on sites should also be considered. The removal of large trees can result in the formation of highly compressible zones of voided soils, elevated moisture conditions and can impact existing slope stability. Such areas should be treated as zones of possible risk and should be dealt with accordingly in the design.

No significant biological activity was visible across the site generally attributed to the ongoing human activities across the region.

3. Basic Terrain Analysis

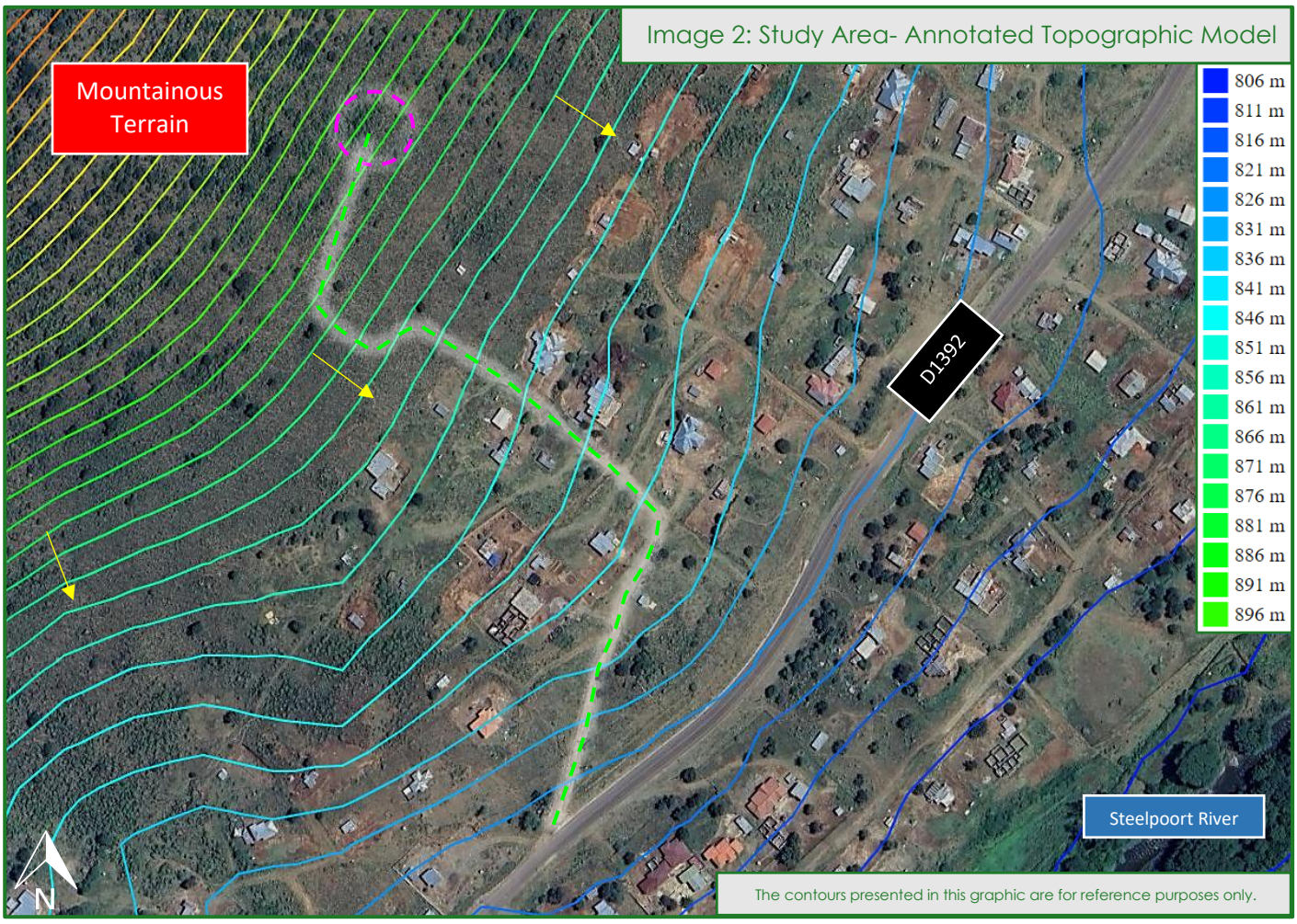
3.1. Site Topography

Topography is based on elevation profiles from the available remote sensing information and basic field observations. This does not substitute land survey data. Topography and regional hydrology (e.g., steep slopes, very flat slopes, defined drainage features, and rapid changes in slope) affect the distribution of ground as it affects the weathering, erosion, transport, and deposition of materials. As such, it provides a valuable indication of possible changes in subsurface ground and water conditions, but also affects the stability of slopes and the direction of surface runoff.

As seen in the annotated topographic map below (Image 2); the north western portions of the study area are seen to exhibit a **high-lying** topographic nature in the form of a **prominent mountainous terrain**. The mountainous terrain serves as the **watershed feature** for the study area and its immediate surrounds. The orientation and extent of the watershed feature directly impacts the geomorphological nature of the site in question.

Furthermore, the **natural slopes** (yellow arrows) extend in a general south easterly direction from the high-lying terrain, towards the surrounding low-lying areas (green and blue contours) and associated Steelpoort River. As depicted by the spacing of the contours, there is an overall **reduction in declivity** with a **decrease in surface elevation**.

Refer to Image 2 below which graphically depicts the topographic nature of the study area and its immediate surrounds.



With reference to Image 2, the **planned reservoir- and associated access road-** are located along the steeply to very steeply sloping south eastern flanks of the mapped mountainous terrain. Consequently, the **natural** topographic nature of the site can be largely characterised by **steep/very steep slopes** (natural)- extending from the higher lying areas to the north west- towards the low-lying south eastern portions.

Moreover, the undeveloped areas to the north west of the village were generally seen to exhibit a **very steep sloping rocky surface**- with natural slopes **in excess of 12 degrees.** In these areas, the planned road adopts a **meandering shape** in order to accommodate the abrupt change in surface elevation. Although generally orientated at an obtuse angle to the natural slopes, the road exhibits a continuous increase in elevation with an increase in chainage as the road rises upward towards the planned reservoir location.

Across the **developed areas**, the natural **declivity** of the surface was seen to **reduce**, with **steep slopes** of **between ~ 6 and 12 degrees**. As a result of the existing gravel roads orientation in this area in relation to the natural slope, its initial ~100 m was very steep- followed by an abrupt decrease in slope prior to its 90 degree turn to the north west. Furthermore, the remaining section of the existing gravel road is orientated ~NW/SW, generally aligned **parallel** to the **natural steep slope**.

The lowest surface elevation of ~ 823 meters above mean sea level (MAMSL) is recorded at the access road's starting point (far southern portions). The surface elevation increases in a general northernly to north easterly direction towards the routes' termination point- proximal to the reservoir location- with a surface elevation of ~890 MAMSL (calculated using Google Earth PRO ^{tm}).

Localised slope variances were encountered due to the occurrence of small-scale natural/anthropogenic anomalies. Once surveyed, anomalies will need to be addressed individually in the engineering design and in so doing eliminating their localised effects. Based on the available information, the development will entail the rehabilitation of the sites surface- within and immediately surrounding the planned future structures and roadways.

3.2. Drainage Attributes

The drainage nature of the study area will mirror its' topographic nature as described in Section 3.1 of this report. The crest of the **mountainous terrain**- located to the north west of the site- will serve as the **primary watershed** feature for the site and its immediate surrounds.

Developments of this nature typically include the rehabilitation/remoulding of the site's surface. As a result of the sites complex topography and geographic location, the design and implementation of **fit-for-purpose site modification and drainage measures** are essential for the stability and longevity of the development. Future anthropogenic attributes will influence natural infiltration, shallow throughflow and run-off rates. Importance should be placed on surface drainage and storm water control measures to avoid instabilities, focused infiltration, surface water ponding and erosion.

Addressing the concerns surrounding the **convergence** of surface water upon the site- originating from the bordering crest of the ridge- is key to the stability and longevity of the development as a whole. Convergent high-energy flow upon the site from the surrounding high-lying terrain elevates the rate/energy of surface water flow- increasing the risk of erosion and instability of future cuts.

The cumulative **developments orientation** in relation to the natural slopes- specifically with regards to the meandering access road- will impact the rate and associated energy of the overland flow. Topographic anomalies identified during the professional survey can be addressed individually in the design.

Across most of the sites' footprint, due its' **steep to very steep sloping nature**, it will drain mainly by means of **high energy surface run-off (sheet-flow);** with storm water flowing from the high lying north western portions of the site, in a general south easterly direction.

Most of the access roads' route was seen to traverse the natural slopes at an **obtuse angle**, with its central section orientated **parallel** to the natural slopes. This cumulative orientation results in **medium to high energy surface water flow**, expected to take place **along the length of the road**. The anticipated high energy run-off across the sites' footprint elevates the risk of erosion as well as the instability of slopes following modification.

Conversely, where cuts/platforms or terracing are implemented to modify the sites surface, these **artificially induced very gentle/gentle sloping** portions will drain mainly by means of **low energy surface run-off (sheet-flow).** These portions of the site will be subjected to elevated degrees of **surface water infiltration** into the underlying soils, rather than rapid surface water flow, accentuating **surface water ponding** and **fluctuating moisture conditions** after precipitation events. Furthermore, the sudden decreased rate of surface water flow from the steep portions and cuttings to anthropogenically induced flat slopes/platforms may result in a combination of focused infiltration and piping/erosion.

The planned infrastructure is located downslope of currently undeveloped land. Although generally steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of shallow ground water throughflow may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

According to the available information (Topocadastral Maps 2430 Cc- Figure 3), **no** natural drainage structures are seen to traverse the site.

3.3. Erosion

As a result of the sites' natural slope, erosion will be a concern. Across the undeveloped upslope portions, no erosional landforms were visible at the time of the investigation- predicted to be as a result of the stabilising effect of the natural vegetation and retarding effect of the rocky/bouldery surface on flow.

In contrast, across the developed areas erosional landforms were prolific along the existing gravel road- the extent of which was prolific in its initial ~100 m. This attribute serves as evidence for the elevated risk of erosion in the local setting following the modification of the surface and associated removal of natural vegetation and clearing of surficial anomalies which combine to limit the rate/ energy of sheet wash.

According to the TRH20, the ability of the material to resist/avoid erosion depends on the shear strength of the material which is equal to the cohesion of the material as no normal stress is applied to the blanketing materials. If the attractive force of the water is greater than the shear strength of the material, then erosion will occur.

The following are generally accepted findings on the relationships between different properties and erodibility parameters of soil:

- An increase in percentage clay, accompanied with an elevated cohesion, leads to an increase in erosion resistance.
- In general, an increase in PI leads to an increase in erosion resistance.
- Fine, poorly graded material with limited coarse particles (grading coefficient of less than 16) are highly susceptible to erosion.
- High energy channelized flow surface water flow will elevate the risk for erosion and scouring/undercutting across the footprint.
- Steep/converging slopes increase flow velocities/volumes and as such decrease erosion resistance.
- Dispersive soils tend to be less erosion resistant.
- Erosion may cause changes in the properties of the material over the design life as certain fractions are removed.

Inadequate temporary erosion and drainage control measures can result in severe damage to infrastructure. The following can be done to **minimize erosion** of problematic soils during and following the planned construction:

- Erosion can be reduced by elevating the shear strength of the material by increasing its compaction and ensuring a well-graded mixture of material resulting in increased particle interlock. The improved interlocking increases suction forces within the material and decreases permeability/penetrability.
- Intercept or minimise surface wash towards the future infrastructure from upslope areas. The energy of the water can be decreased by retarding the rate of flow using good drainage measures.
- Drainage measures at regular intervals along newly constructed roads, with these drainage systems designed in such a way so as to reduce erosion across the outflow/discharge areas.
- Depressions created along the steep sloping routes may act as preferential flow paths following precipitation- with the channelised flow inevitably resulting in the formation of erosional landforms.
- Trench backfills and shoulder materials should be modified to an equivalent compaction/density of surrounding soil- in so doing controlling the natural infiltration/through flow characteristics of the regional materials (i.e., eliminating irregularities).
- Consider treating dispersive subsoils with gypsum prior to compaction and/or backfilling to minimise risk of tunnel erosion- along the road shoulder and back filled pipeline routes.

Lastly, a maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.

3.4. Natural Slope and Future Cutting Stability

Detailed stability assessments of existing- and future- deep cuttings did not form part of the scope of this initial phase investigation. With this said, **no natural** slope instabilities or inherent ground instability signs- such as tension cracks etc.- were evident during the site walkover and basic visual inspection.

Across most of the site, excluding the localised mobilisation of cobbles and gravels, it is envisaged that temporary shallow trenches and/or cuttings to depths of up to 1 m will remain stable- the stability of which can be assessed periodically. Where thick successions of the heterogeneous colluvium are encountered, minor collapse in the form of dislodged particles may occur.

The final layout of the development is not known but based on the natural slopes prior to modification, specialised methods for the stabilisation of cuts into the existing slopes are deemed necessary. It is predicted that the extent of the required cuttings will be considerably less than that of the larger concrete/command reservoir structures. Cutting depth is an important parameter which impacts future slope stability, with deeper/extensive cuts requiring specialist stabilisation techniques (benching, various cutting angles pertaining to materials of different origins/stability, retaining walls, etc.).

It is recommended that specialist geotechnical investigations for major cuts be undertaken by a competent person as part of design level studies. Where possible, detailed face mapping and joint line surveys can be undertaken along freshly created cuttings.

In contrary to the problematic colluvial sediments, the local igneous rock masses are not generally prone to major instabilities based on the available theoretical databases and as seen in local cuttings. Although it is predicted that fresh exposures in bedrock exhibit stable conditions in near vertical cuts (depending on orientation), it is recommended that the permanent cuttings be adequately sloped (approximately 60 to 75 degrees) or stabilised to reduce the risk of instabilities. Instability in these igneous bodies is predicted to be in the form of localised rock block failure, necessitating the removal or stabilisation of unstable rock blocks. Though rare, problematic joint sets/features can be present especially surrounding geological structures.

As a guide, where deep cuts/thick fills are implemented to modify the sites surface, cut/fill embankments will need to be adequately sloped, modified or stabilised- and vegetated where possible- to ensure long-term stability in saturated conditions. Soil slope modification methods/considerations may include- but are not limited to- the following:

- Visually identifying and alleviating local boulders/debris in the vicinity of the planned cuttings. Caution taken during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/infrastructure or life.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.

- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability. Therefore, adequate drainage measures need to be implemented for major cuttings.
- Modifying the slope geometry by reducing the slope angle, removing weight from the slope head, increasing weight at the slope toe and/or constructing of benches or berms.
- Constructing walls or other retaining elements (reinforced earth walls, gabion walls, loffelstein walls).
- Surface protection measures including wire meshes, geotextiles and using plant cover to help reinforce the ground surface of soil slopes.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the road/reservoir shoulder.
- All cuttings should be periodically assessed by a geo-professional or competent engineer.
- No loading of the temporary slopes by machinery, equipment, excavated soil or materials shall be allowed.

Due to the site gradient- cut to fill site preparation is expected. A carefully engineered fill embankment should not settle more than 0.5% of its height due to self-weight. Density control of placed fill material should be undertaken at regular intervals during fill construction. Engineered fill slopes should be over constructed and thereafter trimmed back to the required position.

4. Geotechnical Evaluation- 250 kl Steel Tank Reservoir

4.1. Introduction and Description

This section of the report focusses on the geotechnical attributes within proximity to the predetermined footprint of the planned **reservoir**- hereafter referred to as the **site.** Attributes surrounding the planned access road route will be addressed in the subsequent section (Section 5).

A pin location defining the centre of the planned structure was provided by the Client prior to the field work phase of the investigation. The final working levels/layout of the development is not known at this stage, with this study utilising typical attributes of structures of this nature to guide discussions.

Access to- and mobility- across the target areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by **hand** across the footprint of the planned structure. The presented geotechnical model is based on a data base of available information and available on-site exposures.

4.2. Trenching

The field work phase of the investigation was conducted by GeoCalibre in June 2024. Across the reservoir site, a total of TWO (2) test pits (TP4 and TP5) were excavated using labours digging by **hand** (pick-and-shovel method), to a depth of approximately 1.0 meters below the existing ground level, or refusal.

Trial pit placements were undertaken in such a way so as to create an accurate and reproducible site-specific geotechnical model. Test pit locations were primarily based on the Client's specific outcomes (foot print analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model.

A *Geologist* supervised the excavation of the trial pits. The description of the exposed ground profile is done according to SANS 633:2012 and describes the moisture, colour, consistency, structure, (soil) texture and origin. The soil profile is described according to the following parameters:

- **Moisture** dictates the colour and consistency of soils and indicates how and where water moves and the depth to perched water systems.
- **Colour** indicates the oxidizing or reducing state of soils and assist in the identification of minerals in completely weathered to fresh rock.
- **Consistency** is separated between cohesive and granular as the drainage and permeability affects the soil's shear strength.
- **Structure** describes any relict features from rock or soil and those that form through packing, soil and rock structures, seepage, reworking/biotic action.
- **Texture** is the abundance of different grain sizes in soils and is described by means of field test.
- **Origin** is the formation of the soil by means of transport of weathering.

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development.

4.3. Generalized Ground Profile

Note: this description is based on field observations and does **not** reflect the results of any laboratory tests.

4.3.1. Introduction

During the trenching phase of the investigation, it was noted that the investigated area is generally blanketed by an organic-rich horizon of gravity transported material- profiled as **colluvium**.

The blanketing sediments were underlain by **varying degrees of weathered gabbro bedrock** deemed to be in the late stages of rock decomposition/early stages of soil formation. The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock.

Pedogenic inclusions in the form of calcification staining and calcrete nodules were encountered within the weathered material. These pedogenic inclusions can be attributed to infiltrating water and subsequent alteration/ weathering of the calcium-rich minerals in the rock mass.

Overall, the weathering/alteration of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and protolith continuity.

In depth soil profile descriptions for each test pit location are presented in **Appendix A.**

The information presented in the sections to follow is based on point data. Every effort was made during the site investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. Variances in soil quality and quantity from those predicted may be encountered during construction and these should be recorded.

Although the section below presents a summary of the generalised soil profile exposed across the site- it should be noted that variability was encountered in numerous individual excavations, amplifying geotechnical variability.

Refer to Table 3 overleaf which depicts the summarised ground profile of the site. Following this table, Image 3 depicts the testing locations and basic field observations across the site.

Table 3: Summarised Ground Profile for the Site

Summarised Ground Profile									
Test Pit	Colluvium			Weathered Gabbro Bedrock			Excavation Character		
	From	To	Thickness (m)	From	To	Thickness (m)	Test pit depth (m)	Termination Conditions	Termination Material
TP4	0.00	0.56	0.56	0.56	0.88	0.32	0.88	R	WGB
TP5	0.00	0.16	0.16	0.16	0.94	0.78	0.94	R	WGB
Data Summary	**Minimum**		0.16	0.16	0.88	0.32	0.88		
	Max		0.56	0.56	0.94	0.78	0.94		
	Average		**0.36**	0.36	0.91	**0.55**	**0.91**		
Notes:	Thickness refers to the exposed thickness of each soil horizon (meters) All depths displayed in meters (m) Horizon depths displayed in the table are average measured values Excavation conditions: R-Refusal; DE - Difficult Excavation; ES- Excavation Stopped Materials: RG- Residual Gabbro; WGB- Weathered Gabbro Bedrock								

Image 3: Testing Locations and Field Observations



The ground profiles across the site can be **generally summarised** as follows:

4.3.2. Transported Sediments- Colluvium

This undeveloped area was blanketed by organic rich and granular transported material, deemed to be of a **colluvial origin**.

These materials have been transported by a natural agent during relatively recent geological times and have not undergone lithification into a sedimentary rock. Furthermore, due to their age and shallow occurrence- these deposits may lack essential pre-consolidation characteristics. This may result in additional movement upon saturation and loading.

The colluvium was seen to host the major **root systems** and associated biotic activity across the site. Although limited across the footprint, in areas proximal to large flora species, the roots zone is anticipated to extend to significant depths.

The colluvium is dominated by **sand** but hosts a variable assortment of gravels, cobbles and boulders which have been transported downslope and gradually incorporated into the horizon over time. The larger granular materials are generally concentrated at- or near- the surface of the horizon as can be seen by the rocky nature of the site.

The exposed successions of colluvium were seen to be slightly variable, with fluctuations in composition and colour across the investigated area. Overall, the colluvium exhibited a **low in-situ density**, **heterogeneous composition** and voided nature.

The **colluvium** was described by the field team as; *slightly moist; dark brown, blotched olive**; medium dense**; intact or matrix supported**; clayey sand** with sub-angular gravels or sub-angular gravels and cobbles in a matrix of clayey sand; colluvium; **heterogeneous composition** and poorly sorted nature; minor fine roots in the upper extent.*

This organic rich transported material was generally seen to extend from the surface to depths of between **0.16 and 0.56 m** below the existing ground level (E.G.L.)- with an **average exposed thickness of ~0,36 m.**

4.3.3. Weathered Gabbro- *Dsjate Subsuite*- Rustenburg Layered Suite

Across the proposed reservoir location, the organic-rich transported sediments were underlain by **varying grades of weathered rock,** formed from the decomposition of the regionally abundant **gabbro** bedrock.

Based on the limited exposures, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material. Due the unstable nature of the minerals within mafic rocks at normal atmospheric conditions, these rocks are susceptible to **chemical weathering**. The resulting soils are generally seen to comprise of significant amounts of clays which are typically associated with **compressible** and **potentially active** soils.

Furthermore, the calcium-rich minerals within the exposed upper extent of the rock mass have been significantly altered by infiltrating water and associated processes over time- resulting in the formation of pedogenic inclusions in the form of calcification staining/calcrete nodules. The calcification and degree of weathered is anticipated to decrease with an increased depth from natural ground level (where weathering is most concentrated).

The **weathered gabbro** was generally described by the field team as: *slightly moist; light creamy white or olive, blotched olive or white, stained brown;* ***dense****;* ***coarse grained****; closely jointed;* ***highly weathered; soft rock****;* ***Gabbro*** *of the Dsjate Subsuite- Rustenburg Layered Suite; pockets of completely weathered bedrock decreasing with depth;* ***infiltration zones*** *in the upper extent; extensive* ***calcification*** *on exposed faces; discolouration extending from joints planes throughout the rock mass.*

Weathered gabbro was profiled to extend to depths of between **0.88 and 0.94 m** below E.G.L; displaying an **average exposed thickness** of **0.55 m**.

In both test pits TP4 and TP5, excavations underwent refusal to pick-and-shovel on less weathered bedrock at depth. Due to the implemented mode of excavation, no intact/fresh rock was exposed across the footprint of the site.

4.4. Groundwater and Shallow Seepage

4.4.1. Introduction and Discussion

A detailed hydrocensus was not undertaken across the study area. For this reason, the static rest level and chemistry of the ground water cannot be discussed. Without knowledge on the depth to permanent groundwater in the region- it is not possible to comment on the occurrence of permanent groundwater flow within/below the subsurface of the site.

If required, a detailed hydro census can be conducted across the site to determine/model the permanent ground water table depth, location and quality underlying the site. Additional to this process, monitoring boreholes/ piezometers can be installed across the development area to examine ground water patterns seasonally.

Managing surface water across the development area will play a pivotal role in reducing ponding, erosion as well as limiting the volumes of sub-surface flow. Additional to the considerations listed above, a **maintenance regime** and ongoing performance testing should be put in place to monitor the nature of the system over its useful life.

4.4.2. Measured Ground Water Occurrences

No ground water seepage or permanent water table was encountered during the fieldwork phase of the investigation.

As a side note, if the constructed water bearing structures (pipelines and reservoirs) are not properly constructed/maintained resulting in leakages, the additional influx of water into the subterrain will impact the rate of chemical decomposition of the underlying mafic rock mass and its' associated mechanical properties.

4.4.3. Fluctuating Moisture Conditions

The predominant runoff will occur as high energy overland-flow following the topography. As discussed in Section 3.2, the planned infrastructure is located downslope of currently undeveloped land. Although generally steep, should infiltration take place across the **extensive upslope areas** it is predicted that elevated volumes of **shallow ground water throughflow** may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

Altering the soil profile in areas underlain by shallow bedrock commonly affects the subsurface seepage.

Following site modification practises (cut-to-fill), the upper transported materials will allow **infiltration**. Infiltrating water is predicted to temporarily flow/perch along the **rock-soil interface**, with its flow dynamics dependant on the topography of the rock mass at that point. This typically manifests as a weak, relatively **short-lived perched water** table associated with slight groundwater seepage present directly after a precipitation event. Furthermore, the **undulating topography** of the bedrock affects the continuity of the **shallow water flow dynamics** of the site.

The weathered gabbro bedrock was seen to host variable amounts of **pedogenic** materials in the form of calcification staining and calcrete nodules. These pedogenic materials are not predicted to have formed due to excessive amounts of infiltrating/perching of water but are likely amplified by the mineralogy of the rock and susceptibility of the mafic minerals to decomposition. Nonetheless, these pedogenic inclusions indicate the periodic occurrence of **fluctuating moisture conditions** after prolonged precipitation events.

Good site drainage measures, on surface and subsurface, must be implemented to prevent moisture changes, which may add to the development of temporary perched groundwater tables.

During construction and after development, shallow perched water systems may develop yet further due to stormwater management practices, localised infiltration and site modification practices**.** The implementation of a sub-surface drainage system is deemed necessary should foundation configurations result in the damming up of ground water flow.

Foundations and installed services will cause soil density and texture changes which may lead to variations in soil moisture across the site with flow changes and build-up of moisture that may differ from the natural conditions. The weight of the structures on the surface may result in an increased ground water rest level. As good construction practice, adequate damp-proofing measures should be implemented beneath individual structures.

Excavations may need to be dewatered following prolonged precipitation events- to be undertaken in line with the prescribed HSE protocols. Furthermore, the influx of water- both surface and sub-surface- into the trenches may drastically impact their stability.

4.5. Bedrock Outcrops/Boulders

No outcrops were visible across the footprint of the structure.

Boulders were seen to dominate the surface of the investigated site. Boulders ranged in size and shape. Surficial occurrences were inspected and photographed by the field team- examples of which are included in the photo series below. In large scale unrestricted cuttings, the impact of these features is reduced.

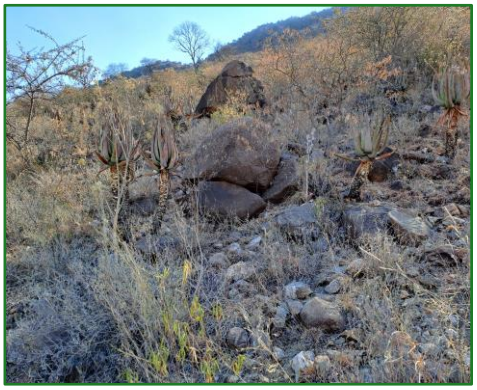
It is recommended that the exact location of the major anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the structures location- and adjoining access roads/pipelines- can be partially adjusted on ground level to avoid major anomalies exposed in the initial earthworks.

Boulders will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development.

Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.

The photo series below depicts examples of these anomalies.





4.6. Site Excavatability

4.6.1. Introduction and Discussion

Excavatability is a measure of material to be excavated/dug/mined with conventional excavation equipment such as a bulldozer with rippers, mechanical excavator, or other grading equipment.

Profiles were described in trenches excavated by means of labourers digging by hand (**pick-and-shovel method**). End of hole conditions were due to **refusal** on less weathered bedrock at depths of between **0.88 and 0.94 m** below E.G.L.

As was seen in exposed ground profiles across the cumulative site, the weathered bedrock typically hosts irregular pockets of more and less intact material. Based on the variable weathering profile exposed in the excavations/local exposures across the site- the weathered gabbro bedrock is anticipated to display an **undulating bedrock topography** which is characteristic of igneous rock masses/terrains.

The **average** excavation depth across the site was approximately **0.91 m.** The excavation type to an **average** depth of **0.91 m** below the existing ground level is deemed to be **SOFT Excavation** (SANS 10400G/SANS1200D).

Excluding surficial boulders, **no significant problems** are foreseen during the excavation of **shallow foundation** trenches to a depth of approximately **0.91 m** below E.G.L. Following this depth, **significant problems** are foreseen in the excavation of **deep service trenches/bulk excavations** though the use of light excavation methods (i.e., hand excavation, TLBs etc.)- due to the shallow and undulating occurrence of weathered gabbro bedrock.

4.6.2. Excavation Notes- Gabbro Bedrock

In rock masses, excavatability is governed by the shear strength of both the intact rock and the discontinuities separating them. Fluctuating excavation conditions correlate to the depth, spacing and degree of fracturing of the underlying rock mass. In a closely jointed rock mass, the excavatability is mostly controlled by failures along joint planes, whereas in widely jointed rock masses, the failure of the intact rock is required before the material can be ripped.

Where deep excavations are undertaken for structures, services, foundations or to modify the sites surface- the excavation properties of the gabbro rock mass need to be considered. The inherent excavatability is predicted to fluctuate over short distances as a result of varying degrees of weathering and spacing of discontinuities.

The physical and mineralogical nature of **gabbro** has led to the formation of a **highly undulating bedrock topography**. These sub-surface features are expected to have an impact on the overall **continuity of the excavatability** across the site, with pockets of deeper less weathered bedrock being present within the soil-like completely weathered bedrock. This variability can take place over a **very short distance**.

The fresh rock mass at depth will require **hard rock excavation** to unearth. Cognisance should be taken of the fact that the depth to bedrock might vary between the trial pits (known points).

The final layout of the development is not known (including associated earthworks); however, allowance should be made for HARD Excavation, typically requiring blasting, wedge and split, chemical fracturing and/or heavy pecking -the exact method of which is dependent on the required final working levels, available equipment and the local environment.

Blasting shallow holes in bedrock or other hard material with no overburden to act as a damping blanket will create fly rock which could be problematic.

If blasting is to be undertaken, it should be designed by and conducted under the supervision of a blasting specialist and advice should be sought as to whether or not it is best to drill and blast through the overburden or whether small areas of this pedocrete can be blasted post-stripping of the overburden provided that appropriate measures such as the use of blast mats are adopted.

A provisional volume of material can be determined using the information from the trial pits and the final earthworks model. The calculated volume should also include excavation for sumps and deep services.

4.6.3. Excavation Safety

The following general notes should be considered regarding workings within and surrounding bulk excavations (SANS 10400 Part G and Section 11 of the OHS Act Construction Regulations):

- The provisions of the Occupational Health and Safety Act of 1993, SANS 10400 and Construction Regulations (most recent edition) must be followed in the excavations and workings therein.
- In terms of Section 11 of the Construction Regulations the contractor must appoint an excavation supervisor. All excavations should be inspected by a competent person (engineer or geo-professional with relevant training and experience) at least once a day and following any periods of rain or any long periods where no work has taken place.
- Where the excavation work involves the use of explosives, a method statement is developed in accordance with the applicable explosives legislation, by an appointed person who is competent in the use of explosives for excavation work and that the procedures therein are followed.
- No load, material, plant or equipment is placed or moved near the edge of any excavation where it is likely to cause its collapse and thereby endangering the safety of, any person, unless precautions such as the provision of sufficient and suitable shoring or bracing are taken to prevent the sides from collapsing.
- Sheet wash from stormwater or other waters shall be prevented from running over the trench/cutting flanks. Trenches/box-cuts may need to be dewatered between and following prolonged precipitation events because of water temporarily perching upon the underlaying less permeable materials at depth.

4.7. Engineering and Material Characteristics

4.7.1. Sampling

The engineering material properties of the various sampled soil horizons were measured in laboratory conditions as per accredited testing procedures.

Standard foundation indicator, compaction tests and soil chemistry tests were conducted by Tzaneen Lab (**SANAS Accredited**) on disturbed and bulk soil samples. These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the construction.

Full lab test results are presented in **Appendix B**.

The sampling which took place during this investigation was based on both the in-situ geotechnical properties of the exposed soil horizons as well as the nature of the development. Problem soil horizons were accurately sampled where encountered (i.e., collapsible/expansive soils).

This section focuses on the identification and assessment of the soil properties which will influence the proposed construction. Where deemed necessary by the field team, mixed samples were created in order to measure the engineering material characteristics which can be expected following bulk site modification practises.

The sampling process **excluded** the following inclusions:

- Oversized particles
- Organic materials
- Anthropogenic contamination

4.7.2. Bulk and Disturbed Samples- Laboratory Test Results

The soil testing which was conducted across the site can be subdivided into three broad categories, as follows:

- **Foundation Indictor Tests**

  Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage) and Particle-size Distribution

- **Compaction Tests**

  Maximum Dry Density versus Optimum Moisture Content and Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)

- **Soil Chemistry Tests**

  pH and EC analysis (corrosivity) as well as double hydrometers as an indication of material dispersivity.

The results presented in the summaries to follow are as received from the accredited testing facility. Although the summaries have been annotated **no** amendments have been made to the results themselves.

The tables to follow summarise the results of the soil tests conducted on the various sampled materials.

Table 4: Foundation Indictor Test Results

Foundation Indictor Test Results																				
Sample Number	Test Pit	Depth (m)	Sampled Material	Particle Size Distribution								Atterberg Limits SANS 3001-GR10 (%)			Grading Modulus	Gravel Wearing Course			Material Classification		Heave
				Standard Sieves Cumulative percentage passing					Hydrometer Analysis SANS 3001-GR3												
				37,5 mm	20 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm	0,005 mm	0,002 mm	LL	PI	LS		Grading Coefficient	Shinkjage Product	TRH20	TRB	USC	
T03344/5	TP4	0,00-0,88	Mixed: Colluvium/Weathered Gabbro Bedrock	69	61	24	16	12	10.8	5.9	3.8	44	21	10.0	2.5	16	163	Erodible	A-2-7	GP-GC	LOW
T03344/6	TP5	0,16-0,94	Weathered Gabbro Bedrock	78	67	25	16	12	11.3	5.9	4.0	48	23	10.5	2.5	18	168	Good	A-2-7	GP-GC	LOW
Notes:	1. Atterberg Limits undertaken on material passing the <0,425 mm sieve 2. Atterberg Limits: Liquid Limit (LL), Plasticity Index weighted (PI), Linear Shrinkage (LS). 3. Heave: Potential expansiveness (acc. Van Der Merwe, 1964).																				

Table 5: Compaction Test Results

Compaction Test Results												
Sample Number	Test Pit	Depth (m)	Sampled Material	Compaction Test Results					Material Classification		
				MDD (kg/m^3)	OMC (%)	Interpreted CBR Values SANS 3001-GR40 Mod AASHTO Method			COLTO	Material re-usage potential	
						90%	93%	100%			
T03344/5	TP4	0,00-0,88	Mixed: Colluvium/Weathered Gabbro Bedrock	2123	8.8	13	19	46	<G9	POOR	Does not meet G9 requirements due to: PI>17,44
T03344/6	TP5	0,16-0,94	Weathered Gabbro Bedrock	2135	9.6	8	11	27	<G9	POOR	Does not meet G9 requirements due to: PI>17,41
Notes:	1. Compaction Test Results; percentage compaction of MDD (MOD AASTHO Method); CBR of 13.344 kN 2. MDD- Maximum Dry Density; OMC- Optimum Moisture Content 3. Material classification and re-usage potential based on the COLTO classification system										

4.7.3. Laboratory Test Results- Summary and Discussion

At the planned reservoir site, the sampled materials can be summarised as follows:

- The samples grade as **gravel** with a **grading modulus (GM)** of **2.5.**
  - The colluvium which blankets this area exhibits a visible heterogenous composition. For this reason, the GM of this material is expected to fluctuate- as seen along the access road- generally decreasing with an increase in depth in the horizon.
  - The GM of the weathered bedrock is anticipated to varying with fluctuations in degree of weathering.
- The sampled materials exhibit a **HIGH plasticity**, medium linear shrinkage values and an overall **LOW potential for heave** (acc. Van Der Merwe, 1964).
  - Measured PI values range from **21 to 23.**
- Typical Unified Soil Classes (USC) are **GP-GC.** Based on USCS class (GP and GC), drainage will range from poor to practically impervious (GC) or excellent (GP), and a **low compressibility** can be expected once compacted. Moreover, these materials typically display **good/fair compaction characteristics** and classify as **reasonably stable embankment material.**
- Typical TRB Class is **A-2-7.**
- The **combined granular materials** typically displayed a **FAIR reaction** to **compaction:**
  - The sampled materials exhibited a California Bearing Ratio (CBR) value of **between 11 and 19** at a compaction effort of **93 %** Mod AASHTO, increasing to a CBR of **between 27 and 46** at a compaction effort of **100 %** Mod AASHTO.
  - Furthermore, the compacted samples displayed a calculated **remoulded bearing capacity** of between approximately **80 and 130 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5.
  - The **colluvium and weathered gabbro bedrock** classified as **worse than G9-type** material according to the COLTO classification system- generally attributed to the **PI exceeding the allowable limits**.

- Based on the available double hydrometer readings the sampled materials are deemed to be **slightly dispersive**. Measures to reduce the susceptibility of the material to dispersion are recommended. These methods my include improving the structure of the soil and blanketing/covering of the material by use of vegetation (where applicable), manage sodium levels within the material by replacement/addition of calcium (gypsum) and importantly managing water across the contract (adequate drainage measures).

4.7.4. Combined Re-usage Summary and Discussion

The re-usage potential of the topsoil was not tested due to the organic- rich nature of the horizon which poses a risk to the proposed development. This material should be over- excavated from the footprint of future structures, sorted and stockpiled for future landscaping purposes.

The **combined materials** sampled across the site displayed a **POOR** quality with regards to the planned construction- classifying as **worse than G9-** type material according to the COLTO classification system (resulting from its elevated PI). For this reason, these materials are only deemed suitable for use as **subgrade layers (G9/<G9)** in the proposed construction and associated engineered fill/road layer works. This material is not suitable for the use in controlled fills in final engineered layers. Based on the available USCS classification, the granular materials are reasonably stable embankment materials.

Caution should be taken in the **zones of poor-quality material** (i.e., organic rich materials and/or anthropogenic contamination). Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.

The extent of **cut-to-spoil** is dependent on the layout of the development coupled with the design of the planned structures.

Where deep/bulk excavations are undertaken across the reservoir site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction. This material generally serves as good material for the use in engineered fills.

Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction.

4.7.5. Soil Corrosion Discussion

As a brief introduction soil corrosion is an electrochemical process whereby complex chemical reactions between the soil and the contacting metal result in the formation of corrosion products and deterioration of the metal. The severity of corrosion that can be caused by a particular soil type is dependent on a variety of factors, including the soil's chemical properties, environmental conditions and the properties of the metal in contact with the soil.

Corrosion is a natural redox (reduction-oxidation) reaction that converts a refined metal to its more chemically stable state. Three components must be present for corrosion to occur: an anode (the buried metal in contact with the soil), a cathode (oxygen) and an electrolyte (the moisture found in the soil). The degree of corrosiveness and the rate of corrosion differ between different soil types and properties (K. Nanan., 2018).

As part of this analysis, some of the soil samples were tested for pH and electrical conductivity (EC). These results and other indicators of aggressiveness to stee l and concrete (corrosivity) are shown in Table 6.

Table 6: Soil Chemistry Test Results

Soil Chemistry Test Results								
Sample Number	Test Pit	Depth (m)	Sampled Material	Corrosivity Indicators				Dispersivity Indicators
				Profiled In-Situ Moisture	% Clay	pH	EC (mS/m)	Double Hydrometer Results (%)
T03344/6	TP5	0,16-0,94	Weathered Gabbro Bedrock	Slightly Moist	4	7.9	60	22.0
Notes:	1. Material as per soil profile description. 2. Moisture as per soil profile description or natural moisture content. 3. Percentage clay, pH, EC (Electrical Conductivity) and double hydrometer as per laboratory results.							

Table 7: Reference Table- Influences of the Corrosiveness of Soils to Steel and Concrete

PARAMETER	→ INCREASING AGGRESSIVENESS OR CORROSIVENESS OF SOILS →					
EC (S/m)	**<0.0050: Essentially non-corrosive**	**<0.0100: Mildly corrosive**	**<0.0200: Moderately corrosive**	**<0.0333: Corrosive**	**<0.1000: Highly corrosive**	**>0.1000: Extremely corrosive**
Soil type	**Sand and gravel generally have lower EC: Generally less corrosive**			Clay generally has higher EC: Generally more corrosive		
Saturation	**<40% or 100%: Generally not aggressive to mildly corrosive**				60-85%: Maximum expected corrosion rates	
pH	**Soils with neutral pH are generally not very corrosive**			Very acidic or alkaline: corrosive to steel Acidic (pH < 5.5): likely corrosive to concrete		

Based on the combined results presented in Table 6- when compared to the applicable references (Table 7)- all materials which underlie the site are deemed to be **corrosive**. It is advisable not to use steel pipes and engineering measures must be implemented to protect portions of the structure which will come into prolonged contact with soil. These methods may include but are not limited to the following:

- Barrier coatings, sealers and membrane-type coatings (resins, epoxies, emulsions) applied to the concrete surface.
- Concrete reinforcement/steel coatings including nickel, stainless steel and zinc (i.e. galvanisation).
- Cathodic protection or other electro-chemical means.
- Overlays including Portland cement, latex-modified concrete and polymer concrete.
- Addition of corrosion inhibitors and admixtures to the concrete.
- Adequate site drainage measures to avoid soil saturation.

4.8. In-Situ Mechanical Assessment

4.8.1. Introduction

The soils underlying the site have been examined and tested to determine their suitability as founding horizons for the proposed development (water bearing structures) according to the following criteria:

- **Bearing capacities** of the founding materials determined from estimated field consistencies and inferred from tabulated strength values.
- **Compressibility**, where applicable.
- **Collapse potential**, where applicable.
- Potential **heave**, where applicable.
- Predicted **displacements** (settlement/collapse/heave) from the above factors.

Undisturbed sample extraction was not possible/feasible in the exposed granular materials. For this reason, the mechanical assessment of subsoils will be based on the available disturbed soil test results and field observations (i.e., structure, composition, and consistency).

For **light structures** and road ways, the variable successions of **soft materials** including **colluvium and upper weathered material** form the primary materials of concern across the site. Caution must be taken when dealing with these potentially **collapsible/compressible** soils.

During the design of the **planned large reservoir structure**, the mechanical properties of the underlying rock mass- beyond the depth of the exposed soft materials- needs to be considered.

4.8.2. Inferred Material Properties Unified Soil Classification System

As part of this assessment a number of engineering material properties can be **inferred**- to be confirmed/measured in follow-up studies where required. Inferred figures are extracted from the data base available on geotechdata.info.

The Unified Soil Classification System (USCS) is a soil classification system used in engineering and geology to describe the texture and grain size of a soil. The classification system can be applied to most unconsolidated materials and is represented by a two-letter symbol. The demarcated result can be used to infer a wide range of soil properties and characteristics.

The **soils** sampled across the site classified as: **GP-GC.**

The following inferred paraments/attributes can be used in **preliminary designs**:

1. Typical values of **soil friction angle (degrees)**
    a. GP Soils: 32 to 44
    b. GC Soils: 28 to 35
2. Typical values of **soil cohesion (kPa)**
    a. GP/GW/GM Soils: 0
    b. GC Soils: 20

3. Typical values of **soil permeability (m/s)**
    a. GW/GP Soils: $5.0x10^{-4}$ to $5.0x10^{-2}$
    b. GC Soils: $5.0x10^{-9}$ to $5.0x10^{-6}$

Numerous additional inferences can be made based on the available laboratory test results and associated data bank of information. Additional properties can be presented on the request of the project team.

4.8.3. Bearing Capacity and Soil Shear Strength (Light Structures)

1. **Introduction**

Bearing capacity is defined as the pressure which would cause **shear failure** of the supporting soil immediately below and adjacent to a foundation. The estimated allowable bearing capacity of a soil material is a function of the angle of internal friction (reflected in the grading), consistency/cohesion (reflected in the soil grading and density) and degree of saturation (moisture content).

The allowable bearing pressures imposed on the material is a function of both the soils shear strength (ultimate limit state) and its' settlement characteristics (serviceability limit state). The presumptive bearing capacity figures disregard the effect of soil moisture changes that may induce settlement/collapse.

2. **Estimated Allowable Bearing Capacity- Field Estimates**

The estimated presumed bearing values of the foundation materials are only an empirical guide to the maximum load that can be placed on the soil/weathered rock particular to this site without shear failure, and as such are not an indicator of the possible settlement/collapse that may occur at foundation pressures up to the bearing capacity of the soil.

Taking the additional movements due to soil movement into account will imply that foundation improvements will be necessary for structures.

The presumed bearing values below are based on the materials exposed in situ in the test pits and ignore any improvement, which may be obtained by compacting, or treating the site soils. The bearing capacity will increase with an increase in depth due to the increase in grain size and in-situ consistency.

The on-site materials are all deemed to be granular material. Preliminary estimates of bearing capacity for granular material are as follows (Look, 2014):

- **Loose** consistencies in these materials may be roughly correlated to a presumed bearing value of between **30 - 80 kPa.**
- **Medium dense** consistencies may be roughly correlated to a presumed bearing value of between **80 - 225 kPa.**
- **Dense** consistencies in these materials may be roughly correlated to a presumed bearing value of between **225 - 375 kPa**.

- **Colluvium**

  The **colluvium** was profiled to exhibit an **overall medium dense** consistency. **Medium dense** consistencies in the granular soils can be roughly correlated to a presumed bearing value of between **80 - 225 kPa** (Look, 2014). Other sources list presumptive bearing capacity of sandy/gravelly soils to 95 – 150 kPa (Alemdag et al, 2017; BS8004-1986; Builders Engineer 27 October 2012).

  The intrinsic variability of the blanketing sediments (heterogeneous composition and transported nature) should be considered. The in-situ consistency, soil texture and structure are anticipated to fluctuate spatially along the flanks of the ridge. Therefore, the bearing capacity of the upper soil layer may not be adequate for light structures and will require detailed evaluation depending on location.

- **Weathered Gabbro Bedrock**

  As mentioned, the exposed weathered constituent of the rock mass typically represents the transition between the late stages of rock disintegration/ decomposition and early stages of soil formation. It is therefore envisaged that the exposed upper weathered extent of the rock mass will display properties- including bearing capacity attributes- in line with a **dense granular soil**.

  Dense consistencies in the granular soils can be roughly correlated to a presumed bearing value of between **225 - 375 kPa** (Look, 2014). Furthermore, the combined granular materials typically displayed a FAIR reaction to compaction, with the compacted samples displaying a calculated **remoulded bearing capacity** of between approximately **80 and 130 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5 during indicative CBR analysis in a laboratory (disturbed samples).

  The intact rock mass at depth is anticipated to serve as a good founding medium for planned structures (Section 4.8.7 of this report).

4.8.4. Settlement Characteristics of the In-Situ Soils

Compressible soils are soils of low stiffness that settle significantly when loaded. In free-draining soils (e.g., sands), this settlement occurs during and shortly after loading. In low permeability soils (e.g., clays), this settlement occurs over a period of time as the pore pressures set up during loading dissipate.

Considering the material characteristics measured in lab conditions and observed within the soil profiles; the soft materials exposed in the excavations underlying the site are deemed to display a **slightly compressible nature** at light foundation loads.

The compressibility is predicted be greater in the blanketing colluvial deposits. Furthermore, the upper extent of the weathered gabbro is deemed to display a slightly compressible nature but is anticipated to drastically reduce with depth as the degree of weathering reduces and associated increase intact rock strength.

4.8.5. Heave Characteristics

Expansive soils are soils that undergo changes in volume due to changes in moisture content, swelling when the moisture content increases and shrinking when the moisture content decreases.

Based on the results from the various **disturbed samples** from the on-site materials it was noted that these soils exhibit a **HIGH plasticity** and medium linear shrinkage values. As a result of its **low clay content in the sample material**, the PI of the whole sample is drastically reduced resulting in an overall **LOW potential for heave** (according to Van Der Merwe, 1964).

With that said, the effect of water on the **mafic igneous rocks** should be highlighted. The clay minerals in some mafic rocks- have the ability to absorb and release varying amounts of water. This change in moisture content is usually accompanied by a **change in volume**. Furthermore, the prolonged saturation of this lithology- both naturally and/or anthropogenically- may result in further decomposition of the parent material into fine-grained soils with a predicted expansive behaviour.

The degree of movement/heave will increase with a decrease in the induced overall load of the proposed structures.

The **trigger mechanism** for heave is **fluctuating moisture conditions**. For this reason, other than precautionary foundations measures, adequate drainage measures are key to preserving stable site conditions.

4.8.6. Collapse Settlement Characteristics of the In-Situ Soils

Collapsible soils are open-textured (high void ratio) soils that are stiff when dry but lose their stiffness when they become wet. This can lead to sudden, large settlements taking place when the moisture content of the soils below a foundation increase, even many years after construction.

The elevated PI results from the sampled materials typically negates the possibility of collapse. Differential settlement is amplified across the site due to the heterogenous composition of the colluvium and variable weathering profile of the underlying rock mass (pockets of soil-like material vs less weathered rock particles).

4.8.7. Basic Rock Mechanics- Large Structures

Discussion

As discussed in the preceding sections of this report, the site is underlain by shallow undulating gabbro bedrock. Due to the limited exposures of the rock mass- coupled with its weathered state- the exact composition of the gabbro rock mass could not be defined, as well as its geotechnical nature at depth.

The mechanical properties of a rock mass are dependant not only on the properties of the intact rock (Uniaxial Compressive Strength etc.) but also on the properties of the discontinuities (spacing, orientation, continuity, etc.). The various intact rock and discontinuity properties will each have their own impact on the overall geotechnical properties of the rock mass, such as the permeability and strength.

Ideally the assessment of the underlying rock mass would be undertaken through the implementation of a rotary core drilling regime- with associated rock core logging, photography, sampling and lab testing on the cores (physical and chemical attributes).

Possible Follow-up Actions

In gabbro rock masses, due to the relatively high strength and low permeability of the intact rock, the rock mass properties are predominantly a function of the **discontinuity properties.** As such, the properties of a jointed rock mass are generally best determined through the use of rock mass classification systems such as the Rock Mass Rating by Bieniawski (1989), and the Norwegian Q-Index, presented by Barton et al (1974). These rock mass properties are generally determined from exposures allowing for the classification of the foundation rock.

Based on the available theoretical data, the fresh igneous rock masses which underlie the study area **display favourable strength characteristics** with regards to the construction of the planned water storage structures. However, should more detailed information be required- one or more of the following actions can be implemented to model the rock mass as a whole:

1. Joint line surveys and/or window mapping of the bulk excavations created in the early stages of the construction.
2. Geophysical surveys to model the extent of the weathered zone of the rock mass, map geological anomalies and indicate the excavatability of the rock mass at depth (i.e. seismic velocities).
3. Hydrological studies to model the movement of ground water across the development's footprint, including possible chemical assessments.
4. Borehole drilling with associated core logging, sampling and rock core laboratory testing. The rock core samples should be submitted for testing in order to determine the physical and chemical properties of the rock material. The drilling results will shed light on the extent and quality of the gabbro bedrock underlying the site- which will further aid the design of the proposed infrastructure.

4.9. Foundation Design Options- Large Structures

4.9.1. Introduction

The diverse geotechnical attributes of the site have been discussed at length in the preceding sections of this report. There are geotechnical attributes of the site which are not ideally suited for the planned development (delineated in this report)- for this reason, **advanced engineering solutions** will be required to ensure the stability and longevity of the development.

Soil/rock mechanics calculations are based on the geometry of the foundation and measured parameters. During the design of the **planned steel tank reservoir**, the mechanical properties of the underlying rock mass- beyond the depth of the exposed soft materials- needs to be considered. The allowable bearing pressures imposed on the material is a function of both the shear strength (ultimate limit state) and its' settlement/deformation characteristics (serviceability limit state).

Structural solutions shall improve the flexibility and strength of the structure to enable the building to tolerate potential movements so that the resulting response to actions is within the limits specified in SANS 10400-B. The structure must be strengthened to allow for the predicted differential settlement.

Please consult a competent engineer for additional options and final designs.

It is recommended that the structural engineers calculate the best economical foundation option for the proposed development based on the type of structure and the different available construction methods/materials to remedy the negative effects of the measured geotechnical constraints.

The final layout of the development is not known at this stage, with the discussion points to follow using typical attributes for structures of this nature.

Additional to the proposed foundation configurations, an important factor in the promotion of a stable site is the control and removal of both surface and ground water from the site. The implementation of a sub-surface drainage system is deemed necessary should foundation configurations result in the damming up of ground water flow.

4.9.2. Deep Foundation Discussion

Considering the **complex terrain** and **mechanical properties** of the in-situ materials- in conjunction with the nature of the development- it is recommended that the foundations for the planned **steel tank structure** be taken down to **sound bedrock** beyond the depth of the exposed soft materials, including the variable colluvial sediments and upper weathered extent of the rock mass.

Considerations surrounding general **deep foundation configurations** are presented below. GeoCalibre is open to future discussions with the design team should other foundation options be explored once final structural configurations are defined.

- This option entails foundations founded upon **intact bedrock** below problematic soft materials, with the reinforcement of the foundations to the point at which they can withstand the expected differential movements resulting from site modification practises.
- Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand across the footprint of the planned structure. Once access/mobility has been modified follow-up studies can be conducted, where required.
- Deep excavations should be inspected once created to confirm exact geotechnical conditions in the exposures- for both cutting stability and foundations- with the adaption of the ground model where required.
- Based on the available theoretical data, the fresh igneous rock masses which underlies the site displays favourable strength characteristics with regards to the construction of the planned water storage structure. Although not defined at this stage due to the limited exposures- at the refusal point, a conservative field estimated allowable bearing capacity of >300 kPa can be inferred for the rock mass. Once exposures are logged, the overall quality can be defined using available Rock Mass Rating (RMR) systems or similar indices.
- As addressed in detail in Section 3 of this report, due to the site gradient- cut to fill site preparation is expected, with cuts primarily extending into the weathered gabbro bedrock which occurs from shallow depths.
    - In contrary to the problematic colluvial sediments, the local igneous rock masses are not generally prone to major instabilities based on the available theoretical databases and as seen in local cuttings.

- Although it is predicted that fresh exposures in bedrock exhibit stable conditions in near vertical cuts (depending on orientation), it is recommended that the permanent cuttings be adequately sloped (approximately 60 to 75 degrees) or stabilised to reduce the risk of instabilities.
- Instability in these igneous bodies is predicted to be in the form of localised rock block failure, necessitating the removal or stabilisation of unstable rock blocks. Though rare, problematic joint sets/features can be present especially surrounding geological structures.
- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the reservoir.
- Drainage measures required across the constructed platforms so as to limit ponding and infiltration which may lead to perching in these areas.

- It is recommended that the foundation be place on a uniform founding medium (i.e., bedrock across the cut portion of the platform) so as to limit the degree of differential settlement. Where possible, foundations should not span across the cut/fill interface or from soil to rock so as to limit differential settlement.
- The force of the proposed structure should be applied horizontally uniform across the exposed jointed rock surface; this will allow for the spanning of the various joint sets and the avoidance of point loads on individual unstable rock blocks. Boulders are to be avoided wherever possible.
- The depth to bedrock is expected to fluctuate, attributed to the characteristic undulating nature of the regional extrusive igneous rock (gabbro). The final profile of the excavation will be undulating, over break and over excavation will occur in both the base and sidewalls of the excavations and provision made in the pricing, and quantities in the relevant contract documentation.
  - Jackhammer trimming of the base and sidewalls of excavations in bedrock must be expected and allowed for in the contract documentation.
  - Provision should be made for additional mass concrete in the foundation trenches to ensure that the TOC is always at the specified level.
  - Provision should be made for blinding particularly where the footings are founded in bedrock. A decision can be made on site during construction as to whether or not blinding is actually necessary.
  - Emphasis must be placed on the final cleaning of the excavation, with the complete removal of loose debris prior to the injection of mass concrete or blinding layers.
- The sampled soft materials are deemed to be corrosive. Engineering measures must be implemented to protect portions of the structure which will come into prolonged contact with the soft material.

- It is recommended that earthworks be carried out along the guidelines given in SABS 1200/SANS 10400 (current version).
- Areas subjected to extensive fills need to be adequately modified/ compacted to limit soil movement over time (i.e., fill creep).
- Where implemented, it is essential that backfilled materials are of sufficient quality and compacted in controlled layers (material quality/required density as per engineer's design).
    - The combined materials sampled across the site displayed a POOR quality with regards to the planned construction- classifying as worse than G9- type material according to the COLTO classification system (resulting from its elevated PI). For this reason, these materials are only deemed suitable for use as subgrade layers (G9/<G9) in the proposed construction and associated engineered fill/road layer works. This material is not suitable for the use in controlled fills in final engineered layers.
    - Based on the available USCS classification, the granular materials are reasonably stable embankment materials.
    - Caution should be taken in the zones of poor-quality material (i.e., organic rich materials). Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.
    - Where deep/bulk excavations are undertaken across the reservoir site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction. This material generally serves as good material for the use in engineered fills.
    - Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction.
- Across the fill portion of the platforms, placement of imported layers should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve 93% Modified AASHTO maximum dry density at ±2% optimum moisture content.
- Density control of placed fill material should be undertaken at regular intervals during fill construction.
- Quality control testing should be undertaken by an accredited laboratory where possible.
- Deep excavations may need to be dewatered during construction- especially during the summer months of the year (rainy season).
- Lastly, a maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.

5. Geotechnical Evaluation- Access Road

5.1. Introduction and Description

This section of the report summarises the cumulative findings of the **centreline** and **materials investigation** conducted in support of the design and construction of the new access road to the proposed Tsakane Steel Tank Reservoir. Numerous geotechnical attributes which were discussed at length in the preceding section of this report are duplicated in this section. These sections are included where deemed applicable to assist the design team in their processes.

As discussed in the preceding sections of this report, the development includes the **upgrading/construction** of a **gravel access road**- with a length of ~ **500 m.** A **basic materials assessment** was conducted along the route of the new access road. The initial construction of the existing section of gravel road entailed the bulk earthworks required to create the originally prescribed working levels.

The planned **starting point (0+000)** of the access road is located within the central extent of the village- at the **intersection** between the existing gravel road in question and the **D1392**. From this point, the gravel road forks off in a general north easterly direction- cresting a local ridge. At ~0+170, the existing road makes a 90 degree turn to the north west- following this bearing to ~0+300- traversing developed land, confined by residential properties and their associated services.

Furthermore, from **~0+300**, the existing gravel road ends- with the planned route entering **undeveloped land** along the villages' north western permitter. Following this transition, the access road meanders its way up the very steep sloping flanks of a major ridge, on-route to the proposed reservoir location to the north. The **termination point of ~0+500** is achieved as the road approaches the structures' planned **footprint** from the south west.

Across the **developed areas** the access roads' footprint/shape is limited to **existing attributes** such as property services, boundaries etc. Conversely, across the undeveloped areas to the north west of the village, the footprint of the planned development was not defined on ground level, with the Client providing a path for the future gravel road. In this area, the access road's shape- as presented by the Client- represents an attempted optimisation of the infrastructure across the complex topographic setting, including attributes such as road length/footprint, modification requirements, usability constraints and budget considerations, to name a few.

The access road is located at the following coordinates:

Start- 0+000	**Latitude:** 24.864903° S	**Longitude:** 30.043238° E
End- 0+500	**Latitude:** 24.861717° S	**Longitude:** 30.042349° E

The results of this geotechnical analysis models that the whole site exhibits geotechnical characteristics that may require the implementation of design and/or precautionary measures to reduce the risk of structural damage due to adverse geotechnical characteristics. However, these characteristics do not disqualify the site from being used for the development, but rather require the implementation of **site-specific precautionary engineering measures**.

The exact design and configurations of the planned structures was not known at the time of compiling this report. GeoCalibre is open to ongoing discussions regarding site specific engineering solutions once final configurations are known.

GeoCalibre has compiled a **simplified summary** including field observations, summarised ground profiles, laboratory and DCP test results for the road, in order to guide the design phase of the development (presented at the end of this section). The purpose of this summary is to eliminate data complexity. During the detailed design phase of the development, local areas of concern can be extracted from the summary and can be dealt with individually.

5.2. Trenching

The field work phase of the investigation was conducted by GeoCalibre in June 2024. As a result of the limited access, along the route of the planned access road, test pits were excavated using labours digging by **hand** (pick-and-shovel method), to a depth of approximately 1.0 meters below the existing ground level, or refusal. Where available, local cuttings/exposures along the route were mapped for the amalgamation into the sites geotechnical model.

Excavations were conducted as to accurately describe the general near surface conditions occurring across the target areas. Trial pit placements were undertaken in such a way so as to create an accurate and reproducible site-specific geotechnical model.

Test pit locations were primarily based on the Client's specific outcomes (foot print analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model.

A *Geologist* supervised the excavation of the trial pits. The description of the exposed ground profile is done according to SANS 633:2012 and describes the moisture, colour, consistency, structure, texture and origin.

The soil profile is described according to the following parameters:

- **Moisture** dictates the colour and consistency of soils and indicates how and where water moves and the depth to perched water systems.
- **Colour** indicates the oxidizing or reducing state of soils and assist in the identification of minerals in completely weathered to fresh rock.
- **Consistency** is separated between cohesive and granular as the drainage and permeability affects the soil's shear strength.
- **Structure** describes any relict features from rock or soil and those that form through packing, soil and rock structures, seepage, reworking and biotic action.
- **Texture** is the abundance of different grain sizes in soils and is described by means of field test.
- **Origin** is the formation of the soil by means of transport of weathering.

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development. Laboratory testing commenced on the samples collected during the field work phase of the investigation.

5.3. Ground Profile Discussion

Note: this description is based on field observations and does **not** reflect the results of any laboratory tests.

5.3.1. Introduction

The information presented below is based on point data. Every effort was made during the site investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. Variances in soil and rock quality and quantity from those predicted may be encountered during construction and these should be recorded.

Across the developed portions of the site, the surface of the existing gravel road was seen to display an **artificially reworked nature** attributed to its original construction, maintenance and daily use- aggravated through natural processes such as erosion resulting from channelised flow. All in all, these combined activities have resulted in localised fluctuations in both **material volume** (thickness and lateral extent of the uppermost soil horizons) and **material quality**. It is predicted that this will result in discontinuous fluctuations in thickness, composition and consistency of the blanketing soil layers during the upgrading of the existing gravel road.

Across the high-lying north western portions of the site, the proposed footprint of the access road traverses **undeveloped land** and is not defined by any existing pathways/roadways on ground level. Due to the undisturbed nature of the soil profile, the upper extent of the exposed soil layers was seen to be **organic rich**. Although predicted to be more influential surrounding trees, the degree of organic material was noted to gradually decrease with depth- generally limited to the blanketing colluvial sediments.

The footprint of the planned road is underlain by a similar sequence of materials as the proposed reservoir- discussed in length in the preceding sections of this report. Moreover, across the combined areas, during the trenching phase of the investigation, it was noted that the roads- new and existing- are generally blanketed by **transported soils,** further underlain by varying grades of weathered **gabbro bedrock.**

Each type of material present in the study area displays its own unique gradual change in material properties, both laterally and vertically.

In depth soil profile descriptions for each test pit location are presented in **Appendix A.** The extent of each material along the proposed road is graphically depicted in the **cross section** which forms part of the summaries in **Section 5.10**.

The following predominant material horizons were encountered across the site:

- **Anthropogenically Reworked Materials- Developed Areas**
- **Colluvium**
- **Weathered Gabbro Bedrock**

The **combined general characteristics** of the various materials encountered across the site can be **summarised** as follows:

5.3.2. Anthropogenically Reworked Materials

The stretch of gravel road across the developed areas in question was seen to be blanketed by a thin **surface wash**. Surface wash is a combination of imported and reworked natural materials which have been **modified** to serve as the existing gravel wearing course. This is a thin variable succession of material, exposed to the natural elements and anthropogenic activities- the result of which is a variable overall quality and continuity.

The thickness/extent of these imported/reworked materials was seen to fluctuate sporadically across the investigated road; with the road **NOT exhibiting a controlled uniform good quality imported horizon.** This attribute indicates that the road layers are not homogeneous as would be found/expected in well designed and constructed roads.

Surficial landfill/waste material was present across scattered sections of the developed portion of the site. These combined successions of fill material were dumped across the area in an **uncontrolled manner** during past anthropogenic activities. Dumped fills were more prolific in areas which have undergone erosion- where locals had filled problem zones to protect the existing surface from additional scouring.

5.3.3. Transported Sediments

Based on available exposures, the vast majority of the site is blanketed by a **heterogeneous deposit** of transported material profiled as **colluvium**.

Along the existing gravel road, the upper extent of the transported sediments was generally **modified/contaminated** during to the construction of and/or daily use of the existing gravel road (as discussed above). Furthermore, along the shoulders of the gravel road, the uppermost extent of this material can be expected to be organic rich, with the degree of organics decreasing with an increase in depth.

Across the undeveloped high-lying northern to northern western portions of the site, the blanketing unaltered gravity transported material display an **overall granular nature** with a large range in particles sizes varying from sand to boulders. In these areas, the colluvium was seen to host major root systems and associated biotic activity. The organics were seen to gradual decrease with an increase in depth. In areas proximal to large flora species, the roots zone is anticipated to extend to significant depths below the surface of the site.

These combined transported materials have been transported by a natural agent during relatively recent geological times and have not undergone lithification into a sedimentary rock. Furthermore, due to their age and shallow occurrence- these deposits may lack essential pre-consolidation characteristics. This may result in additional movement upon saturation and loading.

The various transported sediments were seen to display variances in composition along the length of the road attributed to the fluctuating geomorphological environment in which they were deposited and have subsequently evolved.

Based on field observations, the larger particles are generally more prolific in the high-lying areas, concentrated at or near the surface of the slope resulting in the **rock/bouldery surface** of this portion of the site. The size of surficial cobbles/ boulders is anticipated to gradually decrease with an increased distance from the crest of the ridge. Larger particles require significant amounts of energy to be transported and are therefore frequently found close to their original source. As the depositional energy gradually decreases with distance, the particles that can be transported **steadily reduce in size**.

The colluvium was profiled by the field team as a: *slightly moist; dark brown or dark creamy brown or light orangey brown, blotched white, olive or grey;* ***loose****,* ***medium dense or dense****;* ***matrix supported or intact****;* ***clayey sand*** *with minor sub-rounded or sub-angular gravels or gravels and cobbles in* ***a matrix of clayey/silty sand****; colluvium or calcified colluvium; surficial cobbles and boulders;* ***heterogenous composition*** *and poorly sorted nature; abundant or minor fine roots; upper extent serving as wearing course; calcification increasing with depth; infiltration zones; undulating exposure*.

Across the combined excavated test pits, the colluvium is present from surface and extends to depths of between **0.16** and **0.56 m** below the existing ground level (E.G.L.)- displaying an **average exposed thickness of 0.34 m.**

5.3.4. Weathered Gabbro- *Dsjate Subsuite*- Rustenburg Layered Suite

As alluded to in the introductory discussions, the formation of residual soil is generally limited along the steep sloping flanks of the ridge/site due to the reduced amounts of infiltrating water- with the majority of the overland flow converging downslope towards the low-lying areas. For this reason, the blanketing sediments along the route were generally underlain by **weathered gabbro bedrock**.

As a result of the limited exposures in hand excavated test pits, varying degrees of protolith weathering and alteration/calcification- classification of the exact rock mass properties was not possible. Accurate rock mass characterization/ mapping can be undertaken across cuttings/exposures resulting from the planned bulk earthworks.

The calcium-rich minerals within the exposed upper extent of the rock mass have been significantly altered by infiltrating water and associated processes over time- resulting in the formation of pedogenic inclusions in the form of calcification staining/calcrete nodules. The calcification and degree of weathering is anticipated to decrease with an increased depth.

The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock. Moreover, based on the limited exposures, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material.

Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and rock mass continuity.

The **weathered gabbro** was generally described by the field team as: *slightly moist; light olive grey or light reddish grey, blotched olive, brown or white, stained white, orange or red or banded red; coarse grained;* ***very closely jointed*** *or* ***closely jointed; highly/completely weathered; generally soft rock; Gabbro*** *of the Dsjate Subsuite- Rustenburg layered suite; traces of fine roots in the upper extent; infiltration zones; staining extending from joint planes throughout the fabric of the rock;* ***undulating weathering profile*** *or overall reduction in weathering with an increase in depth; calcified rock faces; joint planes stained and filled with granular residual soil.*

The varying grades of weathered bedrock were encountered from below the blanketing colluvium, extending to depths of between **0.88 and 1.96 m** below the E.G.L.- displaying an **exposed average thickness of 0.73 m**.

5.4. Groundwater and Shallow Seepage

5.4.1. Introduction and Discussion

A detailed hydrocensus was not undertaken across the study area. For this reason, the static rest level and chemistry of the ground water cannot be discussed. Without knowledge on the depth to permanent groundwater in the region- it is not possible to comment on the occurrence of permanent groundwater flow within/below the subsurface of the site.

If required, a detailed hydro census can be conducted across the site to determine/model the permanent ground water table depth, location and quality underlying the site. Additional to this process, monitoring boreholes/ piezometers can be installed across the development area to examine ground water patterns seasonally.

Across the developed portions of the site, the natural seepage and ground water flow characteristics of the area would have been partially altered during the original operations undertaken across the village.

Managing surface water across the contract will play a pivotal role in reducing ponding, erosion as well as limiting the volumes of shallow sub-surface through flow. Future roadways can be targeted for the use in the drainage network and in so doing limiting the disturbance to the local road users. Additional to the considerations listed above, a **maintenance regime** and performance testing should be put in place to monitor the nature of the system over its design life.

5.4.2. Measured Ground Water Occurrences

No ground water seepage or permanent water table was encountered during the fieldwork phase of the investigation.

5.4.3. Fluctuating Moisture Conditions

The predominant runoff will occur as high energy overland-flow following the topography. As discussed in Section 3.2, the planned infrastructure is located downslope of currently undeveloped land. Although generally very steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of **shallow ground water throughflow** may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

Altering the soil profile in areas underlain by shallow bedrock commonly affects the subsurface seepage.

Following site modification practises (cut-to-fill), the upper transported materials will allow **infiltration**. Infiltrating water is predicted to temporarily flow/perch along the **rock-soil interface**, with its flow dynamics dependant on the topography of the rock mass at that point. This typically manifests as a weak, relatively **short-lived perched water** table associated with slight groundwater seepage present directly after a precipitation event. Furthermore, the **undulating topography** of the bedrock affects the continuity of the **shallow water flow dynamics** of the site.

The weathered gabbro bedrock was seen to host variable amounts of **pedogenic** materials in the form of calcification staining and calcrete nodules. These pedogenic materials are not predicted to have formed due to excessive amounts of infiltrating/perching of water but are likely amplified by the mineralogy of the rock and susceptibility of the mafic minerals to decomposition. Nonetheless, these pedogenic inclusions indicate the periodic occurrence of **fluctuating moisture conditions** after prolonged precipitation events.

The evidence for fluctuating moisture conditions was encountered within the **upper 1.0 meter** of the profile. This attribute will become a greater concern in the **lower-lying sections** of the roads- due to the predicted convergent shallow ground water through flow.

Good site drainage measures, on surface and subsurface, must be implemented to prevent moisture changes, which may add to the development of temporary perched groundwater tables. During construction and after development, shallow perched water systems may develop yet further due to stormwater management practices, localised infiltration and site modification practices**.**

Cuttings and installed services will cause soil density and texture changes which may lead to variations in soil moisture across the site with flow changes and build-up of moisture that may differ from the natural conditions.

Excavations may need to be dewatered following prolonged precipitation events- to be undertaken in line with the prescribed HSE protocols.

5.5. Bedrock Outcrops/Boulders

Other than minor exposures of weathered rock in erosional landforms, no notable outcrops were visible along the route of the road.

The surface of the route across both the developed and undeveloped portions of the site were seen to exhibit a particularly rocky surface- with the frequent occurrence of **surficial cobbles and boulders**. In general, the occurrence of boulders was seen to suddenly increase across the high-lying portions of the site, generally along the transition between developed and undeveloped land.

The rough terrain across the undeveloped areas is anticipated to result in significant mobility/access and excavatability issues across the site, specifically during the initial phases of construction.

Boulders ranged in size and shape. Surficial occurrences were inspected and photographed by the field team- examples of which are included in the photo series below. In large scale unrestricted cuttings, the impact of these features is reduced.

It is recommended that the exact location of the major anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the route of the access road can be partially adjusted on ground level to avoid major anomalies.

Boulders will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development.

Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.

5.6. Site Excavatability

Excavatability is a measure of material to be excavated/dug/mined with conventional excavation equipment such as a bulldozer with rippers, mechanical excavator, or other grading equipment. In rock masses, this characteristic is governed by the shear strength of both the intact rock and the discontinuities separating them. Fluctuating excavation conditions correlate to the depth, spacing and degree of fracturing of the underlying rock mass.

Profiles were described in trenches excavated by means of labourers digging by hand (pick-and-shovel method). End of hole conditions were due to either **refusal** or maximum reach at depths of between **0.88 and 1.22 m** below E.G.L.

The **terraced exposure** logged towards the start of the road (EXP1) was seen to extend to a depth of **~1.96 m below the natural ground level.** Based on the nature of this cutting it is predicted to have been excavated by means of light excavation methods (in this case a TLB)- exposing fractured weathered rock at the base. No fresh rock was exposed in the cutting (Appendix A).

As was seen in exposed ground profiles and local cuttings, the weathered bedrock typically hosts irregular pockets of more and less intact material. Based on the variable weathering profile exposed in the excavations and local cuttings- the weathered gabbro bedrock is anticipated to display an **undulating bedrock topography** which is characteristic of igneous rock masses/terrains. Cognisance should be taken of the fact that the depth to bedrock might vary between the trial pits.

Excluding EXP1, the average depth of excavation along the **entire length of road** was **0,99 m**. For this reason, the excavation type to an **average depth of 0.99 m** is deemed to be SOFT Excavation (SANS 10400G/ SANS1200D).

Due to the implemented mode of excavation, the excavatability properties of the less weathered gabbro bedrock at depth could not be determined. Excavations problems relating to shallow boulders and undulating bedrock can be expected in deep/bulk excavations.

It is anticipated that the fresh rock mass at depth will require **hard rock excavation** to unearth. Where deep cuts into the natural steep slopes are implemented to modify the surface of the site, the excavation properties of the gabbro rock mass need to be considered as discussed in section 4.6.2.

5.7. Engineering and Material Characteristics

5.7.1. Introduction and Sampling

The engineering material properties of the various sampled soil horizons were measured in laboratory conditions as per accredited testing procedures.

Standard foundation/road indicator, compaction tests and soil chemistry tests were conducted by Tzaneen Lab (**SANAS Accredited**) on disturbed and bulk soil samples. These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the proposed construction.

The sampling which took place during this investigation was based on both the in-situ geotechnical properties of the exposed soil horizons as well as the nature of the development (gravel road assessment).

This section focuses on the identification and assessment of the soil properties which will have an effect on the proposed **access road construction**. Where deemed necessary by the field team, mixed samples were created in order to measure the engineering material characteristics which can be expected following bulk site modification practises.

Full laboratory test results are included in **Appendix B**.

The sampling process **excluded** the following inclusions:

- Oversized particles
- Organic materials
- Anthropogenic contamination

5.7.2. Bulk and Disturbed Samples- Laboratory Test Results

The soil testing for the site can be subdivided into two categories, as follows:

- **Road Indictor Tests**

  Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage) and Particle-size Distribution

- **Compaction Tests**

  Maximum Dry Density versus Optimum Moisture Content and Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)

The results presented in the summaries to follow (Section 5.10) are as received from the accredited testing facility.

5.8. On-site Material Suitability Discussion

5.8.1. Introduction

Detailed annotated summaries are presented in the sections to follow (Section 5.10). The succession of materials encountered across the site each display their own variability- impacting the overall **continuity** of the expected material quality with regards to the planned construction.

5.8.2. TRH20/COTO- Unsealed Roads

The nomenclature to follow is used in the technical recommendations for the design, construction and maintenance of unsealed roads (TRH20).

Corrugations are one of the most disturbing functional defects of unsealed roads and cause significant roughness and poor vehicle directional stability. Corrugations consist of parallel pinnacles of sandy materials which form perpendicular to the flow of traffic.

Moreover, corrugations are typically characterized as loose of fixed depending on the degree of compaction of the crests/pinnacles. Loose corrugations are easily remediated by blading, whereas fixed corrugations may require cutting or even light ripping with a grader in order to spread the material. The wavelength of the corrugations is proportional to the speed of the traffic using the road.

Ravelling refers to the degradation of the road surface by the generation of loose gravel under traffic and represents a significant economic, safety and maintenance problem. The loose gravel may be distributed across the entire surface of the road or concentrated between wheel tracks forming dangerous zones of debris which frequently cause damage to vehicles.

Erosion can simply be described as the loss of surfacing material caused by the flow of water over the road. According to the TRH20, the ability of the material to resist/avoid erosion depends on the shear strength of the material which is equal to the cohesion of the material as no normal stress is applied to the blanketing materials across the surface of the road. If the attractive force of the water is greater than the shear strength of the material than erosion will occur.

Fine, poorly graded material with limited coarse particles (grading coefficient less than 16) are highly susceptible to erosion. Erosion results in the formation of run off channels-sometimes referred to as runnels- which may form across the surface of the road resulting in an extremely rough surface along the footprint of the road resulting in the formation of deep ruts.

Slipperiness is caused by the migration of plastic/clayey materials to the surface of the road under the impact of rain or tires of vehicles. A road with sufficient coarse fraction may become slippery if fine clay/silt become concentrated on the surface of the unsealed road. The saturated clay/fine materials on the surface of the road may have a similar effect to aquaplaning on sealed roads. In dry weather conditions, a roadway may become slippery if there is an accumulation of fine particles on the road reducing the skid-resistance of the surface.

5.8.3. On-site Material Classification

Caution should be taken in the **zones of poor-quality material** (i.e., organic rich materials), with allowance for adequate site supervision and ongoing quality control testing during the construction phase. Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.

From the USCS classification of the on-site materials (SC, GC and GP) these materials are inferred to be **reasonably stable embankment material**.

Where deep/bulk excavations are undertaken across the site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction. This material is anticipated to serves as good material for the use in engineered fills.

Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction

Colluvium- Gravel Road (TP1)

Where sampled along the **existing gravel road**, the blanketing **colluvium** displayed a **FAIR quality (G7) quality** with regards to the planned road construction (COLTO 1998). According to COLTO 1998- the colluvium is suitable for the use in **selected layers (G7/G8)** in the planned road construction.

Furthermore, the **colluvium** exhibits a measured **CBR value of 17 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the colluvium falls within subgrade class **SG1-** with adequate CBR values at 93% (>15) to be deemed suitable subgrade material for flexible pavements.

The intrinsic variability of the colluvium, reworked nature in developed areas and its organic-rich nature in undeveloped areas should be addressed during the design of the planned road structure- with allowance for adequate site supervision and ongoing quality control testing during the construction phase of the development.

Weathered Gabbro Bedrock (TP3 and TP5)

In test pits TP3 and TP5, clean samples of the weathered rock mass were extracted and tested. In these test pits, the underlying weathered protolith displayed a **POOR quality (<G9) quality** with regards to the planned road construction (COLTO 1998). According to COLTO 1998- the sampled weathered rock is suitable for the use in **subgrade layers (G9/<G9)** in the road construction.

Furthermore, the **weathered gabbro** exhibits **measured CBR values** ranging from **7 to 11 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the sampled materials fall within subgrade class **SG2** and may therefore not be adequate subgrade material for flexible pavements due its CBR at 93% not **exceeding 15.**

Although the quality of the material was measured to be poor with elevated PI values and fair to poor compaction characteristics, there is predicted to be an **increase in quality and overall continuity with an increase in depth** along with a reduction in protolith decomposition.

Mixed Samples- Colluvium and Gabbro Bedrock (EXP1, TP2 and TP4)

Across the remaining portions of the site, the exposed colluvium and underlying weathered bedrock were mixed to measure the engineering material characteristics which can be expected following bulk site modification practises.

The resultant mixes displayed a **POOR quality (<G9) quality** with regards to the planned road construction (COLTO 1998). According to COLTO 1998- the sampled weathered rock is suitable for the use in **subgrade layers (G9/<G9)** in the road construction.

Furthermore, the **mixed samples** exhibit **measured CBR values** ranging from **10 to 19 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the sampled materials fall within subgrade class **SG2** and may therefore not be adequate subgrade material for flexible pavements due its CBR at 93% not consistently **exceeding 15.**

Performance as Gravel Wearing Course (TRH20)

According to the **TRH20**, the **colluvium** classifies as **Class A** (erodible), the **weathered bedrock** classifies as **Class E** (good) and the **mixed samples** classify as **Class E** (good) and **Class A** (erodible) in terms of **performance as a gravel wearing course**.

Erosion (Class A) can be reduced by elevating the shear strength of the material by increasing its compaction and ensuring a well-graded mixture of material resulting in increased particle interlock- increasing suction forces within the material and decreased permeability. Similarly, the energy of the water can be decreased by retarding the rate of flow using good drainage measures and adjusting camber angles of the road. Erosion may cause the changes in the properties of the material as certain fractions are removed.

5.9. DCP Testing- Centerline Investigation

A total of **SIX (6)** Dynamic Cone Penetrometer (DCP) tests were performed across the site so as to give an indication of the consistency of the in-situ material.

DCP test results are presented in the graphics to follow (Section 5.10)- with full detailed results included in **Appendix C.**

In the design of roads, the DCP is a practical test used for onsite measuring of road material strength. The test results can be correlated with the California Bearing Ratio (CBR) by applying a formula; results of which can be correlated to the laboratory tests conducted on the soils from the same location.

DCP tests were performed at **natural moisture conditions** and thus the values vary greatly from the CBR results measured under controlled conditions within the laboratory. This variation is mainly due to the lab specimens being analysed under saturated conditions. It should be noted that the strength of the in-situ soil changes greatly with change in moisture conditions.

Fluctuations of the in-situ moisture content within the exposed soil horizons may have had a detrimental effect on the accuracy of the DCP results. DCP test should therefore only be used as indicative statistics for the site.

Summarised DCP results discussion

With reference to the CBR readings with depth (graphic in Section 5.10):

- The DCP tests conducted across the site displayed a **variable penetration resistance with depth** and associated in-situ consistency.
- All DCP tests conducted across the site refused at depths of between **135 and 974 mm** with average penetration depth across the proposed footprint of **568 mm**.
- DCP test **DCP1 and DCP3** both reached **maximum reach** at depths of between **970 and 974 mm** below the E.G.L.
- Based on the average depth of penetration, the DCP probe managed to penetrate the colluvial sediments and upper extent of the weathered rock.
- Where encountered, refusal was typically encountered along the transition zone into less weathered rock at depth.
- As seen in the various annotated graphics, the in-situ CBR values inferred for the entire soil profile were notably high- in fact, considerably higher than that of the attributes measured in saturated conditions in the lab.
- From these excessive values it is clear that the accuracy of the DCP probe has been negatively affected by the granular nature and low in-situ moisture content of the subsoils. The presence of sand/ gravel and/or cobble sized rock fragments, in conjunction with fluctuations of the in-situ moisture content within the exposed soil horizons may have had a detrimental effect on the accuracy of the DCP results.
- Once the area has been rehabilitated and final starting levels have been created on site- DCP testing can be conducted at regular intervals in order to determine the in-situ CBR of the road bed at any given point/location.

5.10. Combined Geotechnical Summaries

GeoCalibre has compiled a simplified site summary, including laboratory and DCP test results in order to guide the design phase of the development.

The purpose of this summary is to eliminate data complexity, for this reason, extensive/in-depth soil profile discussions have been omitted from this exercise.

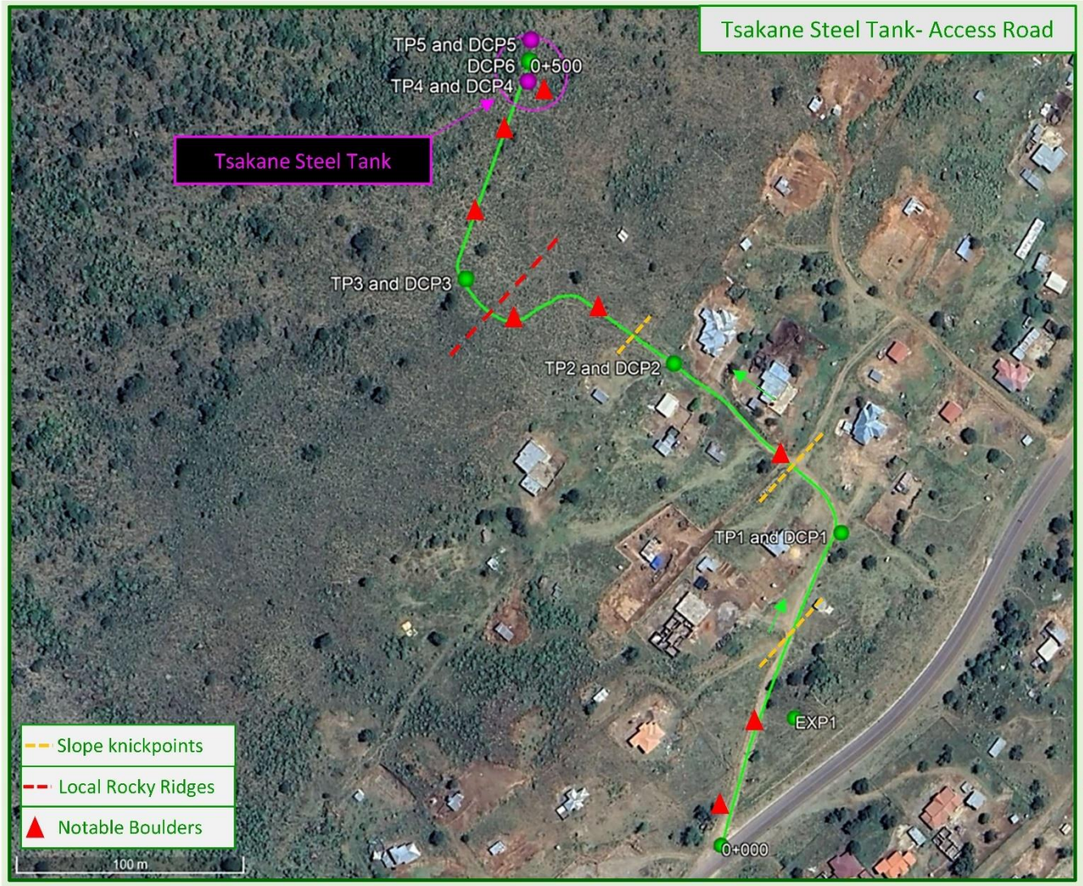
Major geotechnical attributes are highlighted and listed where applicable.

The follow legend guides the understanding of the tables/graphics to follow:

- Discussions points presented in the summaries are based on the information presented by the field team (observations and photography), available remote sensing information and the cumulative results of the study.
- All depths displayed in **meters** (m).
- Thickness refers to the **exposed thickness** of the soil horizon (meters).
- The field observations annotated on the graphics serve as an indication.
- Horizon depths displayed in the tables are **average measured values**.

- Excavation conditions:
  - **ES-** Excavation **stopped**.
  - **DE-** Difficult Excavation
  - **R- Refusal**.
- Material codes used in the summary:
  - **C-** Colluvium
  - **WGB-** Weathered Gabbro Bedrock
- Presented chainages are inferred from the available remote sensing information- adjustments can be made where required.
- CBR graphs make use of the **combined materials sampled** across the access road in question- irrespective of depth.
- Oversized particles: **Cobbles** refer to particles with an average diameter of between 0.06 - 0.20 m; particles larger than this are deemed to be boulders.
- The provided **cross sections** serve as a practical **graphical depiction** of the various layers underlying the various roads. These graphics are <u>not</u> to scale.
- Lab results are presented as received from **Tzaneen Lab.** Although the summaries have been annotated- no amendments have been made to the results themselves.

The combined graphics to follow depict the **summarised findings** from the **fieldwork** and **laboratory testing phases** of the investigation.





Summarized Discussion

- Upgrading/ construction of a gravel road- with a length of approximately **500 m**- set to form its primary access route during construction and subsequent stages.
- The planned starting point (0+000) central extent of the village- at the intersection between the existing gravel road in question and the D1392.
- At ~0+170, the existing road makes a 90 degree turn to the north west- following this bearing to ~0+300- traversing developed land. From ~0+300, the existing gravel road ends. Following this transition, the access road meanders its way up the very steep sloping flanks of a major ridge, on-route to the reservoir location to the north.
- Developed areas- road confined by residential property boundaries and services. Limited movement of large equipment. Across these areas, the anthropogenic reworking of the surface will result in local variations of surface water flow.
- The surface of the route across both the developed and undeveloped portions of the site were seen to exhibit a particularly rocky surface.
- The occurrence of boulders was seen to suddenly increase across the high-lying portions of the site. Boulders ranged in size and shape.
- The roads orientation in relation to the natural slopes will impact the rate and associated energy of the overland flow.
- Emphasis should be placed on surface drainage and storm water control measures across the developments footprint in order to avoid instabilities, focused infiltration, surface water ponding and erosion/ structural undercutting.
- Addressing the concerns surrounding the convergence of surface water upon the future road is key to the stability and longevity of the development as a whole.
- Vast extents of the access road exhibit a steep sloping nature, generally orientated approximately parallel/obtuse to the regional natural slopes. Increased overland flow/energy. High energy channelized flow and converging surface water flow elevates the risk for erosion and associated scouring/undercutting.
- Across the developed areas erosional landforms were prolific along the existing gravel road- as evidence for the elevated risk of erosion in the local setting following the modification of the surface and associated removal of natural vegetation.
- Varying degrees of cut-to-fill site preparation expected across the site. Slope, boulders and undulating bedrock topography anticipated to significantly hamper excavatability especially during cut-to-fill site preparation.
- The undulating topography of the bedrock affects the continuity of the shallow water flow dynamics of the site. Water is predicted to flow/perch along the weathered bedrock-soil interface.
- Road seen to host poor quality materials with regards to road construction.

Summarized Ground Profile:

- **Anthropogenic Materials/Reworking**: The stretch of gravel road across the developed areas was seen to be blanketed by a combination of imported and reworked natural materials which have been modified to serve as the existing gravel wearing course. The thickness of these imported/reworked materials was seen to fluctuate sporadically across the investigated road; with the road NOT exhibiting a controlled uniform good quality imported horizon.
- **Colluvium**: various transported sediments were seen to display variances in composition along the length of the road attributed to the fluctuating geomorphological environment in which they were deposited.
  - Along the existing gravel road, the upper extent of the transported sediments was generally modified/contaminated. Across the undeveloped portions of the site, blanketing unaltered gravity transported material display an overall granular nature with a large range in particles sizes varying from sand to boulders.
  - Colluvium is present from surface and extends to depths of between **0.16 and 0.56 m** below the E.G.L.- displaying an **average exposed thickness of 0.34 m.**
  - **Fair** quality material in TP1- expected to be variable across the footprint.
  - Heterogeneous/organic-rich nature may pose a risk to the planned construction.
- **Varying Grades of Weathered Gabbro:** The blanketing sediments along the route were generally underlain by weathered gabbro bedrock.
  - Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and rock mass continuity.
  - Profiled as: **coarse grained; closely jointed; completely/highly weathered; generally soft rock; Gabbro** (Dsjate Subsuite).
  - The varying grades of weathered bedrock were encountered from below the blanketing colluvium, extending to depths of between **0.88 and 1.96 m** below the E.G.L.- displaying an exposed **average thickness of 0.73 m.**
  - Measured **poor quality**. Variability due to variable profile.
  - Localised excavation problems due to undulating topography and boulders.
- Final excavation depths range between **0,88** and **1,22 m** below the ground level- EXP1 to a depth of 1,96 m. **Average excavation depth in test pits 0,99m.**

Summarised Ground Profile- Tsakane Steel Tank- 250kl

Area	Chainage	Test Pit	Colluvium			Weathered Gabbro Bedrock			Excavation Character		
			From	To	Thickness (m)	From	To	Thickness (m)	Test pit depth (m)	Termination Conditions	Termination Material
Access Road	0+060	EXP1	0.00	0.20	0.20	0.20	1.96	1.26		-	WGB
	0+160	TP1	0.00	0.28	0.28	0.28	0.90	0.62	0.90	ES	WGB
	0+280	TP2	0.00	0.30	0.30	0.30	1.00	0.70	1.00	ES	WGB
	0+400	TP3	0.00	0.52	0.52	0.52	1.22	0.70	1.22	ES	WGB
Reservoir Location	0+480	TP4	0.00	0.56	0.56	0.56	0.88	0.32	0.88	R	WGB
	0+500	TP5	0.00	0.16	0.16	0.16	0.94	0.78	0.94	R	WGB
Data Summary			**Minimum**		0.16	0.16	0.88	0.32	0.88		
			Max		0.56	0.56	1.96	1.26	1.22		
			Average		**0.34**	**0.34**	**1.15**	**0.73**	**0.99**		

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Road Description

Mampuru Bulk Water Scheme

Tsakane Steel Tank- 250 kl

Access Road

Test Pits EXP1 to TP5

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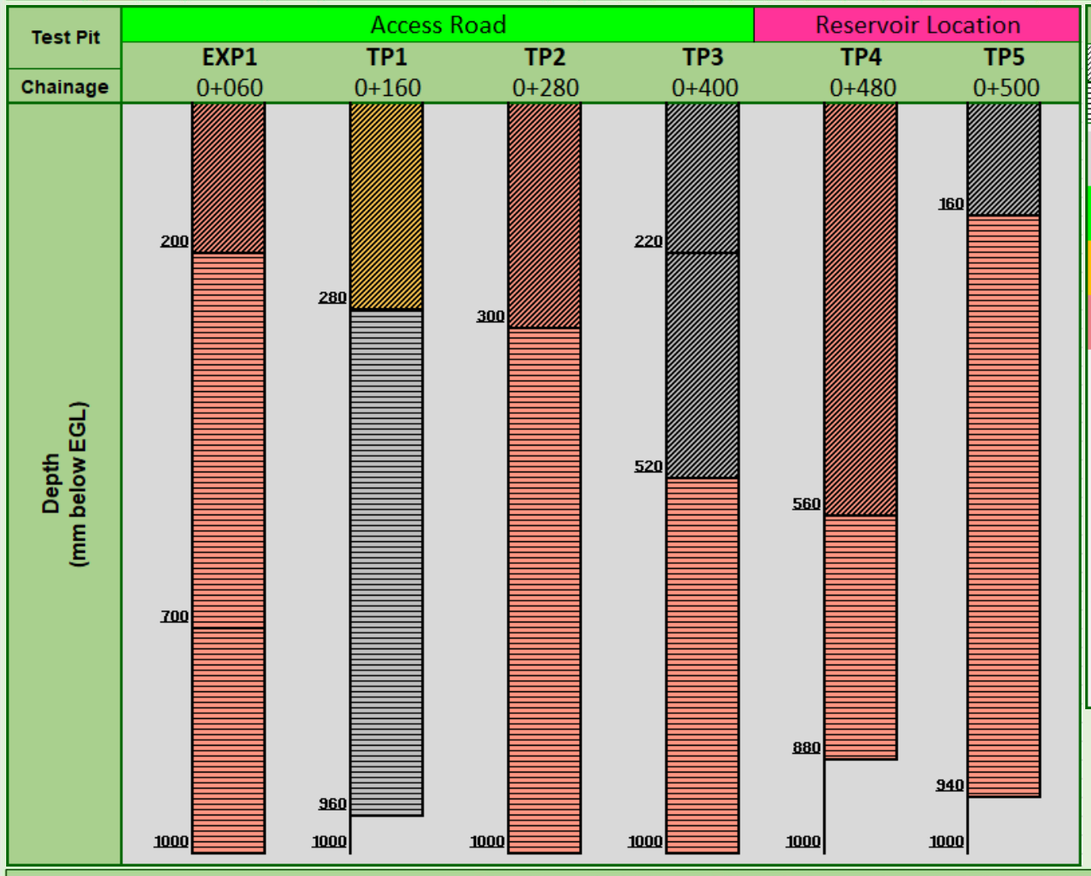
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Combined Laboratory Test Results Summary

Sample Description						Particle Size Distribution										Dispersivity Indicator	Atterberg Limits			Compaction Test Results Mod AASHTO Method				Material Classification			Performance as Gravel Wearing Course		
						Sieve Analysis (Cumulative Percentage Passing)											Atterberg Limits			Mod AASHTO		Interpreted CBR Values								
Sample No.	Area	Test Pit	Sample Depth (m)	Chainage	Material	50.0	37.5	28.0	20.0	14.0	5.0	2.0	0.425	0.075	GM	Double Hydrometer Results (%)	LL	PI	LS	MDD (Kg/m³)	OMC (%)	100%	95%	93%	COLTO CLASS.	US Highway	Unified Soil Classification	Grading Coefficient (Gc)	Shrinkage Product (Sp)	TRH20 Classification
T03344/1	Access Road	EXP1	0,00-1,96	0+060	Mixed: Colluvium/Weathered Gabbro Bedrock	99	78	71	68	62	53	36	18	13	2.3	-	41	17	8.2	2086	10.7	24	13	10	<G9	A-2-7	GC	19	148	Class E Good
T03344/2		TP1	0,00-0,28	0+160	Colluvium	93	84	74	61	49	31	28	22	16	2.3	-	39	16	7.8	2143	7.7	44	22	17	G7	A-2-6	GC	14	170	Class A Erodible
T03344/3		TP2	0,00-1,00	0+280	Mixed: Colluvium/Weathered Gabbro Bedrock	-	98	94	90	85	68	49	27	19.4	2.1	-	42	18	8.6	2101	10.4	42	17	12	<G9	A-2-7	SC	31	229	Class E Good
T03344/4		TP3	0,52-1,22	0+400	Weathered Gabbro Bedrock	-	93	90	88	82	57	40	29	20	2.1	-	44	24	11.5	2074	9.7	20	10	7	<G9	A-2-7	SC	29	332	Class E Good
T03344/5	Reservoir Location	TP4	0,00-0,88	0+480	Mixed: Colluvium/ Weathered Gabbro Bedrock	97	69	66	61	57	37	24	16	12	2.5	-	44	21	10.0	2123	8.8	46	25	19	<G9	A-2-7	GP-GC	16	163	Class A Erodible
T03344/6		TP5	0,16-0,94	0+500	Weathered Gabbro Bedrock	-	78	72	67	57	38	25	16	12	2.5	22.0	48	23	10.8	2135	9.6	27	14	11	<G9	A-2-7	GP-GC	18	169	Class E Good



Graphic Legend

- Coarse Colluvium
- Weathered Gabbro Bedrock
- Not Sampled
- G5/G6- type Material — Suitable for use in Subbase Layers
- G7-G8- type Material — Suitable for use in Selected Layers
- G9/<G9- type Material — Suitable for use in Subgrade Layers

The presented lab results are in accordance with those provided by Tzaneen Lab

The material types are extrapolated from the presented soil profiles.

The soil profile results are presented up to a depth of 1 m below the existing wearing course.

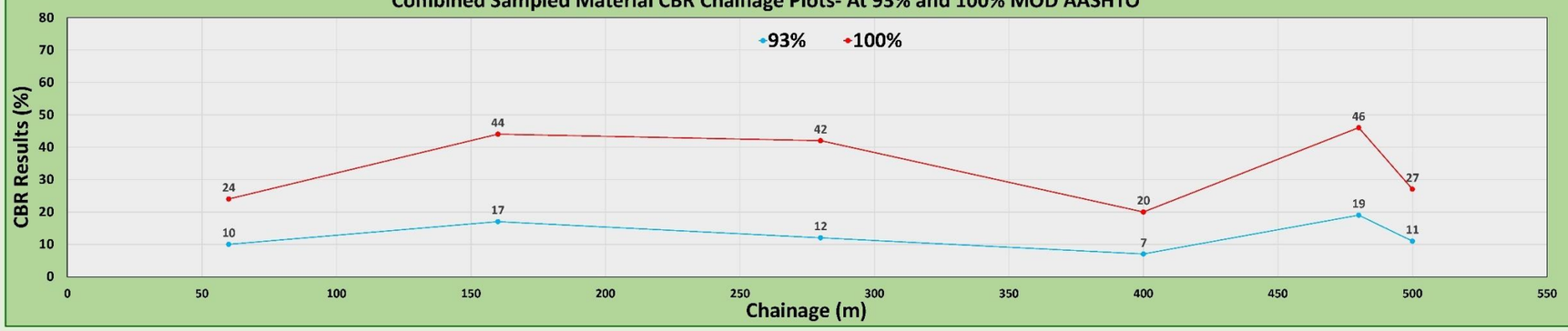
The material quality as presented is in accordance with the COLTO Classification System (1998).

The graphics are not to scale

Summarized Test Results

- The on-site materials classify as **Class A** (erodible) and **Class E** (good) performance as gravel wearing course (TRH20)
- Where sampled along the existing gravel road, the blanketing **colluvium** displayed a **FAIR quality** (G7) quality with regards to the planned road construction (COLTO 1998). According to the South African Pavement Manual, the colluvium falls within **subgrade class SG1-** with adequate CBR values at 93% (>15) to be deemed suitable subgrade material for flexible pavements.
- The **intrinsic variability** of the colluvium, reworked nature in developed areas and its organic-rich nature in undeveloped areas should be addressed during the design of the planned road structure.
- The underlying **weathered protolith** displayed a **POOR quality (<G9)** (COLTO 1998). According to the South African Pavement Manual, the sampled materials fall within subgrade class **SG2** and may therefore not be adequate subgrade material for flexible pavements due its CBR at 93% not exceeding 15.
- Although the quality of the weathered bedrock was measured to be poor with elevated PI values and fair to poor compaction characteristics, there is predicted to be an increase in quality and overall continuity with an increase in depth along with a reduction in protolith decomposition.

Combined Sampled Material CBR Chainage Plots- At 93% and 100% MOD AASHTO



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Laboratory Summary

Mampuru Bulk Water Scheme

Tsakane Steel Tank- 250 kl

Access Road

Test Pits EXP1 to TP5

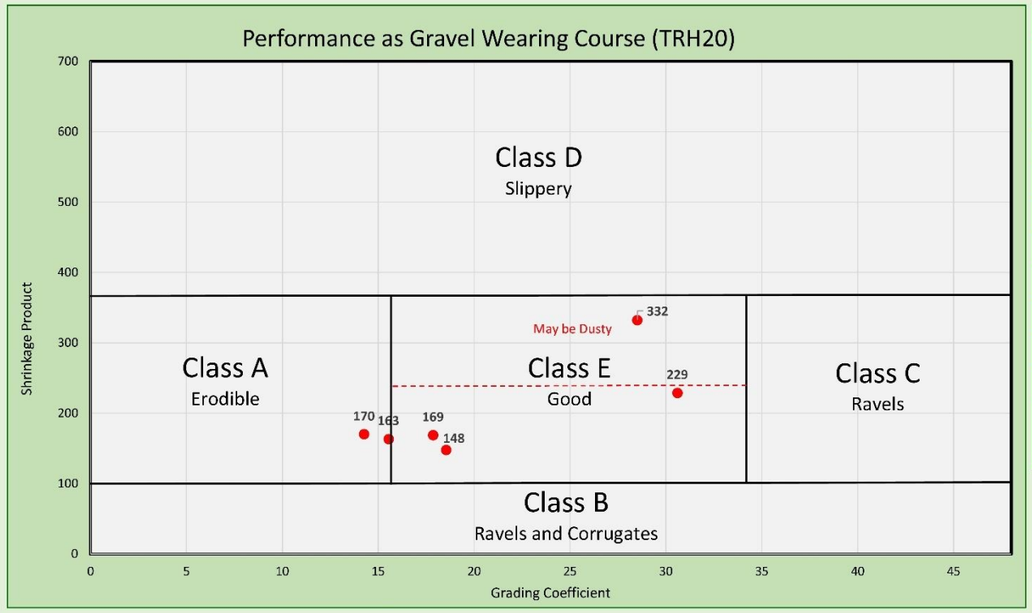
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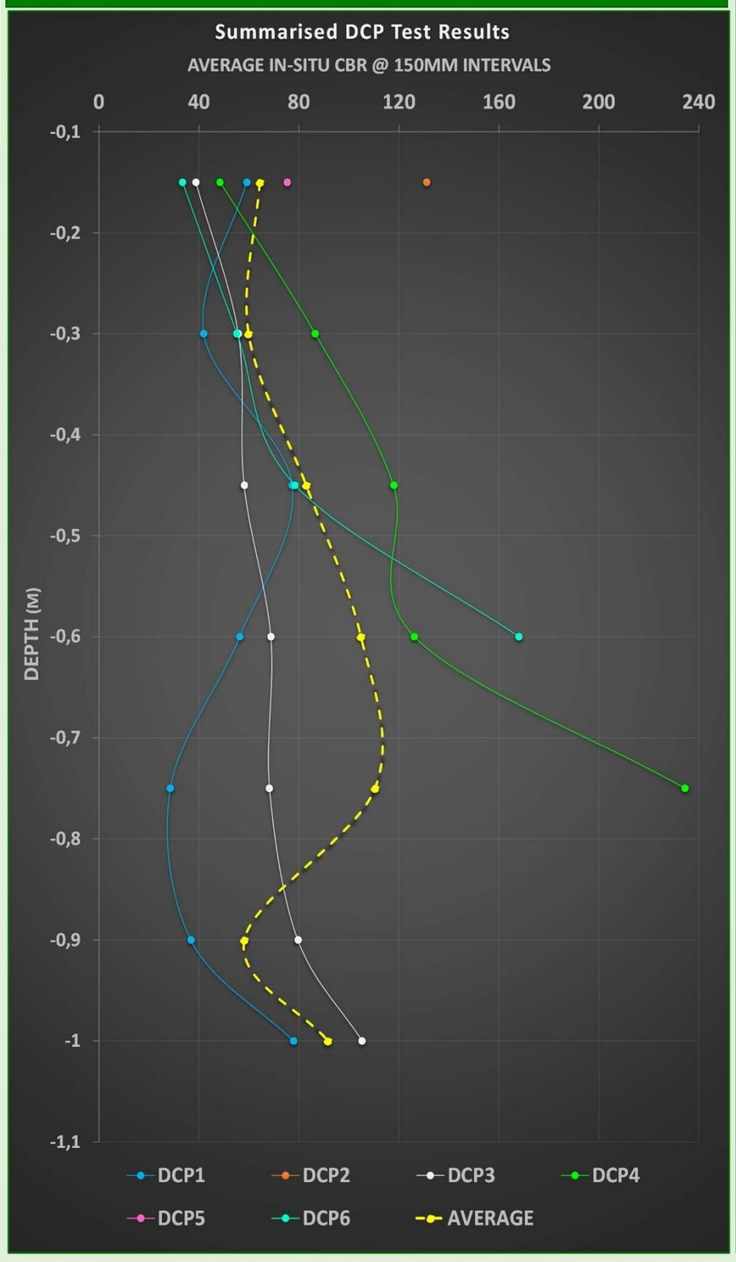
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Summarised DCP Test Results

Depth (m)	Average In-Situ **CBR** Values						AVERAGE
	Access Road				Reservoir Location		
	DCP1 0+160	DCP2 0+280	DCP3 0+390	DCP4 0+400	DCP5 0+480	DCP6 0+500	
0.00	-	-	-	-	-	-	-
-0.15	59	131	39	49	75	33	64
-0.30	42	Refusal	56	87	Refusal	55	60
-0.45	77	-	58	118	-	78	83
-0.60	56	-	69	126	-	168	105
-0.75	29	-	68	235	-	Refusal	110
-0.90	37	-	80	Refusal	-	-	58
-1.00	78	-	105	-	-	-	92
Termination Depth (mm)	974	135	970	638	133	556	568



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Gravel Wearing Coarse

Mampuru Bulk Water Scheme

Tsakane Steel Tank- 250 kl

Access Road

DCP Tests DCP1 to DCP6

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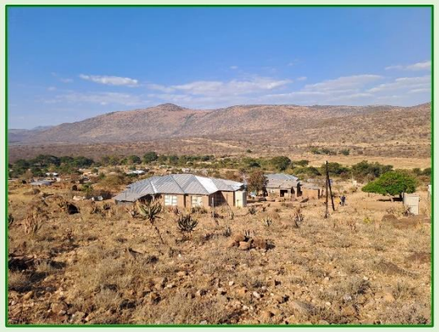
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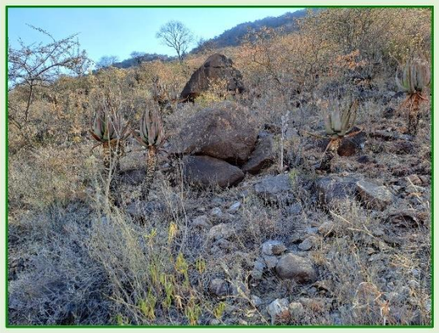


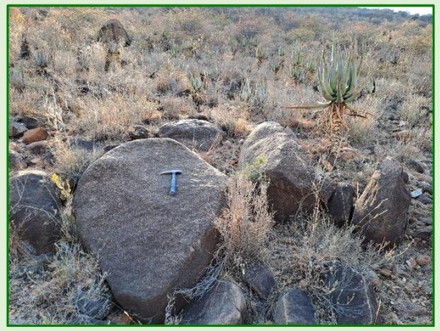









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Photographs

Mampuru Bulk Water Scheme

Tsakane Steel Tank- 250 kl

Access Road

Test Pits EXP1 to TP5

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5.11. Design Considerations- Access Road

The diverse geotechnical attributes of the site have been discussed at length in the preceding sections of this report. There are geotechnical attributes of the site which are not ideally suited for the planned development (delineated in this report)- for this reason, **engineering solutions** will be required to ensure the stability and longevity of the development.

The following considerations and generally accepted standards of practise should be contemplated during the design and construction of the planned new access road:

- All future actions across the site should be aligned with the most recent applicable standards of practise/technical specification documents of South Africa (SANS, TRH, TMH, COLTO/COTO and SAPEM).
- Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand along the route of the planned access road structure.
    - Access to- and terrain mobility across- the site will need to be modified in the early stages of the development, the extent of which should be sufficient to allow for long term access to ensure smooth daily operations, ongoing maintenance and possible future upgrades.
    - Once access/mobility has been modified follow-up studies can be conducted, where required.
- The initial stretch of the access road traverses the central portion of the village and associated developed land (varying degrees).
    - In these areas, the footprint of the road structure was seen to fluctuate, confined by residential property boundaries in its central extent, prior to the transition into the undeveloped land to the north west.
    - Human activities/processes in these areas have resulted in the reworking of the natural surface- with the frequent occurrence of anthropogenic anomalies- including varying degrees of fill materials, structures etc.
    - The exact extent of the surface and subsurface infrastructure in this region is not known.
    - The natural vegetation was denuded across the developed portions of the site, with the cover in these areas limited to a sparse grass and scattered small trees. Roots and biotic activity can be expected when extending the existing gravel road into its vegetated flanks.
- Across the undeveloped portions, the natural vegetation was considerably more prolific, comprised of a continuous grass cover with intermittent shrubs, xerophytes and isolated small trees scattered between the rocky surface.
    - The natural vegetation cover protects the slope from erosion (run-off and rain splash) and serves as an anchoring mechanism to reduce the possibility of shallow seated instabilities. The effects of the removal of trees on sites should also be considered.

- Developments of this nature typically include the rehabilitation/remoulding of the site's surface including major cut-to-fill site preparation in order to create the prescribed working levels as well as the construction of the associated infrastructure including basic drainage measures.
- As a results of the sites complex topography and geographic location, the design and implementation of fit-for-purpose site modification and drainage measures are essential for the stability and longevity of the development.
- As a result of the roads shape in relation to the very steep natural slopes, site modification practises are required. Where cuts/thick embankment fills are implemented to modify the sites surface, cut/fill embankments will need to be adequately sloped, modified or stabilised- and vegetated where possible- to ensure long-term stability in saturated conditions.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the roads' flank.
- Importance should be placed on drainage/storm water control measures to avoid instabilities, focused infiltration, surface water ponding and erosion.
- Future anthropogenic attributes will influence natural infiltration, shallow throughflow and run-off rates.
- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the road cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability.
- Inadequate temporary erosion and drainage control measures can result in severe damage to infrastructure.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.
- A maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.
- Areas subjected to extensive fills need to be adequately modified/ compacted to limit soil movement over time (i.e., fill creep).
    - Where implemented, it is essential that backfilled materials are of sufficient quality and compacted in controlled layers (material quality/required density as per engineers' design).
    - Ensure the removal of topsoil within the footprint of planned fill areas.
    - A carefully engineered fill embankment should not settle more than 0.5% of its height due to self-weight.
    - Engineered fill slopes should be over constructed and thereafter trimmed back to the required position.
    - Cut and fill heights greater than 2 metres should be inspected and approved by a competent person.

- The surface of the route across both the developed and undeveloped portions of the site were seen to exhibit a particularly rocky surface- with the frequent occurrence of surficial cobbles and boulders. In general, the occurrence of boulders was seen to suddenly increase across the high-lying portions of the site, generally along the transition between developed and undeveloped land.
    - The rough terrain across the undeveloped areas is anticipated to result in significant mobility/access and excavatability issues across the site, specifically during the initial phases of construction. In large scale unrestricted cuttings, the impact of these features is reduced.
    - It is recommended that the exact location of the major anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the route of the access road can be partially adjusted on ground level to avoid major anomalies.
    - Boulders will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development.
    - Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.
- A key flexible pavement design principle is that the subgrade provides an adequate foundation. A minimum CBR of 15% (G7-type compaction) is generally required for flexible pavements (SAPEM, 2014).
- Special attention must be given to the selection of the correct material to be used for the fill material and the general backfill in the construction of pavement layers/gravel wearing course.
    - The exposed colluvium and underlying weathered bedrock were mixed to measure the engineering material characteristics which can be expected following bulk site modification practises. The resultant mixes displayed a POOR quality (<G9) quality with regards to the planned road construction (COLTO 1998).
    - Furthermore, the mixed samples exhibit measured CBR values ranging from 10 to 19 at 93% Mod AASHTO density. According to the South African Pavement Manual, the sampled materials fall within subgrade class SG2 and may therefore not be adequate subgrade material for flexible pavements due its CBR at 93% not consistently exceeding 15.
    - According to the TRH20, the colluvium classifies as Class A (erodible), the weathered bedrock classifies as Class E (good) and the mixed samples classify as Class E (good) and Class A (erodible) in terms of performance as a gravel wearing course.
    - From the USCS of the on-site materials (SC, GC and GP) these materials are inferred to be reasonably stable embankment material.
    - Caution should be taken in the zones of poor-quality material (i.e., organic rich materials), with allowance for adequate site supervision and ongoing quality control testing during the construction phase.
    - Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers.

- All earthworks should be carried out in a manner to promote stable development of the site.
    - It is recommended that earthworks be carried out along the guidelines given in SABS 1200/SANS 10400 (current version).
    - Placement of fill layers should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve 93% Modified AASHTO maximum dry density at ±2% optimum moisture content.
    - Density control of placed fill material should be undertaken at regular intervals during fill construction.
- All bulk excavations should be inspected by a competent person (engineer or geo-professional with relevant training and experience) at least once a day and following any periods of rain or any long periods where no work has taken place.
- With reference to the exposed soil profiles and accompanying lab results, the materials exposed across the site were seen to display a variable composition and in-situ geotechnical nature.
    - With this said, an adequate quality control system should be implemented during the construction phase of the development to ensure that pockets of poorer quality soils be removed/treated.
    - Ongoing laboratory testing can be conducted by an accredited laboratory during the construction phase of the development.

6. Report Provisions

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The investigation was conducted according to the accepted proposal and the scope of works and literature references provided in this document. Field work and reporting were conducted and/ or overseen by professionally registered scientists with the South African Council for Natural Scientific Professions. Furthermore, GeoCalibre has have employed accepted engineering geologic procedures, and our opinions and conclusions are made in accordance with generally accepted principles and practices in engineering geology.

The presented geotechnical model is based on a data base of available information and available on-site exposures. Parcels of land within the developmental area which are free of excavations are modelled using on-site observations and surrounding exposures. While every effort is made during the fieldwork phase to identify the different soil horizons, areas subject to a perched water table, areas of poor drainage, areas underlain by hard rock and to estimate their distribution, it is impossible to guarantee that variations are excluded over the extent of the site which are the subject of this report.

Variable founding conditions and materials are expected to be encountered. This variability includes soils of different age, composition and associated pre-consolidation pressures. In view of the variability inherent in natural materials, a competent person must inspect all foundation excavations at the time of construction to ensure that the materials are adequate for the proposed structure and that they are in accordance with the recommendations stated in this report.

The design and implementation of the planned engineering fills remains the responsibility of the consulting engineers/competent person- with GeoCalibre and its' employees carrying no liability in this regard. The placement of engineered fill must be controlled with suitable field tests to ensure that the required densities are achieved during compaction, and that the quality of the fill material is within specification to ensure the longevity of the development.

The determination of flood lines and delineation of wetland areas were not part of this investigation scope and should be addressed by suitably competent professionals prior to the final site development plan is compiled, if deemed necessary. If the site or a portion thereof is situated within the 1:100-year flood line, or has been delineated as a wetland, it is the prerogative of the Civil Engineer or other suitably experienced specialist to overwrite the recommendations for such portions.

Although not anticipated at this site, it should be noted that this investigation did not include the assessment of any potential environmental hazards, or groundwater impacts that may be present, or ensue from the construction of the proposed structures.

GeoCalibre is open to ongoing discussions with all the parties involved in order to elaborate on the methodology implemented during this assessment and its associated findings/ground models.

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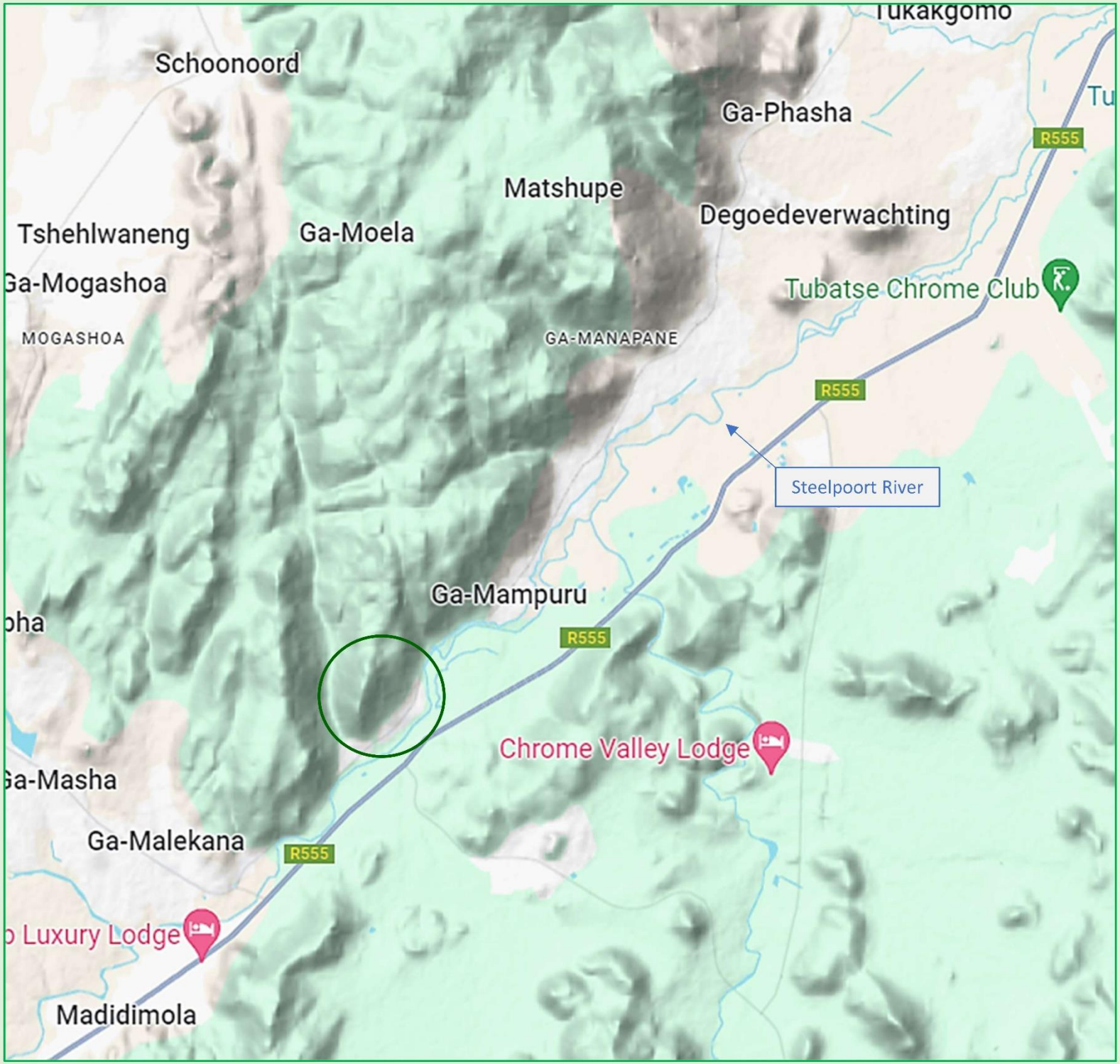
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Layout Maps



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Figure 1

Study Area Location

LEGEND

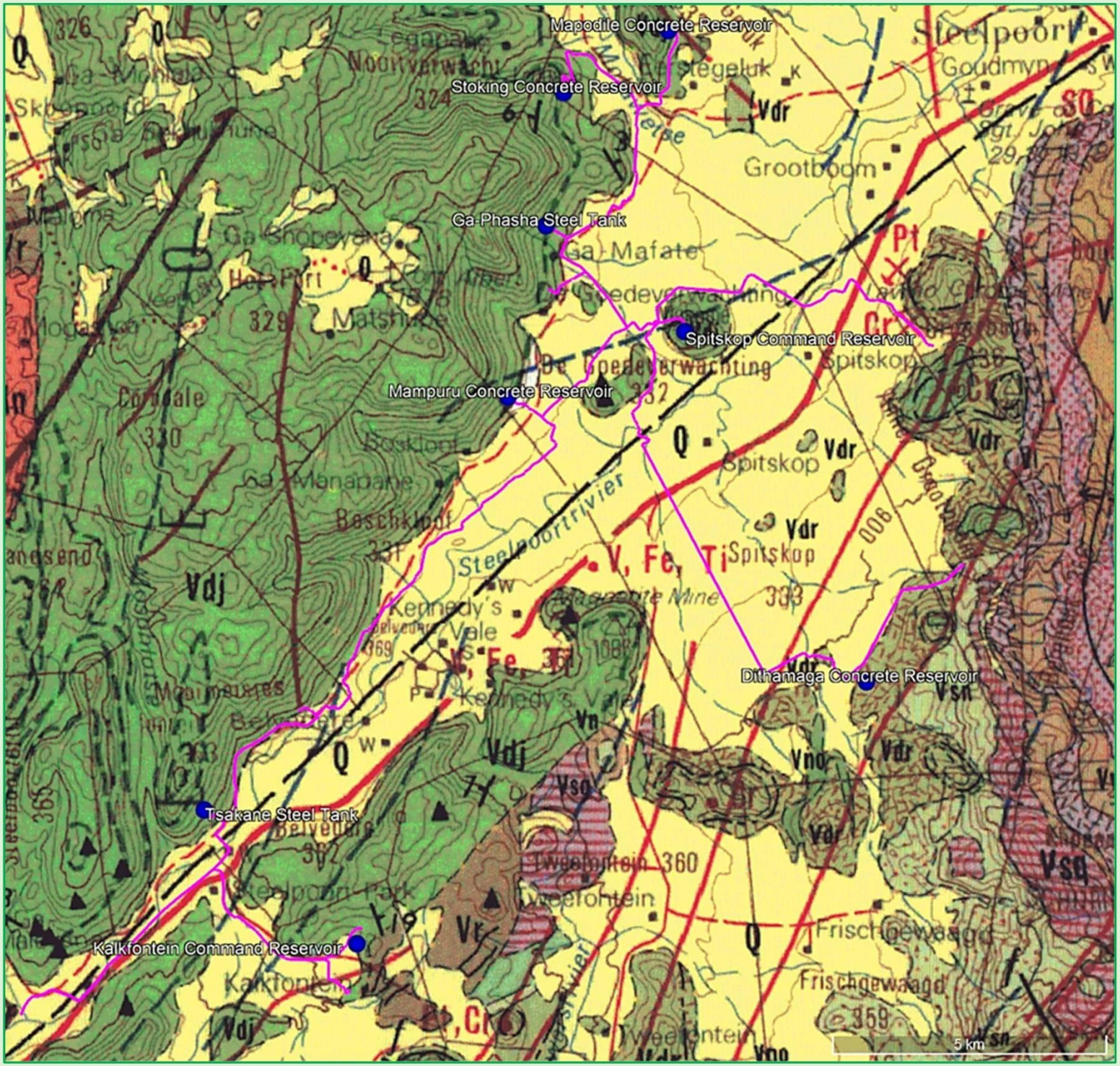
Study Area

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Figure 2A

Regional Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.
- Vdr — Medium to coarse-grained norite and anorthosite (upper part)-***Dwars River Subsuite***
- Vsq — Fine to medium-grained quartzite, purple sandstone and shale with quartz clasts and thin conglomerate layers- ***Steenkampsberg Formation*** of the Pretoria Group

Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

N

GeoCalibre Geotechnical Consultancy (PTY) LTD

Kevin Coertzen
Pri.Sci.Nat and MSAIEG

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Nelspruit
1200



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Figure 2B

Tsakane Steel Tank- Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.

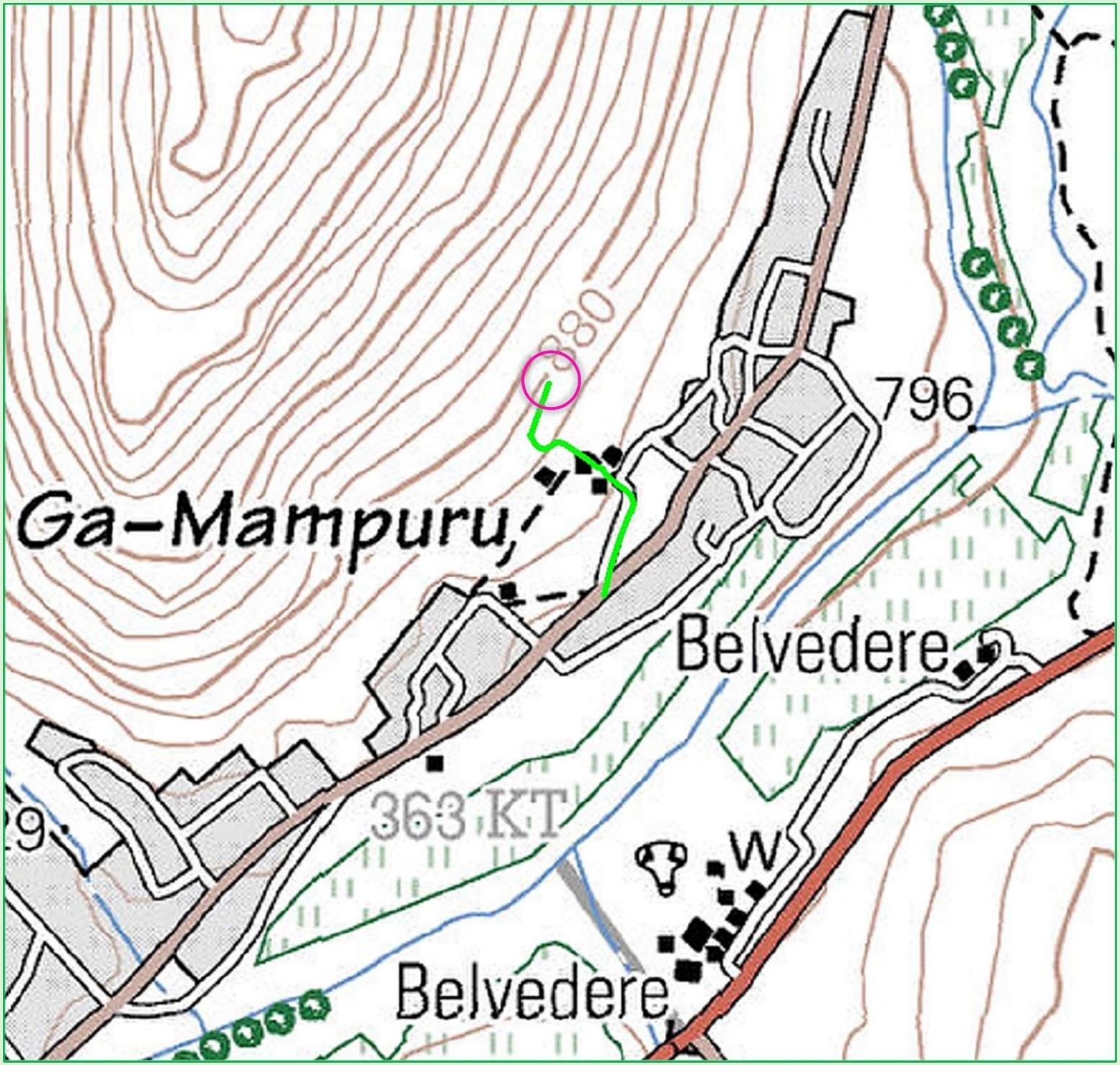
Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

N

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Figure 3

Topocadastral Map- Tsakane Steel Tank

LEGEND

Planned Access Road

Reservoir Site

Topocadastral Maps:
2430 Cc; Scale 1 : 50 000

N

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Figure 4

Site Location- Aerial View

LEGEND

Reservoir Location

N

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Figure 5A

Testing Locations- Access Road

LEGEND

- Test Pit and DCP
- Access Road
- Reservoir Location Received from Client

N

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Figure 5B

Testing Locations- Planned Reservoir

LEGEND

- Test Pit and DCP
- Access Road
- Planned Reservoir
- Arbitrary Boundary R= ~15 m

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Testing Locations

GC-24-144B

Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

Test Pit Locations

Test Pit Number	Chainage	Location		Elevation (meters above mean sea level)	Final Excavation Depth by Hand (m)
		Latitude (South)	Longitude (East)		
EXP1	0+060	24.864345	30.043569	831	1,96
TP1	0+160	24.863558	30.043766	840	0,90
TP2	0+280	24.862861	24.862861	853	1,00
TP3	0+400	24.862542	30.042074	879	1,22
TP4	0+480	24.861791	30.042342	886	0,88
TP5	0+500	24.861640	30.042355	890	0,94

Please note that all GPS co-ordinates are extracted from a handheld GPS and elevation data from Google Earth PRO

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DCP Testing Locations

GC-24-144B

Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

DCP Test Locations

DCP Number	Chainage	Location		Elevation (meters above mean sea level)	Final Penetration Depth with DCP (mm)
		Latitude (South)	Longitude (East)		
DCP1	0+160	24.863558	30.043766	840	974
DCP2	0+280	24.862861	24.862861	853	135
DCP3	0+390	24.862542	30.042074	879	970
DCP4	0+480	24.861791	30.042342	886	638
DCP5	0+500	24.861640	30.042355	890	133
DCP6	0+500	24.861717	30.042349	888	556

Please note that all GPS co-ordinates are extracted from a handheld GPS and elevation data from Google Earth PRO

Appendix Index

Tsakane Steel Tank Reservoir- 250 kl

Appendix A: Soil Profiles

Appendix B: Laboratory Test Results- Bulk and Disturbed Samples

Appendix C: DCP Test Results

Appendix D: Site Classification Reference Tables

Appendix A

Soil Profiles

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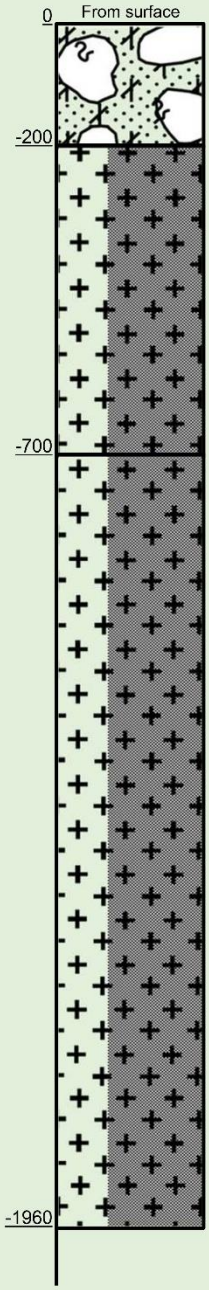
Exposure 1

GC-24-144B

Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

Ground Profile- Exposure 1



slightly MOIST; dark BROWN; medium DENSE; MATRIX SUPPORTED; gravel and cobbles in a matrix of clayey SAND; COLLUVIUM; abundant surficial cobbles and boulders; heterogenous composition and poorly sorted nature; abundant fine roots; Stockpile Bulk Sample No. T1.

Gradual contact

slightly MOIST; light reddish GREY, blotched olive; COARSE grained; VERY CLOSELY JOINTED; COMPLETELY weathered; very soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; traces of fine roots in the upper extent; infiltration zones; variable transition to underlying less weathered bedrock; staining extending from joint planes throughout the fabric of the rock; Stockpile Bulk Sample No. T1.

Gradual contact

slightly MOIST; light olive GREY, stained red; COARSE grained; CLOSELY JOINTED; HIGHLY weathered; medium hard rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; pockets of less weathered bedrock increasing with depth; undulating weathering profile; Stockpile Bulk Sample No. T1.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	-
Groundwater Seepage:	N/A	**Excavation Method:**	-
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Exposure
Samples Extracted:	1 Stockpile Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	834	**Coordinates:**	24.86435°S 30.04357°E

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GC-24-144B
Tsakane Steel Tank- 250kl

Profile Photo: Exp1



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GC-24-144B
Tsakane Steel Tank- 250kl

Material Present in Exp1







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GC-24-144B
Tsakane Steel Tank- 250kl

Surroundings of Exp1





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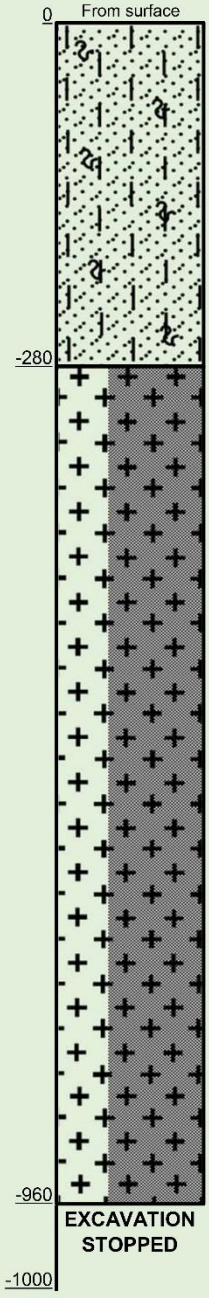
Test Pit TP1

GC-24-144B

Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP1



slightly MOIST; dark creamy BROWN, blotched white; LOOSE; MATRIX SUPPORTED; sub-rounded gravels in a matrix of silty SAND; COLLUVIUM; upper extent serving as the existing wearing course; heterogeneous composition and poorly sorted nature; abundant fine roots; Bulk Sample No. T2.

slightly MOIST; light creamy OLIVE, blotched white and stained red; COARSE grained; CLOSELY JOINTED; COMPLETELY weathered; very soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; pockets of residual soil decreasing with depth; calcification of rock surface; overall reduction in weathering with an increase in depth; Not Sampled.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Excavation stopped in weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	841	**Coordinates:**	24.86356°S 30.04377°E

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GC-24-144B
Tsakane Steel Tank- 250kl

Profile Photo: TP1



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GC-24-144B
Tsakane Steel Tank- 250kl

Material Present in Test Pit: TP1







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GC-24-144B
Tsakane Steel Tank- 250kl

Surroundings of Test Pit: TP1





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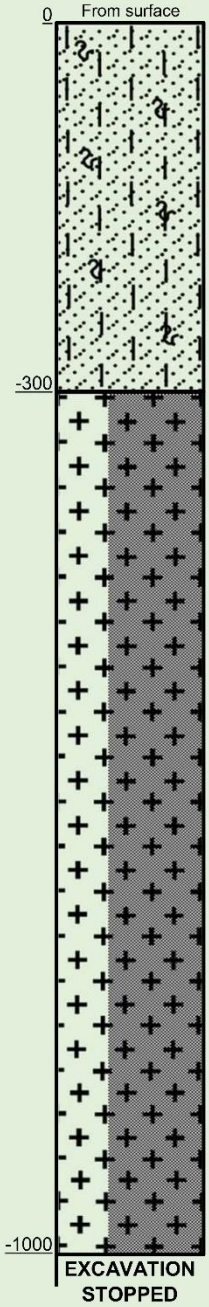
Test Pit T-TP2

GC-24-144B

Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP2



slightly MOIST; dark BROWN; blotched grey; medium DENSE; MATRIX SUPPORTED; coarse gravels and cobbles in a matrix of silty SAND; COLLUVIUM; heterogeneous composition and poorly sorted nature; minor fine roots; Bulk Sample No. T3.

slightly MOIST; light creamy OLIVE, stained white and orange, banded red; COARSE grained; CLOSELY JOINTED; COMPLETELY weathered; very soft rock to soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; calcified rock faces; gradual transition to less weathered bedrock at the base; staining extending from joint planes throughout the rock fabric; Bulk Sample No. T3.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Excavation stopped in weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	853	**Coordinates:**	24.86286°S 30.04299°E

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GC-24-144B
Tsakane Steel Tank- 250kl

Profile Photo: TP2



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144B
Tsakane Steel Tank- 250kl

Material Present in Test Pit: TP2







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GC-24-144B
Tsakane Steel Tank- 250kl

Surroundings of Test Pit: TP2





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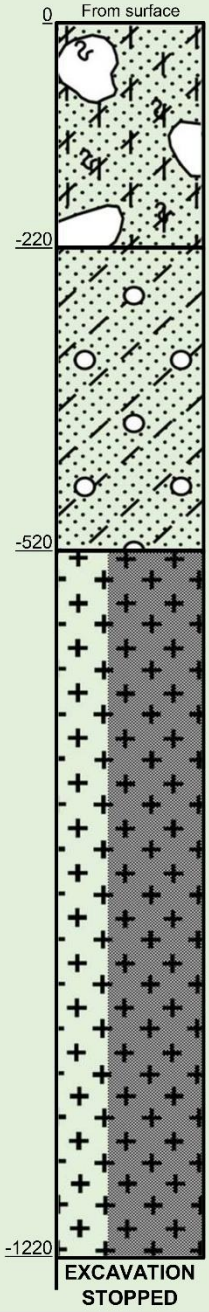
Test Pit TP3

GC-24-144B

Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP3



slightly MOIST; dark BROWN; medium DENSE; INTACT; clayey SAND with minor sub-angular gravels; COLLUVIUM; surficial cobbles and boulders; abundant fine roots; Not Sampled.

Gradual contact

slightly MOIST; light orangey BROWN, blotched olive and white; DENSE; INTACT; clayey SAND with minor sub-rounded gravels; calcified COLLUVIUM; calcification increasing with depth; infiltration zones; undulating exposure; Not Sampled.

~Undulating contact (460 to 580)

slightly MOIST; light creamy OLIVE, blotched brown; COARSE grained; CLOSELY JOINTED; COMPLETELY weathered; very soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; irregular pockets of less weathered rock; fabric increasing with depth; joint planes stained and filled with granular residual soil; Bulk Sample No. T4.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Excavation stopped in weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	887	**Coordinates:**	24.86179°S 30.04234°E

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GC-24-144B
Tsakane Steel Tank- 250kl

Profile Photo: TP3



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GC-24-144B
Tsakane Steel Tank- 250kl

Material Present in Test Pit: TP3







GEOCALIBRE
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GC-24-144B
Tsakane Steel Tank- 250kl

Surroundings of Test Pit: TP3





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Test Pit TP4

GC-24-144B

Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP4



slightly MOIST; dark BROWN, blotched olive; medium DENSE; INTACT; clayey SAND with sub-angular gravels; COLLUVIUM; heterogeneous composition and poorly sorted nature; minor fine roots in the upper extent; Mixed Bulk Sample No. T5.

Gradual contact

slightly MOIST; light creamy WHITE, blotched olive; DENSE; COARSE grained; CLOSELY JOINTED; HIGHLY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; pockets of completely weathered bedrock decreasing with depth; infiltration zones in the upper extent; extensive calcification on exposed faces; Mixed Bulk Sample No. T5.

~Undulating excavation depth (860 to 900)

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Mixed Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	887	**Coordinates:**	24.86179°S 30.04234°E

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GC-24-144B
Tsakane Steel Tank- 250kl

Profile Photo: TP4



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144B
Tsakane Steel Tank- 250kl

Material Present in Test Pit: TP4







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GC-24-144B
Tsakane Steel Tank- 250kl

Surroundings of Test Pit: TP4





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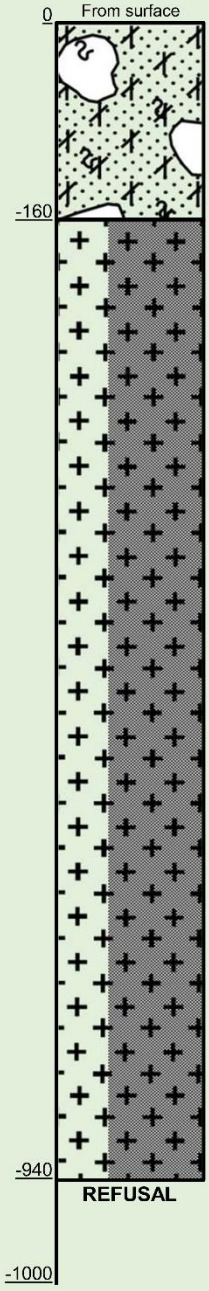
Test Pit TP5

GC-24-144B

Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP5



slightly MOIST; dark BROWN; medium DENSE; MATRIX SUPPORTED; sub-angular gravels and cobbles in a matrix of clayey SAND; COLLUVIUM; heterogeneous composition and poorly sorted nature; minor fine roots; Not Sampled.

~Undulating contact

slightly MOIST; light creamy OLIVE, stained brown, blotched white; DENSE; COARSE grained; CLOSELY JOINTED; HIGHLY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; variable rock mass exposure with pockets of less weathered bedrock; calcification; discolouration extending from joints planes throughout the rock mass; Bulk Sample No. T6.

~Undulating excavation depth

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	25/06/2024
Elevation (MAMSL):	890	**Coordinates:**	24.86164°S 30.04235°E

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GC-24-144B
Tsakane Steel Tank- 250kl

Profile Photo: TP5



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GC-24-144B
Tsakane Steel Tank- 250kl

Material Present in Test Pit: TP5







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GC-24-144B
Tsakane Steel Tank- 250kl

Surroundings of Test Pit: TP5





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Appendix B

Laboratory Test Results

Bulk and Disturbed Samples

Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

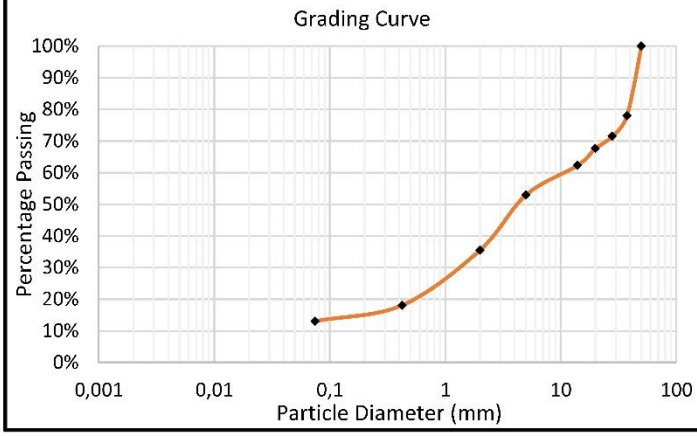
Hanko Investments T/A Tzaneen Lab | P.O. Box 3784, Tzaneen, 0850 |1992 Industria Road, Tzaneen | www.tzaneenlab.co.za | admin@tzaneenlab.co.za | 015 307 1661

Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/1
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	T- Exposure from 0,00 to 1,96m below E.G.L (T1)	Date Reported:	2024/07/11

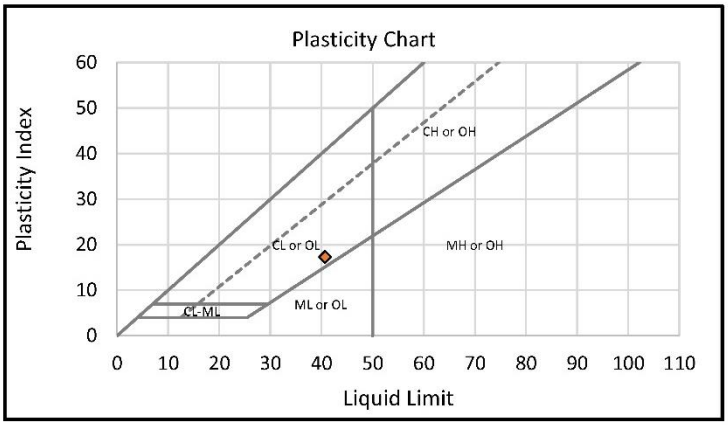
Road Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	-
50,0	100%
37,5	78%
28,0	71%
20,0	68%
14,0	62%
5,0	53%
2,0	36%
0,425	18,1%
0,075	13,1%

Description: Dark Brown Clayey Gravel



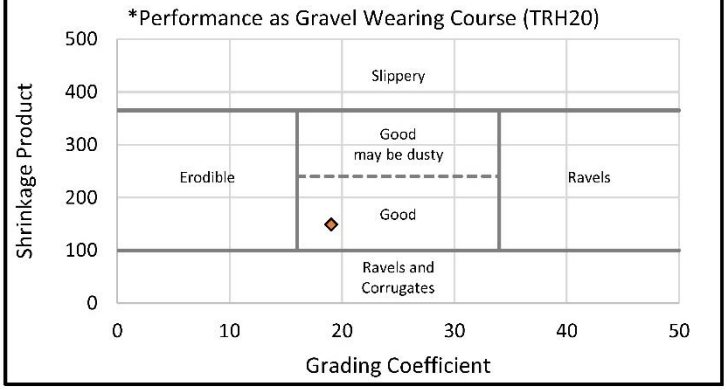
*Grading Characteristics		
Grading Modulus	GM	2,33
Effective Size	D_{10}	0,06
Uniformity Coef.	C_u	172,61
Curvature Coef.	C_c	2,18



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	49%
Fine Sand	0.425 - 0.075 mm	14%
Silt and Clay	<0.075 mm	37%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	41%
Plasticity Index	PI	17%
Linear Shrinkage	LS	8,17%

Grading Coefficient	Gc	19,0
Shrinkage Product	Sp	148



*Classifications		
	Unified Soil Classification- USCS	**GC**
	COLTO Classification	**<G9**
	US Highway	**A-2-7 (0)**

TZANEEN LAB P.O. Box 3784 TZANEEN

CHECKED

Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,99

Results in this report only relate to the item(s) tested by Tzaneen Civil Lab. Results and advice are subject to correct sampling being followed. Tzaneen Lab does not accept responsibility for any matters arising from the further use of these results. This report is confidential and is only intended for the use of the individual or entity to which it is addressed.

Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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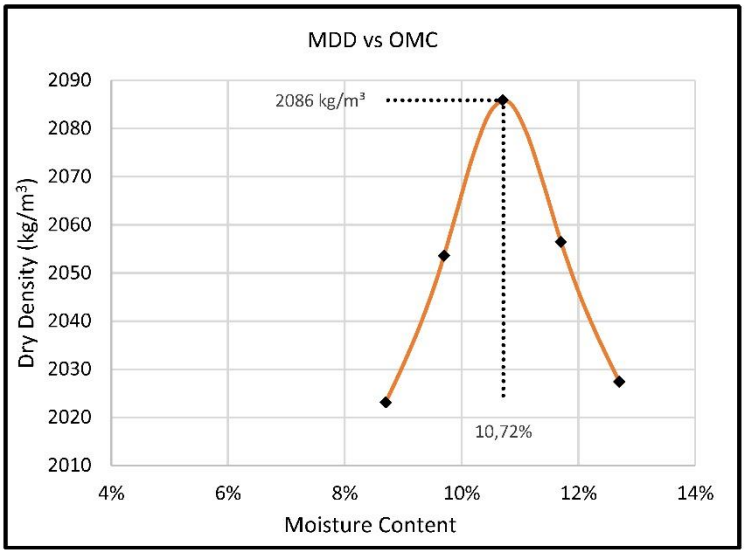
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/1
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	T- Exposure from 0,00 to 1,96m below E.G.L (T1)	Date Reported:	2024/07/11

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	8,7%	2023
2	9,7%	2054
3	10,7%	2086
4	11,7%	2056
5	12,7%	2027

Optimum Moisture Content (OMC):	**10,7%**
Maximum Dry Density (MDD):	**2086 kg/m³**

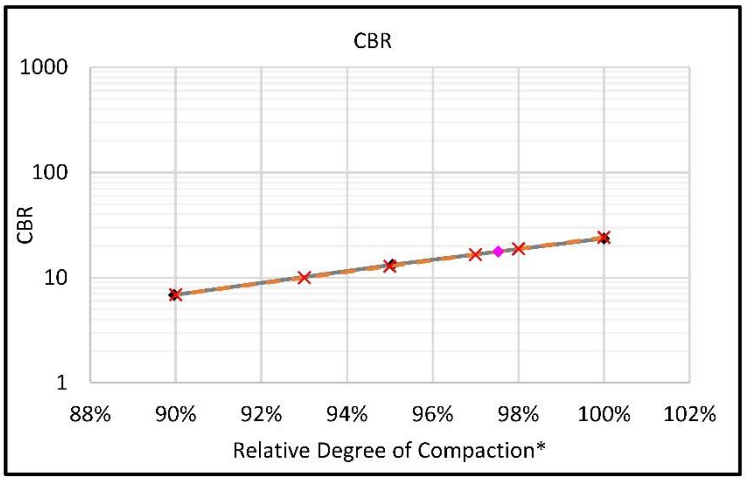


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	10,8%		
Dry Density (kg/m³)	2086 kg/m³	1983 kg/m³	1876 kg/m³
Relative compaction (%)	100,0%	95,1%	90,0%
Measured CBR	24	13	7
% Swell	0,09	0,14	0,17

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	24
98%	19
97%	17
95%	13
93%	10
90%	7



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Tel: 015 307 1661
Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,99

Results in this report only relate to the item(s) tested by Tzaneen Civil Lab. Results and advice are subject to correct sampling being followed. Tzaneen Lab does not accept responsibility for any matters arising from the further use of these results. This report is confidential and is only intended for the use of the individual or entity to which it is addressed.

Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

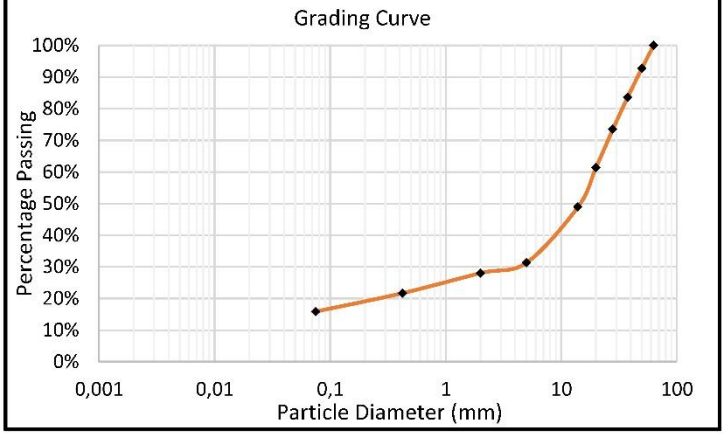
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Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/2
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	Test Pit 1 from 0,00 to 0,28m below E.G.L (T2)	Date Reported:	2024/07/11

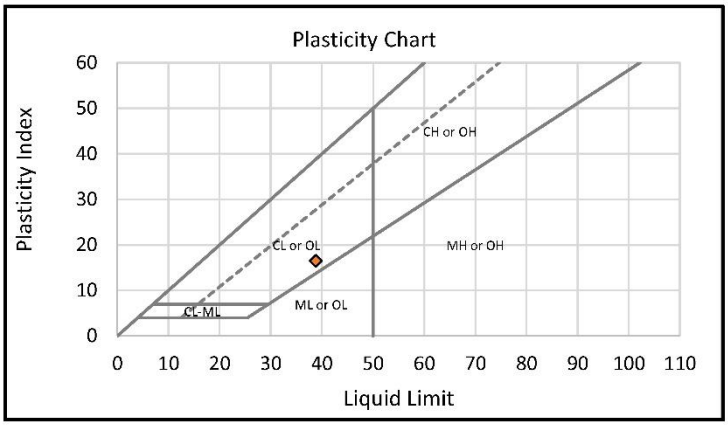
Road Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	93%
37,5	84%
28,0	74%
20,0	61%
14,0	49%
5,0	31%
2,0	28%
0,425	21,7%
0,075	15,9%

Description: Dark Brown Clayey Gravel



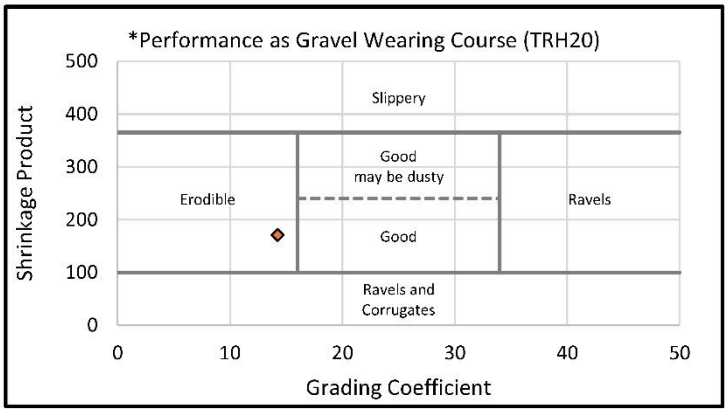
*Grading Characteristics		
Grading Modulus	GM	2,34
Effective Size	D_{10}	0,06
Uniformity Coef.	C_u	335,55
Curvature Coef.	C_c	10,81



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	23%
Fine Sand	0.425 - 0.075 mm	21%
Silt and Clay	<0.075 mm	57%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	39%
Plasticity Index	PI	16%
Linear Shrinkage	LS	7,84%

Grading Coefficient	Gc	14,2
Shrinkage Product	Sp	170



*Classifications		
	Unified Soil Classification- USCS	**GC**
	COLTO Classification	**G7**
	US Highway	**A-2-6 (0)**

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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: PI>14,68, LS>5, CBR @ 95%<25

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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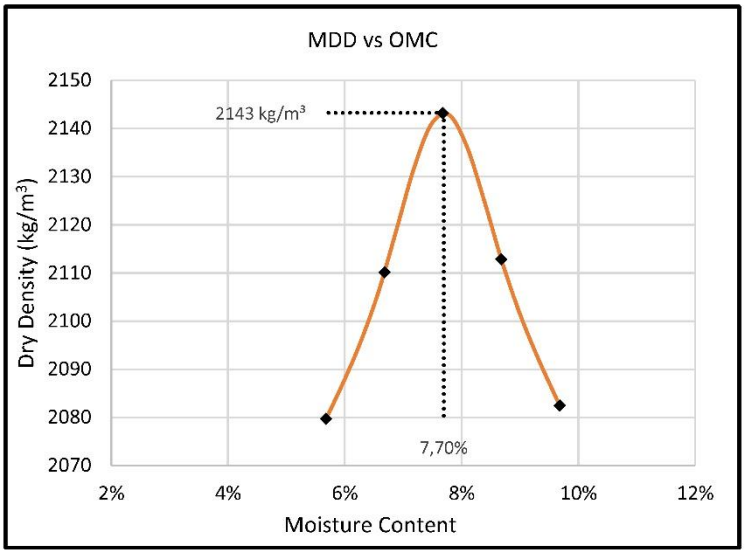
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/2
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	Test Pit 1 from 0,00 to 0,28m below E.G.L (T2)	Date Reported:	2024/07/11

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	5,7%	2080
2	6,7%	2110
3	7,7%	2143
4	8,7%	2113
5	9,7%	2082

Optimum Moisture Content (OMC):	**7,7%**
Maximum Dry Density (MDD):	**2143 kg/m³**

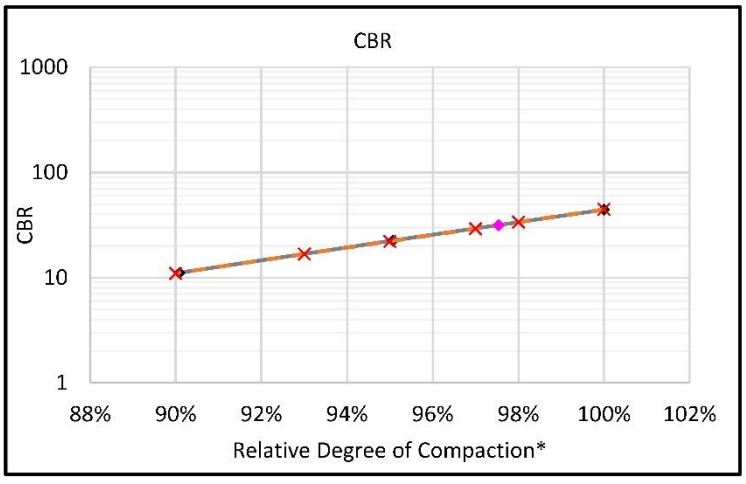


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	7,6%		
Dry Density (kg/m³)	2146 kg/m³	2040 kg/m³	1933 kg/m³
Relative compaction (%)	100,0%	95,1%	90,1%
Measured CBR	44	22	11
% Swell	0,07	0,10	0,13

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	44
98%	34
97%	29
95%	22
93%	17
90%	11



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Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: PI>14,68, LS>5, CBR @ 95%<25

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

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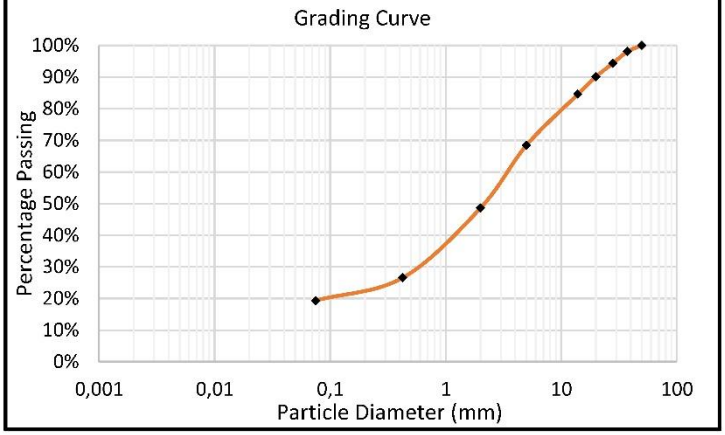
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Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/3
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	Test Pit 2 from 0,00 to 1,00m below E.G.L (T3)	Date Reported:	2024/07/11

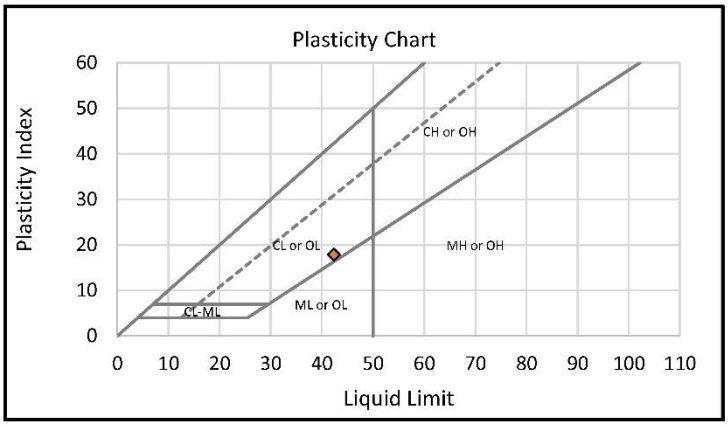
Road Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	-
50,0	100%
37,5	98%
28,0	94%
20,0	90%
14,0	85%
5,0	68%
2,0	49%
0,425	26,6%
0,075	19,4%

Description: Dark Yellowish Orange clayey Sand



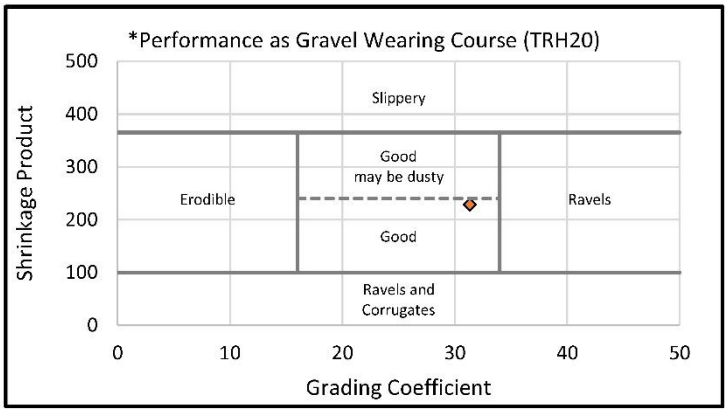
*Grading Characteristics		
Grading Modulus	GM	2,05
Effective Size	D_{10}	0,05
Uniformity Coef.	C_u	64,26
Curvature Coef.	C_c	1,64



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	45%
Fine Sand	0.425 - 0.075 mm	15%
Silt and Clay	<0.075 mm	40%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	42%
Plasticity Index	PI	18%
Linear Shrinkage	LS	8,60%

Grading Coefficient	Gc	31,3
Shrinkage Product	Sp	229



*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**<G9**
	US Highway	**A-2-7 (0)**

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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,15

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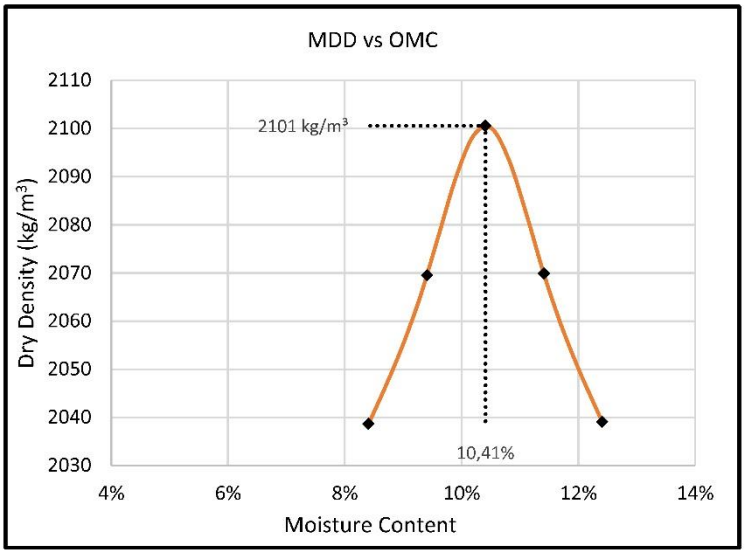
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/3
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	Test Pit 2 from 0,00 to 1,00m below E.G.L (T3)	Date Reported:	2024/07/11

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	8,4%	2039
2	9,4%	2069
3	10,4%	2101
4	11,4%	2070
5	12,4%	2039

Optimum Moisture Content (OMC):	**10,4%**
Maximum Dry Density (MDD):	**2101 kg/m³**

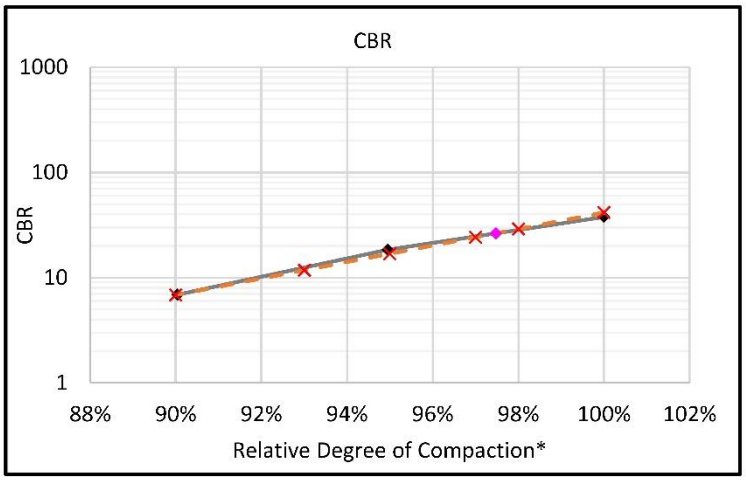


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	10,4%		
Dry Density (kg/m³)	2103 kg/m³	1997 kg/m³	1894 kg/m³
Relative compaction (%)	100,0%	95,0%	90,0%
Measured CBR	38	18	7
% Swell	0,10	0,13	0,18

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	42
98%	29
97%	24
95%	17
93%	12
90%	7



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Cell: 083 [illegible]
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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,15

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

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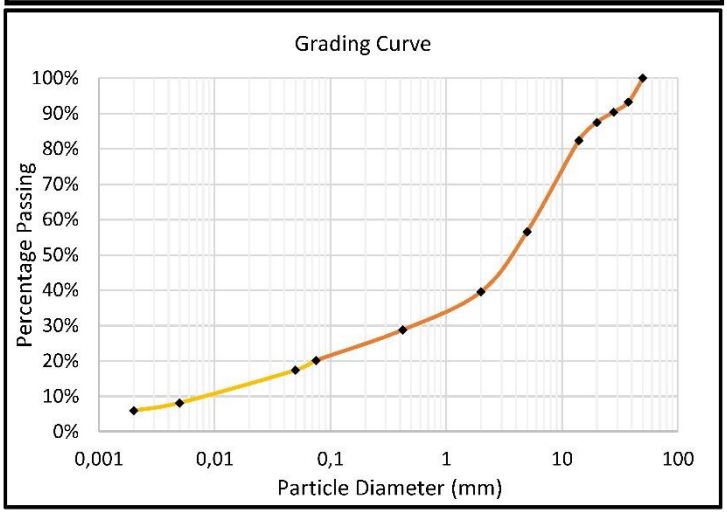
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/4
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description:	Test Pit 3 from 0,52 to 1,22m below E.G.L (T4)	Date Reported:	2024/07/11

Foundation Indicator Test Report: SANS 3001

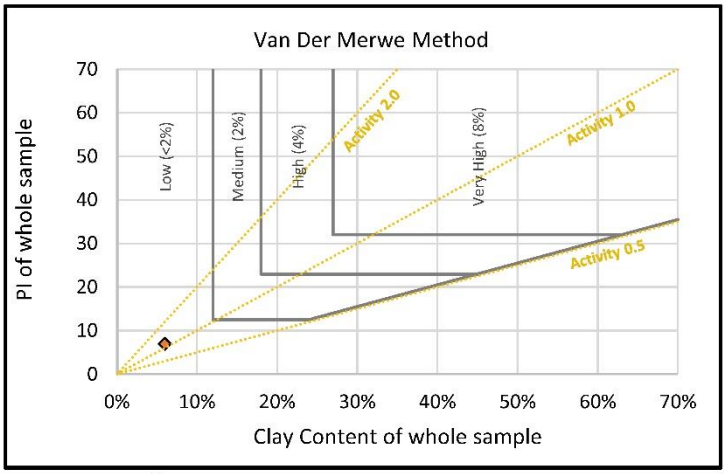
Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	-
50,0	100%
37,5	93%
28,0	90%
20,0	88%
14,0	82%
5,0	57%
2,0	40%
0,425	28,8%
0,075	20,2%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	17,4%
0,005	8,2%
0,002	6,0%

Description: Dusky Red clayey Sand

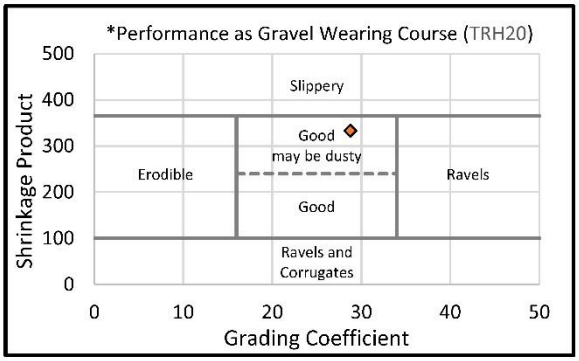


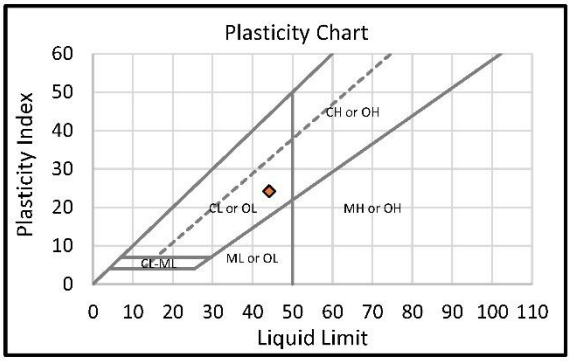
*Grading Characteristics		
Grading Modulus	GM	2,11
Effective Size	D_{10}	0,008
Uniformity Coef.	C_u	728,77
Curvature Coef.	C_c	5,59



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	27%
Fine Sand	0.425 - 0.075 mm	22%
Silt	0.075 - 0.002 mm	30%
Clay	<0.002	21%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	44%
Plasticity Index	PI	24%
Linear Shrinkage	LS	11,53%





*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**<G9**
	US Highway	**A-2-7 (0)**

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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,33

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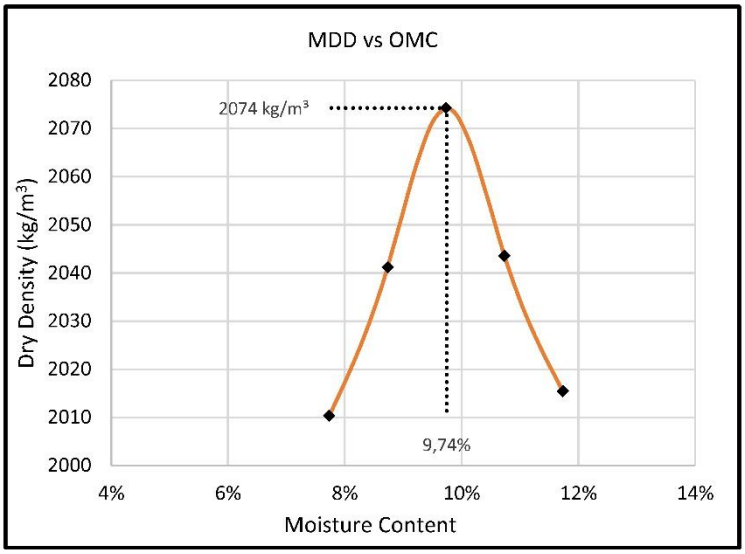
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/4
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	Test Pit 3 from 0,52 to 1,22m below E.G.L (T4)	Date Reported:	2024/07/11

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	7,7%	2010
2	8,7%	2041
3	9,7%	2074
4	10,7%	2044
5	11,7%	2015

Optimum Moisture Content (OMC):	9,7%
Maximum Dry Density (MDD):	2074 kg/m³

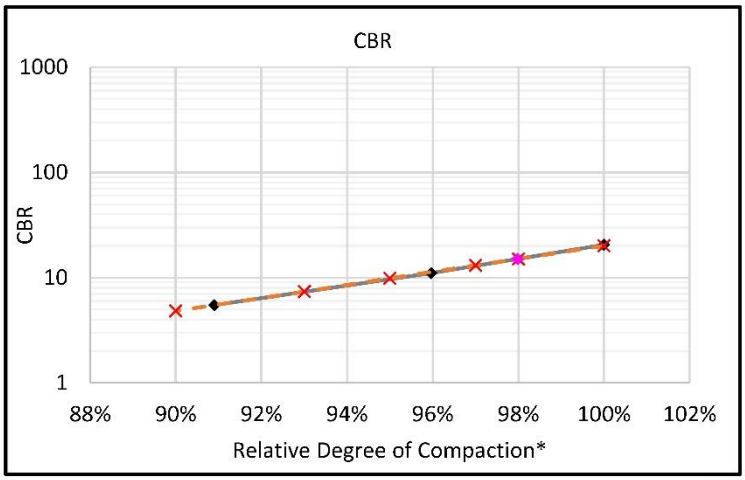


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	9,8%		
Dry Density (kg/m³)	2056 kg/m³	1973 kg/m³	1869 kg/m³
Relative compaction (%)	100,0%	96,0%	90,9%
Measured CBR	21	11	5
% Swell	0,22	0,33	0,49

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	20
98%	15
97%	13
95%	10
93%	7
90%	5





Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,33

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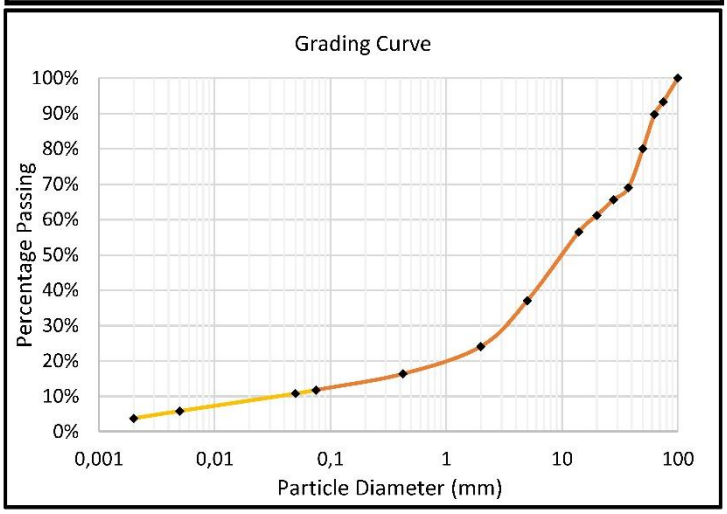
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/5
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description:	Test Pit 4 from 0,00 to 0,88m below E.G.L (T5)	Date Reported:	2024/07/11

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	93%
63,0	90%
50,0	80%
37,5	69%
28,0	66%
20,0	61%
14,0	57%
5,0	37%
2,0	24%
0,425	16,4%
0,075	11,8%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	10,8%
0,005	5,9%
0,002	3,8%

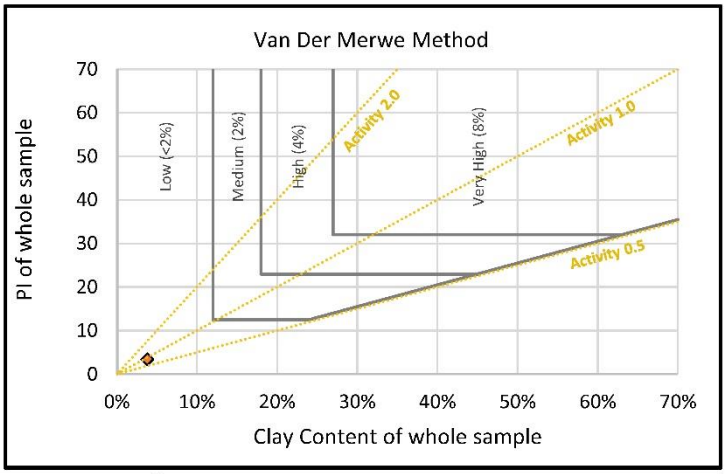
Description: Dark Reddish Orange poorly-graded clayey Gravel

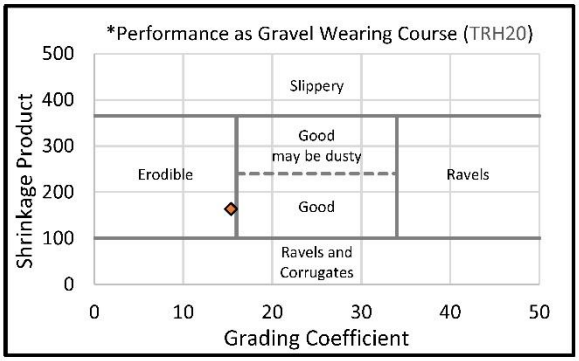


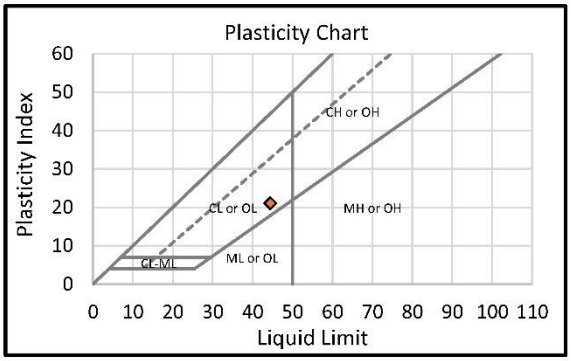
*Grading Characteristics		
Grading Modulus	GM	2,48
Effective Size	D_{10}	0,03
Uniformity Coef.	C_u	526,83
Curvature Coef.	C_c	14,57

*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	32%
Fine Sand	0.425 - 0.075 mm	19%
Silt	0.075 - 0.002 mm	25%
Clay	<0.002	24%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	44%
Plasticity Index	PI	21%
Linear Shrinkage	LS	9,96%







*Classifications		
	Unified Soil Classification- USCS	**GP-GC**
	COLTO Classification	**<G9**
	US Highway	**A-2-7 (0)**

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>17,44

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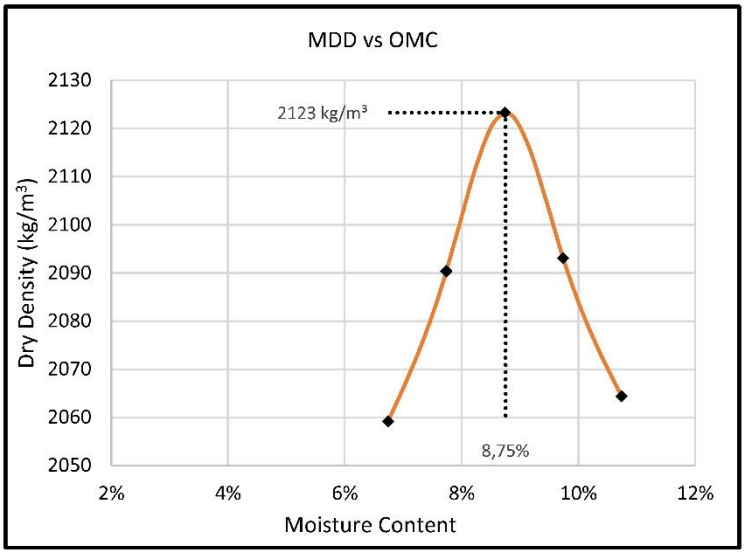
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/5
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	Test Pit 4 from 0,00 to 0,88m below E.G.L (T5)	Date Reported:	2024/07/11

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	6,7%	2059
2	7,7%	2090
3	8,7%	2123
4	9,7%	2093
5	10,7%	2064

Optimum Moisture Content (OMC):	**8,8%**
Maximum Dry Density (MDD):	**2123 kg/m³**

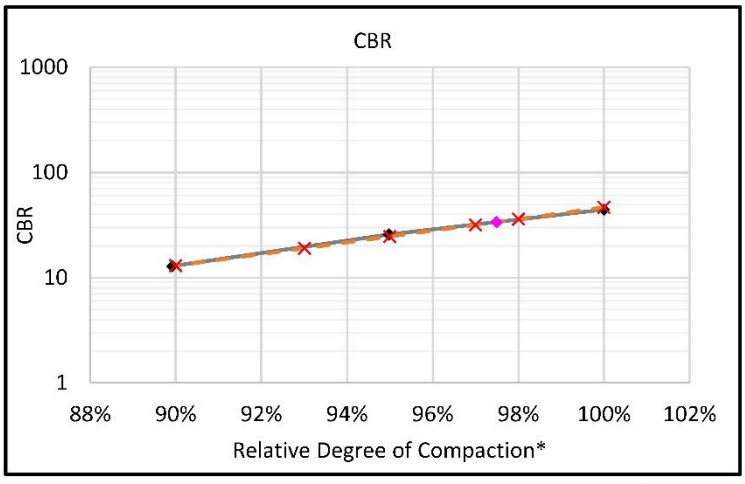


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	8,6%		
Dry Density (kg/m³)	2129 kg/m³	2022 kg/m³	1914 kg/m³
Relative compaction (%)	100,0%	95,0%	89,9%
Measured CBR	44	26	13
% Swell	0,22	0,38	0,49

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	46
98%	36
97%	32
95%	25
93%	19
90%	13



TZANEEN LAB P.O.Box 3784 TZANEEN
CHECKED
Tel: 015 307 1661
Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>17,44

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/6
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description:	Test Pit 5 from 0,16 to 0,94m below E.G.L (T6)	Date Reported:	2024/07/11

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	92%
37,5	78%
28,0	72%
20,0	67%
14,0	57%
5,0	38%
2,0	25%
0,425	15,6%
0,075	11,8%

*Hydrometer Analysis (SANS 3001-GR3)		
Diameter (mm)	**% Passing** **	
0,05	11,3%	6,0%
0,005	5,9%	1,3%
0,002	4,0%	0,4%

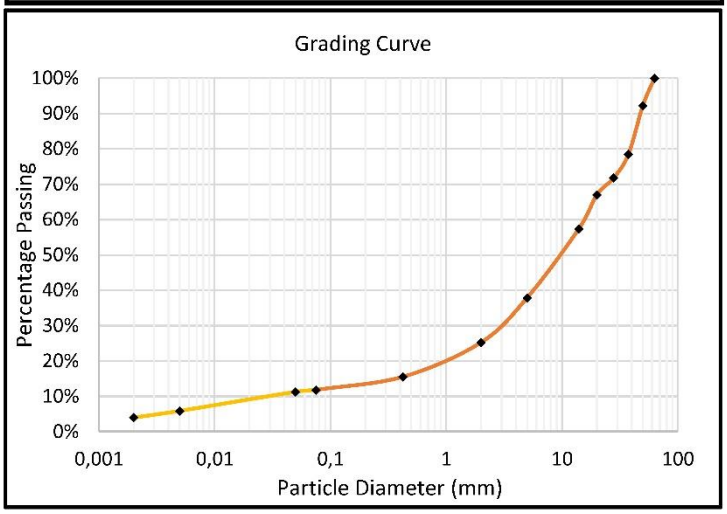
*** without dispersing agent***

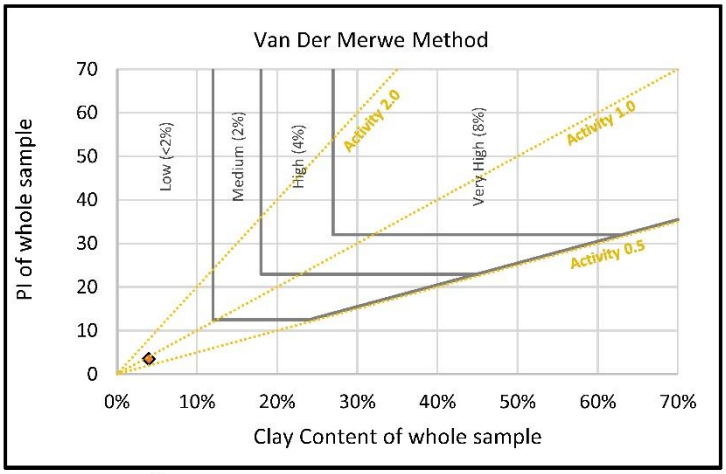
*Grading Characteristics		
Grading Modulus	GM	2,47
Effective Size	D_{10}	0,03
Uniformity Coef.	C_u	536,49
Curvature Coef.	C_c	17,99

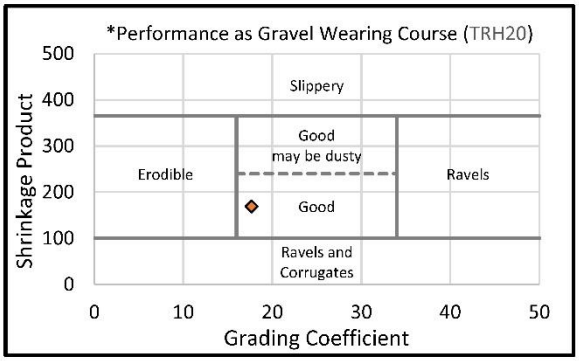
*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	38%
Fine Sand	0.425 - 0.075 mm	15%
Silt	0.075 - 0.002 mm	23%
Clay	<0.002	23%

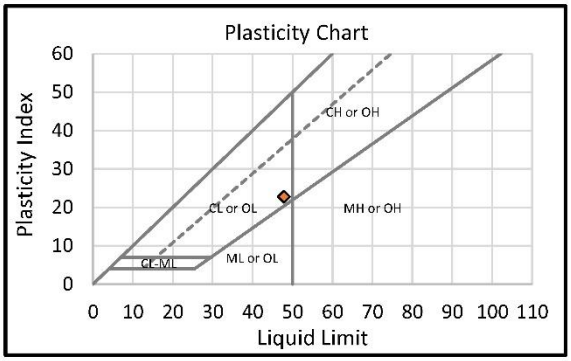
Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	48%
Plasticity Index	PI	23%
Linear Shrinkage	LS	10,84%

Description: Dark Yellowish Orange poorly-graded clayey Gravel









*Classifications		
	Unified Soil Classification- USCS	**GP-GC**
	COLTO Classification	**<G9**
	US Highway	**A-2-7 (0)**

*pH: 7,9	*Electrical Conductivity: 60 mS/m	*Double Hydrometer: 22,0%

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>17,41

TZANEEN LAB P.O.Box 3784 TZANEEN Tel: 015 307 1661 Cell: 083 437 9258 CHECKED

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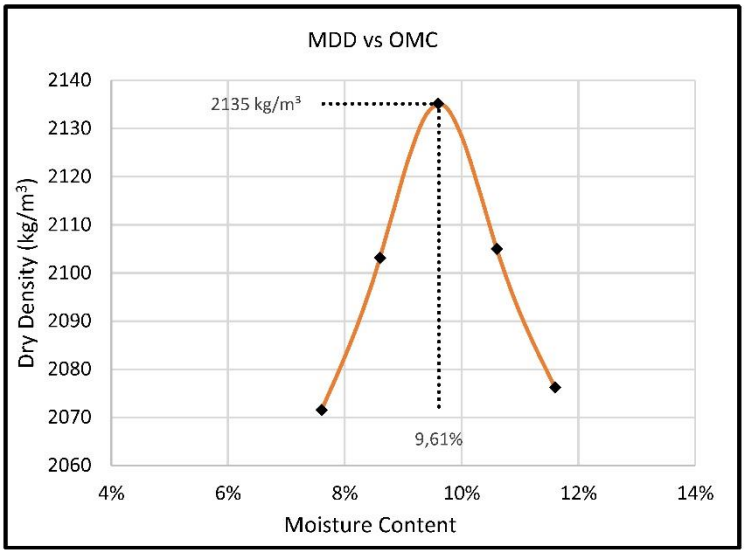
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03344/6
Project:	Tsakane Steel Tank Reservoir and Access Road	Date Sampled:	2024/06/25
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/05
Description	Test Pit 5 from 0,16 to 0,94m below E.G.L (T6)	Date Reported:	2024/07/11

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	7,6%	2072
2	8,6%	2103
3	9,6%	2135
4	10,6%	2105
5	11,6%	2076

Optimum Moisture Content (OMC):	**9,6%**
Maximum Dry Density (MDD):	**2135 kg/m³**

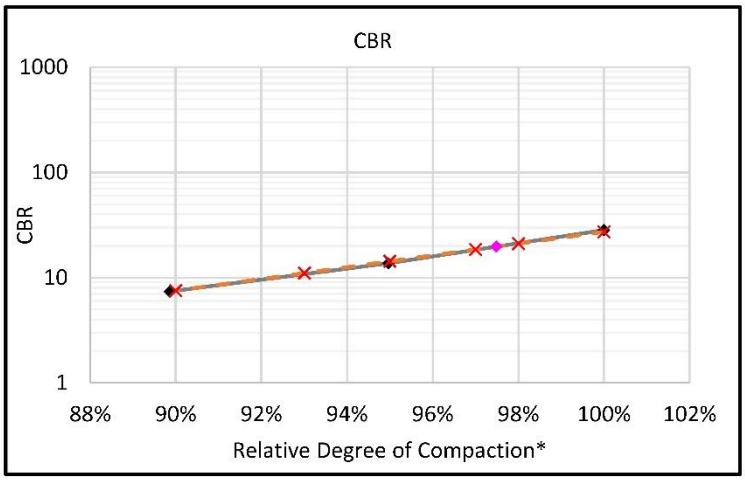


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	9,8%		
Dry Density (kg/m³)	2136 kg/m³	2028 kg/m³	1919 kg/m³
Relative compaction (%)	100,0%	95,0%	89,9%
Measured CBR	28	14	7
% Swell	0,22	0,31	0,38

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	27
98%	21
97%	19
95%	14
93%	11
90%	8





Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>17,41

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Appendix C

DCP Test Results

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144B

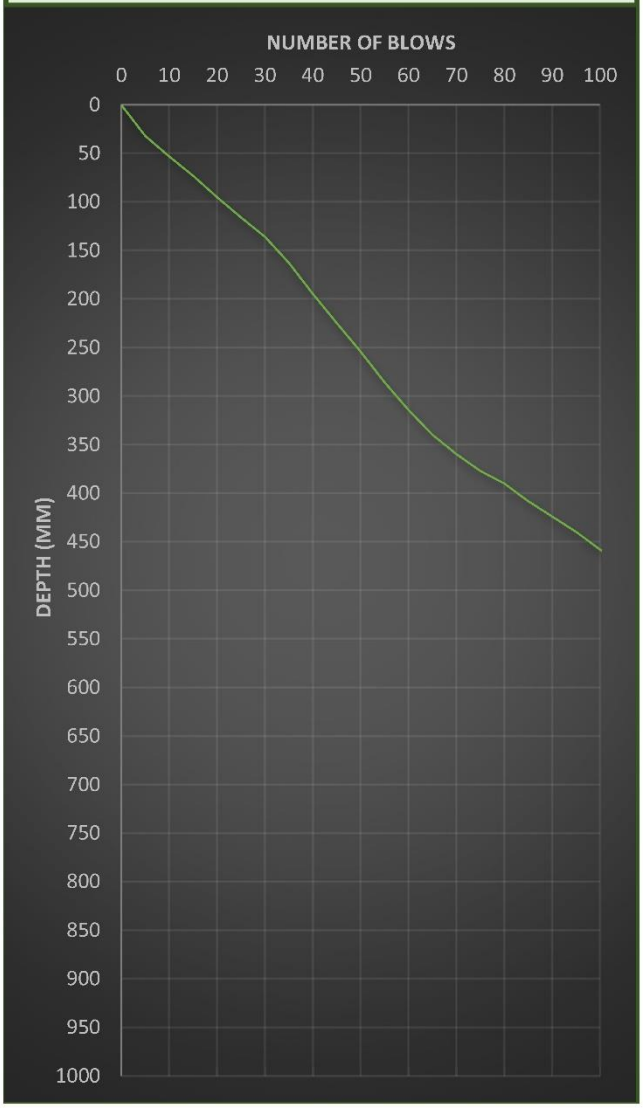
Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd.

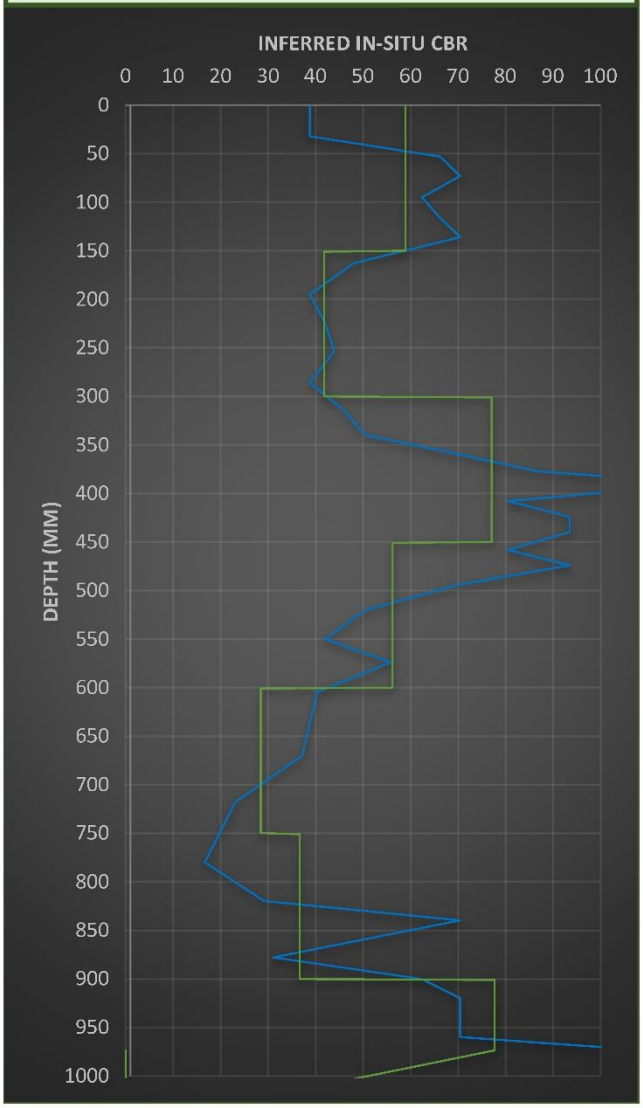
DCP 1 at TP1

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
4,6	**6,0**	**3,7**	**4,8**
601 to 750	751 to 900	901 to 1050	1051 to 1200
8,2	**6,7**	**3,7**	

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
59,0	**41,9**	**77,2**	**56,3**
601 to 750	751 to 900	901 to 1050	1051 to 1200
28,5	**36,7**	**77,8**	

Terminated Depth: 974 mm

Termination Character: Stopped- Max Reach

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144B

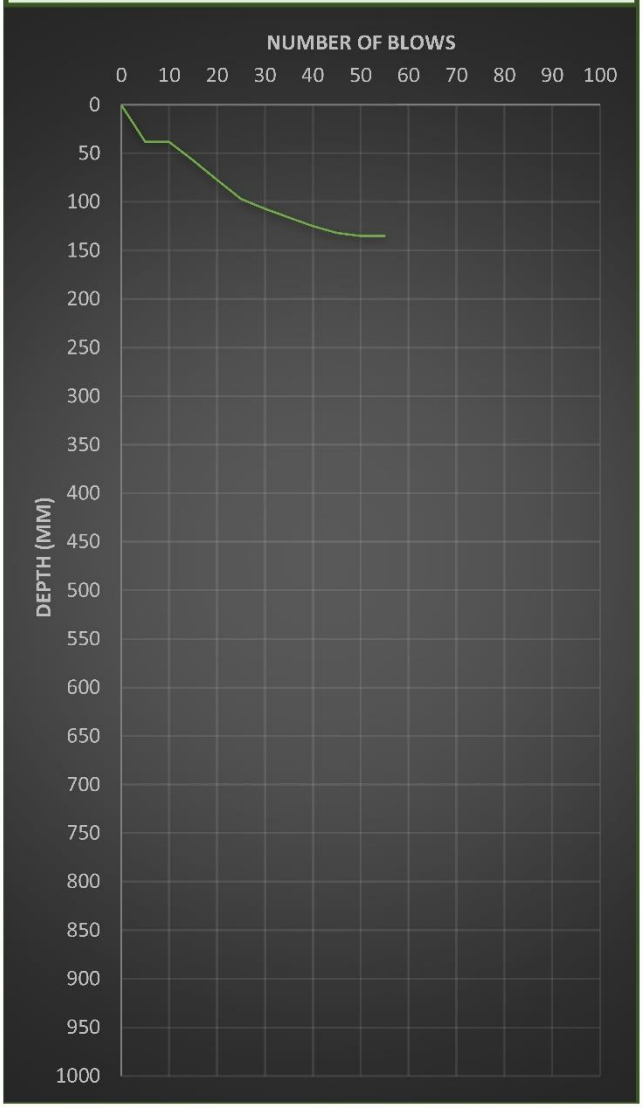
Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd.

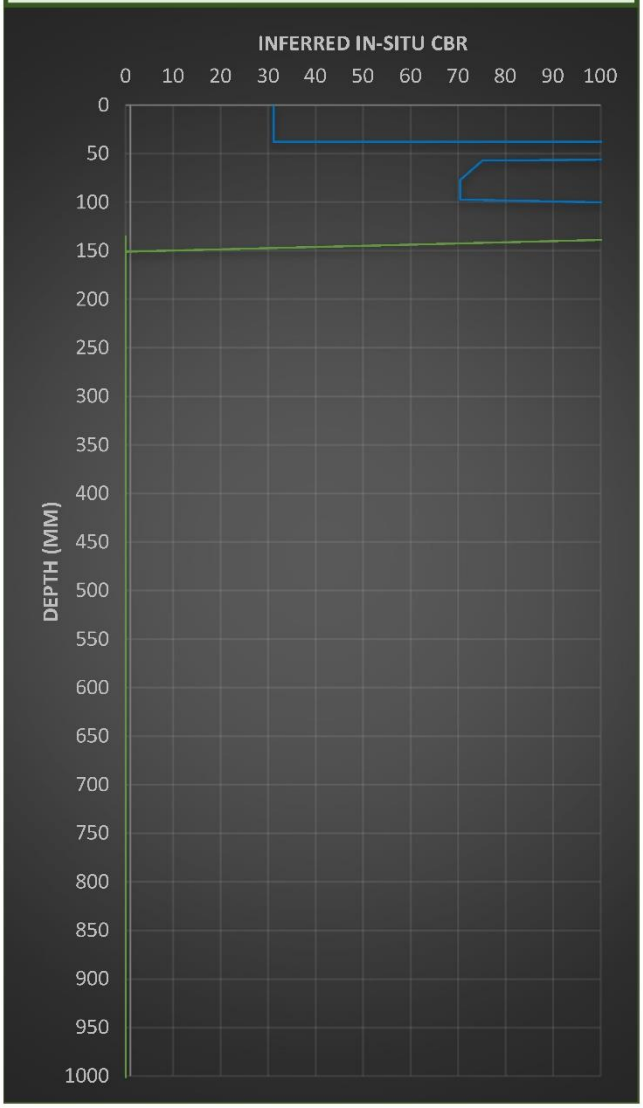
DCP 2 at TP 2

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
2,5			
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
131,1			
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 135 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144B

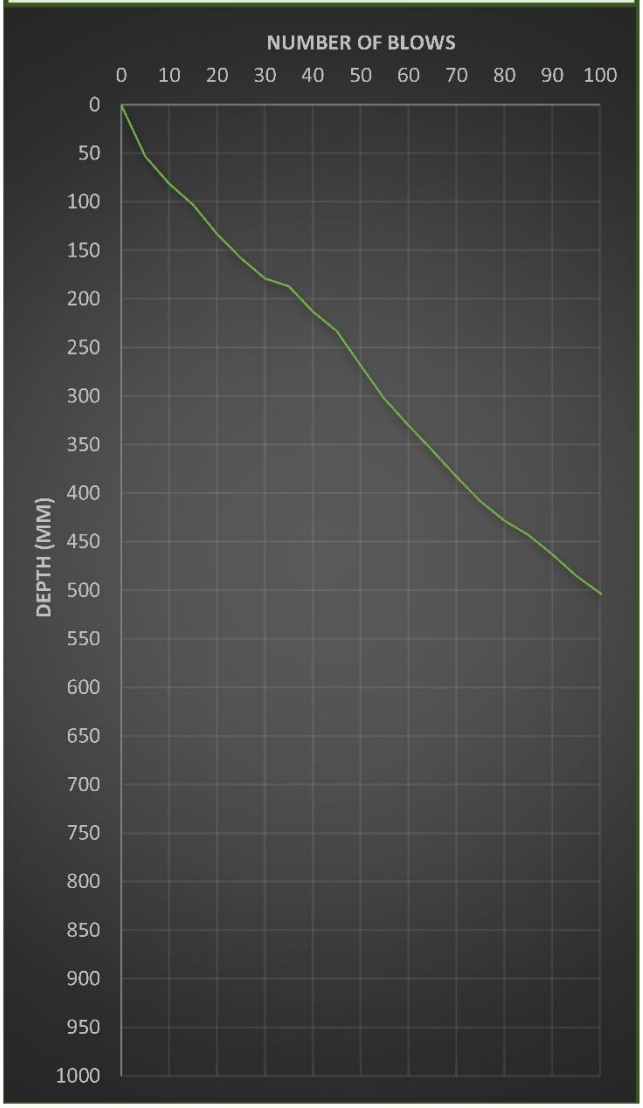
Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd.

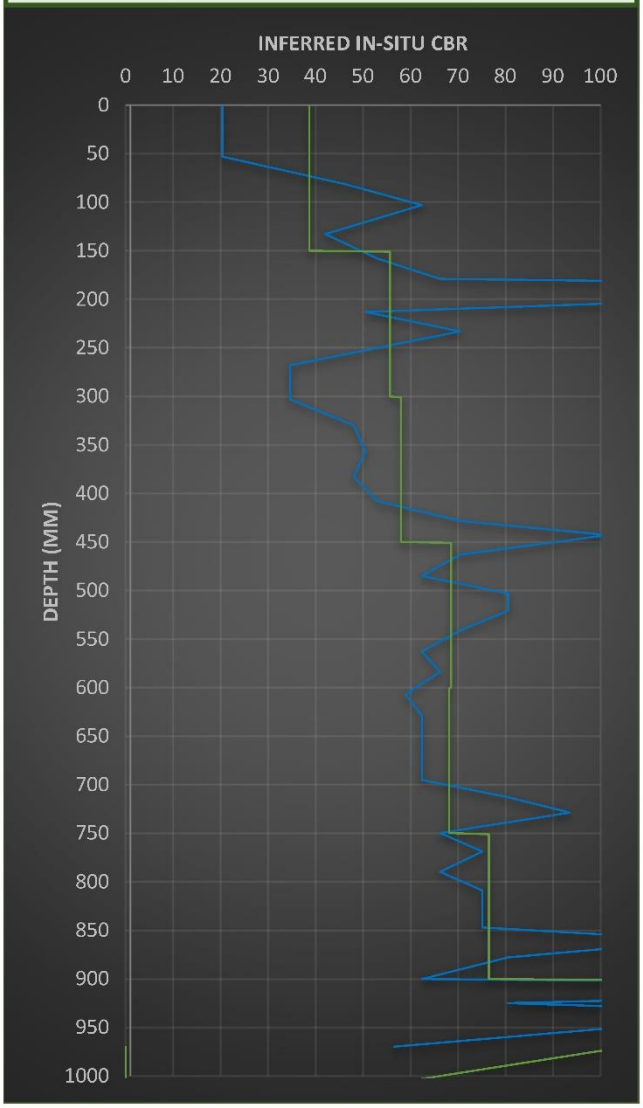
DCP 3 at TP 3

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
6,4	4,8	4,7	4,1
601 to 750	751 to 900	901 to 1050	1051 to 1200
4,1	3,8	2,9	

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
38,7	55,7	58,0	68,7
601 to 750	751 to 900	901 to 1050	1051 to 1200
68,2	76,5	105,3	

Terminated Depth: 970 mm

Termination Character: Stopped- Max Reach

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144B

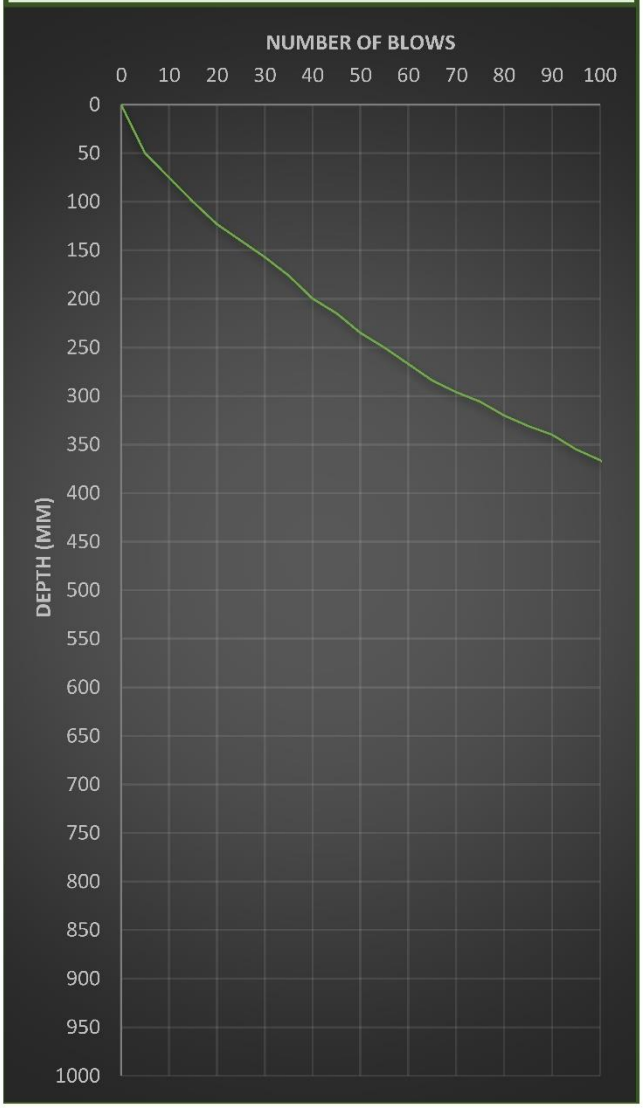
Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd.

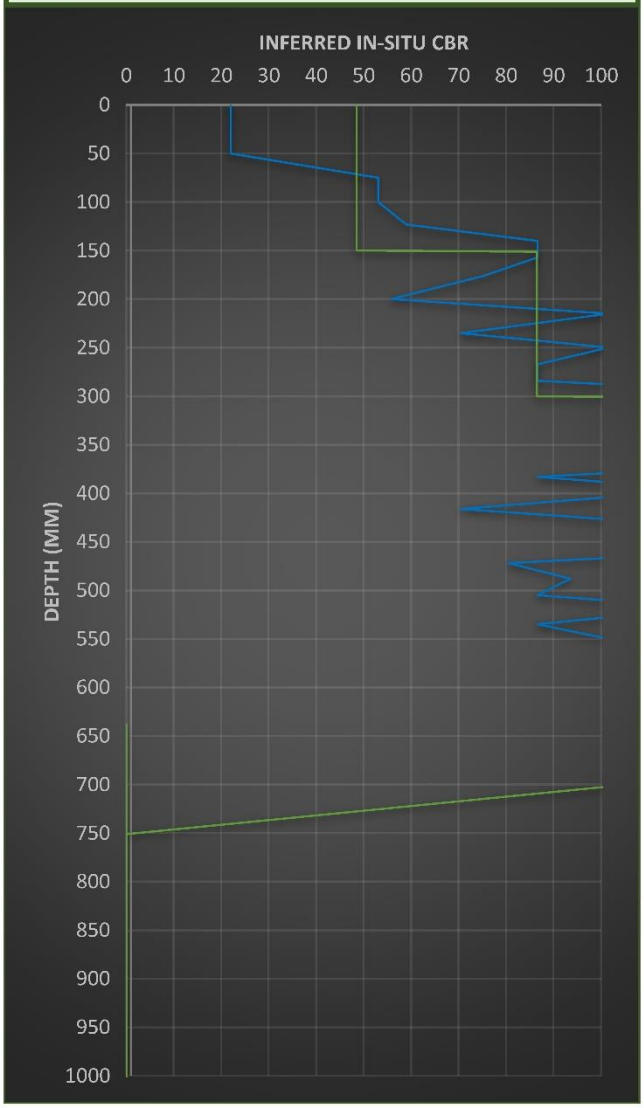
DCP 4 at TP 4

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
5,4	**3,4**	**2,7**	**2,5**
601 to 750	751 to 900	901 to 1050	1051 to 1200
1,4			

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
48,5	**86,5**	**117,8**	**126,2**
601 to 750	751 to 900	901 to 1050	1051 to 1200
234,6			

Terminated Depth: 638 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144B

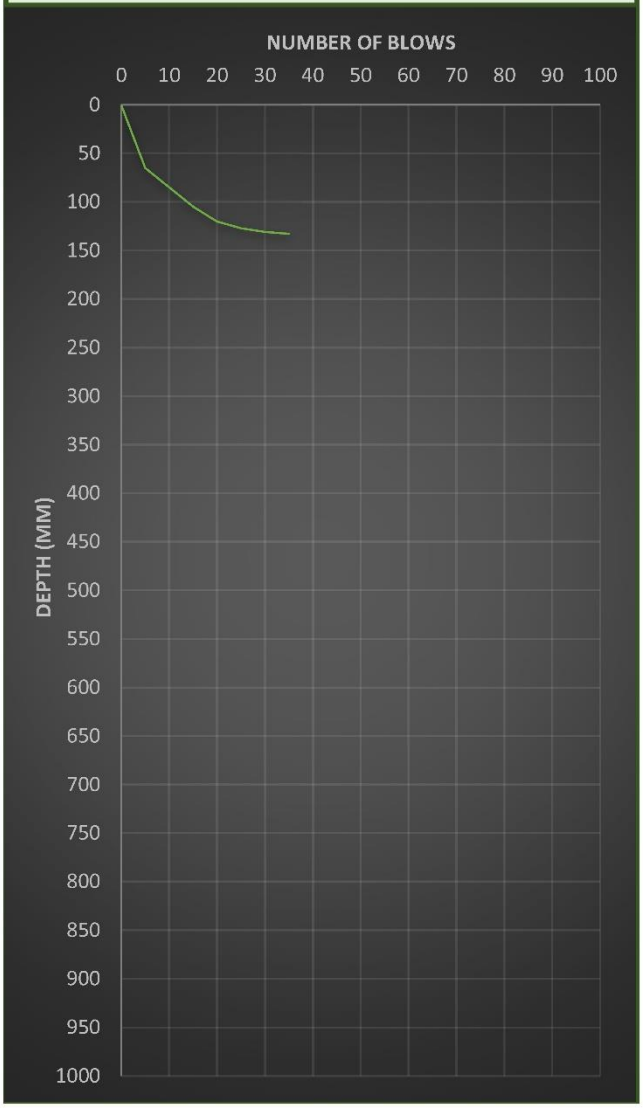
Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd.

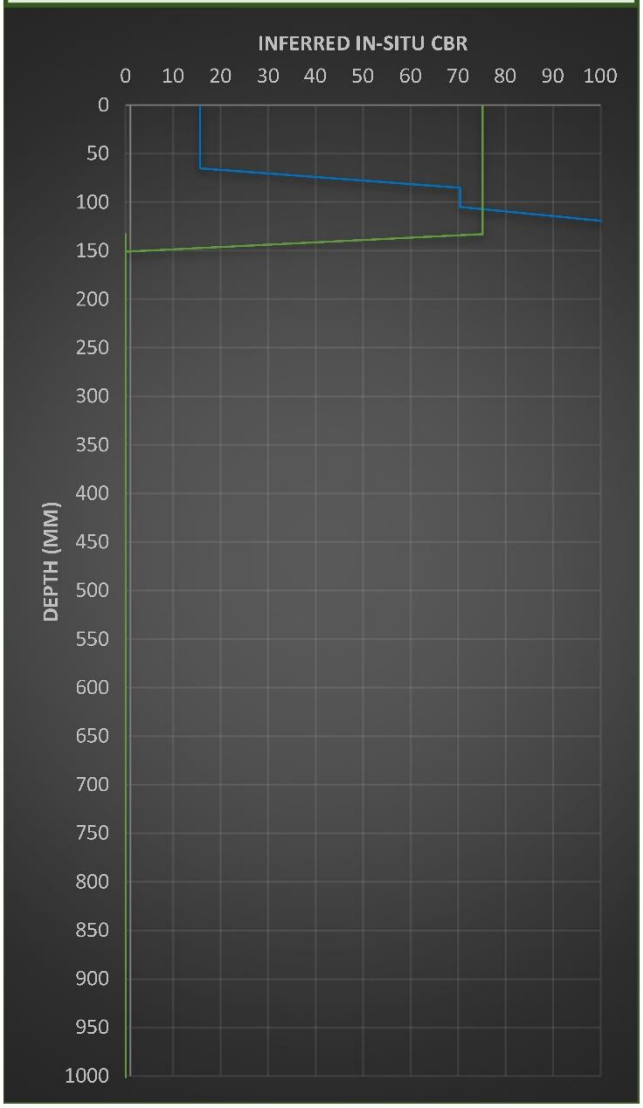
DCP 5 at TP 5

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
3,8			
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
75,2			
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 133 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144B

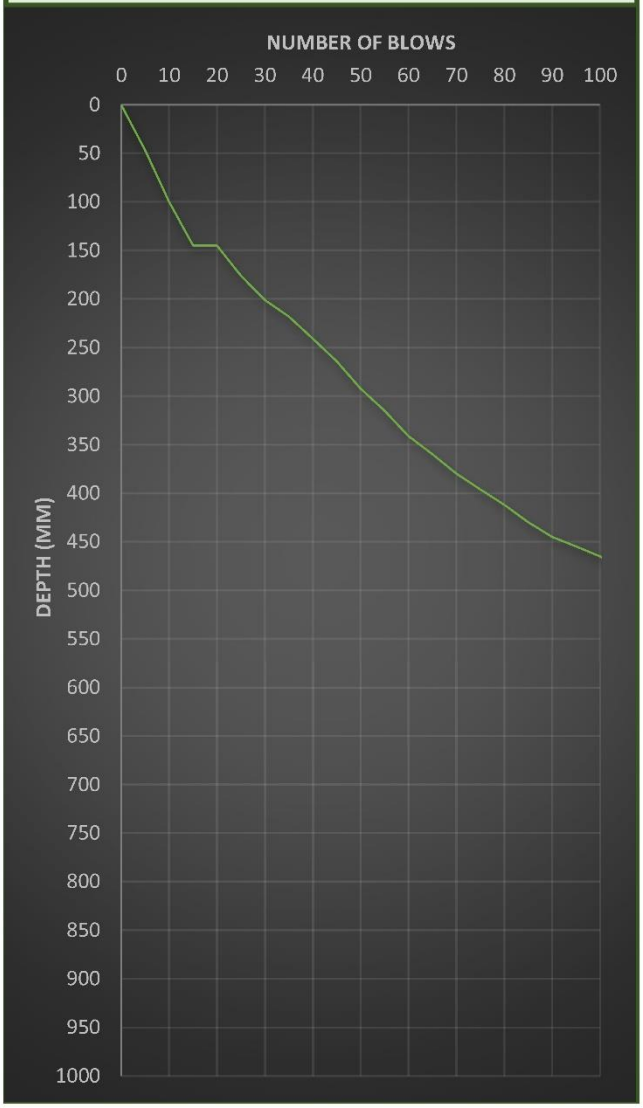
Mampuru Bulk Water Scheme
Tsakane Steel Tank- 250kl

Zutari (Pty) Ltd.

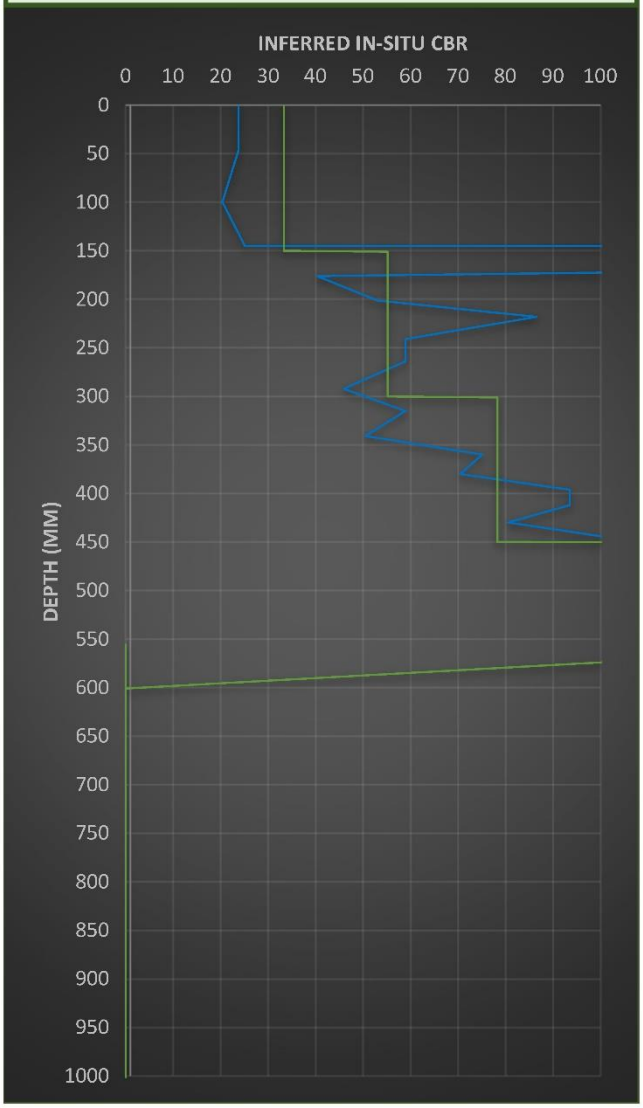
DCP 6

DCP conducted from E.G.L | **Test Date: 25/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
7,2	**4,8**	**3,7**	**2,0**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
33,4	**55,2**	**78,4**	**168,0**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 556 mm

Termination Character: Refusal

Appendix D

Development Reference Tables

Table 8: Geotechnical Constraints in Urban Development (SANS 634:2012)

CONSTRAINT		DESCRIPTOR		
DESCRIPTION		**1 (most favourable)**	**2 (intermediate)**	**3 (least favourable)**
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling depth of less than 750 mm in thickness	Any collapsible horizon or consecutive horizons totalling depth of more than 750 mm in thickness	n/a
B	Seepage	Permanent or perched water table more than 1.5 m below ground surface	Permanent or perched water table less than 1.5 m below ground surface	Swamps and marshes
C	Active soil	Low soil-heave potential anticipated	Moderate soil-heave potential anticipated	High soil-heave potential anticipated
D	Highly compressible soil	Low soil compressibility anticipated	Moderate soil compressibility anticipated	High soil compressibility anticipated
E	Erodibility of soil	Low	Intermediate	High
F	Difficulty of excavation to 1.5 m depth	Scattered or occasional boulders less than 10% of total volume	Rock or hardpan pedocretes between 10% and 40% of total volume	Rock or hardpan pedocretes more than 40% of total volume
G	Undermined ground	Undermining at a depth greater than 200 m below surface	Old, undermined areas to a depth of 200 m below surface	Mining within less than 200 m of surface with total extraction
H	Stability (dolomite land)	Possibly stable	Potentially instable	Known sinkholes and dolines
I	Steep slopes	2-6 degrees	< 2 degrees or 6-18 degrees	> 18 degrees
J	Unstable natural slopes	Low risk	Intermediate risk	High risk
K	Seismic activity	10% probability of an event less than 100 cm/s^2 in 50 years	Mining-induced seismicity > 100 cm/s^2	Natural seismicity > 100 cm/s^2
L	Flooding	n/a	Adjacent to known drainage or channel with slope < 1%	Areas within drainage channel or floodplain

(After Partridge, Wood & Brink, 1993)

Table 9: Rock Mass Rating System as presented by Bieniawski, 1989

A. CLASSIFICATION –PARAMETERS AND THEIR RATINGS									
Parameter			Range of values						
1	Strength of intact rock material	Point-load strength index	>10 MPa	4 - 10 MPa	2 - 4 MPa	1 - 2 MPa	For this low range - uniaxial compressive test is preferred		
		Uniaxial comp. strength	>250 MPa	100 - 250 MPa	50 - 100 MPa	25 - 50 MPa	5 - 25 MPa	1 - 5 MPa	< 1 MPa
	Rating		15	12	7	4	2	1	0
2	Drill core *Quality RQD*		90% - –100%	75% - –90%	50% - 75%	25% - 50%	< 25%		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		> 2 m	0.6 - 2 . m	200 - 600 mm	60 - 200 mm	< 60 mm		
	Rating		20	15	10	8	5		
4	Condition of –discontinuities (See E)		Very rough –surfaces Not continuous No separation Unweathered wall rock	Slightly rough surfaces Separation < 1 mm Slightly weathered walls	Slightly rough surfaces Separation < 1 mm Highly weathered walls	Slickensided surfaces or Gouge < 5 mm thick or Separation 1-5 mm Continuous	Soft gouge >5 mm thick or Separation –> 5 mm Continuous		
	Rating		30	25	20	10	0		
–5	Ground water	Inflow per 10 m tunnel length (l/m)	None	< 10	10 - 25	25 - 125	> 125		
		(Joint water press)/ (Major principal σ)	0	< 0.1	0.1, - 0.2	0.2 - 0.5	> 0.5		
		General conditions	Completely dry	Damp	Wet	Dripping	Flowing		
	Rating		15	10	7	4	0		

B. RATING ADJUSTMENT FOR DISCONTINUITY ORIENTATIONS (See F)						
Strike –and dip orientations		Very favourable	Favourable	Fair	Unfavourable	Very Unfavourable
Ratings	Tunnels & mines	0	-2	-5	-10	-12
	Foundations	0	-2	-7	-15	-25
	Slopes	0	-5	-25	-50	

C. ROCK MASS CLASSES DETERMINED FROM TOTAL RATINGS					
Rating	100 ← 81	80 ← 61	60 ← 41	40 ← 21	< 21
Class number	I	II	III	IV	V
Description	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock

D. MEANING OF ROCK CLASSES					
Class number	I	II	III	IV	V
Average stand-up time	20 yrs for 15 m span	1 year for 10 m span	1 week for 5 m span	10 hrs for 2.5 m span	30 min for 1 m span
Cohesion of rock mass (kPa)	> 400	300 - 400	200 - 300	100 - 200	< 100
Friction angle of rock mass (deg)	> 45	35 - 45	25 - 35	15 - 25	< 15

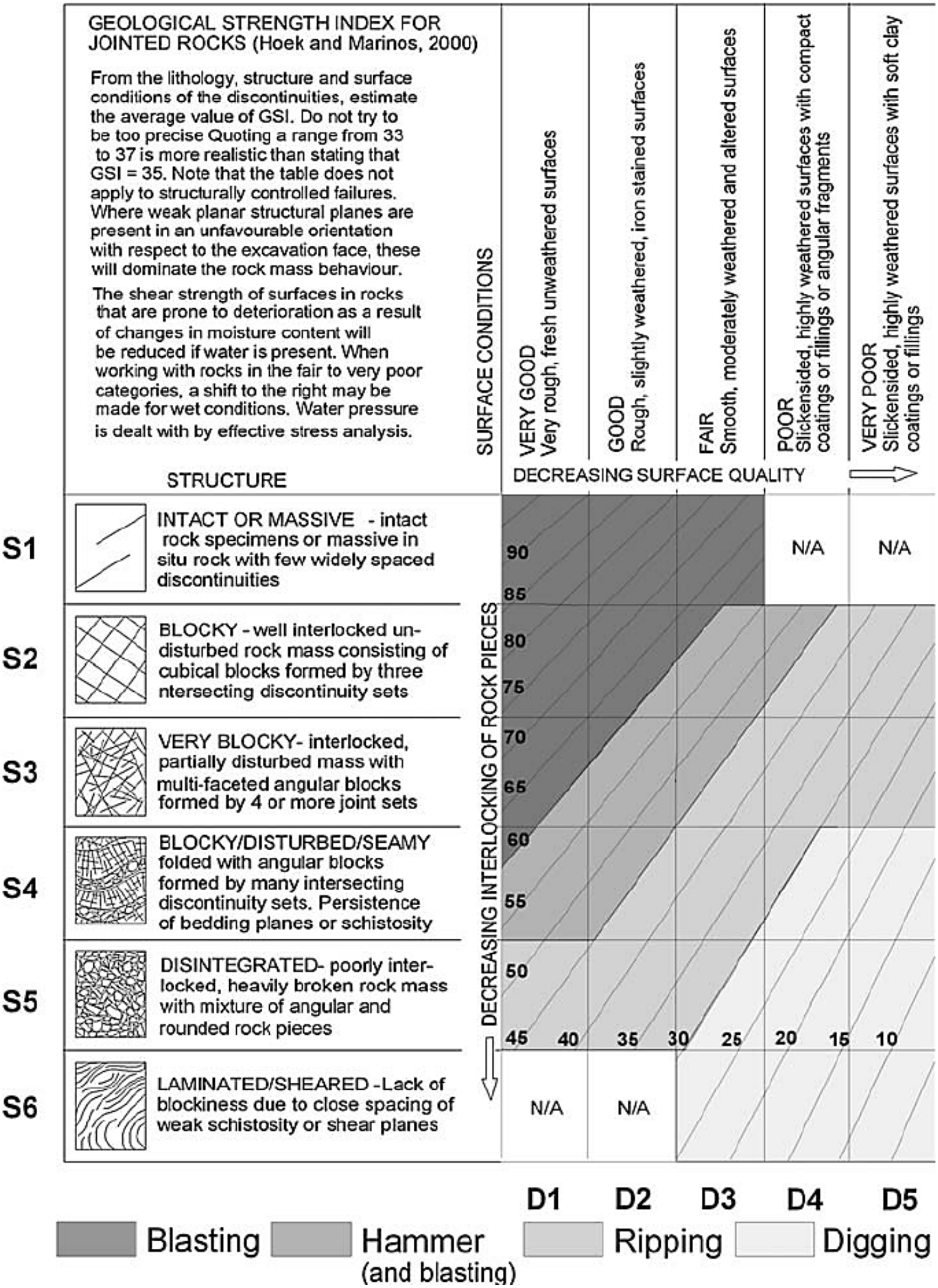
E. GUIDELINES FOR CLASSIFICATION OF DISCONTINUITY conditions					
Discontinuity length (persistence)	< 1 m	1 - 3 m	3 - 10 m	10 - 20 m	> 20 m
Rating	6	4	2	1	0
Separation (aperture)	None	< 0.1 mm	0.1 - 1.0 mm	1 - 5 mm	> 5 mm
Rating	6	5	4	1	0
Roughness	Very rough	Rough	Slightly rough	Smooth	Slickensided
Rating	6	5	3	1	0
Infilling (gouge)	None	Hard filling < 5 mm	Hard filling > 5 mm	Soft filling < 5 mm	Soft filling > 5 mm
Rating	6	4	2	2	0
Weathering	Unweathered	Slightly weathered	Moderately weathered	Highly weathered	Decomposed
Ratings	6	5	3	1	0

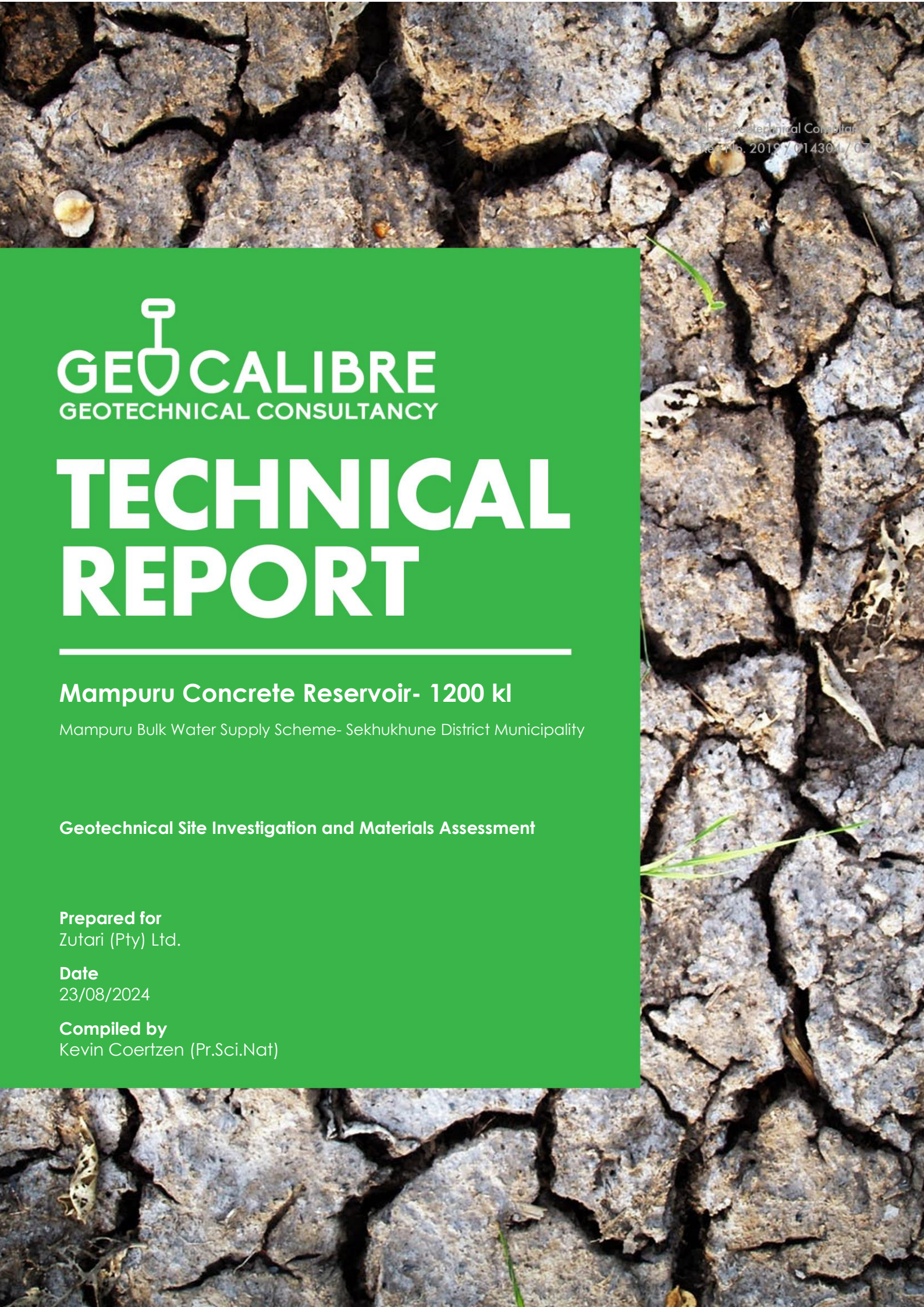
F. EFFECT OF DISCONTINUITY STRIKE AND DIP ORIENTATION IN TUNNELLING**			
Strike perpendicular to tunnel axis		Strike parallel to tunnel axis	
Drive with dip - Dip 45 - 90*	Drive with dip - Dip 20 - 45*	Dip 45 - 90*	Dip 20 - 45*
Very favourable	Favourable	Very favourable	Fair
Drive against –dip - Dip 45-90*	Drive against –dip - –Dip 20-45*	–Dip 0-20 - Irrespective of strike*	
Fair	Unfavourable	Fair	

* Some conditions are mutually exclusive . –For example, if infilling is present, the roughness of the surface will be overshadowed by the influence of the gouge. –In such cases use A.4 directly.

** Modified after Wickham et al (1972).

Table 10: Geological Strength Index for Jointed Rocks (Hoek and Marinos, 2000)





GEOCALIBRE
GEOTECHNICAL CONSULTANCY

TECHNICAL REPORT

Mampuru Concrete Reservoir- 1200 kl

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Geotechnical Site Investigation and Materials Assessment

Prepared for
Zutari (Pty) Ltd.

Date
23/08/2024

Compiled by
Kevin Coertzen (Pr.Sci.Nat)

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Technical Report

GC24/144D

23 August 2024

Mampuru Concrete Reservoir- 1200 kl

Mampuru Bulk Water Supply Scheme- Sekhukhune District Municipality

Project Details

Report Title	Mampuru Concrete Reservoir- 1200 kl
Report Reference	GC24/144D
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Report Compilation and Signatory

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Date	Name	Institution	Version	Format
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1. Project Introduction

1.1. Background

A series of detailed reports have been compiled to shed light on the various phases of the Geotechnical Site Investigation- and associated Materials Assessment- conducted in support of the planned upgrades and additions to the existing **Mampuru Bulk Water Supply Scheme.** The scheme falls under the jurisdiction of the Sekhukhune District Municipality within the Limpopo Province of South Africa.

The formal contract details are as follows:

- **WAS/WSP:** Sekhukhune District Municipality (SDM)
- **Contract Number:** SK08/3/1-30/2017/2018
- **Project Engineers:** Zutari (Pty) Ltd.

Individual reports have been compiled for the planned new **water storage structures** set to form part of the upgrades and additions to the existing bulk water scheme. Separate reports have been created for the planned structures and their access roads, with the various sections in the report referring to specific attributes/routes- for easy reference.

The report breakdown for the project is as follows:

- GC-24-144RS- Regional Setting- Structures and Access Roads
- GC-24-144A- Kalkfontein Command Reservoir- 3000 kl
- GC-24-144B- Tsakane Steel Tank- 250 kl
- GC-24-144C- Dithamaga Concrete Reservoir- 600 kl
- GC-24-144D- Mampuru Concrete Reservoir- 1200 kl
- GC-24-144E- Ga-Phasha Steel Tank- 1300 kl
- GC-24-144F- Spitskop Command Reservoir- 15000 kl
- GC-24-144G- Stoking Concrete Reservoir- 700 kl
- GC-24-144H- Mapodile Concrete Reservoir- 3000 kl

1.2. Terms of Appointment

GeoCalibre Geotechnical Consultancy was appointed by Zutari (Pty) Ltd. (Polokwane Branch) to undertake the required near surface site investigation.

The information presented in this document is based on the information supplied by the Client prior to the commencement of the investigation; therefore, GeoCalibre Geotechnical Consultancy (Pty) Ltd- shall not be held liable for, and is indemnified against all actions, claims, demands, losses, liabilities, costs, damages and expenses prompted by, or in connection with, inaccurately relayed information pertaining to the site and/or the development.

The exact nature and design of the future structures across the greater water scheme were not defined at the time of this study, with this near surface investigation utilising typical attributes of structures of this nature to guide the analysis and corresponding recommendations.

1.3. GeoCalibre- Company Background and Information

GeoCalibre is a specialist geotechnical consulting firm made up of a team of qualified professional geo-practitioners. The firm was established out of a love for the industry and an urge to define a new calibre of professional consulting.

GeoCalibre uses advanced scientific methods to create accurate and reproducible geotechnical models; successfully guiding the implementation of site-specific design precautionary measures/engineering solutions. The methodology followed throughout the investigative process accounts for the nature and location of the development as well as adhering to the standards of our practice (SANS and SAICE).

Investigations undertaken by GeoCalibre are overseen by suitably qualified Engineering Geologists *professionally registered* (Pr.Sci.Nat) with the South African Council of Natural Scientific Professions (SACNASP)- in accordance with all the relevant and required procedures and legislations. GeoCalibres employees are also members of the South African Institute for Engineering and Environmental Geologists (SAIEG).

1.4. Limitations of the Geotechnical Assessment

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an **initial phase near surface geotechnical study**- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The results of this level of assessment provides an overview of the geotechnical character of the site, as well as listing prominent adverse geotechnical characteristics. Once access/mobility has been modified follow-up studies can be conducted, where required.

The presented geotechnical models are based on a data base of available information, on-site soil profiles and the results from soil laboratory tests. Parcels of land within the developmental area which are free of excavations are modelled through interpolation and extrapolation of known testing locations, to identify problem issues of a geotechnical nature on which this report is based.

Geological conditions are seldom uniformly developed and areas and positions where geological and geotechnical conditions on the site might vary locally from those described and assessed in this report.

A centerline and materials assessments primarily focus on near surface attributes along the length of any given linear structure (i.e., access roads and pipelines). The primary aim of such a study is to assess the near surface geotechnical nature of the site in relation to planned development. Shallow and/or basic studies of this nature generally do not include specialist geotechnical studies for attributes such as complex surficial structures, thick fill embankments (existing or future), pipe jacking, natural slope/cutting stability, blasting and/or rock crushing attributes and/or soil/rock mechanics. In depth geotechnical studies across target areas can be undertaken by GeoCalibre as part of follow-up studies.

The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result of either natural processes or human activity. If a substantial lapse of time occurs between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we urge that our report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions.

In addition, advancements in the practice of geotechnical engineering and engineering geology and changes in applicable practice codes may affect the validity of this report. Our investigation did not include the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.

1.5. Development within 1 : 100 year-flood lines

It must be noted that the National Water Act (Act 36 of 1998) states the following regarding development within the 1 : 100 year-flood line of any stream or river (Thompson, 2006): **Section 21(c):** Impeding or diverting the flow of water in watercourses (including alteration of the hydraulic characteristics of flood events) requires licensing according to the Act.

Section 21(i): Any action that may alter the bed, banks, courses or characteristics of watercourses (including flood events) requires licensing according to the Act, including: widening or straightening of the bed or banks of a river to allow for the construction the housing development and altering the course of a river partially or completely (i.e.: river diversion) to be able to use or develop the area where the watercourse originally was.

The National Water Act does not prohibit development within 1 : 100 year-flood lines; however, the Act requires detailed analysis of the effects of the proposed development on the surrounding environment, with special reference to surface and sub-surface water flow. The Act requires that suitable precautionary measures be implemented to limit the effect within and downstream from the proposed development.

1.6. Codes of Practise and Investigative Standard

The investigation was carried according to the following standard practice codes and guidelines:

- Guidelines for Urban Engineering Geological Investigations (SAIEG & SAICE, 1997) for urban development.
- Site Investigation Code of Practice put forward by the Geotechnical Division of SAICE (2010).
- SANS 2001-DP1:2011 Earthworks for buried pipelines and prefabricated culverts.
- SANS 10400.
- Applicable technical specification documents of South Africa (TRH, TMH, COLTO/COTO and SAPEM).
- The guideline and specification documents by the South African Institute of Engineering and Environmental Geologists (SAIEG) and South African Institution for Civil Engineers (1997), AEG/SAIEG/SAICE (2002) were consulted.

1.7. Information Sources

- **Geological Map:**
  - Geological Series Map 2430 Pilgrim's Rest; scale 1:250 000 (digital format)
- **Hydrogeological Data:**
  - SADC Groundwater Information Portal (SADC GIP)
  - Hydrogeological Series Map 2330 Phalaborwa (1998); scale 1: 500 000 (digital format)
  - Electronic Maps of the Water Management Areas and Drainage Regions in South Africa- DWAF [Department of Water Affairs and Forestry]- 1996 and 1999 (www.dwa.gov.za).
- **Topocadastral maps:**
  - 2429 Dd; scale 1:50 000 (digital format)
  - 2430 Ca; scale 1:50 000 (digital format)
  - 2430 Cc; scale 1:50 000 (digital format)
- **Provided by the Client:**
  - Structure location and planned access road route
- **Remote Sensing Information:**
  - Google Earth Pro ™
  - Planet GIS Limpopo Cadastral Land Layer (2022)
- **Available geotechnical reports:**
  - Numerous geotechnical reports from the region compiled by Kevin Coertzen (Pri.Sci.Nat and MSAIEG)

1.8. Scope of the Investigation

A near surface geotechnical site investigation was carried out across each of the areas in question in order to assess the mechanical nature of the underlying strata and model the geomorphological nature of the local setting. Following the assessment, GeoCalibre provides recommendations on the implementation of **site-specific engineering solutions.**

The aim of the overall site investigation can be summarised as follows:

- Establishment of a **regional geological, geomorphological** and **geo-technical** model for the site.
- To delineate the **succession of strata** (soil and rock) underlying the site; with the identification of problematic **physical, chemical** and **mechanical** characteristics which may influence the development.
- To quantify the **in-situ mechanical properties** of the soft materials underlying the site; specifically, with regards to the proposed future developments.
- To compute the **excavatability properties** of the materials underlying the site.
- To assess shallow **groundwater** patterns.
- To evaluate the basic **re-usage potential** of the materials underlying the site.
- To aid the development moving forward through the formulation of an **accurate geotechnical model** for the site under investigation.

The near surface site investigation was undertaken in order to assess the basic engineering geological character of the site, focussing on the geotechnical properties which will affect the development potential of the area in question with regards to the **installation of civil engineering services** and the construction **surficial water storage structures** and their associated **gravel access roads**.

The investigation excludes the following aspects, where applicable:

- Geophysical, resistivity, or corrosion studies.
- Dolomite stability or undermining Investigations
- Detailed hydrological, hydropedological, hydrogeological, pedological, flood line, or wetland delineation studies.
- Excavations by means of light/heavy earth moving equipment and associated soil and/or rock sampling.
- Footprint studies along the pipeline routes for the various water treatment works, pump stations, river crossings and pipe jacking sites.
- Borehole drilling and/or rock strength analysis.
- Detailed slope stability assessments.
- Geo-environmental assessments.
- Township establishment/land rezoning (SANS 634).

1.9. Investigative Methodology

The investigation is undertaken in a number of phases in order to achieve the aims discussed above. The investigative phases are as follows:

- **Phase 1: Introduction and Regional Assessment of the Site**
- **Phase 2: Geotechnical Analysis- Structures**
- **Phase 3: Geotechnical Analysis- Access Roads**
- **Phase 4: Data Assessment and Report Compilation**

1.9.1. Phase 1: Introduction and Regional Assessment of the Site

The collation and evaluation of all the available topographic, geo-morphological and geological data across the investigated site and its' surroundings. This assessment is done through the use of available regional maps and remote sensing images.

This section of the report will include a description and summary of the site's nature, based on existing literature, and is supplemented with the compilation of a series of base maps.

1.9.2. Phases 2 and 3: Geotechnical Analysis

Phases 2 through to 4 shared a similar methodology (presented below); with the distribution of testing locations, depth and nature of sampling/testing and footprint specific geotechnical observations at any given portion of the site relating to the nature of the planned structures at said location.

Trenching

The field work phase of the investigation was conducted by GeoCalibre across June and July 2024.

Access to- and mobility- across the target areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by **hand** across the footprints of the planned structures and along the routes of the various access roads.

Across the various sites, between TWO (2) and TEN (10) test pits were excavated by means of **pick-and-shovel** (local labour digging by hand). A total of **50 test pits** were excavated across the greater project area.

Additionally, where applicable, available **exposures/cuttings** situated within close proximity to the various sites were logged and sampled. In many cases, the local cuttings provide greater exposures- both laterally and vertically- of the in-situ materials as compared to the small hand excavated trial pits.

Test pits were distributed across the various sites placed at locations chosen on merit to map and model variances in the underlying strata. Test pit locations were primarily based on the Client's specific outcomes (footprint analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model. Following a detailed site walkover and associated existing services' mapping exercise, planned trial pits were adapted on ground level.

The succession of soil layers exposed within the test pits and exposures were logged by GeoCalibre. The description of soil profiles is done according to SANS 633:2012 which describes the moisture, colour, consistency, structure, (soil) texture and origin. Following detailed logging, a series of detailed photographs were taken of the different soil layers.

Table 1 below presents a breakdown of the trial pits excavated across the various water storage structure and access road sites.

Table 1: Trial Pit Breakdown

Trial Pit Breakdown- Structures and Access Roads			
Description	**Storage Capacity (kl)**	**Access Road Length (m)**	**Combined Quantities**
Kalkfontein Command Reservoir	3000	360	6
Tsakane Steel Tank	250	500	6
Dithamaga Concrete Reservoir	600	-	2
Mampuru Concrete Reservoir	1200	500	7
Ga-Phasha Steel Tank	1300	480	6
Spitskop Command Reservoir	15000	2330	14
Stoking Concrete Reservoir	700	1190	9
Mapodile Concrete Reservoir	3000	500	7

Sampling

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development. Laboratory testing commenced on the samples collected during the field work phase of the investigation.

Undisturbed sample extraction was not possible/feasible across the various sites as a result of the granular nature and elevated consistency of the foundation zone materials. For this reason, the mechanical assessment of subsoils will be based on the available disturbed soil test results and field observations (i.e., structure, composition, and consistency).

Laboratory Testing

Standard foundation/road indicator and soil compaction tests were conducted by Tzaneen Lab (**SANAS Accredited- 17205**) on disturbed and bulk soil samples.

These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the proposed construction. The following tests were conducted:

I. Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage)- (SANS 3001: GR10/11)

II. Particle-size Distribution (SANS 3001: GR1)

III. Maximum Dry Density vs. Optimum Moisture Content (SANS 3001: GR30)

IV. Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method) (SANS 3001: GR40)

V. pH and Electrical Conductivity (chemical testing)

In-situ Testing- DCP Testing

In-situ penetration tests were conducted alongside and between the excavated test pits in order to determine the quantitative soil consistency conditions.

Standardised DCP tests (8 kg hammer falling 575 mm with a tip/cone of 60°) were implemented as to give an indication of the consistency of the in-situ material of the layer house in question. Soil strength and stiffness are correlated with consistency of earthy soil material and penetrometer testing is used to determine the consistency of both cohesive and non-cohesive materials.

In the design of light structures and roadways, the DCP is a practical test used for onsite measuring of material strength. The test results can be correlated with the California Bearing Ratio (CBR) by applying a formula; results of which can be correlated to the laboratory tests conducted on the soils from the same location. Furthermore, an inferred depth to bedrock can be modelled using the DCP refusal depths. Although not exact, these depths aid in formulating a regional excavation model across the development area.

1.9.3. Phase 4: Data Assessment and Report Compilation

The investigation concluded with the compilation of numerous technical reports detailing the methodology utilised during the study and the summarised results obtained. This includes a potential geotechnical evaluation of the site based on the cumulative results of the near surface investigation.

2. Description of the Environment

2.1. Site Location and Description

The **study area** for this investigation is seen to fall within the southern to south eastern portions of the Limpopo Province of South Africa- proximal to provincial border with Mpumalanga. On a more localised scale, the study area is situated approximately 12 km south west of the mining town of Steelpoort (Figure 1). Furthermore, the study area is positioned across the Remaining Extent (RE) of the Farm De Goede Verwachting 332 KT, within the bounds of the Fetakgomo Tubatse Local Municipality of the greater Sekhukhune District Municipality.

The site forms part of the upgrades and additions to the existing **Mampuru Bulk Water Scheme,** which is a strategic water project from SDM that supplies water to the various end users across the Steelpoort Valley. The portion of land forming the focal point of this investigation is located in the central extent of the cumulative study area.

More specifically, the **site** is strategically positioned along the side slope of a prominent mountainous terrain, which forms the north western boundary of the village of **Mampuru**. The village in question is situated along the District Road 1392 (D1392). Following the D1392, the unnamed gravel road network of the village will need to be navigated to access the cumulative site. The condition of the various gravel roads is anticipated to deteriorate following prolonged precipitation events across the local setting.

The **site** was primarily investigated to assist with the design and construction of a **1200 kl concrete reservoir structure**. Additional to the planned reservoir, the development includes the construction of a **winding access road**, with a length of approximately **500 m**.

The footprint of the planned development was not defined on ground level attributed to the **undeveloped** nature of the site, with the Client providing a pin location delineating the centre of the proposed reservoir and associated path for the future gravel road set to form its primary access route during construction and subsequent stages.

The planned **starting point (0+000)** of the access road is located at the high-lying northern outskirts of the village and extends from an existing gravel road towards the proposed reservoir location- situated in a general north westerly direction.

Moreover, the access road climbs the steep sloping flanks of the mountainous terrain in a meandering fashion, on-route to the proposed reservoir location. Moreover, the road hosts multiple 180-degree hairpin turns at ~0+145 and ~0+320 resulting from the natural slopes along its length. The **termination point of ~0+500** is achieved as the road approaches the structures' planned **footprint** from the south west.

The access road's shape- as presented by the Client- represents an attempted optimisation of the infrastructure across the complex topographic setting, including attributes such as road length/footprint, modification requirements, usability constraints and budget considerations, to name a few.

Refer to Image 1 at the end of this section which graphically depicts the breakdown of the site and its cumulative attributes. The defined points of interest across the site- as received from the Client- are presented in Table 2A and 2B.

Table 2A: Points of Interest

Mampuru Concrete Reservoir- 1200 kl- Points of Interest			
Points of Interest		**Co-ordinates**	
Access Road	**0+000**	Latitude 24.794055°S	Longitude 30.099054°E
	0+500	Latitude 24.792273°S	Longitude 30.098664°E
Reservoir Location		Latitude 24.792289°°S	Longitude 30.098676°E

Table 2B: Test Pit Breakdown

Mampuru Concrete Reservoir- 1200 kl - Test Pit Breakdown		
Description	Test Pits	Chainage
Access Road	Start	0+000
	EXP1	0+040
	TP1	0+080
	TP2	0+130
	TP3	0+330
	TP4	0+440
Reservoir Location	TP5	0+490
	TP6	0+500
	End	0+500

The cumulative development across the surface will encompass the subdivision of this land portion into various land-use zones i.e., infrastructural units, roadways, and services etc. Each of these zones may require their own set of unique geotechnical recommendations determined by the properties of the in-situ material. The geotechnical properties of these separate areas/attributes are dealt with individually in the succeeding sections of this report- as follows:

- Section 3: Combined Terrain Analysis
- Section 4: Geotechnical Evaluation- 1200 kl Concrete Reservoir
- Section 5: Geotechnical Evaluation- Access Road

Report GC-24-144-RS covers the **regional attributes** of the study area, including detailed discussions regarding the topographic setting, regional geology/ hydrogeology, vegetation and local cuttings across the visited villages. Although alluded to, these attributes are not duplicated in this document.

2.2. Site Observations

Numerous observations were made by the field team with regard to the current condition of the investigated site. These observations are graphically depicted in the photo series to follow at the end of the discussion.

The following basic notes were highlighted by the field team:

- **Slope:** the site exhibits a complex topographic setting, with its predominant very steep to steep sloping morphology limiting mobility.
    - The morphology of the area was seen to exhibit a gradual decrease in declivity with an increased distance from the zenith of the mountainous terrain.
    - Various small-scale topographic anomalies in the form of minor ridges and/or depressions were seen to traverse the side slope of the prominent mountainous terrain, specifically surrounding the western-most hairpin turn of the access road. The scale of these anomalies is too small to be indicated on Image 2.
    - Other than the local depressions mentioned above, no major erosional landforms were encountered across the surface of the site. The rocky surface in conjunction with the natural vegetation is predicted to retard surface water flow just enough in order to prevent erosion from occurring. Following manipulation of the surface of the site and removal of vegetation, the possibility of erosion/deformation greatly increases.
- **Rocky/Bouldery Surface and Outcrops:** as seen across the majority of investigated reservoir locations, the surface of the site exhibits a rugged morphology comprised mainly of irregularly shaped outcrops with the frequent occurrence of surficial cobbles and boulders.
    - The rough terrain is anticipated to result in significant mobility/access and excavatability issues across the site, specifically during the initial phases of construction.
    - The possibility of dislodged cobbles/boulders from further upslope following disturbance of the natural conditions should not be overlooked in order to ensure a safe working environment.
- **Vegetation and Biotic Activity:** the flanks of the mountainous terrain are intermittently covered by distinct yellow-green bushes/shrubs. Pockets of vegetation are generally separated by outcrops/boulders.
    - Larger flora species are generally absent across the investigated portion of the side slope.
    - No significant biological activity was encountered across the site attributed to the steep nature of the area.
- **Existing Infrastructure:** although the area exhibits a predominantly undeveloped nature, some noteworthy structures were encountered.
    - A reservoir is located roughly 25 m north of the proposed access road at a chainage of approximately 0+195. This water storage structure was not investigated in detail but was seen to be cut into slope with the cutting measured to be less than 2 m deep.
    - Moreover, the exposed cut face is comprised of weathered gabbro bedrock which displays a variable weathering profile with minimal blanketing transported material.
    - The inclination of the cutting was not measured but was seen to exhibit a near vertical morphology. Based on the exposed volume of bedrock visible in the cutting and surrounding bedrock outcrops, the reservoir is perceived to be founded solely on weathered bedrock. The exact size, shape and capacity of the reservoir is unknown.

- The spacing between the exposed cut and reservoir structure is small with no visible buffer zone for dislodged particles.
- Furthermore, various wire fences traverse the proposed access road and will need to be addressed in the initial phases of construction. It is envisaged that other basic/derelict infrastructure may be obscured by the natural vegetation and rocky surface.
- Lastly, a small livestock enclosure is located just upslope from test pit TP4 (0+440) and may need to be removed due to its proximity to the planned access road's footprint.

Refer to the photo series below which graphically depicts the nature of the site and its immediate surrounds at the time of this study.












Image 1: Site Breakdown- Mampuru Concrete Reservoir and Access Road



2.3. Regional Geology

According to the available geological information (geological series map: 2430 Pilgrim's Rest); the proposed reservoir location and access road are underlain by the following geological units (Figure 2):

1. "**Q**"- Surficial deposits including **alluvium** and **scree.**
2. "**Vdj**"- Coarse-grained **gabbro** and anorthosite with localised anorthosite layers, pyroxenite and magnetite plug- **Dsjate Subsuite** of the *Rustenburg Layered Suite*.

A detailed discussion regarding the regional geological setting and its associated attributes is presented in report GC-24-144/RS.

Following the excavation of the trial pits, it was noted that the site is blanketed by transported sediments of **colluvial origin**. Moreover, the surface of this horizon was notably rocky with surficial cobbles/boulders frequently encountered along the steep sloping flanks of the mountainous terrain.

The blanketing sediments were generally underlain by weathered bedrock- with the accurate determination of the properties of the rock mass not possible due to its limited exposure and weathered state. Based on available exposures, the rock mass underlying the site is deemed to be **gabbro** of the Dsjate Subsuite.

A **minor geological structure** in the form of an inferred linear feature (inferred from aeromagnetic data) is mapped in the vicinity of the proposed reservoir location (~350 m to the north). Due to the nature of the conducted investigation- shallow excavations dug by labourers using picks and shovels- the presence of this or similar features could not be validated underlying the site. The existence and impact of these large/regional geological structures on the development can be addressed during bulk excavations/site remoulding operations.

2.4. Vegetation and Biotic Activity

At the time of this investigation, the vegetation across the site was comprised of abundant shrubs/bushes separated by boulders/outcrops. The vegetation across the area displayed a distinct green/yellow colour with larger flora species sparsely encountered.

In the exposed profiles, the degree of organic material and biotic activity was seen to decrease with an increase in depth, with the major root system reaching an average depth of approximately **0,34 m** below natural ground level.

Regarding bio-engineering, the natural vegetation cover protects the slope from erosion (run-off and rain splash) and serves as a anchoring mechanism to reduce the possibility of shallow seated slope instabilities.

No significant biological activity was visible across the site generally attributed to the ongoing human activities across the region.

3. Basic Terrain Analysis

3.1. Site Topography

Topography is based on elevation profiles from the available remote sensing information and basic field observations. This does not substitute land survey data. Topography and regional hydrology (e.g., steep slopes, very flat slopes, defined drainage features, and rapid changes in slope) affect the distribution of ground as it affects the weathering, erosion, transport, and deposition of materials. As such, it provides a valuable indication of possible changes in subsurface ground and water conditions, but also affects the stability of slopes and the direction of surface runoff.

As seen in the annotated topographic map below (Image 2); the north western portions of the study area are seen to exhibit a **high-lying** topographic nature in the form of a prominent mountainous terrain. The mountainous terrain serves as the **watershed feature** for the study area and its immediate surrounds. The orientation and extent of the watershed feature directly impacts the geomorphological nature of the site in question.

Furthermore, the **natural slopes** (yellow arrows) extend **radially** from the mountainous terrain, towards the surrounding low-lying areas (green and blue contours). As can be seen by the increased spacing of the contours and overall decreased range in elevation towards the south east, the declivity of the terrain gradually reduces with an increased distance from the mountainous landscape.

Refer to Image 2 below which graphically depicts the topographic nature of the study area and its immediate surrounds.

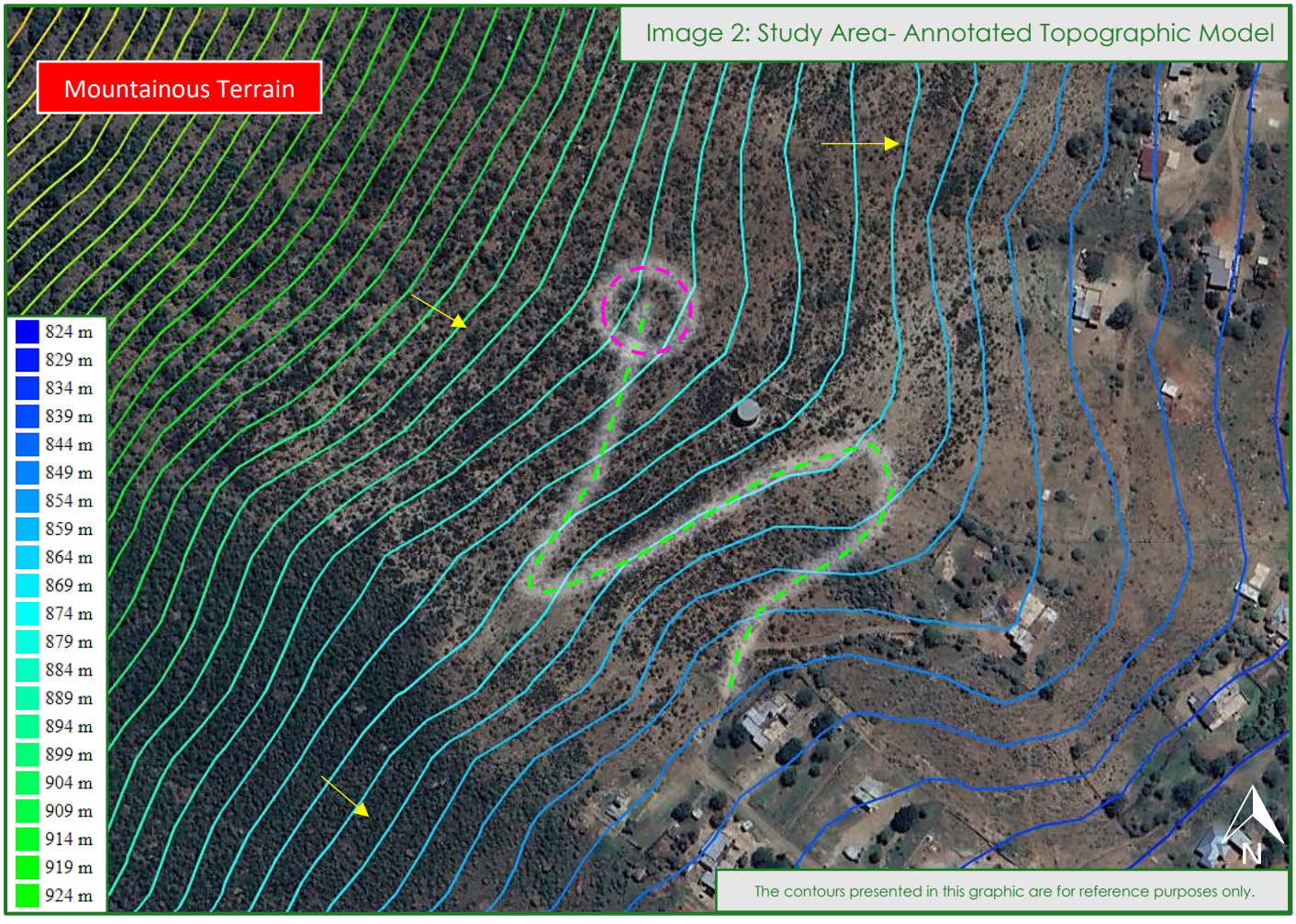


Image 2: Study Area- Annotated Topographic Model

With reference to Image 2, the **planned reservoir- and associated access road-** are located along the very steeply to steeply sloping south eastern slope of the mapped high-lying terrain. Consequently, the **natural** topographic nature of the site can be largely characterised by **very steep to steep slopes** in **excess of 12 degrees** (natural)- extending from the higher lying areas to the north west- towards the low-lying south eastern portions.

The proposed meandering shape of the road serves as further evidence for the steeply sloping nature of the site. The road exhibits an overall continuous increase in elevation with an increase in chainage as it rises upward towards the planned reservoir location.

The lowest surface elevation of ~ 850 meters above mean sea level (MAMSL) is recorded at the access road's starting point (far southern portions). The surface elevation increases in a generally northerly to north westerly direction towards the routes' termination point- proximal to the reservoir location- with a surface elevation of ~897 MAMSL (calculated using Google Earth PRO ™).

Localised slope variances were encountered due to the occurrence of small-scale natural anomalies such as minor depressions surrounding the western-most hairpin turn of the access road. These minor variances further increase the complexity of the topographic and drainage attributes of the site.

Once surveyed, topographic anomalies will need to be addressed individually in the engineering design and in so doing eliminating their localised effects. Based on the available information, the development will entail the rehabilitation of the sites surface- within and immediately surrounding the planned future structures and roadways.

3.2. Drainage Attributes

The drainage nature of the study area will mirror its' topographic nature as described in Section 3.1 of this report. The crest of the mountainous terrain- located to the north west of the site- will serve as the **primary watershed** feature for the site and its immediate surrounds.

Developments of this nature typically include the rehabilitation/remoulding of the site's surface. As a result of the sites complex topography and geographic location, the design and implementation of **fit-for-purpose site modification and drainage measures** are essential for the stability and longevity of the development. Future anthropogenic attributes will influence natural infiltration, shallow throughflow and run-off rates. Importance should be placed on surface drainage and storm water control measures to avoid instabilities, focused infiltration, surface water ponding and erosion.

Addressing the concerns surrounding the **convergence** of surface water upon the site- originating from further upslope- is key to the stability and longevity of the development as a whole. Convergent high-energy flow upon the site from the surrounding high-lying terrain elevates the rate/energy of surface water flow- increasing the risk of erosion and instability of future cuts.

The cumulative **developments orientation** in relation to the natural slopes- specifically with regards to the meandering access road- will impact the rate and associated energy of the overland flow. Topographic anomalies identified during the professional survey can be addressed individually in the design.

Across most of the sites' footprint, due to the **very steep to steeply sloping nature**, it will drain mainly by means of **high energy surface run-off (sheet-flow);** with storm water flowing from the high lying north western portions of the site, in a general south easterly direction. Most of the access roads' route was seen to traverse the natural slopes at an **obtuse angle**, with **medium to high energy surface water flow,** expected to take place **along the length of the road**. The anticipated high energy run-off across the sites' footprint elevates the risk of erosion as well as the instability of slopes following modification.

Conversely, where cuts/platforms or terracing are implemented to modify the sites surface, these **artificially induced very gentle/gentle sloping** portions will drain mainly by means of **low energy surface run-off (sheet-flow).** These portions of the site will be subjected to elevated degrees of **surface water infiltration** into the underlying soils, rather than rapid surface water flow, accentuating **surface water ponding** and **fluctuating moisture conditions** after precipitation events. Furthermore, the sudden decreased rate of surface water flow from the steep portions and cuttings to anthropogenically induced flat slopes/platforms may result in a combination of focused infiltration and piping/erosion.

The planned infrastructure is located downslope of currently undeveloped land. Although generally very steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of shallow ground water throughflow may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

According to the available information (Topocadastral Maps 2430 Cc- Figure 3), **no** natural drainage structures are seen to traverse the site.

Lastly, various topographic anomalies were encountered across the site- with the most significant occurrence along the western portions of the site where the road executes a hairpin turn. These anomalies are generally in the form of small-scale depressions which may act as preferential flow paths with high-energy convergent flow resulting in the formation of erosional landforms. Due to the scale of these features, they are not visible on Image 2. Although not mapped to host stream channels, temporary convergent flow can be expected across this- and similar- features.

3.3. Erosion

As a result of the sites' natural slope, erosion will be a concern. Localised minor erosional landforms were encountered across the side slope of the mountainous terrain. These features are typically in the form of small-scale depressions as mentioned in the preceding section and are generally obscured by the natural vegetation and rocky surface of the site. The formation of major erosional landforms is predicted to be mitigated by the the stabilising effect of the natural vegetation and retarding effect of the rocky/bouldery surface on flow. Once the vegetation and surficial cobbles/boulders are removed following site preparation, the risk for erosion will greatly increase.

According to the TRH20, the ability of the material to resist/avoid erosion depends on the shear strength of the material which is equal to the cohesion of the material as no normal stress is applied to the blanketing materials. If the attractive force of the water is greater than the shear strength of the material, then erosion will occur.

The following are generally accepted findings on the relationships between different properties and erodibility parameters of soil:

- An increase in percentage clay, accompanied with an elevated cohesion, leads to an increase in erosion resistance.
- In general, an increase in PI leads to an increase in erosion resistance.
- Fine, poorly graded material with limited coarse particles (grading coefficient of less than 16) are highly susceptible to erosion.
- High energy channelized flow surface water flow will elevate the risk for erosion and scouring/undercutting across the footprint.
- Steep/converging slopes increase flow velocities/volumes and as such decrease erosion resistance.
- Dispersive soils tend to be less erosion resistant.
- Erosion may cause changes in the properties of the material over the design life as certain fractions are removed.

Inadequate temporary erosion and drainage control measures can result in severe damage to infrastructure. The following can be done to **minimize erosion** of problematic soils during and following the planned construction:

- Erosion can be reduced by elevating the shear strength of the material by increasing its compaction and ensuring a well-graded mixture of material resulting in increased particle interlock. The improved interlocking increases suction forces within the material and decreases permeability/penetrability.
- Intercept or minimise surface wash towards the future infrastructure from upslope areas. The energy of the water can be decreased by retarding the rate of flow using good drainage measures.
- Drainage measures at regular intervals along newly constructed roads, with these drainage systems designed in such a way so as to reduce erosion across the outflow/discharge areas.
- Depressions created along the steep sloping routes may act as preferential flow paths following precipitation- with the channelised flow inevitably resulting in the formation of erosional landforms.
- Trench backfills and shoulder materials should be modified to an equivalent compaction/density of surrounding soil- in so doing controlling the natural infiltration/through flow characteristics of the regional materials (i.e., eliminating irregularities).
- Consider treating dispersive subsoils with gypsum prior to compaction and/or backfilling to minimise risk of tunnel erosion- along the road shoulder and back filled pipeline routes.

Lastly, a maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.

3.4. Natural Slope and Future Cutting Stability

Detailed stability assessments of existing- and future- deep cuttings did not form part of the scope of this initial phase investigation. With this said, **no natural** slope instabilities or inherent ground instability signs such as tension cracks etc. were evident during the site walkover and basic visual inspection.

Across most of the site, excluding the localised mobilisation of cobbles and gravels, it is envisaged that temporary shallow trenches and/or cuttings to depths of up to 1 m will remain stable- the stability of which can be assessed periodically. Where thick successions of the heterogeneous colluvium are encountered, minor collapse in the form of dislodged particles may occur.

The final layout of the development is not known but based on the natural slopes prior to modification, specialised methods for the stabilisation of cuts into the existing slopes are deemed necessary. It is predicted that the extent of the required cuttings will be considerably less than that of the larger command reservoir structures. Cutting depth is an important parameter which impacts future slope stability, with deeper/extensive cuts requiring specialist stabilisation techniques (benching, various cutting angles pertaining to materials of different origins/stability, retaining walls, etc.).

If the proposed reservoir is to exhibit a similar size and shape as the existing reservoir, major cuttings are not expected. As mentioned in the site observations section of this report, the depth of the existing cutting is less than 2 m. Moreover, due to the thickness of blanketing colluvium (average ~0,34 m) the possibility of localised particle failure will be reduced- particularly if this material is adequately sloped- reducing the necessity for a large buffer zone.

It is recommended that specialist geotechnical investigations for major cuts be undertaken by a competent person as part of design level studies. Where possible, detailed face mapping and joint line surveys can be undertaken along freshly created cuttings.

In contrary to the problematic colluvial sediments, the local igneous rock masses are not generally prone to major instabilities based on the available theoretical databases and as seen in local cuttings. Although it is predicted that fresh exposures in bedrock exhibit stable conditions in near vertical cuts (depending on orientation), it is recommended that the permanent cuttings be adequately sloped (approximately 60 to 75 degrees) or stabilised to reduce the risk of instabilities. Instability in these igneous bodies is predicted to be in the form of localised rock block failure, necessitating the removal or stabilisation of unstable rock blocks. Though rare, problematic joint sets/features can be present especially surrounding geological structures.

As a guide, where major deep cuts/thick fills are implemented to modify the sites surface, cut/fill embankments will need to be adequately sloped, modified or stabilised- and vegetated where possible- to ensure long-term stability in saturated conditions. Soil slope modification methods/considerations may include- but are not limited to- the following:

- Visually identifying and alleviating local boulders/debris in the vicinity of the planned cuttings. Caution taken during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/infrastructure or life.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.

- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability. Therefore, adequate drainage measures need to be implemented for major cuttings.
- Modifying the slope geometry by reducing the slope angle, removing weight from the slope head, increasing weight at the slope toe and/or constructing of benches or berms.
- Constructing walls or other retaining elements (reinforced earth walls, gabion walls, loffelstein walls).
- Surface protection measures including wire meshes, geotextiles and using plant cover to help reinforce the ground surface of soil slopes.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the road/reservoir shoulder.
- All cuttings should be periodically assessed by a geo-professional or competent engineer.
- No loading of the temporary slopes by machinery, equipment, excavated soil or materials shall be allowed.

Due to the site gradient- cut to fill site preparation is expected. A carefully engineered fill embankment should not settle more than 0.5% of its height due to self-weight. Density control of placed fill material should be undertaken at regular intervals during fill construction. Engineered fill slopes should be over constructed and thereafter trimmed back to the required position.

4. Geotechnical Evaluation- 1200 kl Concrete Reservoir

4.1. Introduction and Description

This section of the report focusses on the geotechnical attributes within proximity to the predetermined footprint of the planned **reservoir**- hereafter referred to as the **site.** Attributes surrounding the planned access road route will be addressed in the subsequent section (Section 5).

A pin location defining the centre of the planned structure was provided by the Client prior to the field work phase of the investigation. The final working levels/layout of the development is not known at this stage, with this study utilising typical attributes of structures of this nature to guide discussions.

Access to- and mobility- across the target areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by **hand** across the footprint of the planned structure. The presented geotechnical model is based on a data base of available information and available on-site exposures.

4.2. Trenching

The field work phase of the investigation was conducted by GeoCalibre in June 2024. Across the reservoir site, a total of TWO (2) test pits (TP5 to TP6) were excavated using labours digging by **hand** (pick-and-shovel method), to a depth of approximately 1.0 meters below the existing ground level, or refusal.

Trial pit placements were undertaken in such a way so as to create an accurate and reproducible site-specific geotechnical model. Test pit locations were primarily based on the Client's specific outcomes (foot print analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model.

A *Geologist* supervised the excavation of the trial pits. The description of the exposed ground profile is done according to SANS 633:2012 and describes the moisture, colour, consistency, structure, (soil) texture and origin. The soil profile is described according to the following parameters:

- **Moisture** dictates the colour and consistency of soils and indicates how and where water moves and the depth to perched water systems.
- **Colour** indicates the oxidizing or reducing state of soils and assist in the identification of minerals in completely weathered to fresh rock.
- **Consistency** is separated between cohesive and granular as the drainage and permeability affects the soil's shear strength.
- **Structure** describes any relict features from rock or soil and those that form through packing, soil and rock structures, seepage, reworking/biotic action.
- **Texture** is the abundance of different grain sizes in soils and is described by means of field test.
- **Origin** is the formation of the soil by means of transport of weathering.

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development.

4.3. Generalized Ground Profile

Note: this description is based on field observations and does **not** reflect the results of any laboratory tests.

4.3.1. Introduction

During the trenching phase of the investigation, it was noted that the investigated area is generally blanketed by an organic-rich horizon of gravity transported material- profiled as **colluvium**.

The blanketing sediments were underlain by **varying degrees of weathered gabbro bedrock** deemed to be in the late stages of rock decomposition/early stages of soil formation. The formation of residual soil is generally limited across the steep sloping flanks of the mountainous terrain/site due to the reduced amounts of infiltrating water- with the majority of the overland flow converging downslope towards the low-lying areas.

Due to the location of the site proximal to the base of the high-lying terrain, the degree of weathering across the steep slopes is generally amplified as seen in the variable/fluctuating weathering profile of the exposed bedrock. The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock. Moreover, based on the limited exposures, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material. Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and continuity.

Lastly, pedogenic inclusions in the form of calcification staining and calcrete nodules were encountered within the weathered material. These pedogenic inclusions can be attributed to infiltrating water and subsequent alteration/ weathering of the calcium-rich minerals in the rock mass.

In depth soil profile descriptions for each test pit location are presented in **Appendix A.**

The information presented in the sections to follow is based on point data. Every effort was made during the site investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. Variances in soil quality and quantity from those predicted may be encountered during construction and these should be recorded.

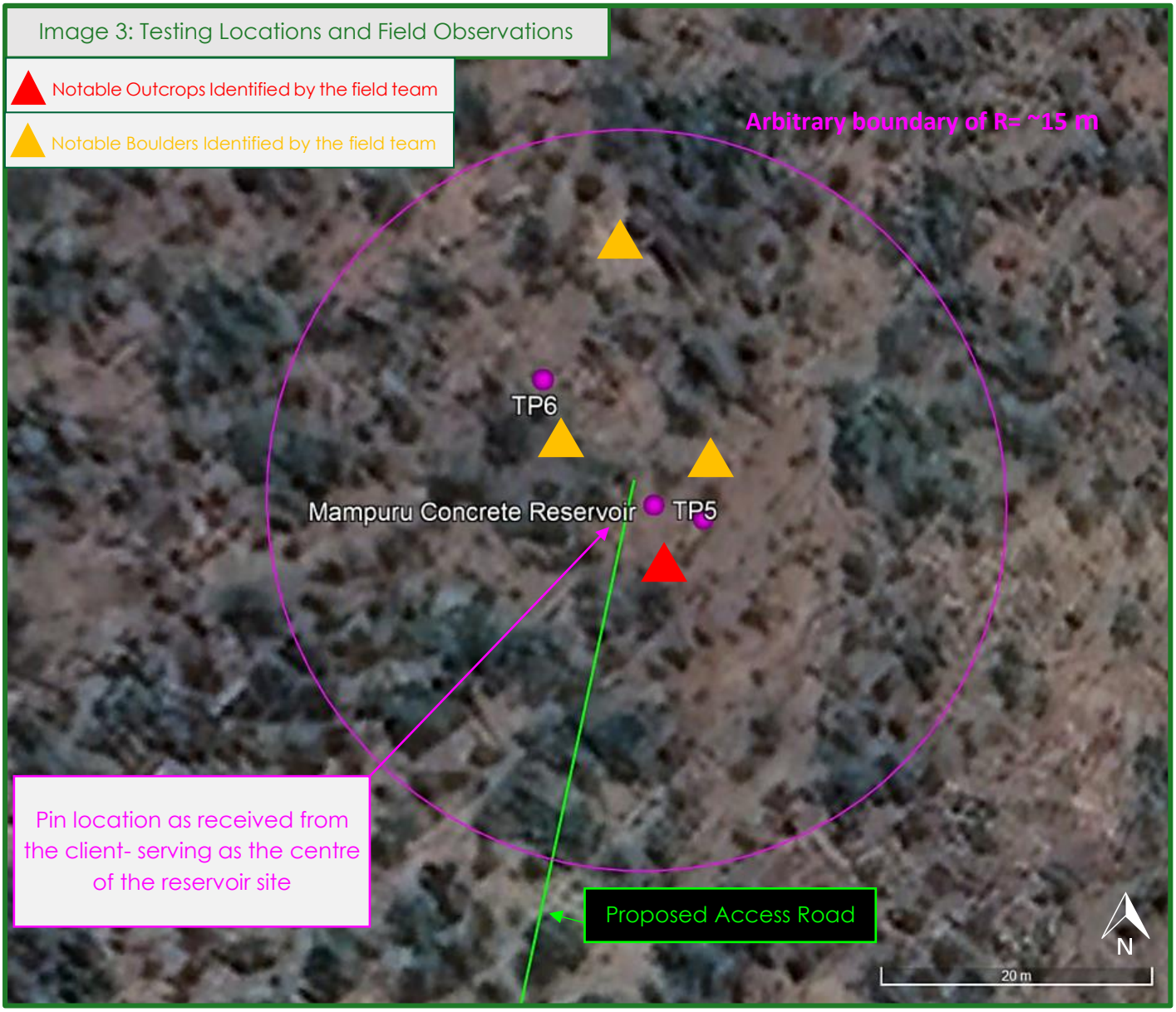
Although the section below presents a summary of the generalised soil profile exposed across the site- it should be noted that variability was encountered in numerous individual excavations, amplifying geotechnical variability.

Refer to Table 3 overleaf which depicts the summarised ground profile of the site. Following this table, Image 3 depicts the testing locations and basic field observations across the site

Table 3: Summarised Ground Profile for the Site

Summarised Ground Profile									
Test Pit	Colluvium			Weathered Gabbro Bedrock			Excavation Character		
	From	To	Thickness (m)	From	To	Thickness (m)	Test pit depth (m)	Termination Conditions	Termination Material
TP5	0,00	0,30	0,30	0,30	0,90	**0,60**	0,90	R	WGB
TP6	0,00	0,34	0,34	0,34	0,96	**0,62**	0,96	R	WGB
Data Summary	**Minimum**		0,30	0,30	0,90	0,60	0,90		
	Max		0,34	0,34	0,96	0,62	0,96		
	Average		**0,32**	0,32	0,93	**0,61**	**0,93**		
Notes:	Thickness refers to the exposed thickness of each soil horizon (meters) All depths displayed in meters (m) Horizon depths displayed in the table are average measured values Excavation conditions: R-Refusal; DE - Difficult Excavation; ES- Excavation Stopped Materials: C- Colluvium; WGB- Weathered Gabbro Bedrock								

Image 3: Testing Locations and Field Observations



The ground profiles across the site can be **generally summarised** as follows:

4.3.2. Transported Sediments- Colluvium

The site is blanketed by organic rich and granular transported material profiled as **colluvium.** These transported materials have been transported by a natural agent during relatively recent geological times and have not undergone lithification into a sedimentary rock. Furthermore, due to their age and shallow occurrence- these deposits may lack essential pre-consolidation characteristics. This may result in additional movement upon saturation and loading.

The colluvium was seen to host the major **root systems** and associated biotic activity across the site. Due to the relatively small plants species occurring across the area, the associated root network was generally shallow and did not extend into the underlying weathered bedrock.

The colluvium is dominated by **sand** but displays a discernible amount fine material in the form of **silty/clay.** The granular nature of the material is amplified by the incorporation of larger gravel, cobble and boulder sized particles all of which were transported downslope by gravity. The larger granular materials are generally concentrated at- or near- the surface of the horizon as can be seen by the rocky nature of the site.

Moreover, the incorporation of larger particles into the horizon over time is not a uniform process, resulting in an uneven distribution of gravels, cobbles, and boulders throughout the soil layer with resulting in intermittent pockets of soil with a distinct absence of large particles (heterogeneous composition across the reservoir footprint).

The exposed successions of colluvium were seen to be slightly variable, with fluctuations in composition and colour across the investigated area. Overall, the colluvium exhibited a **low/moderate in-situ density**, a **heterogeneous composition** and voided nature.

The **colluvium** was described by the field team as; *slightly moist; dark brown;* ***medium dense; intact/pinholed; clayey sand with minor/traces of gravels; minor fine roots rapidly decreasing with depth; surficial gravels/cobbles/boulders***

This organic rich transported material was generally seen to extend from the surface to depths of between **0.30 and 0.34 m** below the existing ground level (E.G.L.)- with an **average exposed thickness of ~0,32 m.**

4.3.3. Weathered Gabbro- *Dsjate Subsuite*- Rustenburg Layered Suite

Across the proposed reservoir location, the organic-rich transported sediments were underlain by **varying grades of weathered rock** formed from the decomposition of the regionally abundant **gabbro** bedrock.

Moreover, the exposed protolith was seen to display an irregular degree of weathering with pockets of less weathered material frequently encountered within the soil-like completely weathered gabbro- representing an irregular and undulating weathering profile characteristic of igneous rock masses.

The calcium-rich minerals within the exposed upper extent of the rock mass have been significantly altered by infiltrating water and associated processes over time- resulting in the formation of pedogenic inclusions in the form of calcification staining/calcrete nodules. The calcification and degree of weathered is anticipated to decrease with an increased depth from natural ground level (where weathering is most concentrated).

The exposed bedrock displayed distinct variances in degree of weathering and rock hardness across the two hand-excavated test pits. Indicating that the properties of the rock mass can vary over short distances.

The **weathered gabbro encountered in test pit TP5** was generally described by the field team as: *slightly moist; light creamy grey, mottled brown and white;* ***coarse grained; closely jointed; completely weathered; very soft rock; Gabbro of the Dsjate Subsuite- Rustenburg Layered Suite;*** *variable weathering profile; calcrete nodules; gradual transition to less weathered bedrock at the base.*

The **weathered gabbro encountered in test pit TP6** was generally described by the field team as: *slightly moist; light creamy white, stained brown, speckled olive;* ***coarse grained; closely jointed; highly weathered; soft rock; Gabbro of the Dsjate Subsuite- Rustenburg Layered Suite****; minor calcrete nodules; gradual transition to less weathered rock at the base.*

Weathered gabbro was profiled to extend to depths of between **0.90 and 0.96 m** below the E.G.L; displaying an **average exposed thickness** of **0.61 m**. Both test pits underwent refusal to pick-and-shovel on less weathered bedrock at depth.

4.4. Groundwater and Shallow Seepage

4.4.1. Introduction and Discussion

A detailed hydrocensus was not undertaken across the study area. For this reason, the static rest level and chemistry of the ground water cannot be discussed. Without knowledge on the depth to permanent groundwater in the region- it is not possible to comment on the occurrence of permanent groundwater flow within/below the subsurface of the site.

If required, a detailed hydro census can be conducted across the site to determine/model the permanent ground water table depth, location and quality underlying the site. Additional to this process, monitoring boreholes/ piezometers can be installed across the development area to examine ground water patterns seasonally.

Managing surface water across the development area will play a pivotal role in reducing ponding, erosion as well as limiting the volumes of sub-surface flow. Additional to the considerations listed above, a **maintenance regime** and ongoing performance testing should be put in place to monitor the nature of the system over its useful life.

4.4.2. Measured Ground Water Occurrences

No ground water seepage or permanent water table was encountered during the fieldwork phase of the investigation.

As a side note, if the constructed water bearing structures (pipelines and reservoirs) are not properly constructed/maintained resulting in leakages, the additional influx of water into the subterrain will impact their associated mechanical properties.

4.4.3. Fluctuating Moisture Conditions

The predominant runoff will occur as high energy overland-flow following the topography. As discussed in Section 3.2, the planned infrastructure is located downslope of currently undeveloped land. Although generally very steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of **shallow ground water throughflow** may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

Altering the soil profile in areas underlain by shallow bedrock commonly affects the subsurface seepage.

Following site modification practises (cut-to-fill), the upper transported materials will allow **infiltration**. Infiltrating water is predicted to temporarily flow/perch along the **rock-soil interface**, with its flow dynamics dependant on the topography of the rock mass at that point. This typically manifests as a weak, relatively **short-lived perched water** table associated with slight groundwater seepage present directly after a precipitation event. Furthermore, the **undulating topography** of the bedrock affects the continuity of the **shallow water flow dynamics** of the site.

The weathered gabbro bedrock was seen to host variable amounts of **pedogenic** materials in the form of calcification staining and calcrete nodules. These pedogenic materials are not predicted to have formed due to excessive amounts of infiltrating/perching of water but are likely amplified by the mineralogy of the rock and susceptibility of the mafic minerals to decomposition. Nonetheless, these pedogenic inclusions indicate the periodic occurrence of **fluctuating moisture conditions** after prolonged precipitation events.

Good site drainage measures, on surface and subsurface, must be implemented to prevent moisture changes, which may add to the development of temporary perched groundwater tables. During construction and after development, shallow perched water systems may develop yet further due to stormwater management practices, localised infiltration and site modification practices**.** The implementation of a sub-surface drainage system is deemed necessary should foundation configurations result in the damming up of ground water flow.

Foundations and installed services will cause soil density and texture changes which may lead to variations in soil moisture across the site with flow changes and build-up of moisture that may differ from the natural conditions. The weight of the structures on the surface may result in an increased ground water rest level. As good construction practice, adequate damp-proofing measures should be implemented beneath individual structures.

Excavations may need to be dewatered following prolonged precipitation events- to be undertaken in line with the prescribed HSE protocols. Furthermore, the influx of water- both surface and sub-surface- into the trenches may drastically impact their stability.

4.5. Bedrock Outcrops/boulders

Boulders/outcrops were intermittently encountered across the site- some of which are indicated on Image 3. Surficial occurrences were inspected and photographed by the field team- examples of which are included in the photo series below. The exact nature and extent of these anomalies is not known generally as a result of the shallow soil cover and existing vegetation. In large scale unrestricted cuttings, the impact of these features is reduced.

These combined features are expected to cause significant mobility and excavatability issues across the development area and will need to be addressed during the initial phases of construction.

It is recommended that the exact location of these anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the structures location- and adjoining access roads/pipelines- can be partially adjusted on ground level to avoid major anomalies exposed in the initial earthworks.

Boulders/outcrops will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development.

The photo series below depicts examples of these anomalies.





4.6. Site Excavatability

4.6.1. Introduction and Discussion

Excavatability is a measure of material to be excavated/dug/mined with conventional excavation equipment such as a bulldozer with rippers, mechanical excavator, or other grading equipment.

Profiles were described in trenches excavated by means of labourers digging by hand (**pick-and-shovel method**). End of hole conditions were due to **refusal** at depths of between **0.90 and 0.96 m** below E.G.L.

As was seen in exposed ground profiles, the weathered bedrock typically hosts irregular pockets of more and less intact material. Based on the variable weathering profile exposed in the excavations and intermittent occurrence of outcrops across the site- the weathered gabbro bedrock is anticipated to display an **undulating bedrock topography** which is characteristic of igneous rock masses/terrains.

The **average** excavation depth across the site was approximately **0.93 m.** The excavation type to an **average** depth of **0.93 m** below the existing ground level is deemed to be **SOFT Excavation** (SANS 10400G/SANS1200D).

Excluding known outcrops and intermittent surficial boulder locations, **no significant problems** are foreseen during the excavation of **shallow foundation** trenches to a depth of approximately **0.93 m** below E.G.L. Following this depth, **significant problems** are foreseen in the excavation of **deep service trenches/bulk excavations** though the use of light excavation methods (i.e., hand excavation, TLBs etc.)- due to the shallow and undulating occurrence of weathered gabbro bedrock.

4.6.2. Excavation Notes- Gabbro Bedrock

In rock masses, excavatability is governed by the shear strength of both the intact rock and the discontinuities separating them. Fluctuating excavation conditions correlate to the depth, spacing and degree of fracturing of the underlying rock mass. In a closely jointed rock mass, the excavatability is mostly controlled by failures along joint planes, whereas in widely jointed rock masses, the failure of the intact rock is required before the material can be ripped.

Where deep excavations are undertaken for structures, services, foundations or to modify the sites surface- the excavation properties of the gabbro rock mass need to be considered. The inherent excavatability is predicted to fluctuate over short distances as a result of varying degrees of weathering and spacing of discontinuities.

The physical and mineralogical nature of **gabbro** has led to the formation of a **highly undulating bedrock topography**. These sub-surface features are expected to have an impact on the overall **continuity of the excavatability** across the site, with pockets of deeper less weathered bedrock being present within the soil-like completely weathered bedrock. This variability can take place over a **very short distance**.

The rock mass at depth will require **hard rock excavation** to unearth. Cognisance should be taken of the fact that the depth to bedrock might vary between the trial pits (known points).

The final layout of the development is not known (including associated earthworks); however, allowance should be made for HARD Excavation, typically requiring blasting, wedge and split, chemical fracturing and/or heavy pecking -the exact method of which is dependent on the required final working levels, available equipment and the local environment.

Blasting shallow holes in bedrock or other hard material with no overburden to act as a damping blanket will create fly rock which could be problematic.

If blasting is to be undertaken, it should be designed by and conducted under the supervision of a blasting specialist and advice should be sought as to whether or not it is best to drill and blast through the overburden or whether small areas of this pedocrete can be blasted post-stripping of the overburden provided that appropriate measures such as the use of blast mats are adopted.

A provisional volume of material can be determined using the information from the trial pits and the final earthworks model. The calculated volume should also include excavation for sumps and deep services.

4.6.3. Excavation Safety

The following general notes should be considered regarding workings within and surrounding bulk excavations (SANS 10400 Part G and Section 11 of the OHS Act Construction Regulations):

- The provisions of the Occupational Health and Safety Act of 1993, SANS 10400 and Construction Regulations (most recent edition) must be followed in the excavations and workings therein.
- In terms of Section 11 of the Construction Regulations the contractor must appoint an excavation supervisor. All excavations should be inspected by a competent person (engineer or geo-professional with relevant training and experience) at least once a day and following any periods of rain or any long periods where no work has taken place.
- Where the excavation work involves the use of explosives, a method statement is developed in accordance with the applicable explosives legislation, by an appointed person who is competent in the use of explosives for excavation work and that the procedures therein are followed.
- No load, material, plant or equipment is placed or moved near the edge of any excavation where it is likely to cause its collapse and thereby endangering the safety of, any person, unless precautions such as the provision of sufficient and suitable shoring or bracing are taken to prevent the sides from collapsing.
- Sheet wash from stormwater or other waters shall be prevented from running over the trench/cutting flanks. Trenches/box-cuts may need to be dewatered between and following prolonged precipitation events because of water temporarily perching upon the underlaying less permeable materials at depth.

4.7. Engineering and Material Characteristics

4.7.1. Sampling

The engineering material properties of the various sampled soil horizons were measured in laboratory conditions as per accredited testing procedures.

Standard foundation indicator, compaction tests and soil chemistry tests were conducted by Tzaneen Lab (**SANAS Accredited**) on disturbed and bulk soil samples. These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the construction.

Full lab test results are presented in **Appendix B**.

The sampling which took place during this investigation was based on both the in-situ geotechnical properties of the exposed soil horizons as well as the nature of the development. Problem soil horizons were accurately sampled where encountered (i.e., collapsible/expansive soils).

This section focuses on the identification and assessment of the soil properties which will influence the proposed construction. Where deemed necessary by the field team, mixed samples were created in order to measure the engineering material characteristics which can be expected following bulk site modification practises.

The sampling process **excluded** the following inclusions:

- Oversized particles
- Organic materials
- Anthropogenic contamination

4.7.2. Bulk and Disturbed Samples- Laboratory Test Results

The soil testing which was conducted across the site can be subdivided into three broad categories, as follows:

- **Foundation Indictor Tests**

  Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage) and Particle-size Distribution

- **Compaction Tests**

  Maximum Dry Density versus Optimum Moisture Content and Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)

- **Soil Chemistry Tests**

  pH and EC analysis (corrosivity) as well as double hydrometers as an indication of material dispersivity.

The results presented in the summaries to follow are as received from the accredited testing facility. Although the summaries have been annotated **no** amendments have been made to the results themselves.

The tables to follow summarise the results of the soil tests conducted on the various sampled materials.

Table 4: Foundation Indictor Test Results

Foundation Indictor Test Results																				
Sample Number	Test Pit	Depth (m)	Sampled Material	Particle Size Distribution: Standard Sieves cumulative percentage passing					Particle Size Distribution: Hydrometer Analysis SANS 3001-GR3			Atterberg Limits SANS 3001-GR10 (%)			Grading Modulus	Gravel Wearing Course			Material Classification		Heave
				37,5 mm	20 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm	0,005 mm	0,002 mm	LL	PI	LS		Grading Coefficient	Shrinkage Product	TRH20	TRB	USC	
T03346/6	TP5	0,30-0,90	Weathered Gabbro Bedrock	86	78	54	41	21	19,5	7	4,5	32	15	7,6	1,8	18	314	Good	A-2-6	SC	LOW
T03346/7	TP6	0,34-0,95	Weathered Gabbro Bedrock	94	91	74	60	31	28,2	10,6	7,9	31	11	5,1	1,4	16	303	Erodible	A-2-6	SC	LOW
Notes:	1. Atterberg Limits undertaken on material passing the <0,425 mm sieve 2. Atterberg Limits: Liquid Limit (LL), Plasticity Index weighted (PI), Linear Shrinkage (LS). 3. Heave: Potential expansiveness (acc. Van Der Merwe, 1964).																				

Table 5: Compaction Test Results

Compaction Test Results												
Sample Number	Test Pit	Depth (m)	Sampled Material	Compaction Test Results					Material Classification		
				MDD (kg/m^3)	OMC (%)	Interpreted CBR Values SANS 3001-GR40 Mod AASHTO Method			COLTO	Material re-usage potential	
						90%	93%	100%			
T03346/6	TP5	0,30-0,90	Weathered Gabbro Bedrock	2048	10,2	8	12	31	G8	FAIR	Does not meet G7 requirements due to: CBR @ 93%<15
T03346/7	TP6	0,34-0,95	Weathered Gabbro Bedrock	1931	12,3	5	8	20	G9	POOR	Does not meet G8 requirements due to: CBR @ 93%<10
Notes:	1. Compaction Test Results; percentage compaction of MDD (MOD AASTHO Method); CBR of 13.344 kN 2. MDD- Maximum Dry Density; OMC- Optimum Moisture Content 3. Material classification and re-usage potential based on the COLTO classification system										

4.7.3. Laboratory Test Results- Summary and Discussion

The results of the weathered gabbro bedrock sampled across the proposed reservoir location can be summarised as follows:

- The samples grade as granular materials ranging between **sand** and **fine gravel** with a **grading modulus (GM)** of between **1.4** and **1.8.**
  - The GM of the weathered bedrock is anticipated to varying with fluctuations in degree of weathering.
- The weathered bedrock exhibits a **medium plasticity**, low linear shrinkage values and an overall **LOW potential for heave** (acc. Van Der Merwe, 1964).
  - Measured PI values range from **11 to 15.**
- Typical Unified Soil Classes (USC) of **SC.**
- Based on USCS class (**SC**), drainage will be **poor** (impervious), and a **low compressibility** can be expected once compacted. Moreover, these materials typically display **good to fair compaction characteristics** and classify as **reasonably stable embankment material**.
- Typical TRB Class of **A-2-6.**
- The **weathered bedrock materials** typically displayed a **VARIABLE reaction** to compaction ranging from **FAIR** to **POOR**:
  - The **weathered gabbro bedrock** classified as **G8** and **G9- type** material according to the COLTO classification system.
  - The sampled materials exhibited a California Bearing Ratio (CBR) value of between **8 and 12** at a compaction effort of 93 % Mod AASHTO, increasing to a CBR of between **20 and 31** at a compaction effort of 100 % Mod AASHTO.
  - The compacted samples displayed a calculated **remoulded bearing capacity** of between approximately **60** and **85 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5.

- Based on the available double hydrometer readings the sampled materials are deemed to be **non-dispersive**. Measures to reduce the susceptibility of the material to dispersion and erosion are however recommended.

4.7.4. Combined Re-usage Summary and Discussion

The sampled **weathered gabbro bedrock** was seen to display a **VARIABLE** quality-ranging from **G9** to **G8-** type material (COLTO 1998). As substantiated by the lab results, the upper extent of the rock mass displays a variable material quality which may be attributed to its variable/undulating weathering profile. Overall, the quality of the rock mass in anticipated to increase with depth.

Portions of the weathered rock mass may be suitable for use in **selected layers (G7/G8)** while pockets that display **poorer compaction characteristics** are only deemed suitable for use as **subgrade layers (G9/<G9)** in the proposed construction and allied engineered fill/road layers (suitability based on the engineer's design).

Although not tested across the reservoir location, the sampled **colluvium** along the proposed access road exhibits an **elevated plasticity, liquid limit and linear shrinkage**. The colluvium sampled along the access road exhibits a **POOR** quality-classifying as **worse than G9-type** material (COLTO 1998). Furthermore, where the **colluvium** and underlying **weathered bedrock** was **mixed** along the route of the access road, the mixed samples displayed a similar **POOR** quality (<G9/G9).

Based on the USCS classification of the colluvium and weathered bedrock, these materials are deemed to be **reasonably stable embankment material**.

Caution should be taken in the **zones of poor-quality material**. Where encountered, zones of poor-quality material should be adequately modified prior to its re-use-within the specifications of the engineer's design.

The extent of **cut-to-spoil** is dependent on the layout of the development coupled with the design of the planned structures.

Where deep/bulk excavations are undertaken across the reservoir site to modify the surface, it is recommended that the re-usage potential of the excavated less weathered rock be determined and stockpiled for the re-use in the planned construction if deemed to be of a suitable quality.

Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction.

4.7.5. Soil Corrosion Discussion

As a brief introduction soil corrosion is an electrochemical process whereby complex chemical reactions between the soil and the contacting metal result in the formation of corrosion products and deterioration of the metal. The severity of corrosion that can be caused by a particular soil type is dependent on a variety of factors, including the soil's chemical properties, environmental conditions and the properties of the metal in contact with the soil.

Corrosion is a natural redox (reduction-oxidation) reaction that converts a refined metal to its more chemically stable state. Three components must be present for corrosion to occur: an anode (the buried metal in contact with the soil), a cathode (oxygen) and an electrolyte (the moisture found in the soil).

The degree of corrosiveness and the rate of corrosion differ between different soil types and properties (K. Nanan., 2018).

As part of this analysis, some of the soil samples were tested for pH and electrical conductivity (EC). These results and other indicators of aggressiveness to stee l and concrete (corrosivity) are shown in Table 6.

Table 6: Soil Chemistry Test Results

Soil Chemistry Test Results								
				Corrosivity Indicators				Dispersivity Indicators
Sample Number	Test Pit	Depth (m)	Sampled Material	Profiled In-Situ Moisture	% Clay	pH	EC (mS/m)	Double Hydrometer Results (%)
T03346/7	TP6	0,34-0,95	Weathered Gabbro Bedrock	Slightly Moist	7,9	8,3	25	17,0
Notes:	1. Material as per soil profile description. 2. Moisture as per soil profile description or natural moisture content. 3. Percentage clay, pH, EC (Electrical Conductivity) and double hydrometer as per laboratory results.							

Table 7: Reference Table- Influences of the Corrosiveness of Soils to Steel and Concrete

PARAMETER	→ INCREASING AGGRESSIVENESS OR CORROSIVENESS OF SOILS →					
EC (S/m)	**<0.0050: Essentially non-corrosive**	**<0.0100: Mildly corrosive**	**<0.0200: Moderately corrosive**	**<0.0333: Corrosive**	**<0.1000: Highly corrosive**	**>0.1000: Extremely corrosive**
Soil type	**Sand and gravel generally have lower EC: Generally less corrosive**			Clay generally has higher EC: Generally more corrosive		
Saturation	**<40% or 100%: Generally not aggressive to mildly corrosive**				60-85%: Maximum expected corrosion rates	
pH	**Soils with neutral pH are generally not very corrosive**			Very acidic or alkaline: corrosive to steel Acidic (pH < 5.5): likely corrosive to concrete		

Based on the combined results presented in Table 6- when compared to the applicable references (Table 7)- the weathered gabbro bedrock is deemed to be **corrosive**. It is advisable not to use steel pipes and engineering measures must be implemented to protect portions of the structure which will come into prolonged contact with soil. These methods may include but are not limited to the following:

- Barrier coatings, sealers and membrane-type coatings (resins, epoxies, emulsions) applied to the concrete surface.
- Concrete reinforcement/steel coatings including nickel, stainless steel and zinc (i.e. galvanisation).
- Cathodic protection or other electro-chemical means.
- Overlays including Portland cement, latex-modified concrete and polymer concrete.
- Addition of corrosion inhibitors and admixtures to the concrete.
- Adequate site drainage measures to avoid soil saturation.

4.8. In-Situ Mechanical Assessment

4.8.1. Introduction

The soils underlying the site have been examined and tested to determine their suitability as founding horizons for the proposed development (water bearing structures) according to the following criteria:

- **Bearing capacities** of the founding materials determined from estimated field consistencies and inferred from tabulated strength values.
- **Compressibility,** where applicable.
- **Collapse potential**, where applicable.
- Potential **heave**, where applicable.
- Predicted **displacements** (settlement/collapse/heave) from the above factors.

Undisturbed sample extraction was not possible/feasible in the exposed granular materials. For this reason, the mechanical assessment of subsoils will be based on the available disturbed soil test results and field observations (i.e., structure, composition, and consistency).

For **light structures** and roadways, the variable successions of **soft materials** including **colluvium and upper weathered material** form the primary materials of concern across the site. Caution must be taken when dealing with these potentially **collapsible/compressible** soils.

During the design of the **planned reservoir structure**, the mechanical properties of the underlying rock mass- beyond the depth of the exposed soft materials- needs to be considered.

4.8.2. Inferred Material Properties Unified Soil Classification System

As part of this assessment a number of engineering material properties can be **inferred**- to be confirmed/measured in follow-up studies where required. Inferred figures are extracted from the data base available on geotechdata.info.

The Unified Soil Classification System (USCS) is a soil classification system used in engineering and geology to describe the texture and grain size of a soil. The classification system can be applied to most unconsolidated materials and is represented by a two-letter symbol. The demarcated result can be used to infer a wide range of soil properties and characteristics.

The **soils** sampled across the site classified as: **SC.**

The following inferred paraments/attributes can be used in **preliminary designs**:

1. Typical values of **soil friction angle (degrees)**
    a. SC Soils: 30 to 40
2. Typical values of **soil cohesion (kPa)**
    a. SC Soils: 5
3. Typical values of **soil permeability (m/s)**
    a. SC Soils: $5.5x10^{-9}$ to $5.5x10^{-6}$

Numerous additional inferences can be made based on the available laboratory test results and associated data bank of information. Additional properties can be presented on the request of the project team.

4.8.3. Bearing Capacity and Soil Shear Strength (Light Structures)

1. **Introduction**

Bearing capacity is defined as the pressure which would cause **shear failure** of the supporting soil immediately below and adjacent to a foundation. The estimated allowable bearing capacity of a soil material is a function of the angle of internal friction (reflected in the grading), consistency/cohesion (reflected in the soil grading and density) and degree of saturation (moisture content).

The allowable bearing pressures imposed on the material is a function of both the soils shear strength (ultimate limit state) and its' settlement characteristics (serviceability limit state). The presumptive bearing capacity figures disregard the effect of soil moisture changes that may induce settlement/collapse.

2. **Estimated Allowable Bearing Capacity- Field Estimates**

The estimated presumed bearing values of the foundation materials are only an empirical guide to the maximum load that can be placed on the soil/weathered rock particular to this site without shear failure, and as such are not an indicator of the possible settlement/collapse that may occur at foundation pressures up to the bearing capacity of the soil.

Taking the additional movements due to soil movement into account will imply that foundation improvements will be necessary for structures.

The presumed bearing values below are based on the materials exposed in situ in the test pits and ignore any improvement, which may be obtained by compacting, or treating the site soils. The bearing capacity will increase with an increase in depth due to the increase in grain size and in-situ consistency.

The on-site materials are all deemed to be granular material. Preliminary estimates of bearing capacity for granular material are as follows (Look, 2014):

- **Loose** consistencies in these materials may be roughly correlated to a presumed bearing value of between **30 - 80 kPa.**
- **Medium dense** consistencies may be roughly correlated to a presumed bearing value of between **80 - 225 kPa.**
- **Dense** consistencies in these materials may be roughly correlated to a presumed bearing value of between **225 - 375 kPa**.

- **Colluvium**

The **colluvium** was profiled to exhibit an **overall medium dense** consistency.

Medium dense consistencies in these overall granular soils can be roughly correlated to a presumed bearing value of between **80 - 225 kPa** (Look, 2014). Other sources list presumptive bearing capacity of sandy/gravelly soils to 95 – 150 kPa (Alemdag et al, 2017; BS8004-1986; Builders Engineer 27 October 2012).

During CBR testing, a reduction in shear strength was measured upon **reworking** and **saturation,** with the colluvium displaying a calculated **remoulded bearing capacity** of approximately **18 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5. Due to the measured reduction in shear strength following saturation, the bearing capacity of the blanketing colluvium may not be adequate for light foundation loads. Due to the limited thickness of the horizon across the site, its overall influence on the construction of both light and large structures is reduced.

Lastly, the intrinsic variability of the blanketing sediments (heterogeneous composition and transported nature) should be considered. The in-situ consistency, soil texture and structure are anticipated to fluctuate spatially across the flanks of the mountainous terrain.

- **Weathered Gabbro Bedrock**

As mentioned, the exposed continent of the rock mass typically represents the transition between the late stages of rock disintegration/decomposition and early stages of soil formation. It is therefore envisaged that the exposed upper weathered extent of the rock mass will display properties- including bearing capacity attributes- in line with a **dense granular soil**.

Dense consistencies in the granular soils can be roughly correlated to a presumed bearing value of between **225 - 375 kPa** (Look, 2014). Furthermore, during CBR testing, the material displayed a calculated **remoulded bearing capacity** of between approximately **60 and 85 kPa** @ 93 % MOD AASHTO with a Factor of Safety of 1.5 (disturbed samples).

The intact rock mass at depth is anticipated to serve as a good founding medium for planned structures (Section 4.8.7 of this report).

4.8.4. Heave Characteristics

Expansive soils are soils that undergo changes in volume due to changes in moisture content, swelling when the moisture content increases and shrinking when the moisture content decreases.

Colluvium

Based on the indicator results from available exposures across the route of the proposed access road, the colluvium exhibits a **medium plasticity**, low/medium linear shrinkage and elevated liquid limit. However, the clay fraction within the transported material is not deemed sufficient for the horizon to exhibit any noteworthy expansive behaviour. Furthermore, the limited thickness of the horizon and anticipated load of the reservoir will restrict any possible movement.

Weathered Gabbro Bedrock

Based on the results from the **weathered bedrock** it was noted that the rock mass exhibits a **medium plasticity**, low linear shrinkage values and an overall **LOW potential for heave** (according to Van Der Merwe, 1964).

These combined results indicate that soil heave will not be a **dominant** factor during the design of the planned reservoir structure.

4.8.5. Settlement Characteristics of the In-Situ Soils

Compressible soils are soils of low stiffness that settle significantly when loaded. In free-draining soils (e.g., sands), this settlement occurs during and shortly after loading. In low permeability soils (e.g., clays), this settlement occurs over a period of time as the pore pressures set up during loading dissipate.

Considering the material characteristics measured in lab conditions and observed within the soil profiles; the soft materials exposed in the excavations underlying the site are deemed to display a **slightly compressible nature** at light foundation loads.

The compressibility is predicted be greater in the blanketing colluvial deposits. Furthermore, the upper extent of the weathered gabbro is deemed to display a slightly compressible nature but is anticipated to drastically reduce with depth as the degree of weathering reduces with an associated increase in intact rock strength.

4.8.6. Collapse Settlement Characteristics of the In-Situ Soils

Collapsible soils are open-textured (high void ratio) soils that are stiff when dry but lose their stiffness when they become wet. This can lead to sudden, large settlements taking place when the moisture content of the soils below a foundation increase, even many years after construction.

The sampled colluvium typically displays elevated liquid limit, plasticity, and linear shrinkage with these attributes not typically associated with collapsible horizons. Therefore, the colluvium is not typically deemed to exhibit a collapsible nature.

Differential settlement is amplified across the site due to the heterogenous composition of the colluvium and variable weathering profile of the underlying rock mass (pockets of soil-like material vs less weathered rock particles).

4.8.7. Basic Rock Mechanics- Large Structures

Discussion

As discussed in the preceding sections of this report, the site is underlain by shallow undulating gabbro bedrock. Due to the limited exposures of the rock mass- coupled with its weathered state- the exact composition of the gabbro rock mass could not be defined, as well as its geotechnical nature at depth.

The mechanical properties of a rock mass are dependant not only on the properties of the intact rock (Uniaxial Compressive Strength etc.) but also on the properties of the discontinuities (spacing, orientation, continuity, etc.). The various intact rock and discontinuity properties will each have their own impact on the overall geotechnical properties of the rock mass, such as the permeability and strength.

Ideally the assessment of the underlying rock mass would be undertaken through the implementation of a rotary core drilling regime- with associated rock core logging, photography, sampling and lab testing on the cores (physical and chemical attributes).

Possible Follow-up Actions

In gabbro rock masses, due to the relatively high strength and low permeability of the intact rock, the rock mass properties are predominantly a function of the **discontinuity properties.** As such, the properties of a jointed rock mass are generally best determined through the use of rock mass classification systems such as the Rock Mass Rating by Bieniawski (1989), and the Norwegian Q-Index, presented by Barton et al (1974). These rock mass properties are generally determined from exposures allowing for the classification of the foundation rock.

Based on the available theoretical data, the fresh igneous rock masses which underlie the study area **display favourable strength characteristics** with regards to the construction of the planned water storage structures. However, should more detailed information be required- one or more of the following actions can be implemented to model the rock mass as a whole:

1. Joint line surveys and/or window mapping of the bulk excavations created in the early stages of the construction.
2. Geophysical surveys to model the extent of the weathered zone of the rock mass, map geological anomalies and indicate the excavatability of the rock mass at depth (i.e. seismic velocities).
3. Hydrological studies to model the movement of ground water across the development's footprint, including possible chemical assessments.
4. Borehole drilling with associated core logging, sampling and rock core laboratory testing. The rock core samples should be submitted for testing in order to determine the physical and chemical properties of the rock material. The drilling results will shed light on the extent and quality of the gabbro bedrock underlying the site- which will further aid the design of the proposed infrastructure.

4.9. Foundation Design Options- Large Structures

4.9.1. Introduction

The diverse geotechnical attributes of the site have been discussed at length in the preceding sections of this report. There are geotechnical attributes of the site which are not ideally suited for the planned development (delineated in this report)- for this reason, **advanced engineering solutions** will be required to ensure the stability and longevity of the development.

Soil/rock mechanics calculations are based on the geometry of the foundation and measured parameters. During the design of the **planned large reservoir structure**, the mechanical properties of the underlying rock mass- beyond the depth of the exposed soft materials- needs to be considered.

The allowable bearing pressures imposed on the material is a function of both the shear strength (ultimate limit state) and its' settlement/deformation characteristics (serviceability limit state).

Structural solutions shall improve the flexibility and strength of the structure to enable the building to tolerate potential movements so that the resulting response to actions is within the limits specified in SANS 10400-B. The structure must be strengthened to allow for the predicted differential settlement.

Please consult a competent engineer for additional options and final designs.

It is recommended that the structural engineers calculate the best economical foundation option for the proposed development based on the type of structure and the different available construction methods/materials to remedy the negative effects of the measured geotechnical constraints.

The final layout of the development is not known at this stage, with the discussion points to follow using typical attributes for structures of this nature.

Additional to the proposed foundation configurations, an important factor in the promotion of a stable site is the control and removal of both surface and ground water from the site. The implementation of a sub-surface drainage system is deemed necessary should foundation configurations result in the damming up of ground water flow.

4.9.2. Deep Foundation Discussion

Considering the **complex terrain** and **mechanical properties** of the in-situ materials- in conjunction with the nature of the development- it is recommended that the foundations for the planned **reservoir structure** be taken down to **sound bedrock** beyond the depth of the exposed soft materials, including the variable colluvial sediments and upper weathered extent of the rock mass.

Considerations surrounding general **deep foundation configurations** are presented below. GeoCalibre is open to future discussions with the design team should other foundation options be explored once final structural configurations are defined.

- This option entails foundations founded upon **intact bedrock** below problematic soft materials, with the reinforcement of the foundations to the point at which they can withstand the expected differential movements resulting from site modification practises.
- Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand across the footprint of the planned structure. Once access/mobility has been modified follow-up studies can be conducted, where required.
- Deep excavations should be inspected once created to confirm exact geotechnical conditions in the exposures- for both cutting stability and foundations- with the adaption of the ground model where required.
- Based on the available theoretical data, the fresh igneous rock masses which underlies the site displays favourable strength characteristics with regards to the construction of the planned water storage structure. Although not defined at this stage due to the limited exposures- at the refusal point, a conservative field estimated allowable bearing capacity of >300 kPa can be inferred for the rock mass. Once exposures are logged, the overall quality can be defined using available Rock Mass Rating (RMR) systems or similar indices.
- As addressed in detail in Section 3 of this report, due to the site gradient- cut to fill site preparation is expected, with cuts primarily extending into the weathered gabbro bedrock which occurs from shallow depths.

- In contrary to the problematic colluvial sediments, the local igneous rock masses are not generally prone to major instabilities based on the available theoretical databases and as seen in local cuttings.
- Although it is predicted that fresh exposures in bedrock exhibit stable conditions in near vertical cuts (depending on orientation), it is recommended that the permanent cuttings be adequately sloped (approximately 60 to 75 degrees) or stabilised to reduce the risk of instabilities.
- Instability in these igneous bodies is predicted to be in the form of localised rock block failure, necessitating the removal or stabilisation of unstable rock blocks. Though rare, problematic joint sets/features can be present especially surrounding geological structures.
- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the reservoir.
- Drainage measures required across the constructed platforms so as to limit ponding and infiltration which may lead to perching in these areas.

- It is recommended that the foundation be place on a uniform founding medium (i.e., bedrock across the cut portion of the platform) so as to limit the degree of differential settlement. Where possible, foundations should not span across the cut/fill interface or from soil to rock so as to limit differential settlement.
- The force of the proposed structure should be applied horizontally uniform across the exposed jointed rock surface; this will allow for the spanning of the various joint sets and the avoidance of point loads on individual unstable rock blocks. Boulders are to be avoided wherever possible.
- Based on the available theoretical data, the fresh igneous rock masses which underlies the site displays favourable strength characteristics with regards to the construction of the planned water storage structures. Although not currently defined at this stage due to the limited exposures- at this refusal point, a conservative field estimated allowable bearing capacity of >300 kPa can be inferred for the rock mass. Once exposures are logged, the overall quality can be defined using available Rock Mass Rating (RMR) systems or similar indices.
- The depth to bedrock is expected to fluctuate, attributed to the characteristic undulating nature of the regional extrusive igneous rock (gabbro). The final profile of the excavation will be undulating, over break and over excavation will occur in both the base and sidewalls of the excavations and provision made in the pricing, and quantities in the relevant contract documentation.
  - Jackhammer trimming of the base and sidewalls of excavations in bedrock must be expected and allowed for in the contract documentation.
  - Provision should be made for additional mass concrete in the foundation trenches to ensure that the TOC is always at the specified level.

- Provision should be made for blinding particularly where the footings are founded in bedrock. A decision can be made on site during construction as to whether or not blinding is actually necessary.
- Emphasis must be placed on the final cleaning of the excavation, with the complete removal of loose debris prior to the injection of mass concrete or blinding layers.

- It is recommended that earthworks be carried out along the guidelines given in SABS 1200/SANS 10400 (current version).
- Areas subjected to extensive fills need to be adequately modified/ compacted to limit soil movement over time (i.e., fill creep).
- Where implemented, it is essential that backfilled materials are of sufficient quality and compacted in controlled layers (material quality/required density as per engineer's design).
  - The sampled weathered gabbro bedrock was seen to display a VARIABLE quality- typically classifying as G8 and G9- type material (COLTO 1998). This material is therefore deemed suitable for the use in the proposed construction and associated engineered fills. However, caution should be exercised when selecting suitable material due to the measured variability of the weathered bedrock.
  - Moreover, the colluvium sampled along the access road indicates that this material is of POOR quality- classifying as a worse than G9- type material (COLTO 1998). The blanketing transported sediments are therefore not deemed suitable for use in the planned construction and associated engineered fills.
  - Caution should be taken in the zones of poor-quality material (i.e., organic rich materials). Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.
  - Where deep/bulk excavations are undertaken across the reservoir site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction.
  - Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction.
- Across the fill portion of the platforms, placement of imported layers should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve 93% Modified AASHTO maximum dry density at ±2% optimum moisture content.
- Density control of placed fill material should be undertaken at regular intervals during fill construction.
- Quality control testing should be undertaken by an accredited laboratory where possible (Tzaneen Lab can assist in this regard).
- Deep excavations may need to be dewatered during construction- especially during the summer months of the year (rainy season).
- Lastly, a maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage

5. Geotechnical Evaluation- Access Road

5.1. Introduction and Description

This section of the report summarises the cumulative findings of the **centreline** and **materials investigation** conducted in support of the design and construction of the new access road to the proposed **Mampuru Concrete Reservoir**. Numerous geotechnical attributes which were discussed at length in the preceding section of this report are duplicated in this section. These sections are included where deemed applicable to assist the design team in their processes.

As discussed in the preceding sections of this report, the development includes the construction of a **winding access road**, with a length of approximately **500 m**.

The planned **starting point (0+000)** is located at the high-lying outskirts of the village of Mampuru where the road initially propagates along an existing gravel road for approximately 25 m before splintering off towards the proposed concrete reservoir located further upslope along the flanks of a prominent mountainous terrain. As the road traverses the complex morphology of the area it hosts multiple 180-degree hairpin turns at ~0+140 and ~0+320. The **termination point of ~0+500** is achieved as the road approaches the structures' planned **footprint** from the south west.

A **basic materials assessment** was conducted along the route of the planned new access road. The footprint of the planned development was not defined on ground level attributed to the **undeveloped** nature of the site, with the Client providing a path for the future gravel road. The planned access road's shape represents an attempted optimisation of the infrastructure across the complex topographic setting, including attributes such as road length/footprint, modification requirements, usability constraints and budget considerations, to name a few.

The access road is located at the following coordinates:

Start- 0+000	**Latitude:** 24.794055° S	**Longitude:** 30.099054° E
End- 0+500	**Latitude:** 24.792273° S	**Longitude:** 30.098664° E

The results of this geotechnical analysis models that the whole site exhibits geotechnical characteristics that may require the implementation of design and/or precautionary measures to reduce the risk of structural damage due to adverse geotechnical characteristics. However, these characteristics do not disqualify the site from being used for the development, but rather require the implementation of **site-specific precautionary engineering measures**.

The exact design and configurations of the planned structures was not known at the time of compiling this report. GeoCalibre is open to ongoing discussions regarding site specific engineering solutions once final configurations are known.

GeoCalibre has compiled a **simplified summary** including field observations, summarised ground profiles, laboratory and DCP test results for the road, in order to guide the design phase of the development (presented at the end of this section). The purpose of this summary is to eliminate data complexity. During the detailed design phase of the development, local areas of concern can be extracted from the summary and can be dealt with individually.

5.2. Trenching

The field work phase of the investigation was conducted by GeoCalibre in June 2024. As a result of the limited access, along the route of the planned access road, test pits were excavated using labours digging by **hand** (pick-and-shovel method), to a depth of approximately 1.0 meters below the existing ground level, or refusal. Where available, local cuttings/exposures along the route were mapped for the amalgamation into the sites geotechnical model.

Excavations were conducted as to accurately describe the general near surface conditions occurring across the target areas. Trial pit placements were undertaken in such a way so as to create an accurate and reproducible site-specific geotechnical model. Test pit locations were primarily based on the Client's specific outcomes (foot print analysis) and where necessary, test pit locations were altered on ground level as to target specific geomorphological features. This allows for data to be extrapolated between known testing points in order to create an accurate geotechnical model.

A *Geologist* supervised the excavation of the trial pits. The description of the exposed ground profile is done according to SANS 633:2012 and describes the moisture, colour, consistency, structure, texture and origin.

The soil profile is described according to the following parameters:

- **Moisture** dictates the colour and consistency of soils and indicates how and where water moves and the depth to perched water systems.
- **Colour** indicates the oxidizing or reducing state of soils and assist in the identification of minerals in completely weathered to fresh rock.
- **Consistency** is separated between cohesive and granular as the drainage and permeability affects the soil's shear strength.
- **Structure** describes any relict features from rock or soil and those that form through packing, soil and rock structures, seepage, reworking and biotic action.
- **Texture** is the abundance of different grain sizes in soils and is described by means of field test.
- **Origin** is the formation of the soil by means of transport of weathering.

Disturbed and bulk samples were taken of the material deemed to be important to the proposed development. Laboratory testing commenced on the samples collected during the field work phase of the investigation.

5.3. Ground Profile Discussion

Note: this description is based on field observations and does **not** reflect the results of any laboratory tests.

5.3.1. Introduction

Excluding the initial starting point, the footprint of the access road traverses undeveloped land and is not defined by any existing pathways/roadways on ground level. Due to the undisturbed nature of the soil profile, the upper extent of the exposed soil layers was seen to be **organic rich**. The degree of organic material was noted to gradually decrease with depth- generally limited to the blanketing colluvial sediments.

The footprint of the planned road is underlain by a similar sequence of materials as the proposed reservoir- discussed in length in the preceding sections of this report. The access road is blanketed by **transported materials** deemed to be of a **colluvial origin**. The transported materials thinly blanket **weathered gabbro bedrock-** with the exposed upper extent of the protolith deemed to be in the late stages of rock decomposition/early stages of soil formation. The formation of residual soil is generally limited across the steep sloping flanks of the site due to the reduced amounts of infiltrating water- with the majority of the overland flow converging downslope towards the low-lying areas.

Due to the location of the site proximal to the base of the high-lying terrain i.e. relatively far from the watershed feature, the degree of weathering across the steep slopes is generally amplified as seen in the variable/fluctuating weathering profile of the exposed bedrock

The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock. Moreover, based on the limited exposures, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material. Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and continuity.

Each soil horizon present in the study area displays its own unique gradual change in material properties, both laterally and vertically.

The information presented below is based on point data. Every effort was made during the site investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. Variances in soil and rock quality and quantity from those predicted may be encountered during construction and these should be recorded.

In depth soil profile descriptions for each test pit location are presented in **Appendix A.** The extent of each material along the proposed road is graphically depicted in the **cross section** which forms part of the summaries in **Section 5.10**.

The following predominant material horizons were encountered across the site:

- **Colluvium**
- **Weathered Gabbro Bedrock**

The **combined general characteristics** of the various materials encountered across the site can be **summarised** as follows:

5.3.2. Transported Sediments

Based on available exposures, the side slope of the prominent mountainous terrain which the proposed access road climbs, is blanketed by a **heterogeneous deposit** of transported material profiled as **colluvium**.

These transported materials have been transported by a natural agent during relatively recent geological times and have not undergone lithification into a sedimentary rock.

The colluvium was seen to host the major root systems and associated biotic activity across the site. The organics were seen to gradual decrease with an increase in depth. The roots zone is anticipated to extend to substantial depths and will influence the proposed road construction- requiring proper mitigated during the early stages of construction.

The exposed successions of colluvium were seen to be variable, with fluctuations in composition and colour across the investigated area. The blanketing gravity transported materials display an **overall sandy nature** with a **discernible plasticity**.

The blanketing sediments have gradually become coarser over time as large particles ranging from gravels to boulders are incorporated into the horizon- transported by gravity from further upslope. Moreover, the incorporation of larger particles into the horizon over time is not a uniform process, resulting in an uneven distribution of gravels, cobbles, and boulders throughout the soil layer with intermittent pockets of soil with a distinct absence of oversized particles. These large particles are generally concentrated at- or near- the surface of the horizon as can be seen by the rocky nature of the site.

Furthermore, the size of surficial cobbles/boulders is anticipated to gradually decrease with an increased distance from the crest of the high-lying terrain. Larger particles require significant amounts of energy to be transported and are therefore frequently found close to their original source. As the depositional energy gradually decreases with distance, the particles that can be transported **steadily reduce in size**. These comparatively finer deposits are anticipated along the foot slopes or across major valleys which separate the various ridges across the study area of this investigation

The colluvium was profiled by the field team as a: *slightly* moist; *dark brown;* ***loose with dense zones, medium dense/dense****; intact/pinholed;* ***clayey sand*** *with traces or minor fine gravels or* ***silty sand*** *with traces of gravels; abundant fine roots;* ***surficial cobbles and boulders****; fluctuating depth to underlying bedrock.*

Across the combined excavated test pits, the colluvium is present from surface and extends to depths of between **0.12** and **0.80 m** below the existing ground level (E.G.L.)- displaying an **average exposed thickness of 0.34 m.**

The **colluvium** can be regarded as a **POOR- quality material** with respect to the planned development.

Where the blanketing sediments were mixed with the underlying grades of weathered bedrock- in order to measure the engineering material characteristics which can be expected following site modification practises- the resulting mixed samples displayed a **POOR- quality**.

Based on these results, the various on-site materials should be kept **separate** due to their distinct material properties. A quality control regime should be established in order to prevent the various on-site materials from mixing following bulk earthworks/site remoulding.

5.3.3. Weathered Gabbro- *Dsjate Subsuite*- Rustenburg Layered Suite

The blanketing sediments along the route are generally underlain by **weathered gabbro bedrock**.

As alluded to in the introductory discussions, the formation of residual soil is generally limited along the steep sloping flanks of the site due to the reduced amounts of infiltrating water- with the majority of the overland flow converging downslope towards the low-lying areas. However, this did not prevent the upper extent of the rock mass from being altered to varying degrees resulting in a variable weathering profile across the side slope of the high-lying terrain.

As a result of the limited exposures in hand excavated test pits, varying degrees of protolith weathering and alteration/calcification- classification of the exact rock mass properties was not possible. Accurate rock mass characterization/ mapping can be undertaken across cuttings/exposures resulting from the planned bulk earthworks.

The fabric of the weathered protolith was typically preserved with separation of the grains/minerals- indicative of completely/highly weathered bedrock. As mentioned, the weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material. Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting is a greater consistency and rock mass continuity.

Furthermore, the calcium-rich minerals within the exposed upper extent of the rock mass have been significantly altered by infiltrating water and associated processes over time- resulting in the formation of pedogenic inclusions in the form of calcification staining/calcrete nodules. An increase in degree of calcification was observed in the exposed weathered material with an increase in chainage- and associated surface elevation- towards the planned reservoir.

The **varying degrees of weathered gabbro** was generally described by the field team as: *slightly moist; light creamy grey/white, mottled olive/white, stained brown or white;* ***coarse grained; closely jointed; highly weathered or completely weathered; very soft rock/soft or medium hard rock; Gabbro of the Dsjate Subsuite- Rustenburg Layered Suite;*** *undulating excavation;* ***variable exposure****;* ***irregular pockets of completely weathered bedrock; weathering rapidly decreasing with depth****; discolouration extending from joint planes throughout the rock mass; minor calcrete nodules.*

The varying grades of weathered bedrock were encountered from below the blanketing colluvium, extending to depths of between **0.70 and 0.96 m** below the E.G.L.- displaying an **exposed average thickness of 0.49 m**.

The various grades of weathered bedrock exposed in the excavations displayed a **VARIABLE quality** ranging from **FAIR** to **POOR** across the access road. The fluctuations in re-use potential of the material are predominantly attributed to its inherent variable weathering profile.

It is predicted that the quality and overall continuity of the rock mass will increase with an increase in depth (reduction in weathering/decomposition with depth).

5.4. Groundwater and Shallow Seepage

5.4.1. Introduction and Discussion

A detailed hydrocensus was not undertaken across the study area. For this reason, the static rest level and chemistry of the ground water cannot be discussed. Without knowledge on the depth to permanent groundwater in the region- it is not possible to comment on the occurrence of permanent groundwater flow within/below the subsurface of the site.

If required, a detailed hydro census can be conducted across the site to determine/model the permanent ground water table depth, location and quality underlying the site. Additional to this process, monitoring boreholes/ piezometers can be installed across the development area to examine ground water patterns seasonally.

Managing surface water across the contract will play a pivotal role in reducing ponding, erosion as well as limiting the volumes of shallow sub-surface through flow. Future roadways can be targeted for the use in the drainage network and in so doing limiting the disturbance to the local road users. Additional to the considerations listed above, a **maintenance regime** and performance testing should be put in place to monitor the nature of the system over its design life.

5.4.2. Measured Ground Water Occurrences

No ground water seepage or permanent water table was encountered during the fieldwork phase of the investigation.

5.4.3. Fluctuating Moisture Conditions

The predominant runoff will occur as high energy overland-flow following the topography. As discussed in Section 3.2, the planned infrastructure is located downslope of currently undeveloped land. Although generally very steep, should infiltration take place across these upslope areas it is predicted that elevated volumes of **shallow ground water throughflow** may occur across the investigated site- the degree of which will fluctuate in relation to the intensity and duration of local precipitation events.

Altering the soil profile in areas underlain by shallow bedrock commonly affects the subsurface seepage.

Following site modification practises (cut-to-fill), the upper transported materials will allow **infiltration**. Infiltrating water is predicted to temporarily flow/perch along the **rock-soil interface**, with its flow dynamics dependant on the topography of the rock mass at that point. This typically manifests as a weak, relatively **short-lived perched water** table associated with slight groundwater seepage present directly after a precipitation event. Furthermore, the **undulating topography** of the bedrock affects the continuity of the **shallow water flow dynamics** of the site.

The weathered gabbro bedrock was seen to host variable amounts of **pedogenic** materials in the form of calcification staining and calcrete nodules. These pedogenic materials are not predicted to have formed due to excessive amounts of infiltrating/perching of water but are likely amplified by the mineralogy of the rock and susceptibility of the mafic minerals to decomposition.

Nonetheless, these pedogenic inclusions indicate the periodic occurrence of **fluctuating moisture conditions** after prolonged precipitation events. A general increase in calcification was noticed with n increase in elevation along the access road.

The evidence for fluctuating moisture conditions was encountered within the **upper 1.0 meter** of the profile. This attribute will become a greater concern in the **lower-lying sections** of the roads- due to the predicted convergent shallow ground water through flow.

Good site drainage measures, on surface and subsurface, must be implemented to prevent moisture changes, which may add to the development of temporary perched groundwater tables. During construction and after development, shallow perched water systems may develop yet further due to stormwater management practices, localised infiltration and site modification practices.

Cuttings and installed services will cause soil density and texture changes which may lead to variations in soil moisture across the site with flow changes and build-up of moisture that may differ from the natural conditions.

Excavations may need to be dewatered following prolonged precipitation events- to be undertaken in line with the prescribed HSE protocols.

5.5. Bedrock Outcrops/Boulders

A combination of both **boulders and outcrops** were visible along the majority of the planned route of the access road.

Surficial occurrences were inspected and photographed by the field team- examples of which are included in the summaries (Section 5.10). The exact nature and extent of these anomalies is not known generally as a result of the shallow soil cover and existing vegetation. In large scale unrestricted cuttings, the impact of these features is reduced.

It is recommended that the exact location of these anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the route of the planned access road can be partially adjusted on ground level to avoid major anomalies exposed in the initial earthworks.

Boulders/outcrops will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development.

Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.

5.6. Site Excavatability

Excavatability is a measure of material to be excavated/dug/mined with conventional excavation equipment such as a bulldozer with rippers, mechanical excavator, or other grading equipment. In rock masses, this characteristic is governed by the shear strength of both the intact rock and the discontinuities separating them. Fluctuating excavation conditions correlate to the depth, spacing and degree of fracturing of the underlying rock mass.

Profiles were described in trenches excavated by means of labourers digging by hand (pick-and-shovel method). End of hole conditions were due to **refusal** on less weathered bedrock at depths of between **0.70 and 0.96 m** below E.G.L.

As was seen in exposed ground profiles, the weathered bedrock typically hosts irregular pockets of more and less intact material. Based on the variable weathering profile exposed in the excavations and dominant occurrence of outcrops across the site- the weathered gabbro bedrock is anticipated to display an **undulating bedrock topography** which is characteristic of igneous rock masses/terrains. Cognisance should be taken of the fact that the depth to bedrock might vary between the trial pits.

The average depth of excavation along the **entire length of road** was **0.85 m**. For this reason, the excavation type to an **average depth of 0.97 m** is deemed to be SOFT Excavation (SANS 10400G/ SANS1200D).

Due to the implemented mode of excavation, the excavatability properties of the less weathered gabbro bedrock at depth could not be determined. Excavations problems relating to shallow boulders, outcrops and undulating bedrock can be expected in deep/bulk excavations.

It is anticipated that the rock mass at depth will require **hard rock excavation** to unearth. Where deep cuts into the natural steep slopes are implemented to modify the surface of the site, the excavation properties of the gabbro rock mass need to be considered as discussed in section 4.6.2.

5.7. Engineering and Material Characteristics

5.7.1. Introduction and Sampling

The engineering material properties of the various sampled soil horizons were measured in laboratory conditions as per accredited testing procedures.

Standard foundation/road indicator, compaction tests and soil chemistry tests were conducted by Tzaneen Lab (**SANAS Accredited**) on disturbed and bulk soil samples. These tests were undertaken in order to determine the composition of the underlying soils (i.e.: the relative percentages of gravel, sand, silt and clay) and to evaluate the suitability of the materials for the re-use in the proposed construction.

The sampling which took place during this investigation was based on both the in-situ geotechnical properties of the exposed soil horizons as well as the nature of the development (gravel road assessment).

This section focuses on the identification and assessment of the soil properties which will have an effect on the proposed **access road construction**. Where deemed necessary by the field team, mixed samples were created in order to measure the engineering material characteristics which can be expected following bulk site modification practises.

Full laboratory test results are included in **Appendix B**.

The sampling process **excluded** the following inclusions:

- Oversized particles
- Organic materials

5.7.2. Bulk and Disturbed Samples- Laboratory Test Results

The soil testing for the site can be subdivided into two categories, as follows:

- **Road Indictor Tests**

  Atterberg limits (Liquid Limit, Plasticity Index and Linear Shrinkage) and Particle-size Distribution

- **Compaction Tests**

  Maximum Dry Density versus Optimum Moisture Content and Californian Bearing Ratio versus Compaction Effort (MOD AASHTO method)

The results presented in the summaries to follow (Section 5.10) are as received from the accredited testing facility.

5.8. On-site Material Suitability Discussion

5.8.1. Introduction

Detailed annotated summaries are presented in the sections to follow (Section 5.10). The succession of materials encountered across the site each display their own variability- impacting the overall **continuity** of the expected material quality with regards to the planned construction.

5.8.2. TRH20/COTO- Unsealed Roads

The nomenclature to follow is used in the technical recommendations for the design, construction and maintenance of unsealed roads (TRH20).

Corrugations are one of the most disturbing functional defects of unsealed roads and cause significant roughness and poor vehicle directional stability. Corrugations consist of parallel pinnacles of sandy materials which form perpendicular to the flow of traffic.

Moreover, corrugations are typically characterized as loose of fixed depending on the degree of compaction of the crests/pinnacles. Loose corrugations are easily remediated by blading, whereas fixed corrugations may require cutting or even light ripping with a grader in order to spread the material. The wavelength of the corrugations is proportional to the speed of the traffic using the road.

Ravelling refers to the degradation of the road surface by the generation of loose gravel under traffic and represents a significant economic, safety and maintenance problem. The loose gravel may be distributed across the entire surface of the road or concentrated between wheel tracks forming dangerous zones of debris which frequently cause damage to vehicles.

Erosion can simply be described as the loss of surfacing material caused by the flow of water over the road. According to the TRH20, the ability of the material to resist/avoid erosion depends on the shear strength of the material which is equal to the cohesion of the material as no normal stress is applied to the blanketing materials across the surface of the road. If the attractive force of the water is greater than the shear strength of the material than erosion will occur.

Fine, poorly graded material with limited coarse particles (grading coefficient less than 16) are highly susceptible to erosion.

Erosion results in the formation of run off channels-sometimes referred to as runnels- which may form across the surface of the road resulting in an extremely rough surface along the footprint of the road resulting in the formation of ruts.

Slipperiness is caused by the migration of plastic/clayey materials to the surface of the road under the impact of rain or tires of vehicles. A road with sufficient coarse fraction may become slippery if fine clay/silt become concentrated on the surface of the unsealed road. The saturated clay/fine materials on the surface of the road may have a similar effect to aquaplaning on sealed roads. In dry weather conditions, a roadway may become slippery if there is an accumulation of fine particles on the road reducing the skid-resistance of the surface.

5.8.3. On-site Material Classification

Caution should be taken in the **zones of poor-quality material** (i.e., organic rich materials), with allowance for adequate site supervision and ongoing quality control testing during the construction phase. Where encountered, zones of poor-quality material should be adequately modified prior to its re-use- within the specifications of the engineer's design.

From the USCS classification of the on-site materials (SC, SM and GC) these materials are inferred to be **reasonably stable embankment material**.

Where deep/bulk excavations are undertaken across the site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction. This material is anticipated to serves as good material for the use in engineered fills.

Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers in the proposed construction

Colluvium

This horizon tested as **POOR quality (<G9)** material according to COLTO 1998. According to this classification system, the colluvium is suitable for the use in **subgrade layers (<G9/G9)** in the planned road construction. The transported deposits typically classify poorly due to a combination of both **poor compaction** characteristics and **elevated plasticity**.

The **colluvium** exhibits a measured **CBR of 2 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the colluvium falls within subgrade class **SG4** and may therefore not be adequate subgrade material for flexible pavements due its CBR at 93% not **exceeding 15.**

The poor quality and organic-rich nature of the colluvium poses a risk to the proposed development and should be addressed during the design of the planned road structure- with allowance for adequate site supervision and ongoing quality control testing during the construction phase.

Varying Grades of Weathered Gabbro Bedrock

The underlying **weathered bedrock** displayed a **variable quality** with regards to the planned road construction- typically associated with the bedrock's inherent **variable weathering profile**.

The variable reusage potential of the material may pose a risk to the road construction and highlights the need for adequate site supervision and ongoing quality control testing. The quality and overall continuity of the rock mass is anticipated to increase with an increase in depth.

The samples tested as **FAIR (G7/G8)** and **POOR (G9) quality** material. Pockets of **material exhibiting poorer compaction characteristics** are only suitable for use as **subgrade layers (<G9/G9)**, whereas better pockets are generally suitable for the use in **selected layers (G7/G8).** in the road construction (COLTO, 1998).

The **weathered gabbro** exhibits **measured CBR values** ranging from **8 to 15 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the weathered material falls within subgrade class **SG2-** with CBR values at 93% not consistently exceeding 15 and may therefore not be suitable subgrade material for flexible pavements.

Mixed Colluvium and Weathered Gabbro Bedrock

Where the on-site materials were mixed in order to get an indication of material reusability/engineering characteristics following bulk earth works/site remolding- the mixed material typically displayed a **POOR quality (<G9)** material according to COLTO 1998.

According to COLTO 1998, the mixed materials are suitable for the use in **subgrade layers (<G9/G9)** in the planned road construction. The materials typically classify poorly due to a combination of both poor/variable compaction characteristics and/or elevated plasticity.

Based on these results, it evident that the **combined variability** of the colluvium (heterogeneous and transported nature) and weathered gabbro bedrock (variable and fluctuation weathering profile) has negatively affected the quality of the mixed materials.

The **mixed colluvium and weathered bedrock** samples exhibit measured **CBR values between 8 and 23 at 93% Mod AASHTO density.** According to the **South African Pavement Manual**, the mixtures fall within subgrade class **SG1 and SG2**- indicating the variability of the mixtures- and may therefore not be adequate subgrade material for flexible pavements due to CBR values at 93% not consistently **exceeding 15.**

Performance as Gravel Wearing Course (TRH20)

According to the **TRH20**, the colluvium classifies as **Class D** (slippery), the weathered bedrock classifies as **Class E** (good) and **Class B** (ravels and corrugates), and the mixed materials classify as **Class A** (erodible) and **Class E** (good) in terms of **performance as gravel wearing course.**

Erosion (Class A) can be reduced by elevating the shear strength of the material by increasing its compaction and ensuring a well-graded mixture of material resulting in increased particle interlock- increasing suction forces within the material and decreased permeability. Similarly, the energy of the water can be decreased by retarding the rate of flow using good drainage measures and adjusting camber angles of the road. Erosion may cause the changes in the properties of the material as certain fractions are removed.

The major remediation measure for **slippery roads** (Class D) is the removal of the fine, high plasticity material and replacement with material with a lower shrinkage product (gravel material). For slippery roads under dry conditions, increasing the coarse material, binder content, and grader blading operations are recommended.

Raveling and Corrugations (Class B) is generally caused by a lack of fine material, poor particles size distribution, insufficient compaction and is generally worse in the dry season. Fine material can be blended with the gravel and good compaction at a suitable moisture content (OMC) can be used to reduce raveling. **Regular road maintenance** will be required in order to mitigate the formation of **corrugations** and to **inhibit loose corrugations** from transition to **fixed corrugation** over time.

5.9. DCP Testing- Centerline Investigation

A total of **FIVE (5)** Dynamic Cone Penetrometer (DCP) tests were performed across the site so as to give an indication of the consistency of the in-situ material.

DCP test results are presented in the graphics to follow (Section 5.10)- with full detailed results included in **Appendix C.**

In the design of roads, the DCP is a practical test used for onsite measuring of road material strength. The test results can be correlated with the California Bearing Ratio (CBR) by applying a formula; results of which can be correlated to the laboratory tests conducted on the soils from the same location.

DCP tests were performed at **natural moisture conditions** and thus the values vary greatly from the CBR results measured under controlled conditions within the laboratory. This variation is mainly due to the lab specimens being analysed under saturated conditions. It should be noted that the strength of the in-situ soil changes greatly with change in moisture conditions.

Fluctuations of the in-situ moisture content within the exposed soil horizons may have had a detrimental effect on the accuracy of the DCP results. DCP test should therefore only be used as indicative statistics for the site.

Summarised DCP results discussion

With reference to the CBR readings with depth (graphic in Section 5.10):

- The DCP tests conducted across the site displayed a **variable penetration resistance with depth** and associated in-situ consistency.
- All DCP tests conducted across the site refused at depths of between **267 and 683 mm** with average penetration depth across the proposed road footprint of **412 mm**.
- Based on the soil profiles, the colluvium extends to an average depth of 0.34 m below E.G.L, indicating that the DCP tests were only able to penetrate the blanketing colluvium and **refused on the underlying weathered rock**.
- As seen in the various annotated graphics, the in-situ CBR values inferred for the entire soil profile were notably high- in fact, considerably higher than that of the attributes measured in saturated conditions in the lab.

- Using this depth, an average in-situ CBR of greater than 35 can be inferred for the transported material. Moreover, an average in-situ CBR of greater than 130 can be inferred for the upper extent of the exposed rock mass.
- From these excessive values it is clear that the accuracy of the DCP probe has been negatively affected by the granular nature and low in-situ moisture content of the shallow materials.
- The presence of sand, gravel and/or cobble sized rock fragments, in conjunction with fluctuations of the in-situ moisture content within the exposed soil horizons may have had a detrimental effect on the accuracy of the DCP results.
- Once the area has been rehabilitated and final starting levels have been created on site- DCP testing can be conducted at regular intervals in order to determine the in-situ CBR of the road bed at any given point/location.

5.10. Combined Geotechnical Summaries

GeoCalibre has compiled a simplified site summary, including laboratory and DCP test results in order to guide the design phase of the development.

The purpose of this summary is to eliminate data complexity, for this reason, extensive/in-depth soil profile discussions have been omitted from this exercise.

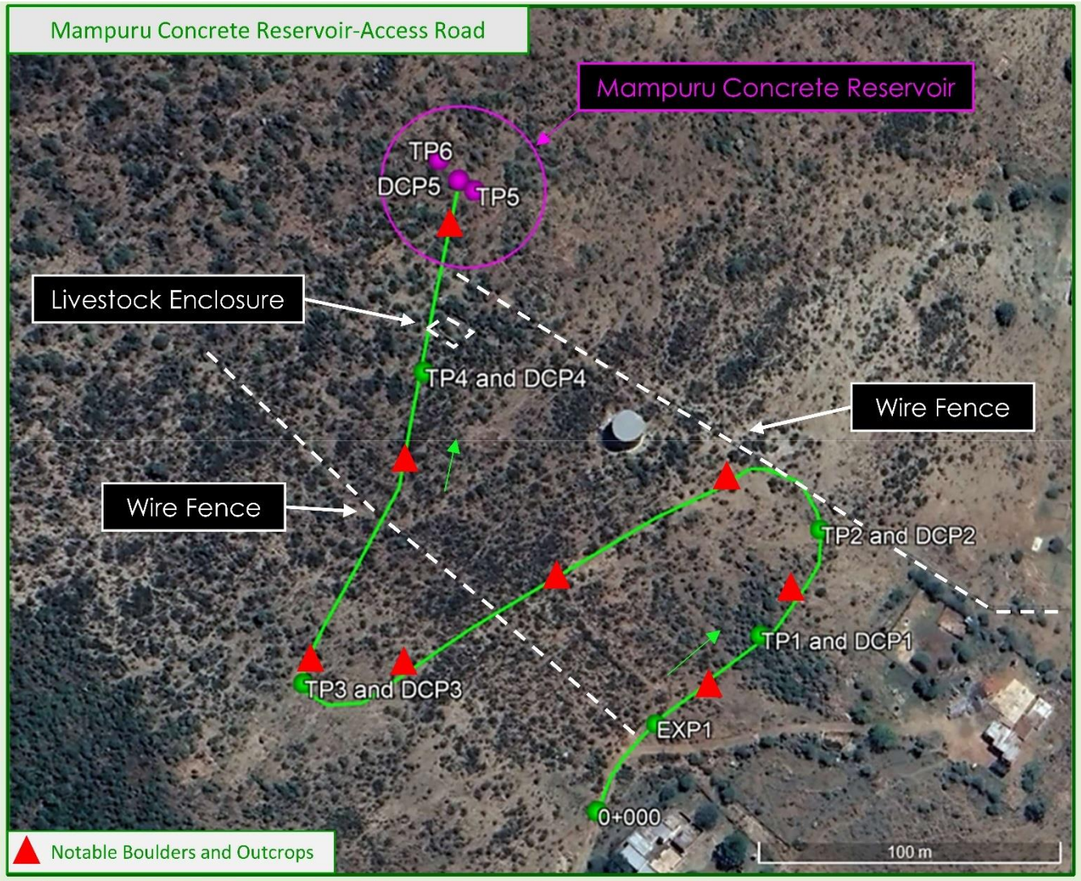
Major geotechnical attributes are highlighted and listed where applicable.

The follow legend guides the understanding of the tables/graphics to follow:

- Discussions points presented in the summaries are based on the information presented by the field team (observations and photography), available remote sensing information and the cumulative results of the study.
- All depths displayed in **meters** (m).
- Thickness refers to the **exposed thickness** of the soil horizon (meters).
- The field observations annotated on the graphics serve as an indication.
- Horizon depths displayed in the tables are **average measured values**.
- Excavation conditions:
  - **ES-** Excavation **stopped**.
  - **DE-** Difficult Excavation
  - **R- Refusal**.
- Material codes used in the summary:
  - **C-** Colluvium
  - **WGB-** Weathered Gabbro Bedrock
- Presented chainages are inferred from the available remote sensing information- adjustments can be made where required.
- CBR graphs make use of the **combined materials sampled** across the access road in question- irrespective of depth.

- Oversized particles: **Cobbles** refer to particles with an average diameter of between 0.06 - 0.20 m; particles larger than this are deemed to be boulders.
- The provided **cross sections** serve as a practical **graphical depiction** of the various layers underlying the various roads. These graphics are not to scale.
- Lab results are presented as received from **Tzaneen Lab.** Although the summaries have been annotated- no amendments have been made to the results themselves.

The combined graphics to follow depict the **summarised findings** from the **fieldwork** and **laboratory testing phases** of the investigation.









Summarized Discussion

- Winding access road- start at high-lying outskirt of the village of Mampuru (0+000) extending to reservoir location situated on the steep side slope of prominent mountainous terrain at 0+500; Length ~0.50 km.
- The road executes multiple hair pin-like turns at 0+140 and 0+320 in order to navigate the complex and steep terrain.
- The footprint of the planned development was not defined on ground level attributed to the undeveloped nature of the site.
- The surface of the site will need to be remolded to improve access and mobility.
- The slopes display a rocky/bouldery morphology with cobbles/boulders and outcrops along most of its length. Outcrops separated by zones of soft materials.
- The slopes are vegetated- flora will be a concern in the blanketing soils. Removal of vegetation from blanketing soils may promote slope/cutting instability.
- Emphasis should be placed on surface drainage and storm water control measures across the developments footprint in order to avoid instabilities, focused infiltration, surface water ponding and erosion/ structural undercutting.
- Addressing the concerns surrounding the convergence of surface water upon the development is key to the stability and longevity of the development as a whole.
- The roads orientation in relation to the natural slopes will impact the rate and associated energy of the overland flow.
- Road exhibits a constant increase in elevation with chainage. Vast extents of the access road exhibit a steep sloping nature, generally orientated approximately obtuse to the natural slopes. Increased overland flow/energy. High energy channelized flow and converging surface water flow elevates the risk for erosion and associated scouring/undercutting- across/along the future road.
- Localised minor erosion encountered- formation mitigated by existing vegetation and rocky surface- removal and remolding of site's surface will greatly increase the risk for erosion.
- Varying degrees of cut-to-fill site preparation expected across the site. Slope, outcrops, boulders and undulating bedrock topography anticipated to significantly hamper excavatability especially during cut-to-fill site preparation.
- No natural slope instabilities were visible in these areas at the time of the investigation (basic visual inspection). Detailed stability assessments of existing- and future- deep road cuttings and thick fill embankments required for future major cuttings/fills.
- Due to the meandering shape of the road, localized sections traverse the natural slopes at an acute angle- decreasing the associated run-off. Similar drainage is expected where cut-to-fill operations are implemented.
- The construction will influence natural infiltration and run-off rates, and appropriate precautions should therefore be implemented as part of the design.

Summarized Ground Profile:

The formation of residual soil is generally limited along the steep sloping flanks of the site due to the reduced amounts of infiltrating water. However, this did not prevent the upper extent of the rock mass from being substantially altered to varying degrees resulting in a variable and undulating weathering profile across the investigated terrain.

- **Colluvium**: the blanketing sediments display a sandy nature with noticeable plasticity. Variable incorporation of gravels, cobbles and boulders over time from further upslope. Larger particles generally concentrated on or near to surface. Organics concentrated in this blanketing horizon.
  - Profiled as: clayey/silty sand with traces/ minor fine gravels; abundant fine roots; surficial cobbles and boulders
  - Variable thickness ranging from **0,12** to **0,80 m**. Average thickness of **0,34 m.**
  - **POOR** quality material. Heterogeneous and organic-rich nature may pose a risk to the planned construction.
- **Varying Grades of Weathered Gabbro:** The weathering of the rock mass was variable- with pockets of better-preserved rock fabric separated by zones of soil-like material.
  - Overall, the weathering of the bedrock is anticipated to decrease with depth- resulting in a predicted increase in material quality.
  - No discernible change in material quality was measured between the exposed varying degrees of rock mass.
  - Profiled as: **coarse grained; closely jointed; completely/highly weathered; very soft rock/medium hard rock; Gabbro** (Dsjate Subsuite);
  - Undulating topography, encountered from between **0,12** to **0,39 m** below E.G.L. Average thickness of **0.49 m**.
  - **VARIABLE quality**- ranging from **FAIR** to **POOR**. Variability due to variable profile.
  - Localised excavation problems due to undulating topography and boulders.
- Final excavation depths range between **0,70** and **0,96 m** below the existing ground level- average excavation depth across the access road **0,85 m**

Summarised Ground Profile- Mampuru Concrete Reservoir- 1200 kl

Area	Chainage	Test Pit	Colluvium			Weathered Gabbro Bedrock			Excavation Character		
			From	To	Thickness (m)	From	To	Thickness (m)	Test pit depth (m)	Termination Conditions	Termination Material
Access Road	0+040	EXP1	0,00	0,80	0,80	-	-	-	0,80	-	WGB
	0+080	TP1	0,00	0,12	0,12	0,12	0,74	0,62	0,96	R	WGB
	0+130	TP2	0,00	0,23	0,23	0,23	0,70	0,48	0,70	R	WGB
	0+330	TP3	0,00	0,39	0,39	0,39	0,70	0,31	0,70	R	WGB
	0+440	TP4	0,00	0,22	0,22	0,22	0,92	0,32	0,92	R	WGB
Reservoir Location	0+490	TP5	0,00	0,30	0,30	0,30	0,90	0,60	0,90	R	WGB
	0+500	TP6	0,00	0,34	0,34	0,34	0,96	0,62	0,96	R	WGB
Data Summary			**Minimum**		0,12	0,12	0,70	0,31	0,70		
			Max		0,80	0,39	0,96	0,62	0,96		
			Average		**0,34**	**0,27**	**0,82**	**0,49**	**0,85**		

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Road Description

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 kl

Access Road

Test Pits EXP1 to TP6

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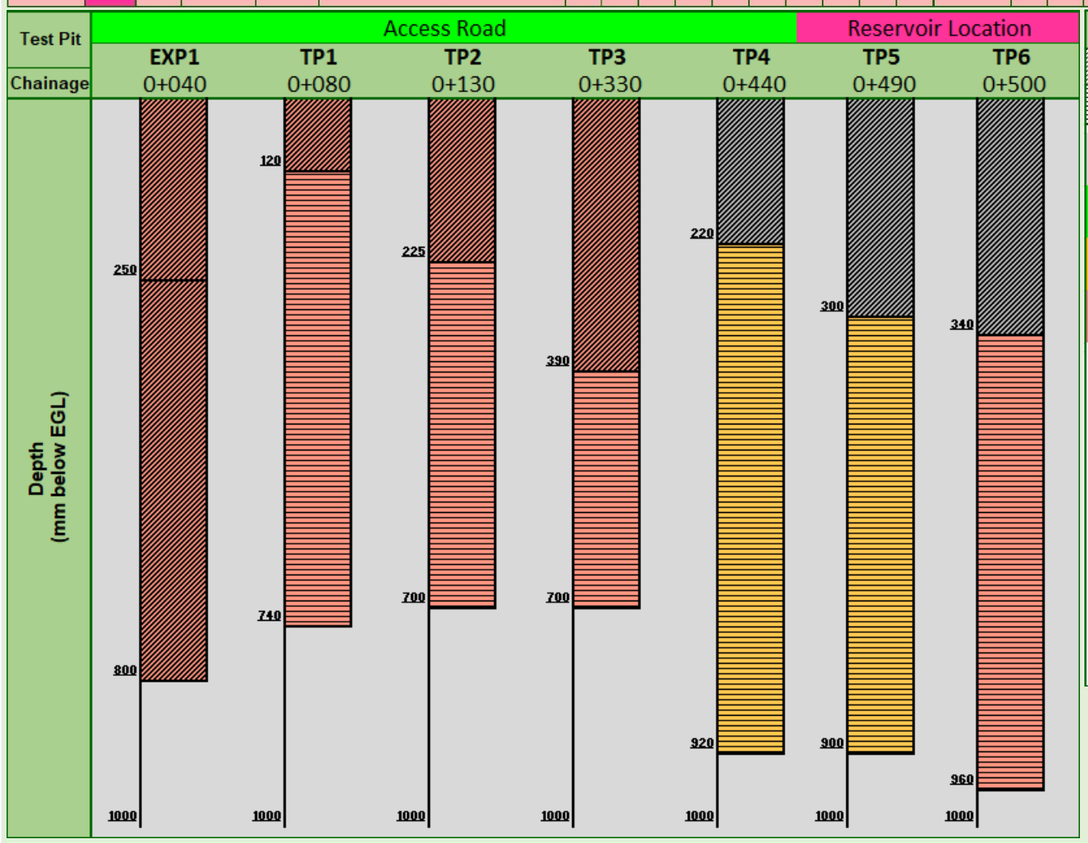
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Combined Laboratory Test Results Summary

Sample Description						Particle Size Distribution										Dispersivity Indicator	Atterberg Limits			Compaction Test Results Mod AASHTO Method				Material Classification			Performance as Gravel Wearing Course		
						Sieve Analysis (Cumulative Percentage Passing)											Atterberg Limits			Mod AASHTO		Interpreted CBR Values								
Sample No.	Area	Test Pit	Sample Depth (m)	Chainage	Material	50,0	37.5	28.0	20.0	14.0	5.0	2.0	0.425	0.075	GM	Double Hydrometer Results (%)	LL	PI	LS	MDD (Kg/m³)	OMC (%)	100%	95%	93%	COLTO CLASS.	US Highway	Unified Soil Classification	Grading Coefficient (Gc)	Shrinkage Product (Sp)	TRH20 Classification
T03346/1	Access Road	EXP1	0,00-0,80	0+040	Colluvium	100	94	90	83	77	70	63	48	31	1,6	-	44	21	11,9	1784	16,1	5	2	2	<G9	A-2-7(1)	SC	19	573	Class D Slippery
T03346/2		TP1	0,00-0,74	0+080	Mixed: Colluvium/Weathered Gabbro Bedrock	74	63	56	50	47	40	36	26	16	2,2	-	38	18	8,7	2064	7,3	71	32	23	<G9	A-2-6(0)	GC	8	229	Class A Erodible
T03346/3		TP2	0,00-0,70	0+130	Mixed: Colluvium/Weathered Gabbro Bedrock	86	79	73	66	60	50	43	30	18	2,1		31	17	8,3	1948	13,0	35	17	13	<G9	A-2-7(0)	SC	15	248	Class A Erodible
T03346/4		TP3	0,00-0,70	0+330	Mixed: Colluvium/Weathered Gabbro Bedrock	91	79	74	71	67	51	42	29	14	2,2	-	32	13	6,4	2131	10,2	30	12	8	G9	A-2-6(0)	SC	16	184	Class E Good
T03346/5		TP4	0,22-0,92	0+440	Weathered Gabbro Bedrock	98	97	95	92	87	82	67	37	13	1,8	-	-	SP	1,2	2128	11,0	38	20	15	G7	A-1-b(0)	SM	23	43	Class B Ravels and Corrugates
T03346/6	Reservoir Location	TP5	0,30-0,90	0+490	Weathered Gabbro Bedrock	90	86	83	78	74	63	54	41	21	1,8	-	32	15	7,6	2048	10,2	31	16	12	G8	A-2-6(0)	SC	18	314	Class E Good
T03346/7		TP6	0,34-0,96	0+500	Weathered Gabbro Bedrock	96	94	93	91	86	83	74	60	31	1,4	17,0	31	11	5,1	1931	12,3	20	10	8	G9	A-2-6(0)	SC	16	303	Class E Good



Graphic Legend

- Coarse Colluvium
- Weathered Gabbro Bedrock
- Not Sampled
- G5/G6- type Material Suitable for use in Subbase Layers
- G7-G8- type Material Suitable for use in Selected Layers
- G9/<G9- type Material Suitable for use in Subgrade Layers

The presented lab results are in accordance with those provided by Tzaneen Lab

The material types are extrapolated from the presented soil profiles.

The soil profile results are presented up to a depth of 1 m below the existing wearing course.

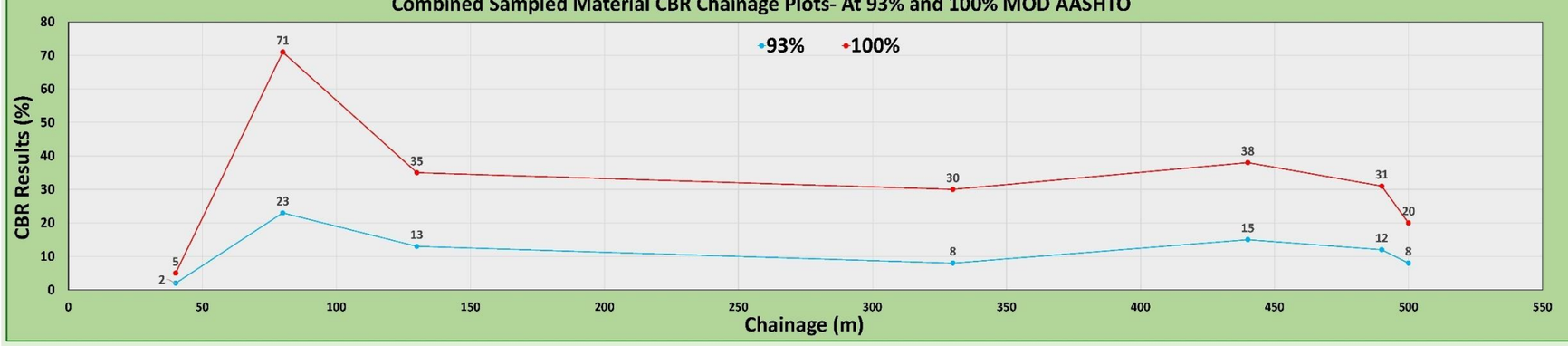
The material quality as presented is in accordance with the COLTO Classification System (1998).

The graphics are not to scale

Summarized Test Results

- The on-site materials classify as Class A (erodible), B (ravels and corrugates), D (slippery) and E (good) performance as gravel wearing course (TRH20)
- The blanketing colluvium classified as **POOR (<G9)** quality material. According to the South African Pavement Manual, the colluvium falls within subgrade class **SG4-** with inadequate CBR values at 93% (>15) to be deemed **suitable subgrade material** for flexible pavements.
- The underlying varying grades of bedrock classified as **FAIR (G7/G8) and POOR (G9)** quality material.According to the South African Pavement Manual, the weathered material falls within subgrade class **SG2** due to its CBR at 93% not consistently exceeding 15 and may not be **suitable subgrade material** for flexible pavements.
- Where the **on-site materials were mixed**, the samples displayed similar reusability potential as the colluvium classifying as **POOR (<G9/G9)** quality. According to the South African Pavement Manual, the mixed materials classify as subgrade class **SG1 and SG2** with variable compaction characteristics and may therefore not be suitable subgrade material for flexible pavements.
- It is advised that a quality control regime and site supervision be implemented to prevent the on-site materials from mixing.

Combined Sampled Material CBR Chainage Plots- At 93% and 100% MOD AASHTO



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Laboratory Summary

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 kl

Access Road

Test Pits EXP1 to TP6

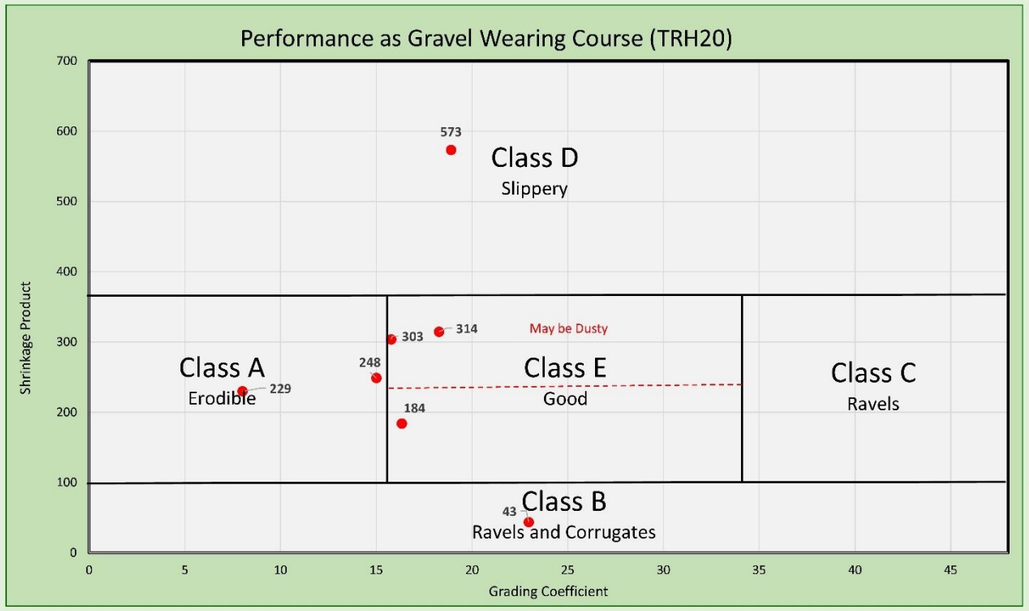
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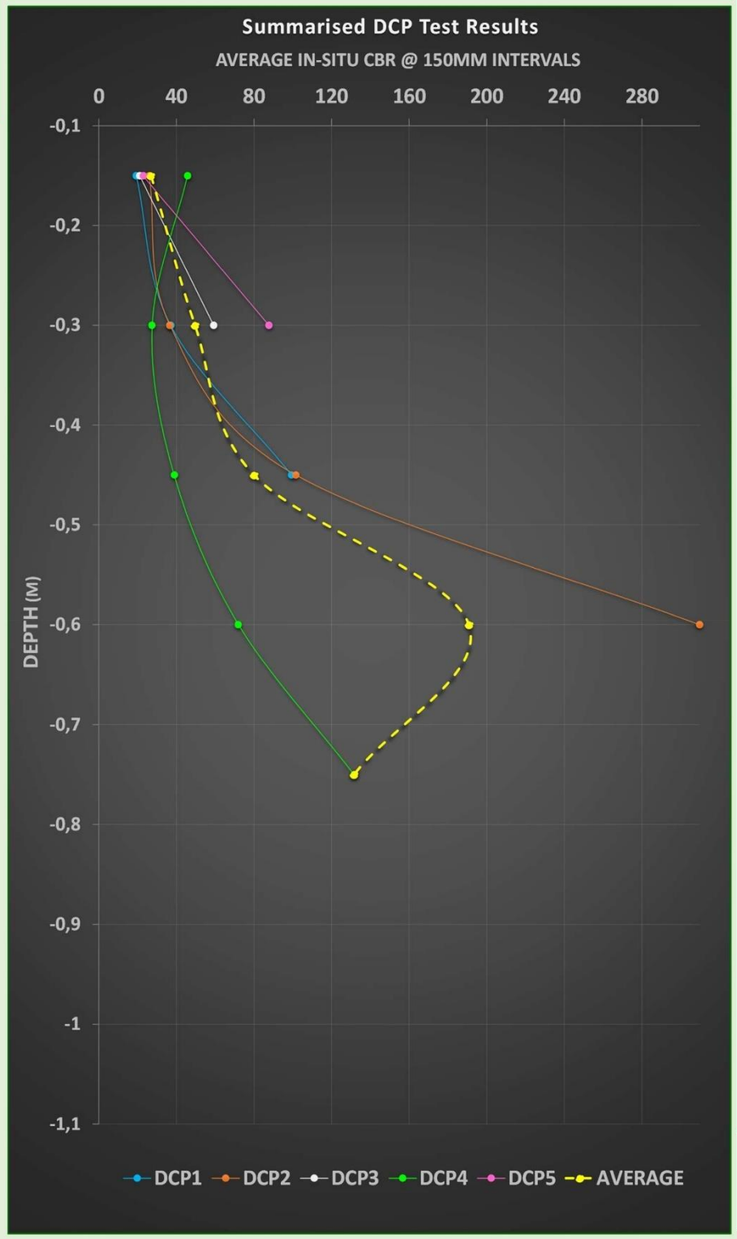
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Summarised DCP Test Results

Depth (m)	Average In-Situ **CBR** Values					AVERAGE
	Access Road				Reservoir Location	
	DCP1 **0+080**	DCP2 **0+130**	DCP3 **0+330**	DCP4 **0+330**	DCP5 **0+440**	
0,00	-	-	-	-	-	-
-0,15	19	26	21	46	23	27
-0,30	37	37	59	28	88	50
-0,45	99	102	-	39	-	80
-0,60	-	310	-	72	-	191
-0,75	-	-	-	132	-	132
-0,90	-	-	-	-	-	-
-1,00	-	-	-	-	-	-
Termination Depth (mm)	434	460	267	683	216	412



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Gravel Wearing Coarse

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 kl

Access Road

DCP Tests DCP1 to DCP6

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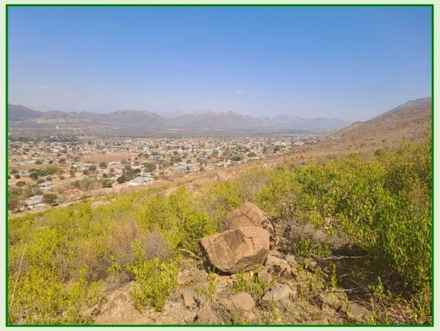
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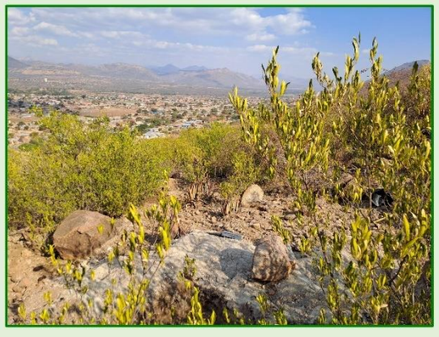














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Photographs

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 kl

Access Road

Test Pits EXP1 to TP6

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5.11. Design Considerations- Access Road

The diverse geotechnical attributes of the site have been discussed at length in the preceding sections of this report. There are geotechnical attributes of the site which are not ideally suited for the planned development (delineated in this report)- for this reason, **engineering solutions** will be required to ensure the stability and longevity of the development.

The following considerations and generally accepted standards of practise should be contemplated during the design and construction of the planned new access road:

- All future actions across the site should be aligned with the most recent applicable standards of practise/technical specification documents of South Africa (SANS, TRH, TMH, COLTO/COTO and SAPEM).
- Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand along the route of the planned access road structure.
    - Access to- and terrain mobility across- the site will need to be modified in the early stages of the development, the extent of which should be sufficient to allow for long term access to ensure smooth daily operations, ongoing maintenance and possible future upgrades.
    - Once access/mobility has been modified follow-up studies can be conducted, where required.
- The full route of the planned access road was vegetated at the time of this study. The natural vegetation will need to be modified in the early stages of the construction to aid access and terrain mobility. Regarding bio-engineering, the natural vegetation cover protects the slope from erosion (run-off and rain splash) and serves as a anchoring mechanism to reduce the possibility of shallow seated instabilities. The effects of the removal of trees on sites should also be considered.
- Developments of this nature typically include the rehabilitation/remoulding of the site's surface including major cut-to-fill site preparation in order to create the prescribed working levels as well as the construction of the associated infrastructure including basic drainage measures.
- Various topographic anomalies were encountered across the site- with the most significant occurrence along the western portions of the site where the road executes a hairpin turn. These anomalies are generally in the form of small-scale depressions which may act as preferential flow paths with high-energy convergent flow resulting in the formation of erosional landforms. Although not mapped to host stream channels, temporary convergent flow can be expected across this- and similar- features.
- As a results of the sites complex topography and geographic location, the design and implementation of fit-for-purpose site modification and drainage measures are essential for the stability and longevity of the development.

- As a result of the roads shape in relation to the very steep natural slopes, site modification practises are required. Where cuts/thick embankment fills are implemented to modify the sites surface, cut/fill embankments will need to be adequately sloped, modified or stabilised- and vegetated where possible- to ensure long-term stability in saturated conditions.
- Where cuttings are undertaken, a buffer/drainage zone should be left between the face of the cutting and the roads' flank.
- Importance should be placed on drainage/storm water control measures to avoid instabilities, focused infiltration, surface water ponding and erosion.
- Future anthropogenic attributes will influence natural infiltration, shallow throughflow and run-off rates.
- Altering the ground profile in areas underlain by shallow bedrock commonly affects the subsurface seepage. Varying degrees of seepage within the road cuttings can be expected throughout the lifetime of the development. Note that water present within the slope, along with destabilising pore pressures, are often the main cause of slope instability.
- Inadequate temporary erosion and drainage control measures can result in severe damage to infrastructure.
- Sheet wash from stormwater or other waters shall be prevented from running over the cut slopes through the implementation of basic upslope cut-off drains. These features serve a dual purpose by also serving as a catchment zone for mobilised debris.
- A maintenance regime should be put in place to periodically assess the nature of the development for a set period following the construction. Areas showing visible deformation should be modified accordingly, in order to avoid further deformation and/or permanent damage.
- Areas subjected to extensive fills need to be adequately modified/ compacted to limit soil movement over time (i.e., fill creep).
    - Where implemented, it is essential that backfilled materials are of sufficient quality and compacted in controlled layers (material quality/required density as per engineers' design).
    - Ensure the removal of topsoil within the footprint of planned fill areas.
    - A carefully engineered fill embankment should not settle more than 0.5% of its height due to self-weight.
    - Engineered fill slopes should be over constructed and thereafter trimmed back to the required position.
    - Cut and fill heights greater than 2 metres should be inspected and approved by a competent person.
- A combination of both boulders and outcrops were visible along the entire route of the planned access road. It is recommended that the location of these anomalies be modelled by the surveyor for the amalgamation into the site's earthworks model. Where deemed necessary by the design team, the route of the planned access road can be partially adjusted on ground level to avoid major anomalies exposed in the initial earthworks.
    - Boulders/outcrops will need to be broken down and moved in a controlled manner- aligned with the HSE protocols of the development.

- Caution should be implemented during the initial earthworks to stop boulders from running uncontrollably downslope- possibly causing damage to local properties/ infrastructure or life.

- A key pavement design principle is that the subgrade provides an adequate foundation. A minimum CBR of 15% (G7-type compaction) is generally required for flexible pavements (SAPEM, 2014).
- Special attention must be given to the selection of the correct material to be used for the fill material and the general backfill in the construction of pavement layers/gravel wearing course.
  - The poor quality and organic-rich nature of the colluvium poses a risk to the proposed development and should be addressed during the design of the planned road structure.
  - The underlying weathered bedrock displayed a variable quality with regards to the planned road construction- typically associated with the bedrock's inherent variable weathering profile. The quality and overall continuity of the rock mass is anticipated to increase with an increase in depth. Where deep/bulk excavations are undertaken across the site to modify the surface, it is recommended that the excavated less weathered rock be stockpiled for the re-use in the planned construction.
  - Where the on-site materials were mixed in order to get an indication of material reusability/engineering characteristics following bulk earth works/site remoulding- the mixed material typically displayed a POOR quality (<G9) material according to COLTO 1998.
  - According to the TRH20, the colluvium classifies as Class D (slippery), the weathered bedrock classifies as Class E (good) and Class B (ravels and corrugates), and the mixed materials classify as Class A (erodible) and Class E (good) in terms of performance as gravel wearing course.
  - From the USCS classification of the on-site materials (SC, SM and GC) these materials are inferred to be reasonably stable embankment material.
  - Caution should be taken in the zones of poor-quality material (i.e., organic rich materials), with allowance for adequate site supervision and ongoing quality control testing during the construction phase.
  - Should additional materials be required, it is recommended that material be imported from a local borrow area or certified/registered commercial source for the use in controlled layers.
- All earthworks should be carried out in a manner to promote stable development of the site.
  - It is recommended that earthworks be carried out along the guidelines given in SABS 1200/SANS 10400 (current version).
  - Placement of fill layers should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve 93% Modified AASHTO maximum dry density at ±2% optimum moisture content.
  - Density control of placed fill material should be undertaken at regular intervals during fill construction.

- All bulk excavations should be inspected by a competent person (engineer or geo-professional with relevant training and experience) at least once a day and following any periods of rain or any long periods where no work has taken place.
- With reference to the exposed soil profiles and accompanying lab results, the materials exposed across the site were seen to display a variable composition and in-situ geotechnical nature.
    - With this said, an adequate quality control system should be implemented during the construction phase of the development to ensure that pockets of poorer quality soils be removed/treated.
    - Ongoing laboratory testing can be conducted by an accredited laboratory during the construction phase of the development.

6. Report Provisions

The planned structures are primarily situated along the steep sloping flanks of the various ridges which combine to form the mountainous terrain which dominants this portion of the Limpopo Province. Access to- and mobility- across these areas was limited at the time of this study. For this reason, the project team opted to undertake an initial phase near surface geotechnical study- entailing excavations by hand across the footprints of the planned structures and along the routes of the various access roads.

The investigation was conducted according to the accepted proposal and the scope of works and literature references provided in this document. Field work and reporting were conducted and/ or overseen by professionally registered scientists with the South African Council for Natural Scientific Professions. Furthermore, GeoCalibre has have employed accepted engineering geologic procedures, and our opinions and conclusions are made in accordance with generally accepted principles and practices in engineering geology.

The presented geotechnical model is based on a data base of available information and available on-site exposures. Parcels of land within the developmental area which are free of excavations are modelled using on-site observations and surrounding exposures. While every effort is made during the fieldwork phase to identify the different soil horizons, areas subject to a perched water table, areas of poor drainage, areas underlain by hard rock and to estimate their distribution, it is impossible to guarantee that variations are excluded over the extent of the site which are the subject of this report.

Variable founding conditions and materials are expected to be encountered. This variability includes soils of different age, composition and associated pre-consolidation pressures. In view of the variability inherent in natural materials, a competent person must inspect all foundation excavations at the time of construction to ensure that the materials are adequate for the proposed structure and that they are in accordance with the recommendations stated in this report.

The design and implementation of the planned engineering fills remains the responsibility of the consulting engineers/competent person- with GeoCalibre and its' employees carrying no liability in this regard. The placement of engineered fill must be controlled with suitable field tests to ensure that the required densities are achieved during compaction, and that the quality of the fill material is within specification to ensure the longevity of the development.

The determination of flood lines and delineation of wetland areas were not part of this investigation scope and should be addressed by suitably competent professionals prior to the final site development plan is compiled, if deemed necessary. If the site or a portion thereof is situated within the 1:100-year flood line, or has been delineated as a wetland, it is the prerogative of the Civil Engineer or other suitably experienced specialist to overwrite the recommendations for such portions.

Although not anticipated at this site, it should be noted that this investigation did not include the assessment of any potential environmental hazards, or groundwater impacts that may be present, or ensue from the construction of the proposed structures.

GeoCalibre is open to ongoing discussions with all the parties involved in order to elaborate on the methodology implemented during this assessment and its associated findings/ground models.

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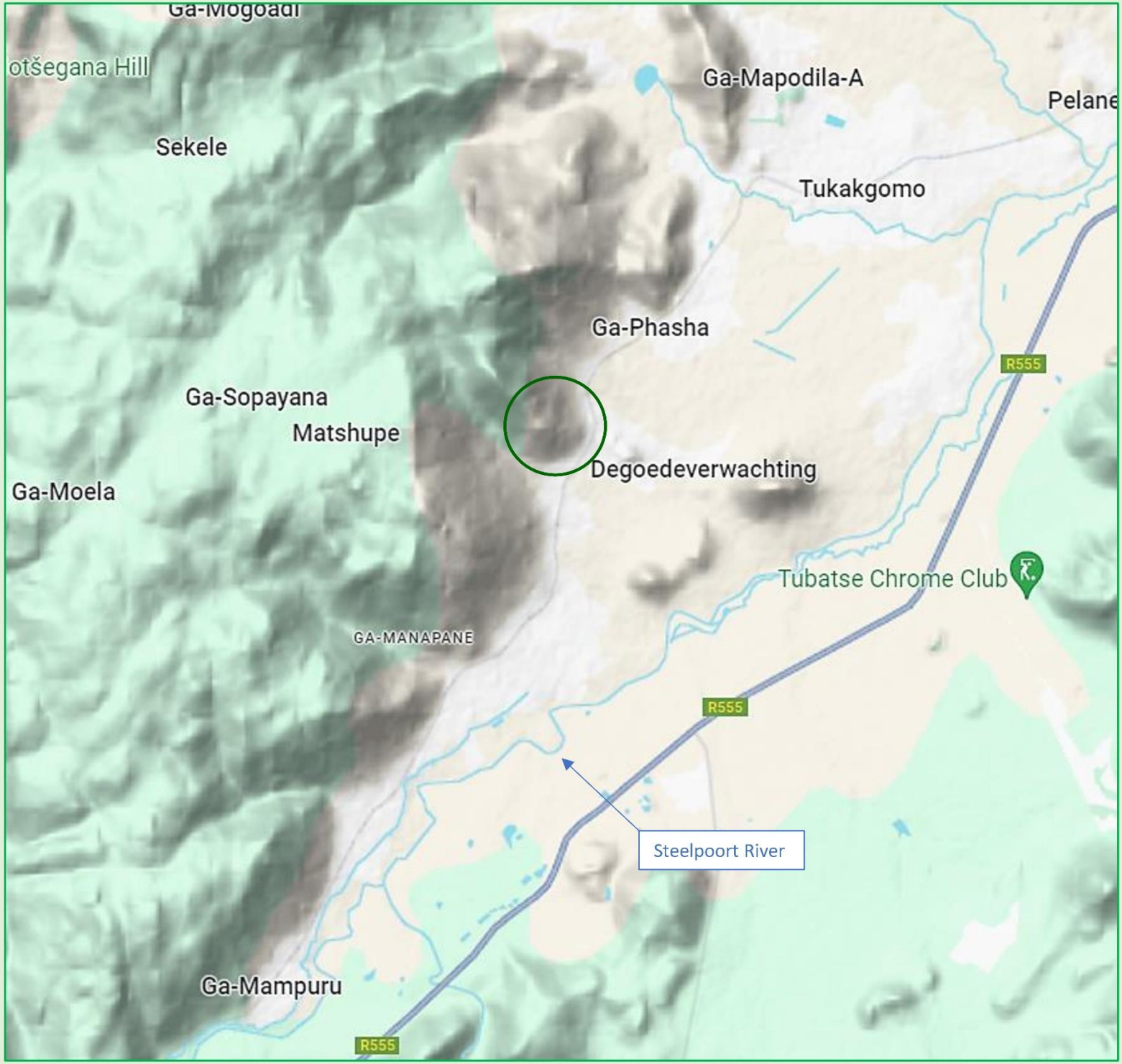
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Layout Maps



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Figure 1

Study Area Location

LEGEND

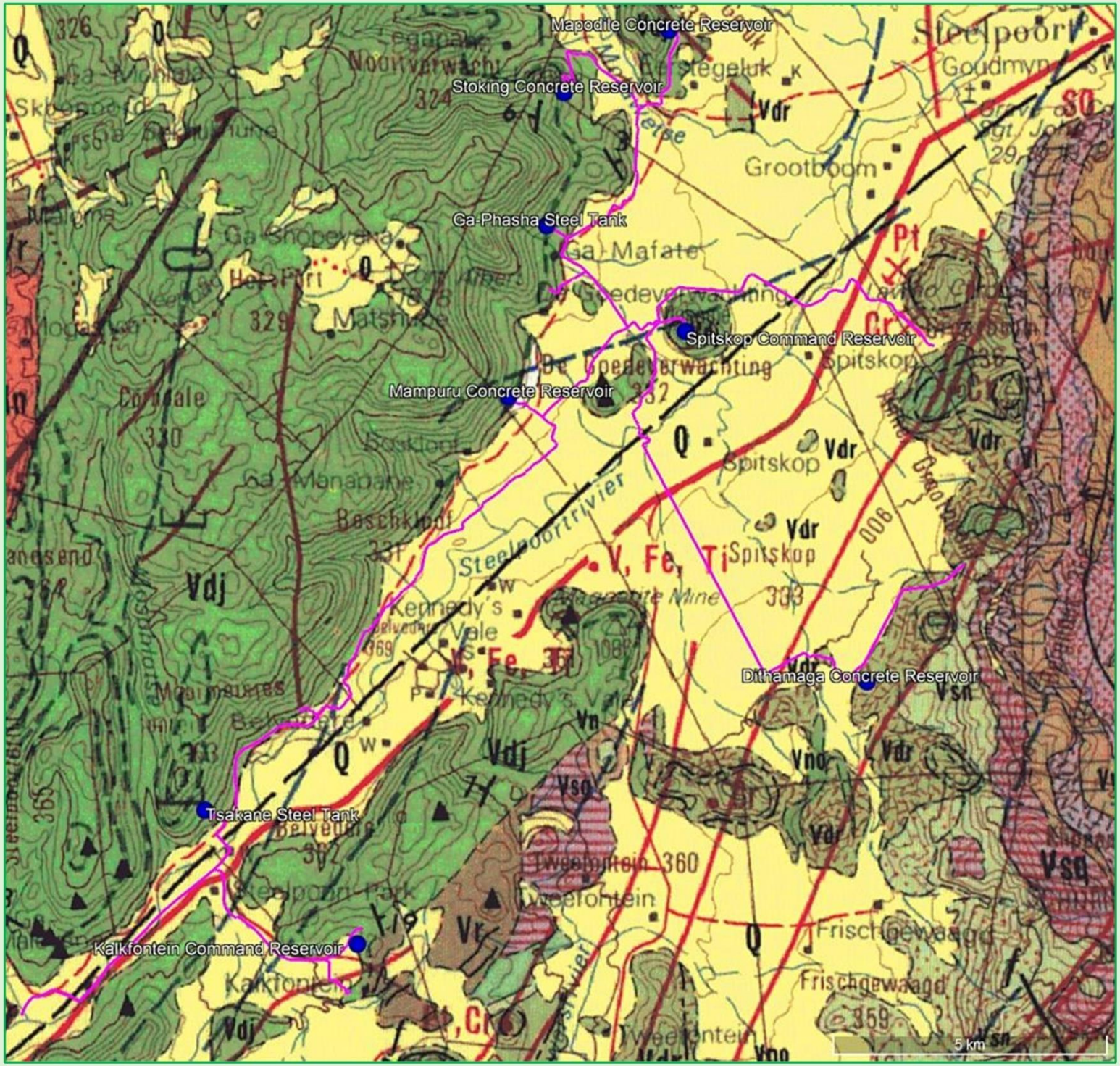
Study Area

N

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Figure 2A

Regional Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.
- Vdr — Medium to coarse-grained norite and anorthosite (upper part)-***Dwars River Subsuite***
- Vsq — Fine to medium-grained quartzite, purple sandstone and shale with quartz clasts and thin conglomerate layers- ***Steenkampsberg Formation*** of the Pretoria Group

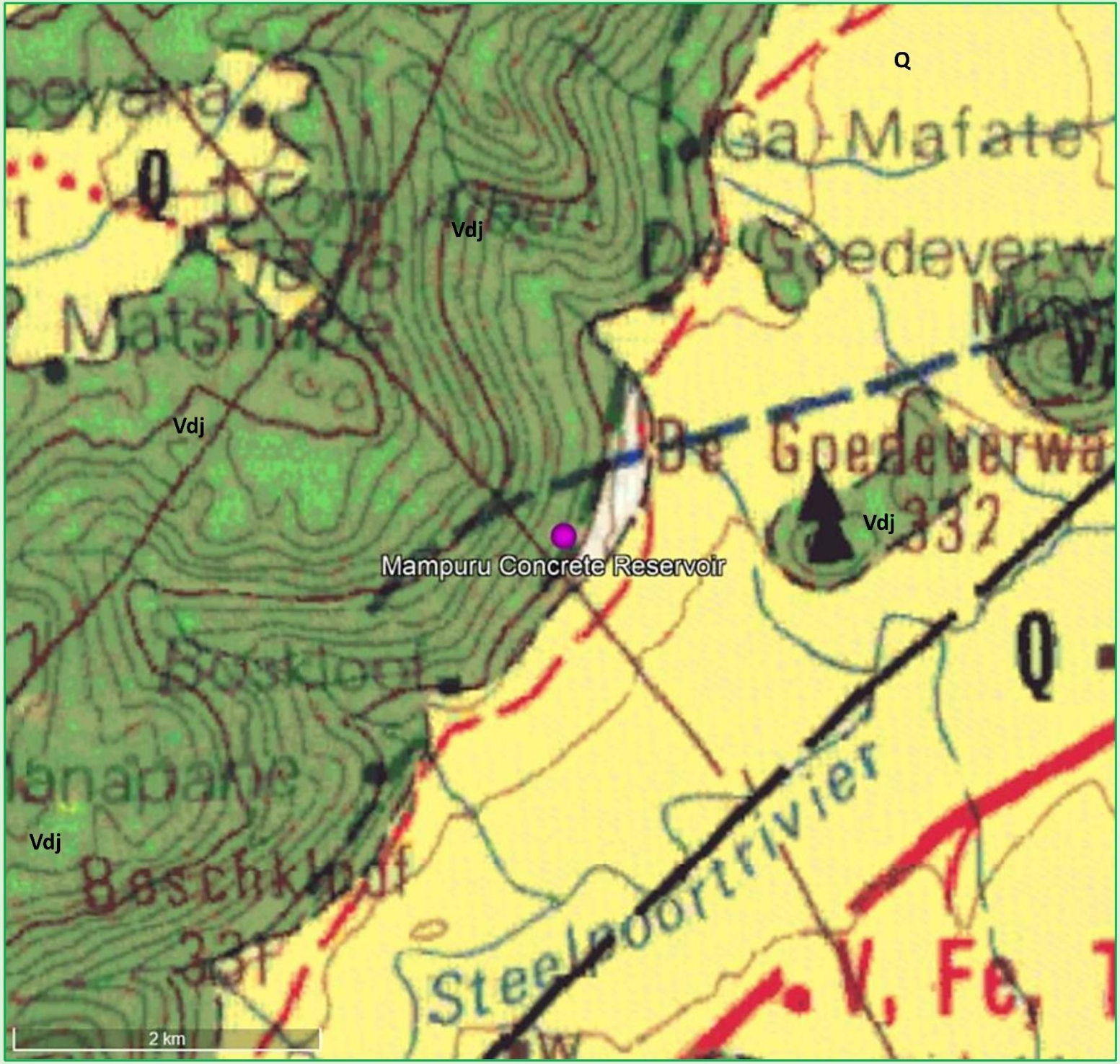
Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

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Figure 2B

Central Portion- Geology Map

LEGEND

- Fault
- Linear feature inferred from aeromagnetic data
- Fine-grained dolerite, commonly porphyritic amygdaloidal in places
- Q — Quaternary surficial deposit including alluvium and scree
- Vr — Medium to coarse-grained magnetite gabbro- ***Roossenekal Subsuite***
- Vdj — Coarse-grained gabbro and anorthosite- ***Dsjate Subsuite***.

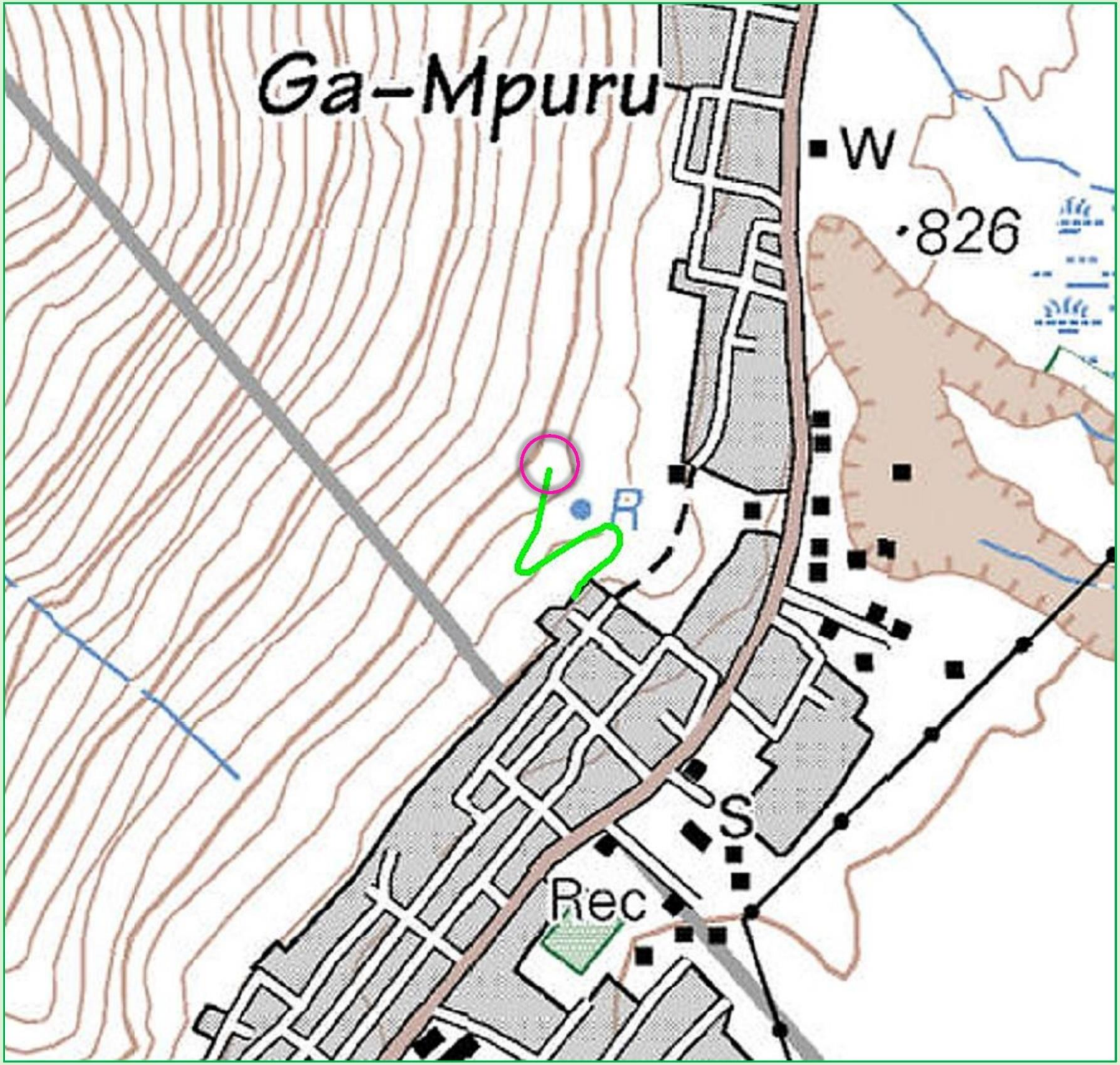
Geological Series Map:
2430 Pilgrim's Rest; Scale 1 : 250 000

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Figure 3

Topocadastral Map- Mampuru Reservoir

LEGEND

Planned Access Road

Reservoir Site

Topocadastral Maps:
2430 Cc; Scale 1 : 50 000

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Figure 4

Site Location- Aerial View

LEGEND

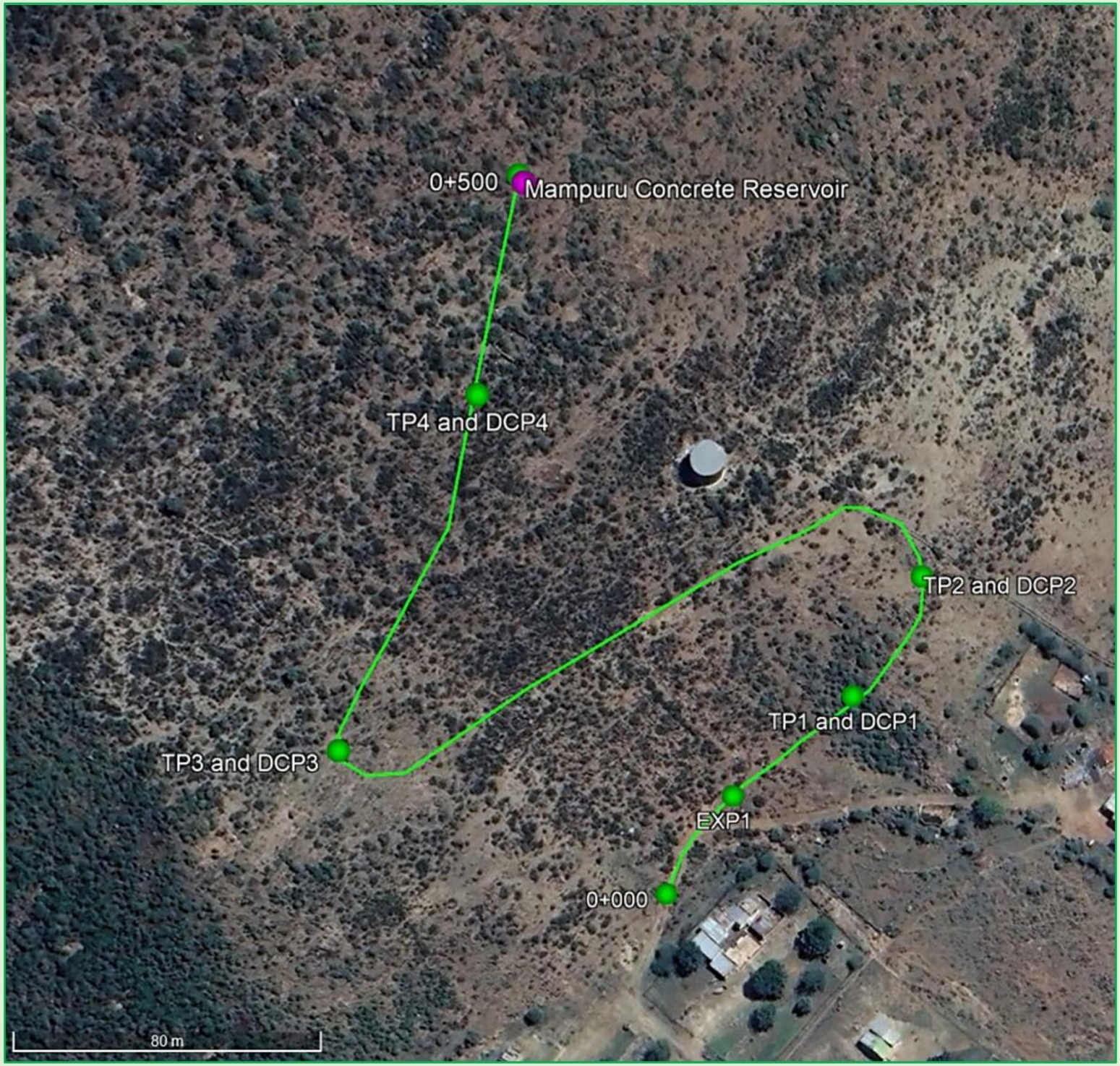
Reservoir Location

N

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Figure 5A

Testing Locations- Access Road

LEGEND

- Test Pit and DCP
- Access Road
- Reservoir Location Received from Client

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Figure 5B

Testing Locations- Planned Reservoir

LEGEND

- Test Pit and DCP
- Access Road
- Reservoir Location Received from Client
- Arbitrary Boundary R= ~15 m

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Testing Locations

GC-24-144D

Mampuru Concrete Reservoir- 1200 kl

Zutari (Pty) Ltd

Test Pit Locations

Test Pit Number	Chainage	Location		Elevation (meters above mean sea level)	Final Excavation Depth by Hand (m)
		Latitude (South)	Longitude (East)		
EXP1	0+040	24.793794	30.099244	854	0,80
TP1	0+080	24.793527	30.099576	862	0,96
TP2	0+130	24.793221	30.099761	868	0,70
TP3	0+330	24.793646	30.098163	880	0,70
TP4	0+440	24.792785	30.098552	893	0,92
TP5	0+490	24.792297	30.098708	896	0,90
TP6	0+500	24.792218	30.098606	899	0,70

Please note that all GPS co-ordinates are extracted from a handheld GPS and elevation data from Google Earth PRO

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DCP Testing Locations

GC-24-144D

Mampuru Concrete Reservoir- 1200 kl

Zutari (Pty) Ltd

DCP Test Locations

DCP Number	Chainage	Location		Elevation (meters above mean sea level)	Final Penetration Depth with DCP (mm)
		Latitude (South)	Longitude (East)		
DCP1	0+080	24.793527	30.099576	862	434
DCP2	0+130	24.793221	30.099761	868	460
DCP3	0+330	24.793646	30.098163	880	267
DCP4	0+440	24.792785	30.098552	893	683
DCP5	0+500	24.792270	30.098662	897	216

Please note that all GPS co-ordinates are extracted from a handheld GPS and elevation data from Google Earth PRO

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Appendix Index

Mampuru Concrete Reservoir- 1200 kl

Appendix A: Soil Profiles

Appendix B: Laboratory Test Results- Bulk and Disturbed Samples

Appendix C: DCP Test Results

Appendix D: Site Classification Reference Tables

Appendix A

Soil Profiles

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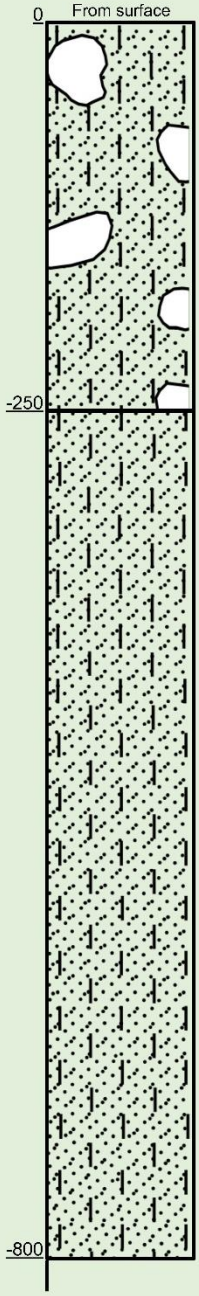
Test Pit Exp1

GC-24-144D

Mampuru Bulk Water Scheme
Mampuru Concrete Reservoir- 1200kl

Zutari (Pty) Ltd

Soil Profile for Test Pit Exp1



slightly MOIST; dark BROWN; medium DENSE; PINHOLED; clayey SAND with minor fine gravels; COLLUVIUM; organic rich topsoil; surficial cobbles and boulders; Mixed Bulk Sample No. MA1.

~Undulating contact (200 to 300)

slightly MOIST; light reddish BROWN, blotched white; medium DENSE; PINHOLED; silty SAND with traces of angular coarse gravels; COLLUVIUM; traces of fine roots; irregular pockets of weathered bedrock at the base; Mixed Bulk Sample No. MA1.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	-
Groundwater Seepage:	N/A	**Excavation Method:**	-
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Exposure
Samples Extracted:	1 Mixed Bulk Sample	**Date Profiled:**	26/06/2024
Elevation (MAMSL):	854	**Coordinates:**	24.793794°S 30.099244°E

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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Profile Photo: Exp1



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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Material Present in: Exp1







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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Surroundings of: Exp1





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Test Pit TP1

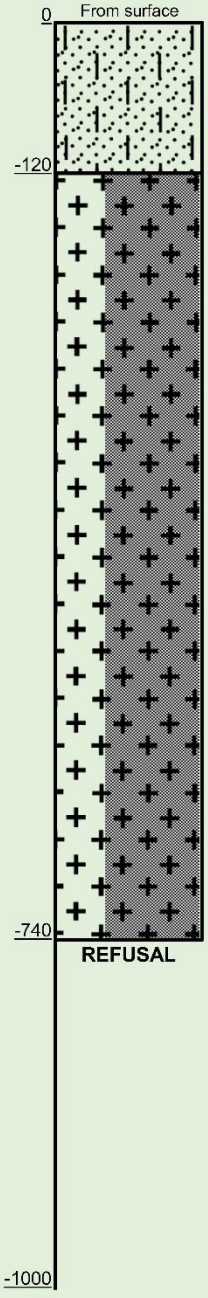
GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP1



slightly MOIST; dark BROWN; medium DENSE; INTACT; clayey SAND with minor fine gravels; COLLUVIUM; abundant fine roots; surficial cobbles and boulders; rapid transition to weathered bedrock; Mixed Bulk Sample No. MA2.

~Undulating contact (100 to 140)

slightly MOIST; light creamy GREY, mottled olive, stained brown; MEDIUM grained; closely JOINTED; HIGHLY weathered; medium hard rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; undulating excavation; variable exposure; irregular pockets of completely weathered bedrock; Mixed Bulk Sample No. MA2.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Mixed Bulk Sample	**Date Profiled:**	26/06/2024
Elevation (MAMSL):	862	**Coordinates:**	24.793527°S 30.099576°E

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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Profile Photo: TP1



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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Material Present in Test Pit: TP1







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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Surroundings of Test Pit: TP1





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Test Pit TP2

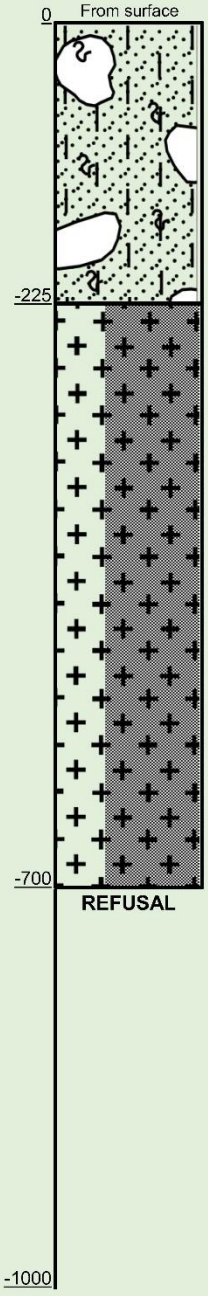
GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP2



slightly MOIST; dark BROWN; medium DENSE; INTACT; clayey SAND with traces of gravels; COLLUVIUM; abundant fine roots; surficial cobbles and boulders; rapid transition to weathered bedrock; Mixed Bulk Sample No. MA3.

~Undulating contact (150 to 300)

slightly MOIST; light creamy GREY, mottled olive, stained brown; COARSE grained; closely JOINTED; HIGHLY weathered; medium hard rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; undulating excavation; variable exposure; weathering rapidly decreasing with depth; Mixed Bulk Sample No. MA3.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Mixed Bulk Sample	**Date Profiled:**	26/06/2024
Elevation (MAMSL):	868	**Coordinates:**	24.793221°S 30.099761°E

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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Profile Photo: TP2



GEOCALIBRE
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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Material Present in Test Pit: TP2







GEOCALIBRE
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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Surroundings of Test Pit: TP2





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Test Pit TP3

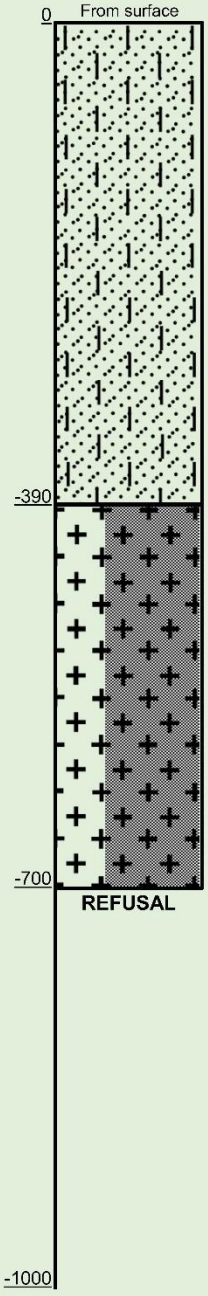
GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP3



slightly MOIST; dark BROWN; LOOSE with dense zones; INTACT; silty SAND with traces of gravels; COLLUVIUM; abundant fine roots; fluctuating depth to underlying bedrock; Mixed Bulk Sample No. MA4.

~Undulating contact (200 to 580)

slightly MOIST; light creamy GREY, mottled olive, stained brown; COARSE grained; closely JOINTED; HIGHLY weathered; medium hard rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; variable exposure; irregular pockets of completely weathered bedrock in the upper extent; rapid transition to less weathered bedrock at the base; Mixed Bulk Sample No. MA4.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Mixed Bulk Sample	**Date Profiled:**	26/06/2024
Elevation (MAMSL):	880	**Coordinates:**	24.793646°S 30.098163°E

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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Profile Photo: TP3



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Material Present in Test Pit: TP3







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Surroundings of Test Pit: TP3





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Test Pit TP4

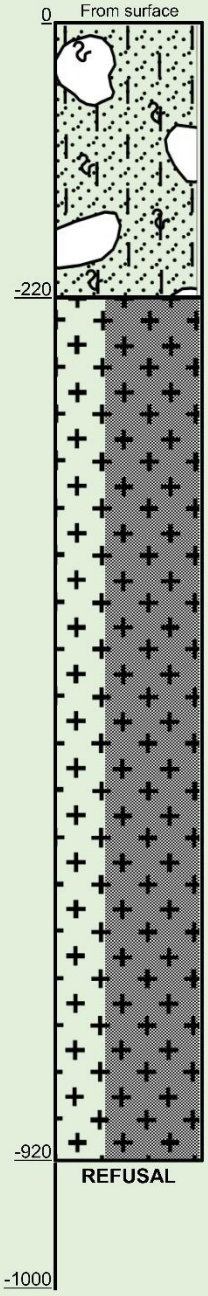
GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP4



slightly MOIST; dark BROWN; DENSE; PINHOLED; clayey SAND with minor gravels; COLLUVIUM; abundant fine roots; surficial cobbles and boulders; Not Sampled.

Gradual contact

slightly MOIST; light creamy GREY, mottled olive, stained white; COARSE grained; CLOSELY JOINTED; HIGHLYY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; discolouration extending from joint planes throughout the rock mass; rapid transition to less weathered bedrock at the base; minor calcrete nodules; Bulk Sample No. MA5.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	26/06/2024
Elevation (MAMSL):	893	**Coordinates:**	24.792785°S 30.098552°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Profile Photo: TP4



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Material Present in Test Pit: TP4







GEOCALIBRE
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GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Surroundings of Test Pit: TP4





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Test Pit TP5

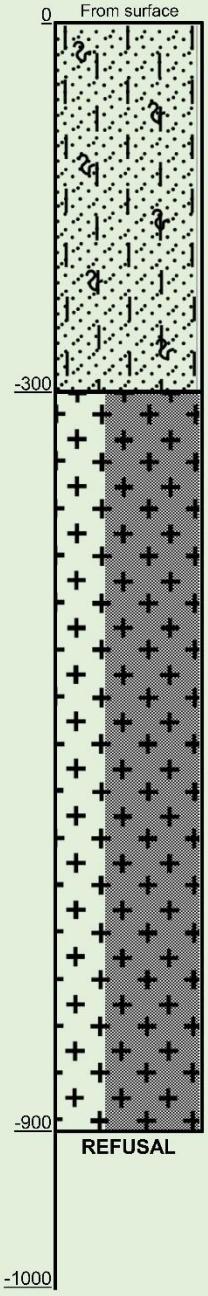
GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP5



slightly MOIST; dark BROWN; medium DENSE; INTACT; clayey SAND with traces of fine gravels; COLLUVIUM; minor fine roots rapidly decreasing with depth; Not Sampled.

Gradual contact

slightly MOIST; light creamy GREY, mottled brown and white; COARSE grained; CLOSELY JOINTED; COMPLETELY weathered; very soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; variable weathering profile; minor calcrete nodules; gradual transition to less weathered bedrock at the base; Bulk Sample No. MA6.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual Labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	26/06/2024
Elevation (MAMSL):	896	**Coordinates:**	24.792297°S 30.098708°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Profile Photo: TP5



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Material Present in Test Pit: TP5







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Surroundings of Test Pit: TP5





GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Test Pit TP6

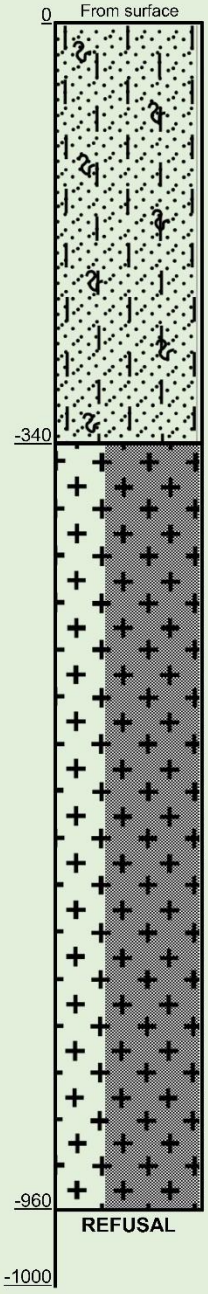
GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200kl

Zutari (Pty) Ltd

Soil Profile for Test Pit TP6



slightly MOIST; dark BROWN; medium DENSE; PINHOLED; clayey SAND with minor gravels; COLLUVIUM; minor fine roots; surficial cobbles; Not Sampled.

slightly MOIST; light creamy WHITE, stained brown, speckled olive; COARSE grained; closely JOINTED; HIGHLY weathered; soft rock; GABBRO of the Dsjate Subsuite- Rustenburg Layered Suite; minor calcrete nodules; gradual transition to less weathered rock at the base; Bulk Sample No. MA7.

Profile Notes		Excavation Description	
Profiled by:	TF Mohale (BSc Hons. Geology)	**Contractor:**	Casual labour
Groundwater Seepage:	N/A	**Excavation Method:**	Hand Excavation- Pick and Shovel Method
Excavation Stability:	Sidewalls stable	**Excavation Character:**	Refusal on less weathered gabbro bedrock
Samples Extracted:	1 Bulk Sample	**Date Profiled:**	26/06/2024
Elevation (MAMSL):	899	**Coordinates:**	24.792218°S 30.098606°E

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Profile Photo: TP6



GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Material Present in Test Pit: TP6







GEOCALIBRE
GEOTECHNICAL CONSULTANCY

GC-24-144D
Mampuru Concrete Reservoir- 1200kl

Surroundings of Test Pit: TP6





GEOCALIBRE
GEOTECHNICAL CONSULTANCY

Appendix B

Laboratory Test Results

Bulk and Disturbed Samples

Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

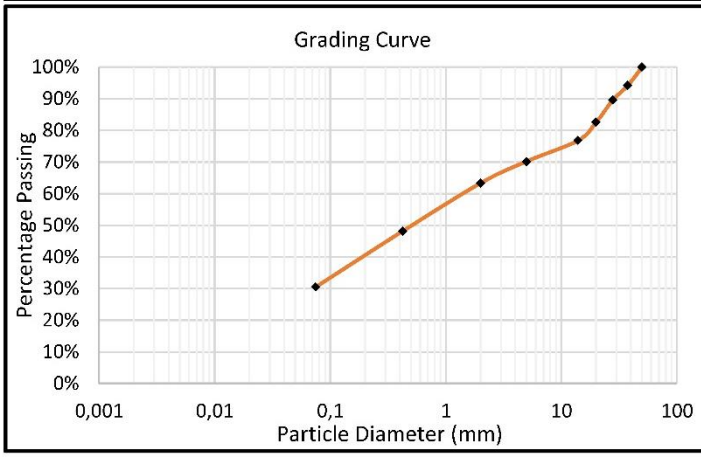
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Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/1
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description	MA-Exposure from 0,00 to 0,80m below E.G.L (MA-1)	Date Reported:	2024/07/17

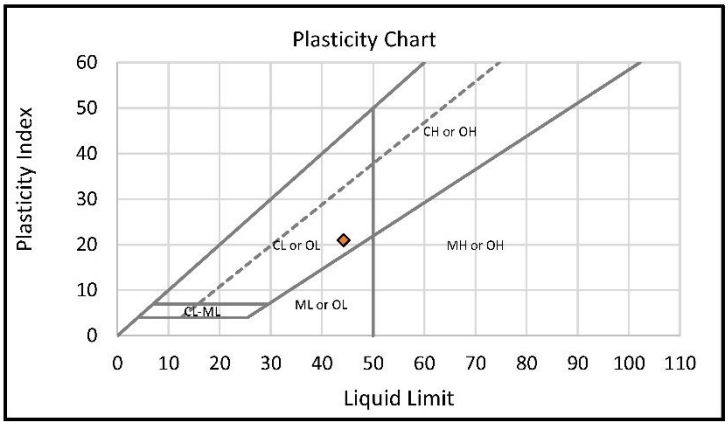
Road Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	-
50,0	100%
37,5	94%
28,0	90%
20,0	83%
14,0	77%
5,0	70%
2,0	63%
0,425	48,2%
0,075	30,5%

Description: Dark Reddish Orange clayey Sand



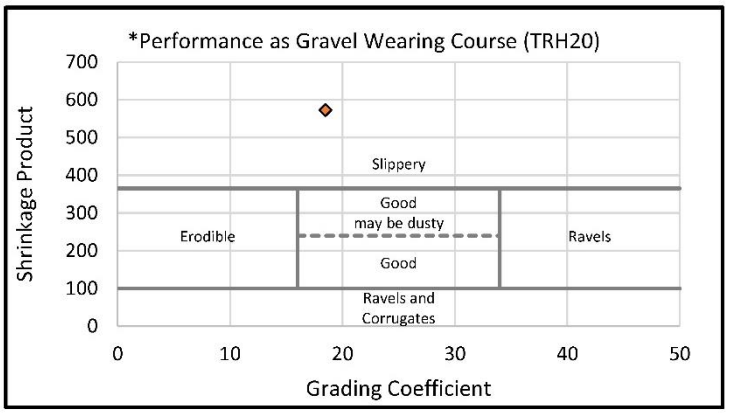
*Grading Characteristics		
Grading Modulus	GM	1,58
Effective Size	D_{10}	0,01
Uniformity Coef.	C_u	209,09
Curvature Coef.	C_c	0,57



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	24%
Fine Sand	0.425 - 0.075 mm	28%
Silt and Clay	<0.075 mm	48%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	44%
Plasticity Index	PI	21%
Linear Shrinkage	LS	11,89%

Grading Coefficient	Gc	18,5
Shrinkage Product	Sp	573



*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**<G9**
	US Highway	**A-2-7 (1)**



Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>14,74, CBR @ 93%<7

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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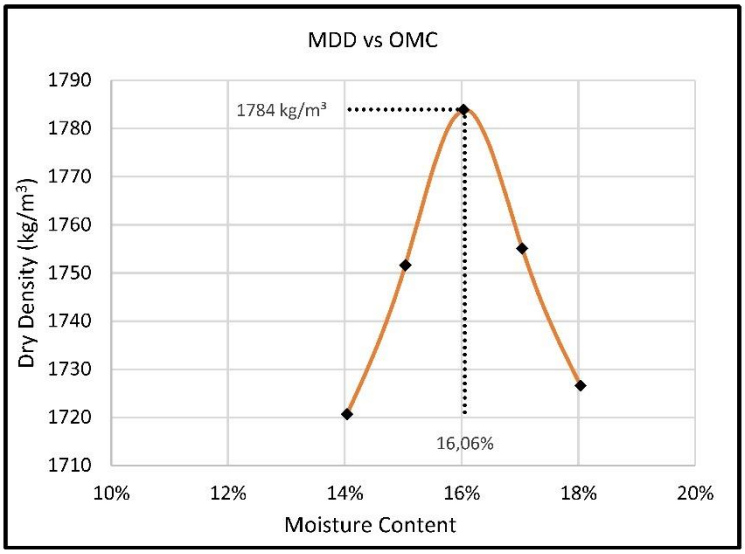
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/1
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description	MA-Exposure from 0,00 to 0,80m below E.G.L (MA-1)	Date Reported:	2024/07/17

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	14,0%	1721
2	15,0%	1752
3	16,0%	1784
4	17,0%	1755
5	18,0%	1727

Optimum Moisture Content (OMC):	**16,1%**
Maximum Dry Density (MDD):	**1784 kg/m³**

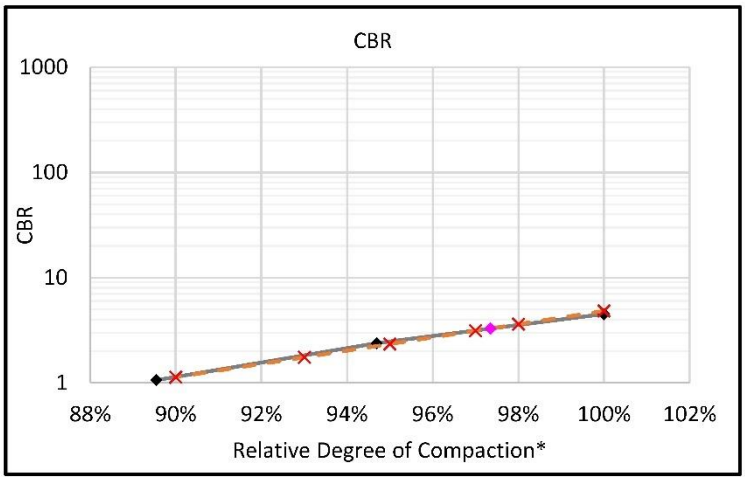


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	16,4%		
Dry Density (kg/m³)	1782 kg/m³	1688 kg/m³	1596 kg/m³
Relative compaction (%)	100,0%	94,7%	89,5%
Measured CBR	5	2	1
% Swell	0,07	0,10	0,14

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	5
98%	4
97%	3
95%	2
93%	2
90%	1





Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>14,74, CBR @ 93%<7

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

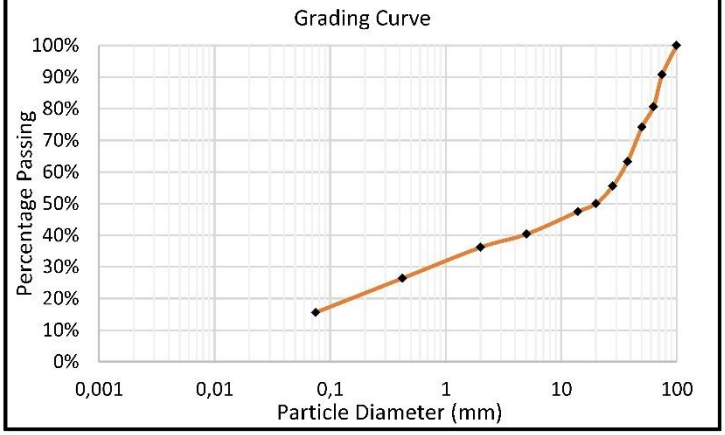
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Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/2
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description	Test Pit 1 from 0,00 to 0,74m below E.G.L (MA-2)	Date Reported:	2024/07/17

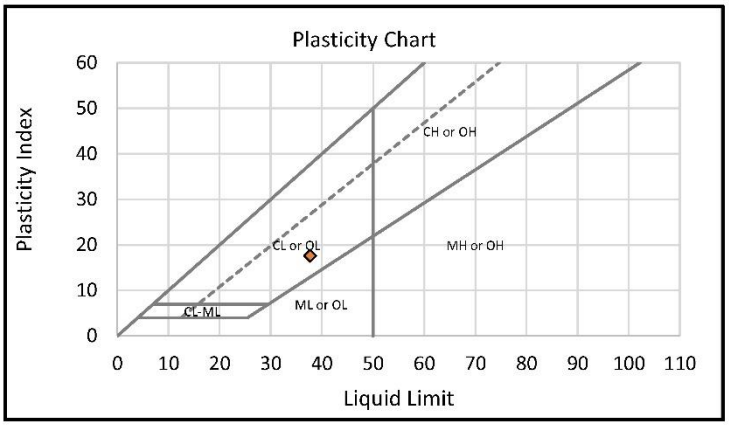
Road Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	91%
63,0	81%
50,0	74%
37,5	63%
28,0	56%
20,0	50%
14,0	47%
5,0	40%
2,0	36%
0,425	26,4%
0,075	15,6%

Description: Dusky Red Clayey Gravel



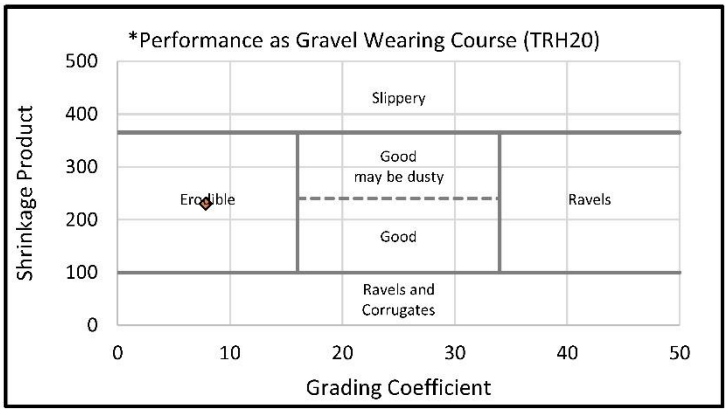
*Grading Characteristics		
Grading Modulus	GM	2,22
Effective Size	D_{10}	0,05
Uniformity Coef.	C_u	610,15
Curvature Coef.	C_c	0,31



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	27%
Fine Sand	0.425 - 0.075 mm	30%
Silt and Clay	<0.075 mm	43%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	38%
Plasticity Index	PI	18%
Linear Shrinkage	LS	8,69%

Grading Coefficient	Gc	7,8
Shrinkage Product	Sp	230



*Classifications		
	Unified Soil Classification- USCS	**GC**
	COLTO Classification	**<G9**
	US Highway	**A-2-6 (0)**

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Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,66

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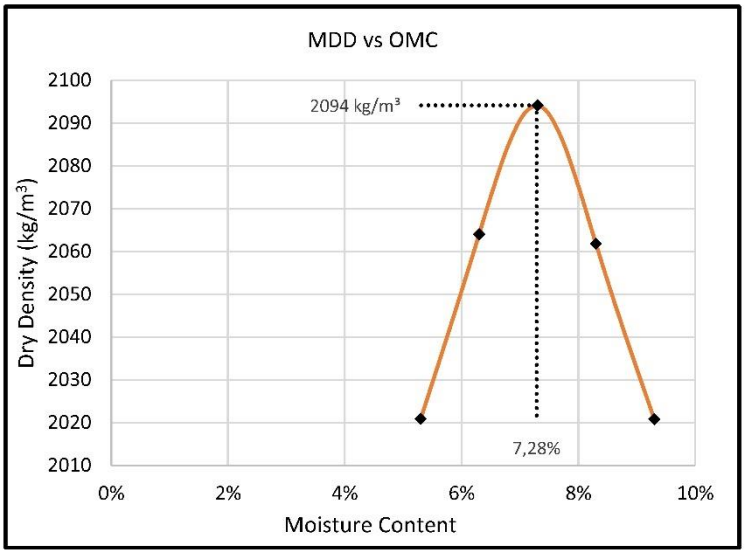
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/2
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description	Test Pit 1 from 0,00 to 0,74m below E.G.L (MA-2)	Date Reported:	2024/07/17

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	5,3%	2021
2	6,3%	2064
3	7,3%	2094
4	8,3%	2062
5	9,3%	2021

Optimum Moisture Content (OMC):	**7,3%**
Maximum Dry Density (MDD):	**2094 kg/m³**

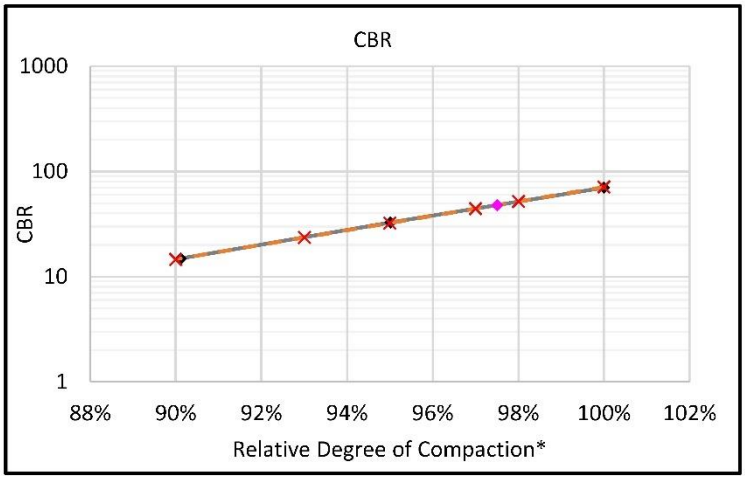


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	7,3%		
Dry Density (kg/m³)	2104 kg/m³	1999 kg/m³	1896 kg/m³
Relative compaction (%)	100,0%	95,0%	90,1%
Measured CBR	70	33	15
% Swell	0,06	0,07	0,10

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	71
98%	52
97%	44
95%	32
93%	23
90%	15





Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,66

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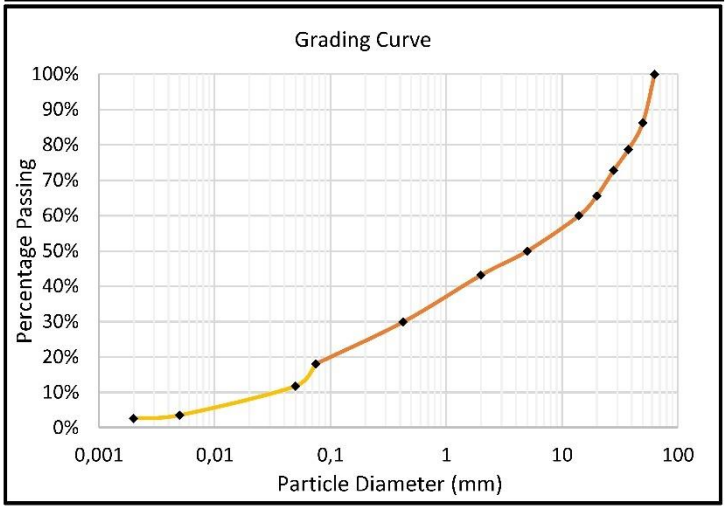
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/3
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/12
Description:	Test Pit 2 from 0,00 to 0,70m below E.G.L (MA-3)	Date Reported:	2024/07/17

Foundation Indicator Test Report: SANS 3001

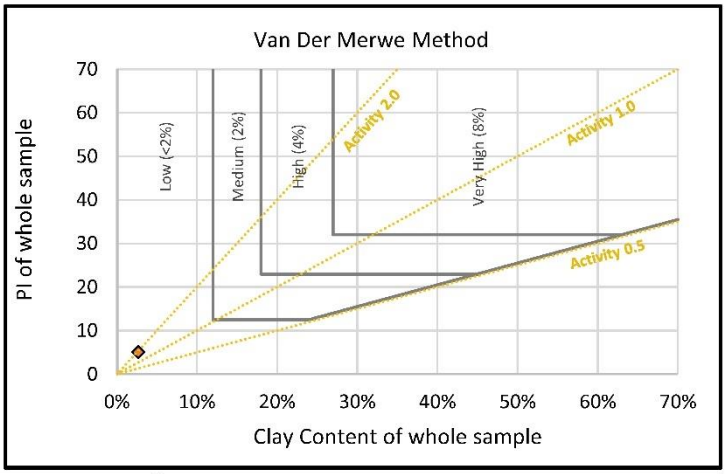
Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	86%
37,5	79%
28,0	73%
20,0	66%
14,0	60%
5,0	50%
2,0	43%
0,425	29,9%
0,075	18,1%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	11,8%
0,005	3,6%
0,002	2,7%

Description: Dark Reddish Brown clayey Sand

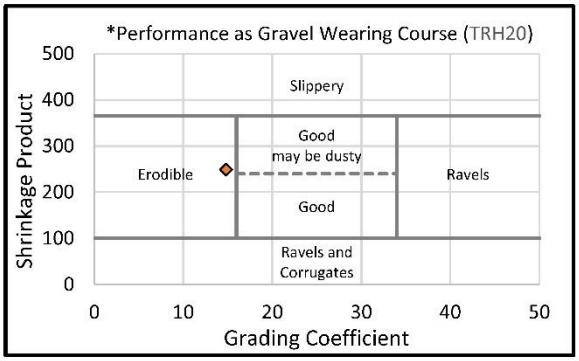


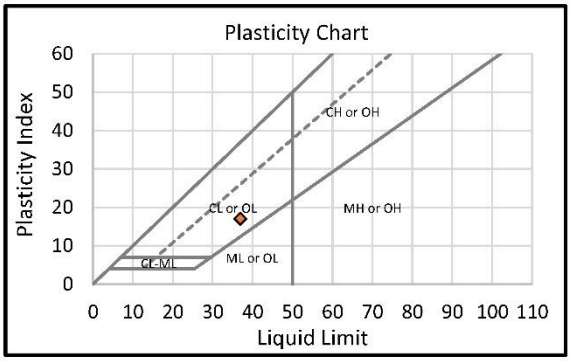
*Grading Characteristics		
Grading Modulus	GM	2,09
Effective Size	D_{10}	0,03
Uniformity Coef.	C_u	462,86
Curvature Coef.	C_c	0,43



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	31%
Fine Sand	0.425 - 0.075 mm	27%
Silt	0.075 - 0.002 mm	34%
Clay	<0.002	8%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	37%
Plasticity Index	PI	17%
Linear Shrinkage	LS	8,31%





*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**<G9**
	US Highway	**A-2-6 (0)**

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Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G9 requirements due to: PI>16,27

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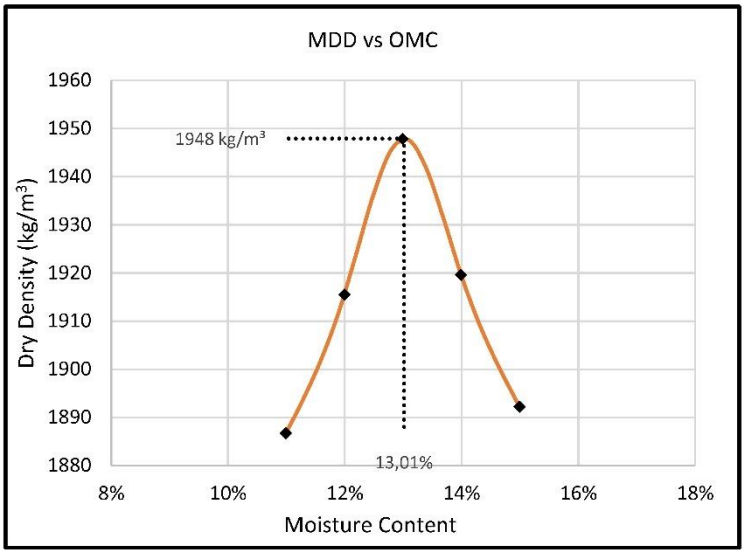
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/3
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/12
Description	Test Pit 2 from 0,00 to 0,70m below E.G.L (MA-3)	Date Reported:	2024/07/17

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	11,0%	1887
2	12,0%	1915
3	13,0%	1948
4	14,0%	1920
5	15,0%	1892

Optimum Moisture Content (OMC):	**13,0%**
Maximum Dry Density (MDD):	**1948 kg/m³**

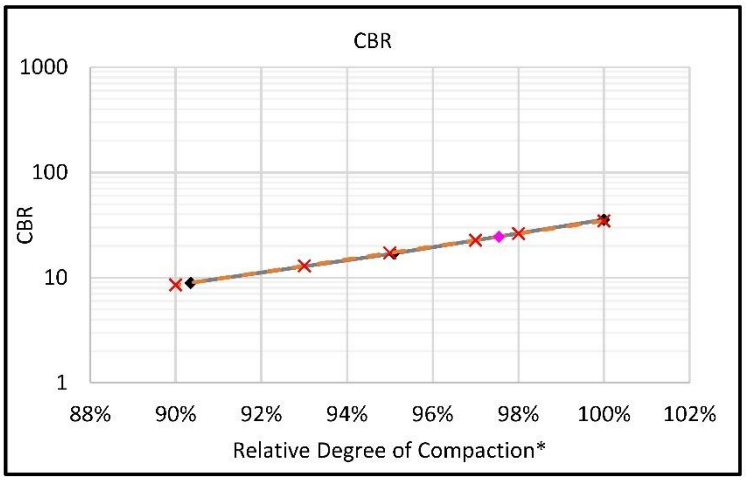


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	13,0%		
Dry Density (kg/m³)	1951 kg/m³	1856 kg/m³	1763 kg/m³
Relative compaction (%)	100,0%	95,1%	90,3%
Measured CBR	36	17	9
% Swell	0,07	0,13	0,17

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	35
98%	26
97%	23
95%	17
93%	13
90%	9



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Technical Signatory

Comments:

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Does not meet G9 requirements due to: PI>16,27

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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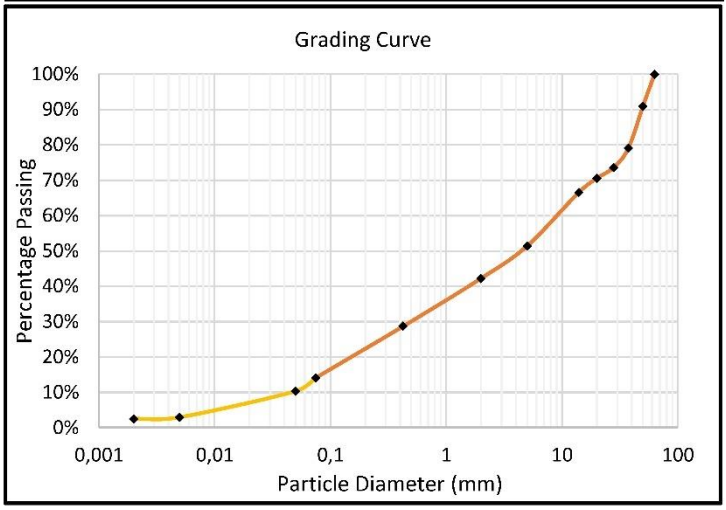
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/4
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description:	Test Pit 3 from 0,00 to 0,70m below E.G.L (MA-4)	Date Reported:	2024/07/17

Foundation Indicator Test Report: SANS 3001

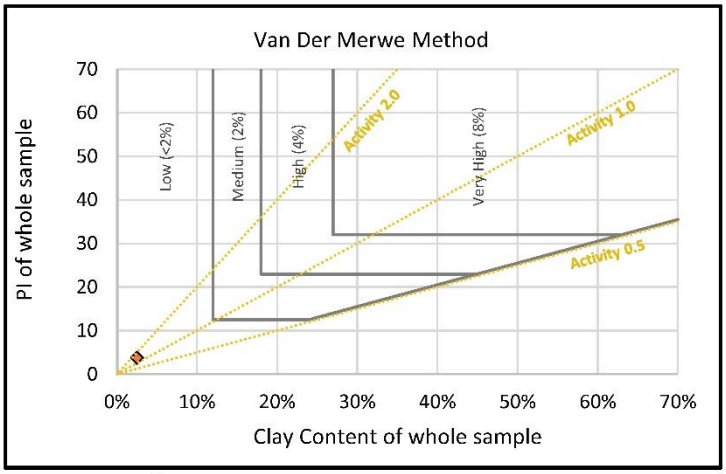
Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	91%
37,5	79%
28,0	74%
20,0	71%
14,0	67%
5,0	51%
2,0	42%
0,425	28,7%
0,075	14,1%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	10,3%
0,005	3,0%
0,002	2,5%

Description: Dark Olive clayey Sand

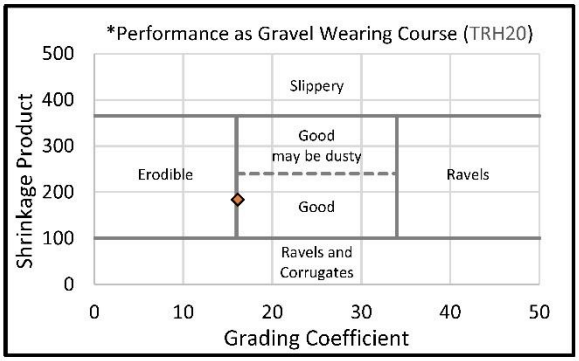


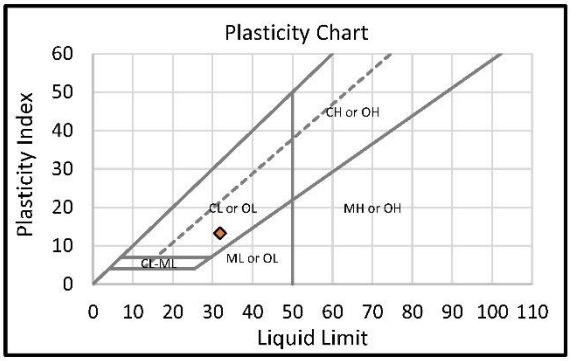
*Grading Characteristics		
Grading Modulus	GM	2,15
Effective Size	D_{10}	0,05
Uniformity Coef.	C_u	198,93
Curvature Coef.	C_c	0,60



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	32%
Fine Sand	0.425 - 0.075 mm	34%
Silt	0.075 - 0.002 mm	26%
Clay	<0.002	7%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	32%
Plasticity Index	PI	13%
Linear Shrinkage	LS	6,40%





*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**G9**
	US Highway	**A-2-6 (0)**

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G8 requirements due to: CBR @ 93%<10

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Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

ilac-MRA sanas Testing Laboratory T0906

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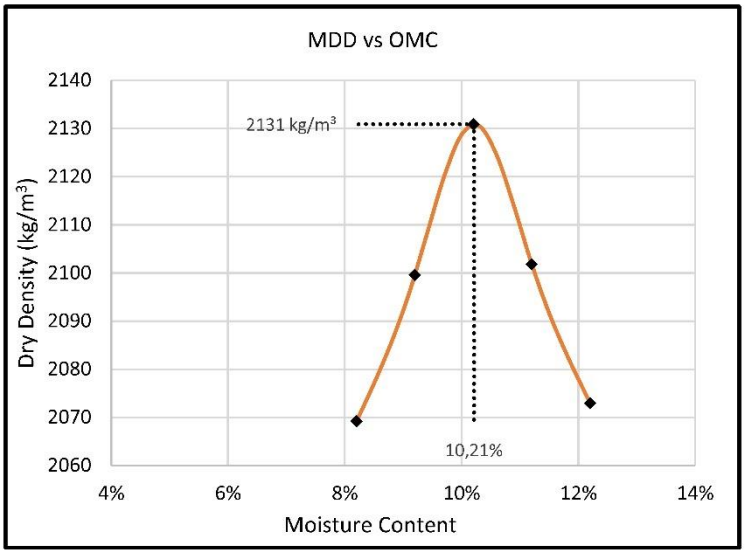
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/4
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description	Test Pit 3 from 0,00 to 0,70m below E.G.L (MA-4)	Date Reported:	2024/07/17

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	8,2%	2069
2	9,2%	2100
3	10,2%	2131
4	11,2%	2102
5	12,2%	2073

Optimum Moisture Content (OMC):	**10,2%**
Maximum Dry Density (MDD):	**2131 kg/m³**

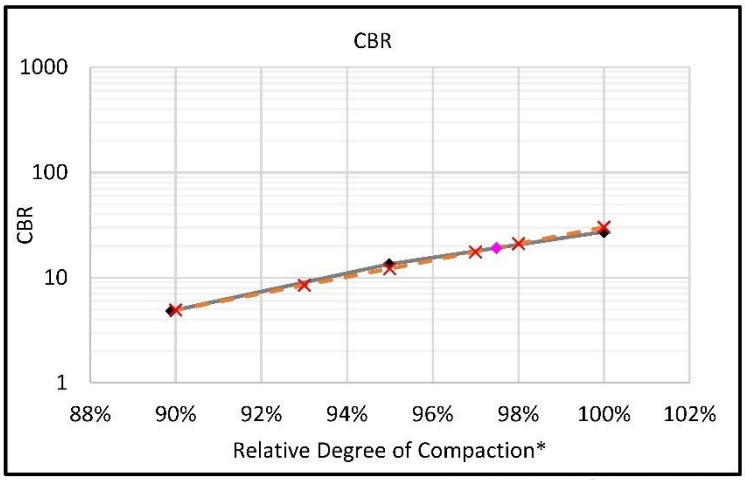


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	10,4%		
Dry Density (kg/m³)	2132 kg/m³	2025 kg/m³	1916 kg/m³
Relative compaction (%)	100,0%	95,0%	89,9%
Measured CBR	27	13	5
% Swell	0,04	0,05	0,06

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	30
98%	21
97%	17
95%	12
93%	8
90%	5



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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G8 requirements due to: CBR @ 93%<10

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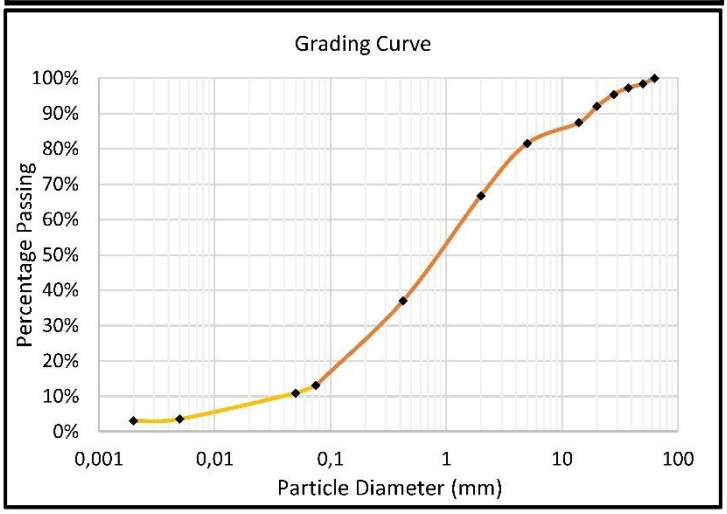
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/5
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/12
Description:	Test Pit 4 from 0,22 to 0,92m below E.G.L (MA-5)	Date Reported:	2024/07/17

Foundation Indicator Test Report: SANS 3001

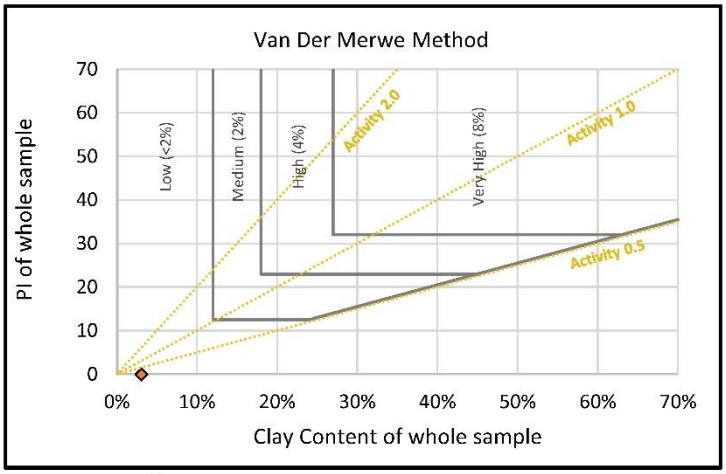
Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	98%
37,5	97%
28,0	95%
20,0	92%
14,0	87%
5,0	82%
2,0	67%
0,425	37,0%
0,075	13,1%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	10,9%
0,005	3,6%
0,002	3,1%

Description: Light Yellow silty Sand

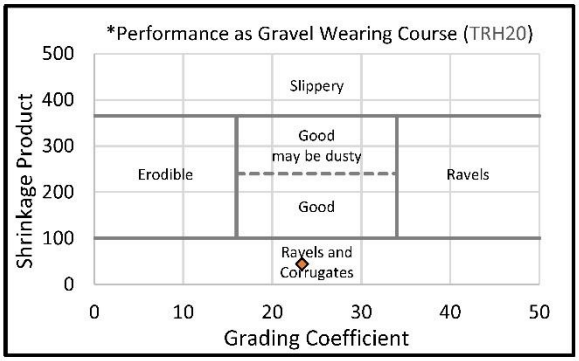


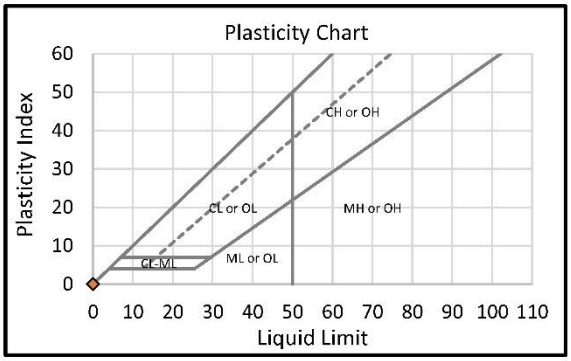
*Grading Characteristics		
Grading Modulus	GM	1,83
Effective Size	D_{10}	0,04
Uniformity Coef.	C_u	37,75
Curvature Coef.	C_c	1,25



*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	45%
Fine Sand	0.425 - 0.075 mm	36%
Silt	0.075 - 0.002 mm	14%
Clay	<0.002	5%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	-
Plasticity Index	PI	SP
Linear Shrinkage	LS	1,17%





*Classifications		
	Unified Soil Classification- USCS	**SM**
	COLTO Classification	**G7**
	US Highway	**A-1-b (0)**

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

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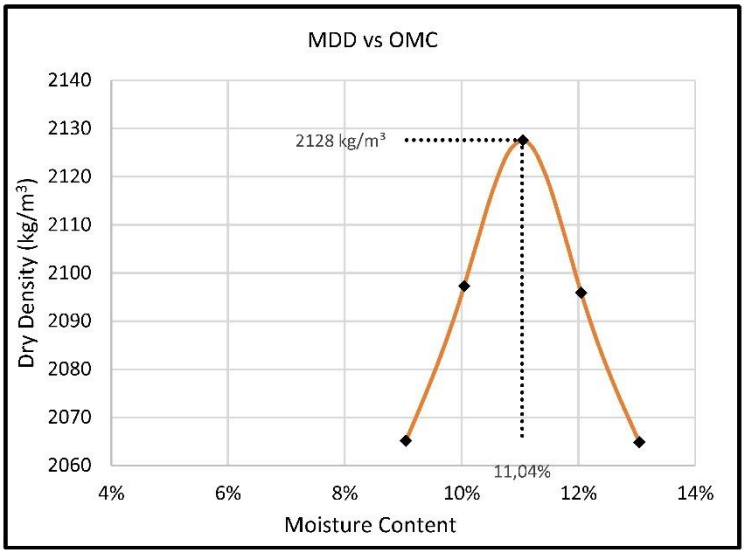
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/5
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/12
Description	Test Pit 4 from 0,22 to 0,92m below E.G.L (MA-5)	Date Reported:	2024/07/17

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	9,0%	2065
2	10,0%	2097
3	11,0%	2128
4	12,0%	2096
5	13,0%	2065

Optimum Moisture Content (OMC):	**11,0%**
Maximum Dry Density (MDD):	**2128 kg/m³**

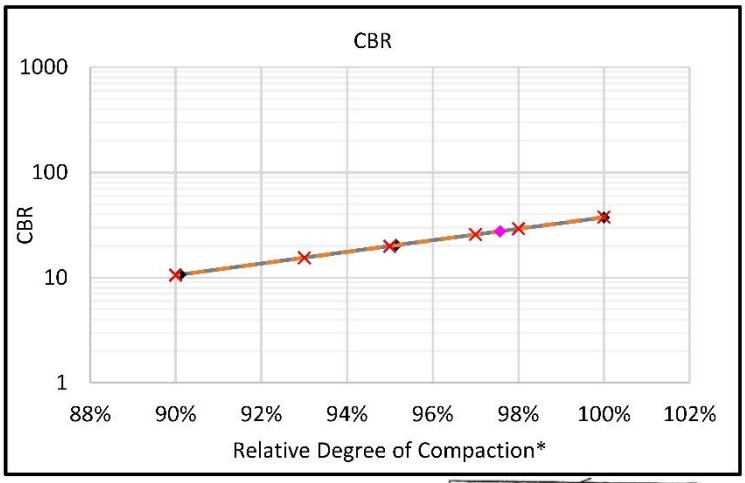


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	10,9%		
Dry Density (kg/m³)	2136 kg/m³	2032 kg/m³	1925 kg/m³
Relative compaction (%)	100,0%	95,1%	90,1%
Measured CBR	37	20	11
% Swell	0,03	0,04	0,06

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	38
98%	29
97%	26
95%	20
93%	15
90%	11



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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G6 requirements due to: CBR @ 95%<25

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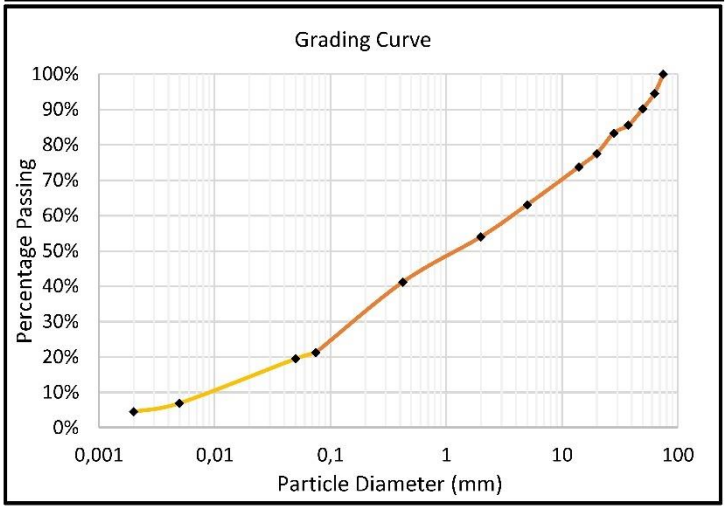
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/6
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description:	Test Pit 5 from 0,3 to 0,9m below E.G.L (MA-6)	Date Reported:	2024/07/17

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	100%
63,0	95%
50,0	90%
37,5	86%
28,0	83%
20,0	78%
14,0	74%
5,0	63%
2,0	54%
0,425	41,3%
0,075	21,3%

*Hydrometer Analysis (SANS 3001-GR3)	
Diameter (mm)	**% Passing**
0,05	19,5%
0,005	7,0%
0,002	4,5%

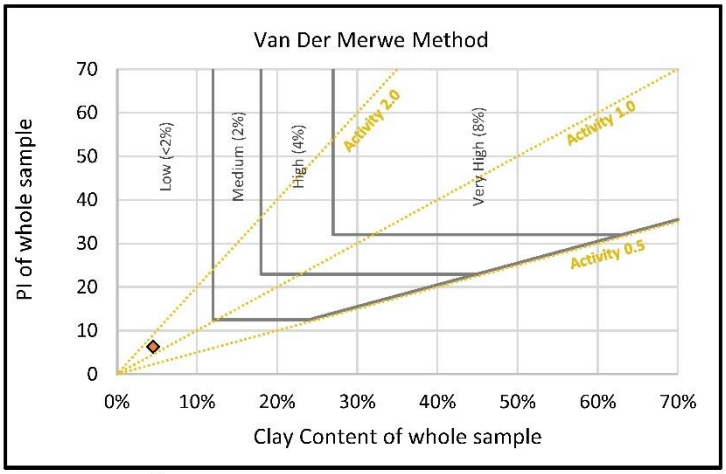
Description: Dark Yellowish Orange clayey Sand

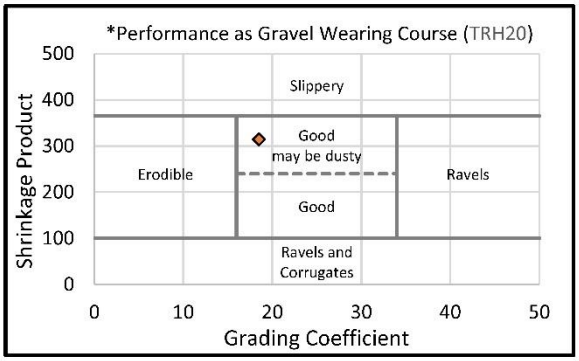


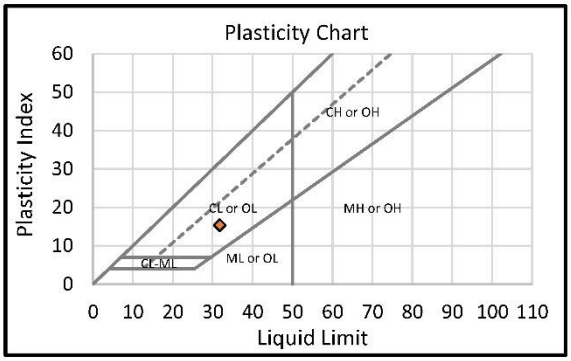
*Grading Characteristics		
Grading Modulus	GM	1,83
Effective Size	D_{10}	0,009
Uniformity Coef.	C_u	420,32
Curvature Coef.	C_c	0,80

*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	24%
Fine Sand	0.425 - 0.075 mm	37%
Silt	0.075 - 0.002 mm	26%
Clay	<0.002	13%

Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	32%
Plasticity Index	PI	15%
Linear Shrinkage	LS	7,61%







*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**G8**
	US Highway	**A-2-6 (0)**

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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G7 requirements due to: CBR @ 93%<15

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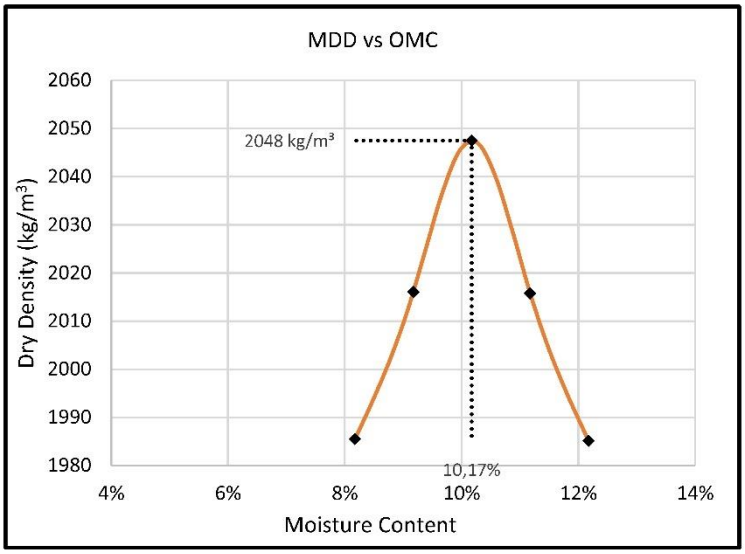
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/6
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description	Test Pit 5 from 0,3 to 0,9m below E.G.L (MA-6)	Date Reported:	2024/07/17

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	8,2%	1985
2	9,2%	2016
3	10,2%	2048
4	11,2%	2016
5	12,2%	1985

Optimum Moisture Content (OMC):	**10,2%**
Maximum Dry Density (MDD):	**2048 kg/m³**

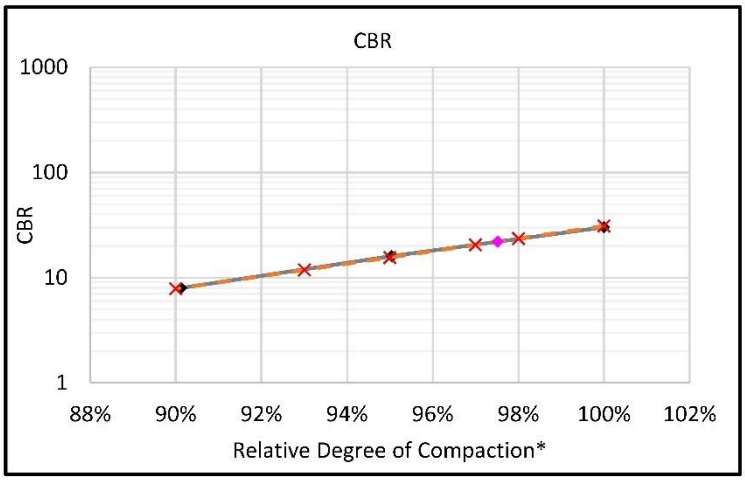


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	10,1%		
Dry Density (kg/m³)	2051 kg/m³	1949 kg/m³	1848 kg/m³
Relative compaction (%)	100,0%	95,0%	90,1%
Measured CBR	30	16	8
% Swell	0,06	0,07	0,10

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	31
98%	23
97%	20
95%	16
93%	12
90%	8





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Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G7 requirements due to: CBR @ 93%<15

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Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/7
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description:	Test Pit 6 from 0,34 to 0,96m below E.G.L (MA-7)	Date Reported:	2024/07/17

Foundation Indicator Test Report: SANS 3001

Particle Size Analysis (SANS 3001-GR1)	
Diameter (mm)	**% Passing**
75,0	-
63,0	100%
50,0	96%
37,5	94%
28,0	93%
20,0	91%
14,0	86%
5,0	83%
2,0	74%
0,425	59,6%
0,075	30,8%

*Hydrometer Analysis (SANS 3001-GR3)		
Diameter (mm)	**% Passing** **	
0,05	28,2%	17,8%
0,005	10,6%	1,8%
0,002	7,9%	0,0%

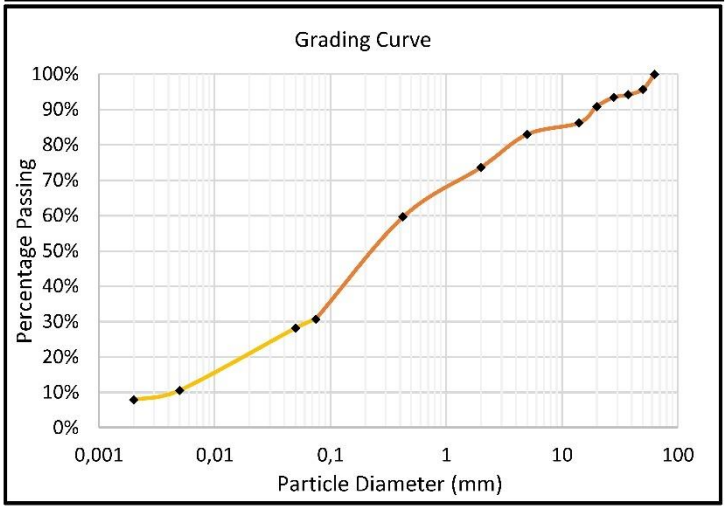
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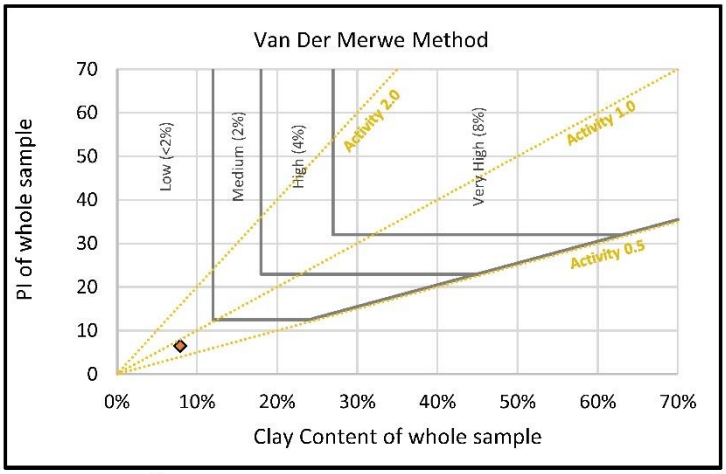
*Grading Characteristics		
Grading Modulus	GM	1,36
Effective Size	D_{10}	0,004
Uniformity Coef.	C_u	108,55
Curvature Coef.	C_c	2,43

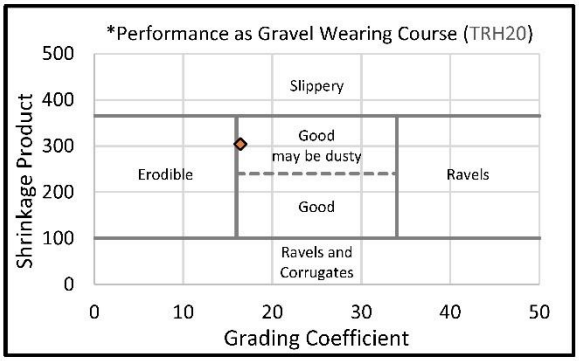
*Soil Mortar Analysis (SANS 3001-PR5)		
Coarse Sand	2.0 - 0.425 mm	19%
Fine Sand	0.425 - 0.075 mm	39%
Silt	0.075 - 0.002 mm	27%
Clay	<0.002	14%

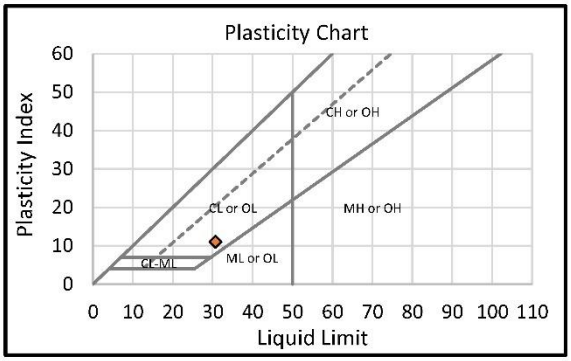
Atterberg Limits (SANS 3001-GR10)		
Liquid Limit	LL	31%
Plasticity Index	PI	11%
Linear Shrinkage	LS	5,09%

Description: Light Reddish Brown clayey Sand









*Classifications		
	Unified Soil Classification- USCS	**SC**
	COLTO Classification	**G9**
	US Highway	**A-2-6 (0)**

*pH: 8,3	*Electrical Conductivity: 25 mS/m	*Double Hydrometer: 17,0%

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G8 requirements due to: CBR @ 93%<10

TZANEEN LAB P.O. Box 3784 TZANEEN CHECKED Technical Signatory Cell: 083 437 5283

Results in this report only relate to the item(s) tested by Tzaneen Civil Lab. Results and advice are subject to correct sampling being followed. Tzaneen Lab does not accept responsibility for any matters arising from the further use of these results. This report is confidential and is only intended for the use of the individual or entity to which it is addressed.

Tzaneen Lab CIVIL MATERIALS TESTING LABORATORIES

Hanko Investments T/A Tzaneen Lab | P.O. Box 3784, Tzaneen, 0850 |1992 Industria Road, Tzaneen | www.tzaneenlab.co.za | admin@tzaneenlab.co.za | 015 307 1661

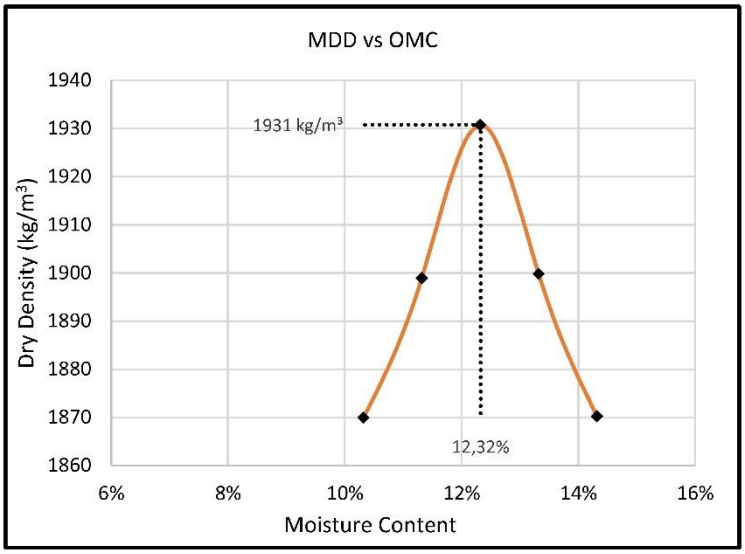
Client:	GeoCalibre Geotechnical Consultancy	Sample No.	T03346/7
Project:	Mampuru Concrete Reservoir and Access Road	Date Sampled:	2024/06/26
Address:	P.O.Box 12493, Steiltes, Nelspruit, 1200	Date Tested:	2024/07/09
Description	Test Pit 6 from 0,34 to 0,96m below E.G.L (MA-7)	Date Reported:	2024/07/17

Mod-CBR Test Report: SANS 3001

MDD and OMC (SANS 3001-GR30)
Mod-AASHTO Method

Mould	Moisture Content (%)	Dry Density (kg/m³)
1	10,3%	1870
2	11,3%	1899
3	12,3%	1931
4	13,3%	1900
5	14,3%	1870

Optimum Moisture Content (OMC):	**12,3%**
Maximum Dry Density (MDD):	**1931 kg/m³**

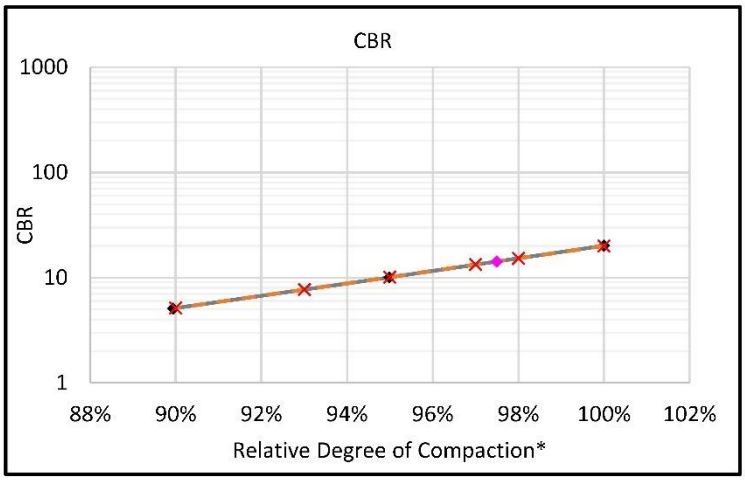


CBR (SANS 3001-GR40)
Mod AASHTO Method

Category	Mod AASHTO	NRB	Proctor
Mould Moisture Content %	12,4%		
Dry Density (kg/m³)	1933 kg/m³	1836 kg/m³	1738 kg/m³
Relative compaction (%)	100,0%	95,0%	89,9%
Measured CBR	20	10	5
% Swell	0,05	0,06	0,06

Interpreted CBR (SANS 3001-GR40)
Mod AASHTO Method

Relative Compaction	CBR
100%	20
98%	15
97%	13
95%	10
93%	8
90%	5





Technical Signatory

Comments:

Test methods marked *, does not form part of our schedule of accreditation.

Does not meet G8 requirements due to: CBR @ 93%<10

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Appendix C

DCP Test Results

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 Kl

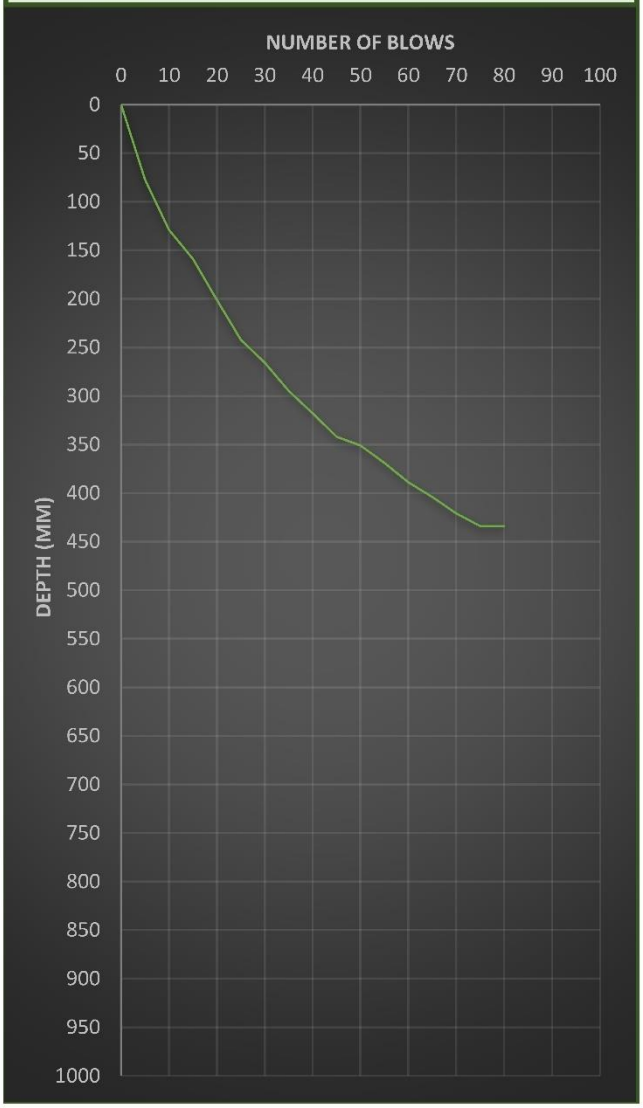
Zutari (Pty) Ltd.

DCP 1

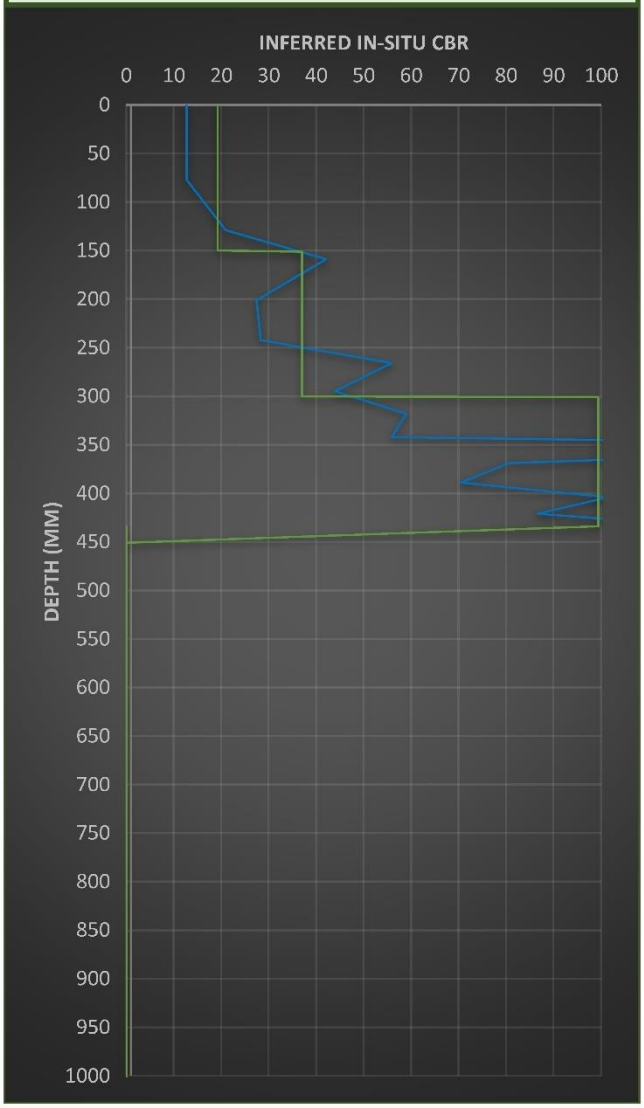
DCP conducted from E.G.L

Test Date: 26/06/2024

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
11,1	**6,6**	**3,1**	
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
19,3	**37,0**	**99,4**	
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 434 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 Kl

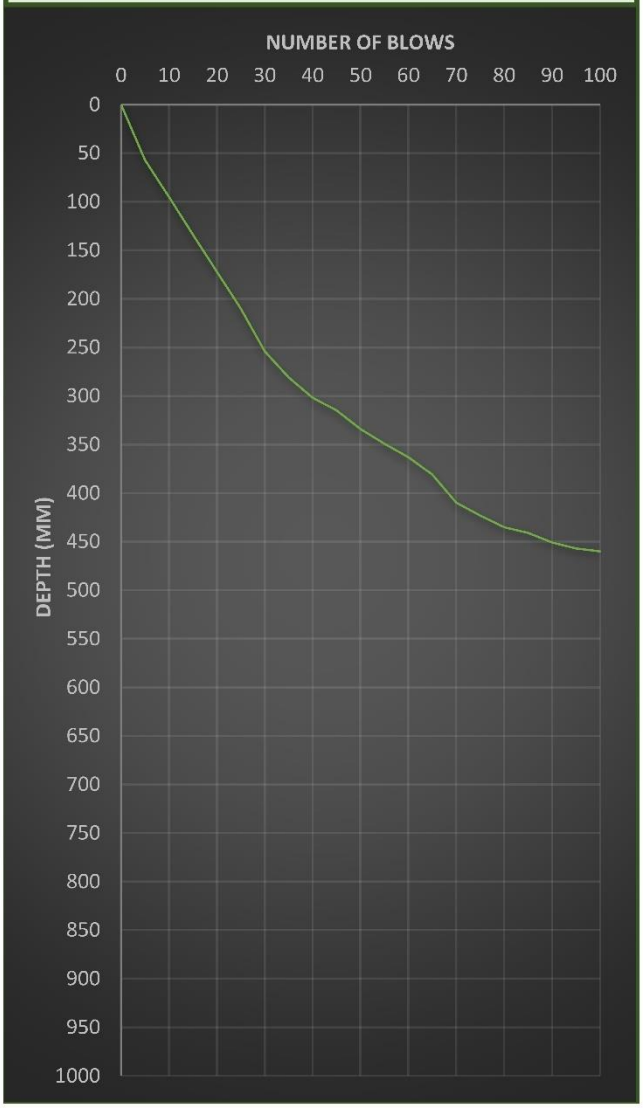
Zutari (Pty) Ltd.

DCP 2

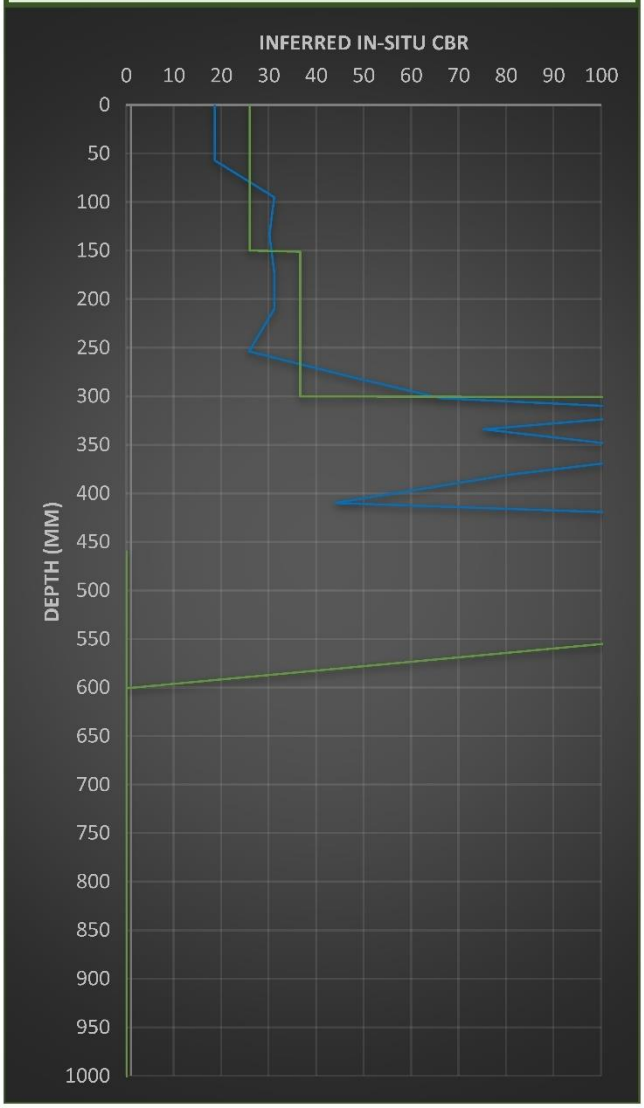
DCP conducted from E.G.L

Test Date: 26/06/2024

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
8,8	**6,7**	**3,0**	**1,0**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
26,0	**36,7**	**101,5**	**309,5**
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 460 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 Kl

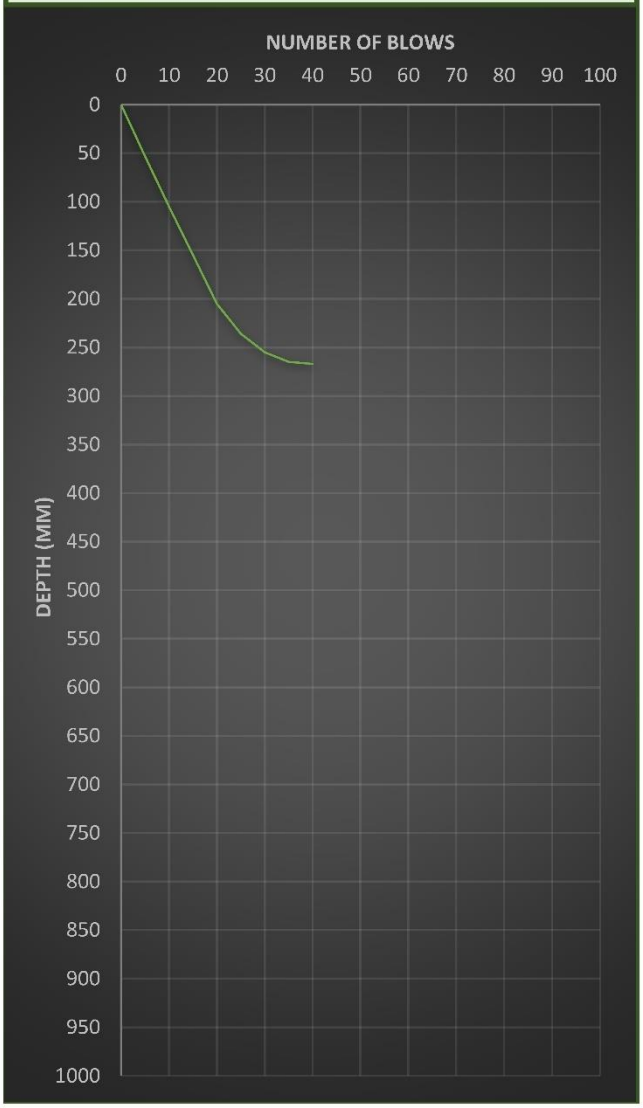
Zutari (Pty) Ltd.

DCP 3

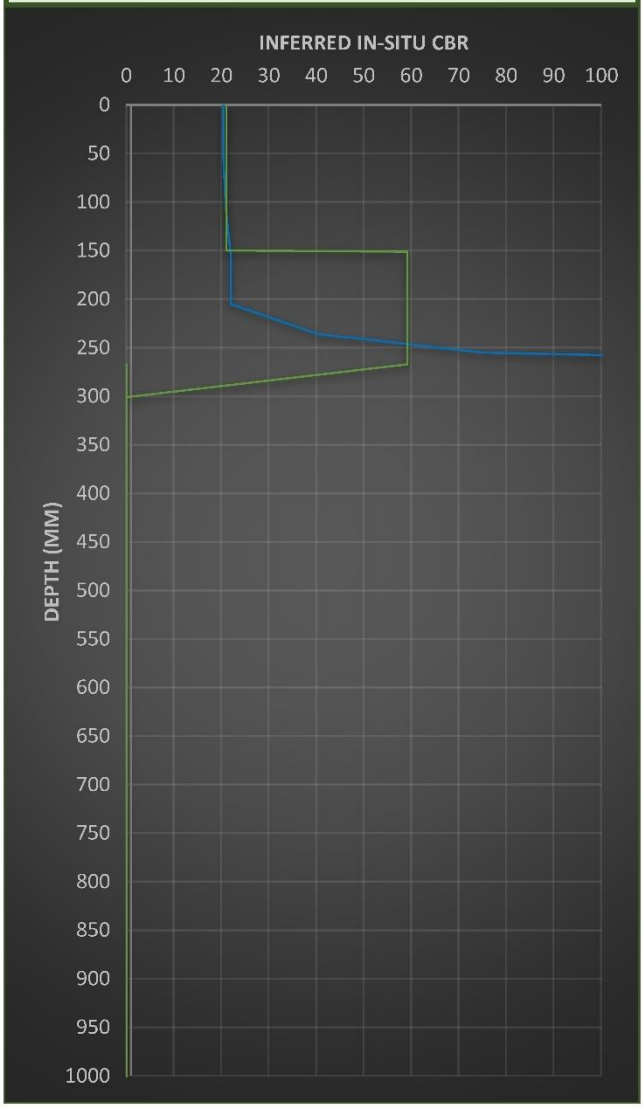
DCP conducted from E.G.L

Test Date: 26/06/2024

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
10,3	**4,6**		
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
21,1	**59,2**		
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 267 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144D

Mampuru Bulk Water Scheme

Mampuru Concrete Reservoir- 1200 Kl

Zutari (Pty) Ltd.

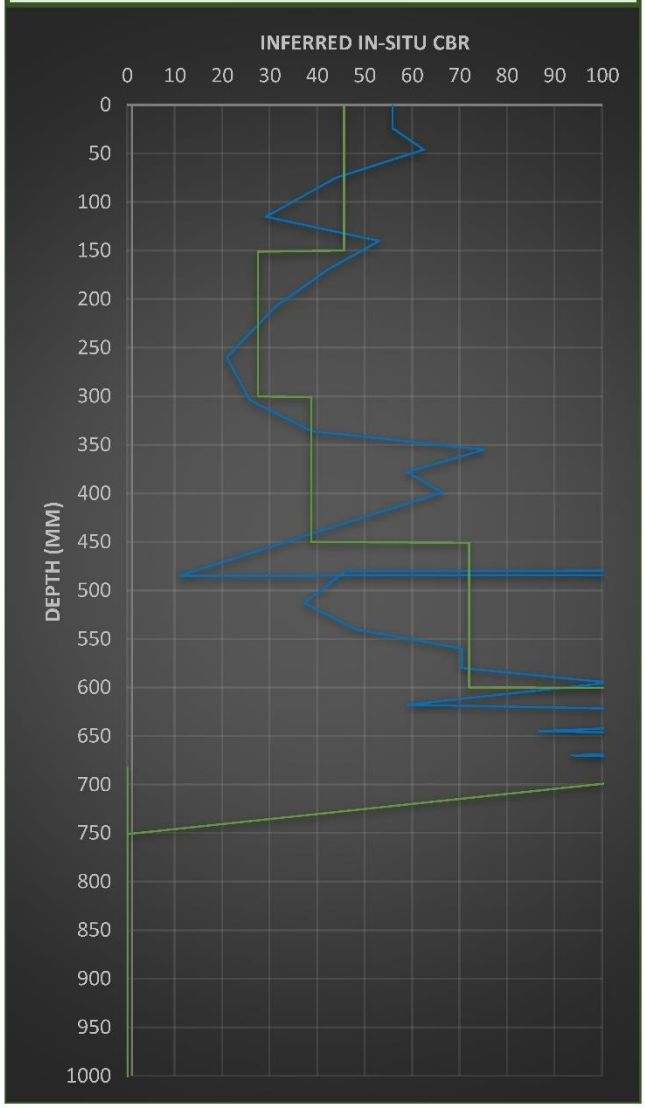
DCP 4

DCP conducted from E.G.L | **Test Date: 26/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
5,6	**8,4**	**6,4**	**3,9**
601 to 750	751 to 900	901 to 1050	1051 to 1200
2,4			

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
45,7	**27,5**	**38,8**	**72,0**
601 to 750	751 to 900	901 to 1050	1051 to 1200
131,6			

Terminated Depth: 683 mm

Termination Character: Refusal

GEOCALIBRE
GEOTECHNICAL CONSULTANCY

DCP Test

GC-24-144D

Mampuru Bulk Water Scheme

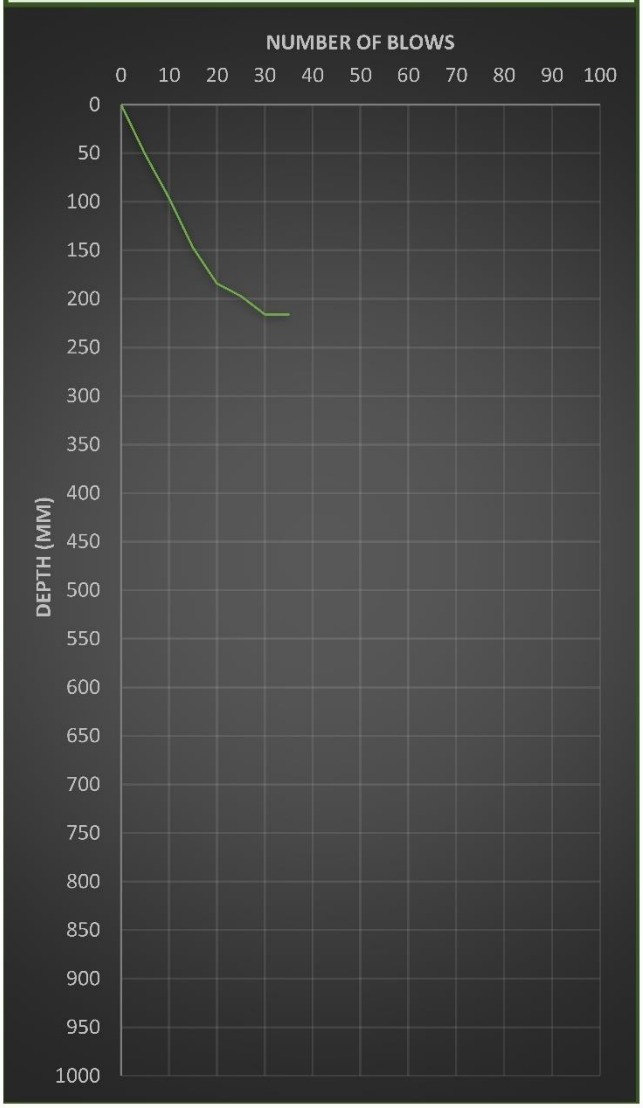
Mampuru Concrete Reservoir- 1200 Kl

Zutari (Pty) Ltd.

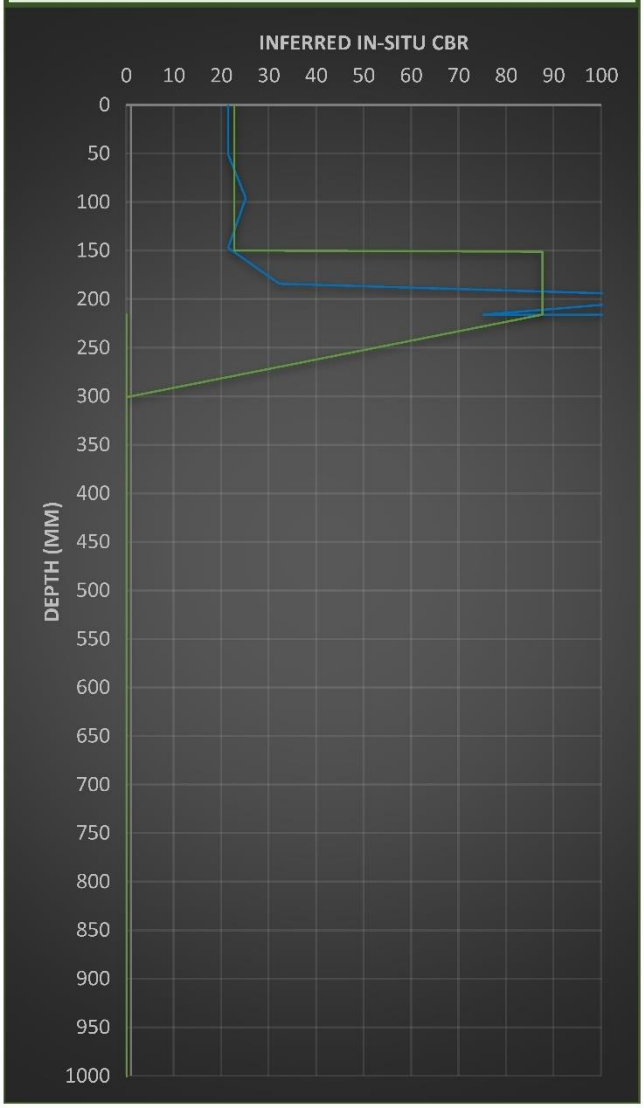
DCP 5

DCP conducted from E.G.L | **Test Date: 26/06/2024**

Number of blows vs penetration depth



In-situ CBR vs penetration depth



Penetration Rate (mm/blow) @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
9,7	**3,4**		
601 to 750	751 to 900	901 to 1050	1051 to 1200

Average in-situ CBR @ 150 mm intervals			
0 to 150	151 to 300	301 to 450	451 to 600
22,8	**87,7**		
601 to 750	751 to 900	901 to 1050	1051 to 1200

Terminated Depth: 216 mm

Termination Character: Refusal

Appendix D

Development Reference Tables

Table 8: Geotechnical Constraints in Urban Development (SANS 634:2012)

CONSTRAINT		DESCRIPTOR		
DESCRIPTION		**1 (most favourable)**	**2 (intermediate)**	**3 (least favourable)**
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling depth of less than 750 mm in thickness	Any collapsible horizon or consecutive horizons totalling depth of more than 750 mm in thickness	n/a
B	Seepage	Permanent or perched water table more than 1.5 m below ground surface	Permanent or perched water table less than 1.5 m below ground surface	Swamps and marshes
C	Active soil	Low soil-heave potential anticipated	Moderate soil-heave potential anticipated	High soil-heave potential anticipated
D	Highly compressible soil	Low soil compressibility anticipated	Moderate soil compressibility anticipated	High soil compressibility anticipated
E	Erodibility of soil	Low	Intermediate	High
F	Difficulty of excavation to 1.5 m depth	Scattered or occasional boulders less than 10% of total volume	Rock or hardpan pedocretes between 10% and 40% of total volume	Rock or hardpan pedocretes more than 40% of total volume
G	Undermined ground	Undermining at a depth greater than 200 m below surface	Old, undermined areas to a depth of 200 m below surface	Mining within less than 200 m of surface with total extraction
H	Stability (dolomite land)	Possibly stable	Potentially instable	Known sinkholes and dolines
I	Steep slopes	2-6 degrees	< 2 degrees or 6-18 degrees	> 18 degrees
J	Unstable natural slopes	Low risk	Intermediate risk	High risk
K	Seismic activity	10% probability of an event less than 100 cm/s^2 in 50 years	Mining-induced seismicity > 100 cm/s^2	Natural seismicity > 100 cm/s^2
L	Flooding	n/a	Adjacent to known drainage or channel with slope < 1%	Areas within drainage channel or floodplain

(After Partridge, Wood & Brink, 1993)

Table 9: Rock Mass Rating System as presented by Bieniawski, 1989

A. CLASSIFICATION –PARAMETERS AND THEIR RATINGS									
Parameter			Range of values						
1	Strength of intact rock material	Point-load strength index	>10 MPa	4 - 10 MPa	2 - 4 MPa	1 - 2 MPa	For this low range - uniaxial compressive test is preferred		
		Uniaxial comp. strength	>250 MPa	100 - 250 MPa	50 - 100 MPa	25 - 50 MPa	5 - 25 MPa	1 - 5 MPa	< 1 MPa
	Rating		15	12	7	4	2	1	0
2	Drill core *Quality RQD*		90% - –100%	75% - –90%	50% - 75%	25% - 50%	< 25%		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		> 2 m	0.6 - 2 . m	200 - 600 mm	60 - 200 mm	< 60 mm		
	Rating		20	15	10	8	5		
4	Condition of –discontinuities (See E)		Very rough –surfaces Not continuous No separation Unweathered wall rock	Slightly rough surfaces Separation < 1 mm Slightly weathered walls	Slightly rough surfaces Separation < 1 mm Highly weathered walls	Slickensided surfaces or Gouge < 5 mm thick or Separation 1-5 mm Continuous	Soft gouge >5 mm thick or Separation –> 5 mm Continuous		
	Rating		30	25	20	10	0		
–5	Ground water	Inflow per 10 m tunnel length (l/m)	None	< 10	10 - 25	25 - 125	> 125		
		(Joint water press)/ (Major principal σ)	0	< 0.1	0.1, - 0.2	0.2 - 0.5	> 0.5		
		General conditions	Completely dry	Damp	Wet	Dripping	Flowing		
	Rating		15	10	7	4	0		

B. RATING ADJUSTMENT FOR DISCONTINUITY ORIENTATIONS (See F)						
Strike –and dip orientations		Very favourable	Favourable	Fair	Unfavourable	Very Unfavourable
Ratings	Tunnels & mines	0	-2	-5	-10	-12
	Foundations	0	-2	-7	-15	-25
	Slopes	0	-5	-25	-50	

C. ROCK MASS CLASSES DETERMINED FROM TOTAL RATINGS					
Rating	100 ← 81	80 ← 61	60 ← 41	40 ← 21	< 21
Class number	I	II	III	IV	V
Description	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock

D. MEANING OF ROCK CLASSES					
Class number	I	II	III	IV	V
Average stand-up time	20 yrs for 15 m span	1 year for 10 m span	1 week for 5 m span	10 hrs for 2.5 m span	30 min for 1 m span
Cohesion of rock mass (kPa)	> 400	300 - 400	200 - 300	100 - 200	< 100
Friction angle of rock mass (deg)	> 45	35 - 45	25 - 35	15 - 25	< 15

E. GUIDELINES FOR CLASSIFICATION OF DISCONTINUITY conditions					
Discontinuity length (persistence)	< 1 m	1 - 3 m	3 - 10 m	10 - 20 m	> 20 m
Rating	6	4	2	1	0
Separation (aperture)	None	< 0.1 mm	0.1 - 1.0 mm	1 - 5 mm	> 5 mm
Rating	6	5	4	1	0
Roughness	Very rough	Rough	Slightly rough	Smooth	Slickensided
Rating	6	5	3	1	0
Infilling (gouge)	None	Hard filling < 5 mm	Hard filling > 5 mm	Soft filling < 5 mm	Soft filling > 5 mm
Rating	6	4	2	2	0
Weathering	Unweathered	Slightly weathered	Moderately weathered	Highly weathered	Decomposed
Ratings	6	5	3	1	0

F. EFFECT OF DISCONTINUITY STRIKE AND DIP ORIENTATION IN TUNNELLING**			
Strike perpendicular to tunnel axis		Strike parallel to tunnel axis	
Drive with dip - Dip 45 - 90*	Drive with dip - Dip 20 - 45*	Dip 45 - 90*	Dip 20 - 45*
Very favourable	Favourable	Very favourable	Fair
Drive against –dip - Dip 45-90*	Drive against –dip - –Dip 20-45*	–Dip 0-20 - Irrespective of strike*	
Fair	Unfavourable	Fair	

* Some conditions are mutually exclusive . –For example, if infilling is present, the roughness of the surface will be overshadowed by the influence of the gouge. –In such cases use A.4 directly.

** Modified after Wickham et al (1972).

Table 10: Geological Strength Index for Jointed Rocks (Hoek and Marinos, 2000)

