Eskom	Scope of Work	Medupi Power Station

Title: **Water Monitoring Scope of Work**

Document Identifier:	**240-167598600**
Alternative Reference Number:	**N/A**
Area of Applicability:	**Medupi Power Station**
Functional Area:	**Environmental Management**
Revision:	**1**
Total Pages:	**15**
Next Review Date:	**N/A**
Disclosure Classification:	**CONTROLLED DISCLOSURE**

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Date: 24/05/2023	Date: 24/05/2023	Date: 25/05/2023

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1. Introduction

The scope of work covered by the monitoring contract covers groundwater, surface and process water from the sewage water treatment plant at Medupi Power Station site in accordance with the most recent requirements set out by the Department of Water and Sanitation's Best Practice Guidelines on Water Monitoring Systems, Medupi Power Station's Waste license Reference No. 12/9/11/L50/5/R1, Water Use Licenses Reference No. 01/A1042/ABCEFGI/5213 and 07/A42H/IIG/6425 (WUL) and other regulatory commitments pertaining to ground and surface water monitoring.

The water quality monitoring is required to ensure that the station complies with South African legislation and issued Environmental Authorisations, permits, licenses and Eskom Groundwater Governance Guideline (GGG). The station is liable for ensuring that water quality is safe for use in the plant, drinking purpose as well as detection for contaminated water which can pollute the environment including groundwater. Eskom has put in place a Groundwater Governance Framework and guidelines which need to be covered for undertaking of all groundwater monitoring throughout the organization.

All water monitoring analysis shall be carried out in accordance with methods prescribed and obtainable from the South African Bureau of Standards, in terms of the Standards Act, 1982 (Act 30 of 1982).

The station therefore requires a contract with a water monitoring service provider for a period of thirty six (36) months. The scope of this contract will cover Medupi Power Station activities and other associated areas.

2. Supporting Clauses

2.1 Scope

2.1.1 Purpose

The purpose of this document is to define the scope of work for the water monitoring services required at Medupi Power Station. This will include all the documentation required, frequency of monitoring and all legislative requirements.

2.1.2 Applicability

This scope of work shall apply throughout Medupi Power Station site including partners and contractors sites were monitoring is required.

2.1.3 Effective date

The effective date of this document will be the date of authorisation.

2.2 Normative/Informative References

2.2.1 Normative

[1] ISO 14001: 2015 Environmental Management System
[2] ISO 9001: 2015 Quality Management System
[3] Act No 107 of 1998: National Environmental Management Act, 1998
[4] Act No 36 of 1998: National Water Act, 1998
[5] Act No 85 of 1993: Occupational Health and Safety Act & Regulations, 1993
[6] Waste Management license Reference No. 12/9/11/L50/5/R1
[7] Water Use Licenses Reference No. 01/A1042/ABCEFGI/5213 and 07/A42H/IIG/6425
[8] Water Use Licenses Reference No. 01/A1042/ABCEFGI/5213
[9] Water Use Licenses Reference No. 07/A42H/IIG/6425

2.2.2 Informative

[1] None

2.3 Definitions

None

2.4 Abbreviations

Abbreviation	Explanation
Gx	Generation Division
GCD	Group Capital Division
IWUL	Integrated Water Use License
WUL	Water Use License
IWWMP	Integrated Waste Water Management Plan

2.5 Roles and Responsibilities

Environmental Management

a) Responsible for the compilation of the scope of work and to ensure that work is carried out accordingly.
b) Monitoring of the water monitoring contract.

2.6 Process for Monitoring

The scope of work carried out will be monitored through audits by the end user.

2.7 Related/Supporting Documents

None

3. Description of Monitoring Services

3.1 Surface Water Monitoring

The scope for surface water monitoring entails sampling and testing of 15 storm water localities on a monthly basis at the storm water facilities as listed in the Medupi WUL; these include all pollution control dams, raw water dams and water pans. Some of these facilities are still under construction and will form part of the scope should they be completed and be in operation during the duration of this contract. Surface water samples shall be analysed and results compared to parameters listed in General Authorisation in terms of section 39 of the Nation Water Act (Act No 36 of 1998) and/or those listed in the Medupi WUL. Chronic toxicity tests addressing at least three (3) taxonomic groups must be analysed every six (6) months interval at a facility containing processed water which is returned into the station for re-use (Crocodile west compartment).

A detailed monthly report shall be compiled and submitted to the end user and results must be compared with WUL limits.

In case of emergencies the contract should allow extra 30 samples during contract period and testing should be done as indicated above. Additional new monitoring points and parameters might be requested in case of emergency situations and/or upon request from the authorities or as stipulated in amendments to the station's WUL.

All possible and valuable information regarding the status of the surface water facilities shall be recorded. This should at least include the following:

a) The date and time of sampling,
b) The water levels of the dams. If a level indicator is not installed, an estimate must be given in the form of low, moderate or full capacity.
c) The current state of the monitoring site, such as housekeeping issues.

Table 1: Surface water parameters to be analysed

Site	Coordinates		Parameters	Units
	Latitude	Longitude		
PCD1	-23.705016	27.541341	Faecal Coliforms	per 100 ml
PCD2	-23.717373	27.536103	Chemical Oxygen Demand	mg/l
PCD2b	-23.704057	27.533126	pH	pH Units
PCD4	-23.725195	27.509293	Ammonia (ionised and un-ionised) as Nitrogen	mg/l
PCD5	-23.720730	27.503221	Nitrate/Nitrite as Nitrogen	mg/l
CSY-PCD	-23.708850	27.557032	Chlorine as Free Chlorine	mg/l
DWD	-23.697748	27.580124	Suspended Solids	mg/l
CWD	-23.697264	27.580082	Electrical Conductivity	mS/m
RWD-C	-23.720591	27.544342	Orthophosphate as phosphorous	mg/l
RWD-M	-23.719983	27.544490	Fluoride	mg/l
EM-RWC8	-23.712305	27.563211	Soap, oil or grease	mg/l
EM-ADP	-23.720509	27.528234	Dissolved Arsenic	mg/l
EM-ECSYP	-23.727687	27.505970	Dissolved Cadmium	mg/l
			Dissolved Chromium (VI)	mg/l
MokoloRaw Water	-23.718500	27.545040	Dissolved Copper	mg/l
Maturation Pond 4	-23.696266	27.575245	Dissolved Cyanide	mg/l
			Dissolved Iron	mg/l
			Dissolved Lead	mg/l
			Dissolved Manganese	mg/l
			Mercury and its compounds	mg/l
			Dissolved Selenium	mg/l
			Dissolved Zinc	mg/l
			Sulphate	mg/l
			Boron	mg/l

3.2 Process Water Monitoring

The scope entails testing 5 process water localities from the Sewage Treatment Plant (STP). Samples will be taken by the STP operators on a monthly basis and submitted to the service provider for analysis.

Monitoring should be conducted as indicated below. Following the analysis, data should be submitted to the employer within 14 days and a detailed monthly report must be submitted to the employer before the next sampling run. Sampling from the Water Treatment Plant shall be done only upon request from Chemical Services Department.

Table 2: Process Water Sampling Register

Sample Description	Parameters	
Raw Sewage	P Alkalinity (pH>8.3)	
Balancing Tank	Conductivity (Laboratory)	
SBR 1 Decant	pH (Laboratory)	
SBR 2 Decant	ORP	
SBR 3 Decant	Chemical Oxygen Demand (COD)	
Contact Tank	Oxygen Dissolved (DO)	
	Ammonia and Ammonium	
	Nitrate and Nitrite (TON)	
	Ortho Phosphate	
	Biological Oxygen Demand (BOD)	
	Total Alkalinity (pH>4.5)	
	Bicarbonate Alkalinity	
	Carbonate Alkalinity	
	M Alkalinity (8.3>pH>4.5)	
Side Stream Tank	Total Alkalinity (pH>4.5)	mg CaCO3/L
Maturation Pond 4	Bicarbonate Alkalinity	mg CaCO3/L
	Carbonate Alkalinity	mg CaCO3/L
	M Alkalinity (8.3>pH>4.5)	mg CaCO3/L
	P Alkalinity (pH>8.3)	mg CaCO3/L
	Conductivity (Laboratory)	mS/m
	pH (Laboratory)	-
	Total Hardness	mg CaCO3/L
	Calcium Hardness	mg CaCO3/L
	Magnesium Hardness	mg CaCO3/L
	Total Dissolved Solids (TDS)	mg/L

	Suspended Solids (TSS)	mg/L
	Temperature	°C
	Chemical Oxygen Demand (COD)	mg O2/L
	Oil, Soap and Grease (OSG)	mg/L
	Ammonia and Ammonium	mg N/L
	Calcium	mg Ca/L
	Total Chlorine (Laboratory)	mg Cl2/L
	Soluable/Free Chlorine (Lab)	mg Cl2/L
	Chloride	mg Cl/L
	Magnesium	mg Mg/L
	Nitrate	mg N/L
	Nitrite	mg N/L
	Ortho Phosphate	mg P/L
	Potassium	mg K/L
	Sodium	mg Na/L
	Silicon	mg Si/L
	Sulphate	mg SO4/L
	Aluminium	mg Al/L
	Fluoride	mg F/L
	Iron	mg Fe/L
	Manganese	mg Mn/L
	Faecal Coliforms	CFU/100mL
	E - Coli	CFU/100mL
	Langelier Index (indicative, not SANS)	
	pHs (indicative, not SANS)	
	Sodium Absorption Ratio (indicative)	
	TDS to EC Ratio (indicative, not SANS)	
	Corrosion Ratio (indicative, not SANS)	
	Ryznar Index (indicative, not SANS)	
	Anion Sum	
	Cation Sum	

3.3 Groundwater Monitoring

The service provider shall be responsible for conducting groundwater sampling and testing at 30 boreholes on a quarterly basis for all boreholes except those around the ash dump. It should be noted that the number of monitoring boreholes may change due to an expansion of the monitoring network as per recommendations from the specialist studies. Boreholes around the vicinity of the

ash dump are to be sampled on a monthly basis. The frequency of monitoring is likely to change when changes to the Waste Management licence are requested from the department (DFFE).

Groundwater monitoring shall be done as per the requirements of the Medupi Power Station Water Use Licences (Reference No. 01/A1042/ABCEFGI/5213 and 07/A42H/IIG/6425) and Condition 6.2 Ash Dump Authorisation (Reference No.12/9/L50/5/R1) or based on any amendments that may be revised from time to time. For investigation and background monitoring, parameters stipulated in Annexure II of the Waste Management Licence will have to be analysed.
The service provider shall evaluate all relevant regulatory and other requirements (e.g. WUL, EIA, EMP, Waste License Conditions, Closure and End Land Use Objectives, IWWMP, Directives etc.) and develop a Medupi Power Station site specific monitoring and sampling protocol considering the requirements of the Eskom Groundwater Governance Framework and Guidelines (GGF&G) Groundwater Monitoring (GWG05a) and Groundwater Sampling (GWG05b) Guidelines as the basis for the development of the site specific monitoring and sampling procedure. The monitoring protocol shall be forwarded to end user for review and approval prior to commencement of the monitoring activities. All boreholes are to be purged at each monitoring run except for boreholes at the raw water dams.

The following parameters have to be recorded during each monitoring event:

a) The date and time of sampling,
b) Static water levels to be taken prior to taking the sample,
c) Sample depth,
d) Any visible anomalies in the water such as odour, colour an turbidity, and
e) The current state of the monitoring site.
f) Amount of water purged after samples have been taken.

Field parameters such as pH, EC and Temperature should be recorded and updated on a database after every monitoring event.

Purging of boreholes should be conducted as follows:

a) The large diameter boreholes must be purged with a submersible pump during at least twice a year of the monitoring event. Purging must be done before the sample is taken from the borehole and the amount of water purged must be recorded.
b) EC measurement must be taken continuously during the purging of the boreholes.

c) Low yielding boreholes must be pumped dry.
d) At least three times the volume of the standing water must be removed at high yielding boreholes.
e) After purging the boreholes must be sampled during the next monitoring phase at the specific depths determined during previous investigations. This is necessary to ensure that the aquifer conditions have recovered to its natural state and that no artificial inflow into the borehole is sampled.
f) For boreholes where there is a significant difference in water levels from the previous monitoring run, the difference should be highlighted and if need be investigation for this should be initiated. The contractor will have to discuss this with the end user.

Table 3: Groundwater Sampling Register

Locality	Description	Latitude	Longitude	Parameters	Frequency
MBH01D	Deep borehole on south western perimeter	S-23.7118	E27.5483	1. pH 2. Conductivity (EC) 3. Calcium (Ca) 4. Magnesium (Mg) 5. Sodium (Na) 6. Potassium (K) 7. Chloride (Cl) 8. Sulphate (SO4) 9. Fluoride (F) 10. Nitrate(NO3) 11. Ecoli 12. Ortho-Phosphate (as P) 13. Ammonia (N) **<u>Ash Dump License parameter listed in Annexure II of waste license</u>** **<u>Additional Analysis for PCD 6, 7 & 8 monthly for the first 12 months</u>** – 14. pH 15. Electrical Conductivity (EC)	Quarterly
MBH01S	Shallow borehole on south western perimeter	S-23.7497	E27.5470		Quarterly
MBH02D	Deep borehole on southern perimeter	S-23.7129	E27.5574		Quarterly
MBH02S	Shallow borehole on southern perimeter	S-23.7128	E27.5574		Quarterly
MBH03D	Deep borehole on south eastern perimeter (next to raw water crossing 8)	S-23.7100	E27.5671		Quarterly
MBH03S	Shallow borehole on south eastern perimeter (next to raw water crossing 8)	S-23.7100	E27.5671		Quarterly
MBH04D	Deep borehole on north eastern perimeter (near clean and dirty water dam and sewage treatment plant)	S-23.6953	E27.5801		Quarterly
MBH04S	Shallow borehole on north eastern perimeter (near	S-23.6953	E27.5801		Quarterly

	clean and dirty water dam and sewage treatment plant)			16. Alkalinity (Alk) 17. Chloride (Cl) 18. Sulphate (SO4) 19.Nitrate (NO3) 20. Ammonium (NH4) 21. Phosphate (PO4) 22. Fluoride (F) 23. Calcium (Ca) 24.Magnesium (Mg) 25. Sodium(Na) 26. Potassium (K) 27.Aluminium (Al) 28. Iron (Fe) 29.Manganese (Mn) 30.Total Chromium (Cr) 31.Copper (Cu) 32. Nickel (Ni) 33. Zinc (Zn) 34.Cobalt (Co) 35. Cadmium (Cd) 36. Lead (Pb)	
MBH05D	Deep borehole on northern perimeter	S-23.6934	E27.5644		Quarterly
MBH05S	Shallow borehole on northern perimeter	S-23.6935	E27.5644		Quarterly
MBH06D	Deep borehole on north western perimeter	S-23.6991	E27.5473		Quarterly
MBH06S	Shallow borehole on north western perimeter	S-23.6992	E27.5474		Quarterly
MBH07	Up gradient from Ash Dump South	-23.7386	27.5044		Quarterly/ 6monthly
MBH08	Up gradient from Ash Dump North	-23.7072	27.5443		Monthly
MBH09	Down gradient from Ash Dump North	-23.7037	27.5369		Monthly
MBH10	Down gradient from Ash Dump North and Dam 3	-23.7237	27.5175		Monthly
MBH11	Down gradient from Ash Dump North	-23.7189	27.5376		Quarterly/ 6monthly
MBH12	Down gradient from Ash Dump North	-23.7148	27.5424		Monthly
MBH13	Down gradient from Ash Dump North and Dam 1	-23.7071	27.5442		Monthly
MBH14	Down gradient from Coal Stockyard	-23.7015	27.5516		Quarterly
MBH15	Down gradient from Coal Stockyard	-23.7101	27.5580		Quarterly
MBH17	Down gradient from Ash Dump South and Dam 5	-23.7418	27.5418		Quarterly/ 6monthly
MBH18	Down gradient from Ash Dump South and Dam 6	-23.7484	27.5307		Quarterly/ 6monthly
MBH19	Down gradient from re-fuelling station and workshops	-23.6984	27.5612		Quarterly
MBH20	Down gradient Bulk Fuel Oil	-23.7099	27.5649		Quarterly
MBH21	Down gradient of clean and dirty water dam	-23.6909	27.5855		Quarterly

Raw Water Dam Boreholes					
EMBH01	North of Raw dam borehole	-23.71938,	27.54632		Quarterly
EMBH02	West of Raw dam borehole	--23.72065,	27.54365		Quarterly
EMBH03	South of Raw dam borehole	-23.72280,	27.54356		Quarterly
EMBH04	South of Raw dam borehole	-23.72275,	27.54532		Quarterly
Existing Private Borehole Adjacent to the Ash Disposal Facility as condition 3.9 of WUL 07/A42H/IIG/6425					
EMHBH06	Western Side of ECSY Dam 5	-23.72107,	27.50262		Quarterly
EMHBH13	Southern side of CSY PCD	-23.7128	27.5632		Quarterly
EMHBH14	Southern side of the CSY PCD	-23.71377	27.56108		Quarterly

3.4 Sampling and Reporting Requirements

The service provider must carry out all tests required in accordance with published laboratory analysis methods or those prescribed by and obtained from the South African Bureau of Standards, referred to in the Standards Act, 2008. Alternative method of analysis can only be used if approved by the relevant authority.

Planned Task Observation (PTO) must be conducted during field sampling and adequate hygiene measures should be applied to prevent contamination of samples. Sampling to be undertaken by experienced personnel and site specific personal protective equipment (PPE) must be worn during sampling period. All water samples are to be stored in cool boxes (containing ice)/fridge whilst in transit between site and the accredited analytical laboratory. Samples must be at the laboratory no later than 48 hours after sampling and within 12 hours for micro biological samples. All water samples must be analysed at an accredited laboratory. The certificates of laboratories to be used must be submitted to the employer prior to commencement of works.

The contractor is encouraged to use the Windows Interpretation System for the Hydrogeologist (WISH) database mainly because it provides a means of distributing data amongst different parties and ensures a consistent format even if consultants or laboratories are switched in the middle of an investigation.

The monitoring report shall include the following;

a) The date, time and monitoring location in respect of each sample taken
b) Map showing monitoring sites and potential pollution sites
c) Current state of the site and monitoring network.
d) Areas of concern
e) Response to previous findings or observations
f) Water Quality data and trends
g) Water Level data and trends
h) Data analysis and interpretation
i) Impact assessment
j) Risk assessment
k) Recommendations

The contractor shall compile monthly and quarterly groundwater monitoring reports and submit to the station for approval. The draft reports shall be reviewed by the employer representative and approved before it is finalised. The final report shall be submitted to the employer 1 month after the conclusion of the monitoring phase.

This report shall also investigates the current state of the monitoring system and various monitoring sites, water quality characteristics, and observed trends in water quality over time, mainly through the use of graphical interpretation methods. These methods include:

a) A description of the current state of the water monitoring system and infrastructure at power station to identify any problems that may require attention;
b) Investigation of water level fluctuations;
c) Maximum/minimum, average and current (MMAC) plots of the water chemistry to relate the current water chemistry to the chemistry observed during previous monitoring phases;
d) Examination of the temporal trends in the water chemistry by means of time graphs;
e) Determine pollution indexes by evaluating all data (including the latest Hydro censes results);
f) Compilation of data tables containing the results of the chemical analyses.

The service provider shall submit an electronic copy of the report after each monitoring run. The service provider shall also be required to send the updated database with all the groundwater monitoring information. The database shall remain the exclusive property of Eskom Medupi Power Station. A quarterly meeting shall be held between the contract and the employer where the surface and groundwater reports with findings of the monitoring phase (or any other work done in that period) is presented to the employer's representative(s).

The contractor will be required to provide feedback on the water quality (portable water, surface water and groundwater) during the Medupi Environmental Monitoring Committee (EMC) on a quarterly basis. This will be in a presentation format and the contractor will be required to answer technical questions from the Committee or public during these meetings.

3.5 Drilling of additional boreholes and/or restoration of collapsed boreholes

Eskom Medupi Power Station appointed the Aurecon Water Unit form the Tshwane Delivery Centre to conduct numerical groundwater modelling to evaluate the existing and probable future groundwater conditions and establish the adequacy of the current monitoring network. The Numerical Flow Model Report (Document No. 500646, V1.6) was finalised in August 2019 and the contractor is hereby required to implement proposed mitigations measures and recommendations made in the report. Contractor is required to:

a) Site five new boreholes using geophysics and drill the boreholes (Refer to figure 23 shown on page 45 and Table 13 shown on page 46 of the Numerical Flow Model Report and Medupi Quarterly Groundwater Report dated January 2020; and
b) The collapsed/damaged boreholes should be repaired or re-drilled in order to restore them to their original depth.

Eskom will there consider the recommendations and drill additional boreholes which will be added to this scope of work upon completion.

3.6 Specialist Study – Groundwater Modelling

The contractor shall undertake a detailed assessment to update the conceptual and numerical model based on the latest site information once during the duration of the contract. Information gaps in the conceptual design shall be identified, and recommendations made in term of how to address the information gaps. Using the updated conceptual design, the Contractor shall develop the numerical model (pollution plume model).

The contractor shall review and update the groundwater plume model every year as required by the Medupi WUL; it should be noted that this frequency is likely to change due to amendments of the WUL. As part of the modelling exercise, impacts of the activities likely to contaminate groundwater shall be investigated.

To develop a comprehensive pollution model, the following activities shall be undertaken;

a) Detailed site assessment;

b) Evaluate the surface topography;
c) Pollution source investigation;
d) Describe the hydrology and geohydrology;
e) Determine aquifer parameters (aquifer physics – slug tests and EC profiling);
f) Describe the geology;
g) Update the water quality database and maps;
h) Construct a 3-dimensional numerical model and make recommendations regarding the monitoring network

In addition to these tasks, the following aspects shall be carried out:

a) Identify and assess current and potential future impacts from the pollution sources and identify and evaluate the monitoring network specific to each pollution source;
b) Assess the influence of recharge and ash from the ashing facilities on the migration of pollutants away from the pollution sources;
c) Evaluate monitoring reports of recent years and ensure properly reconciliation of sites (including site locations, chemistry and water levels) with the previous database as well as with the newly gathered and generated data;
d) Determine the optimal sampling depth by the evaluation of the EC profiling results

3.7 Biomonitoring Assessment

Biomonitoring is utilised as an important tool in assessing the conditions of aquatic ecosystems over time. The biomonitoring protocols give a good reflection of the water quality in the streams studied. These protocols include the *in-situ* chemical assessments, South African Scoring System v.5 (SASS5), Macro Invertebrate Response Assessment Index (MIRAI) and Toxicity analysis results. A registered professional and accredited (SASS5) Aquatic Ecologist should conduct bi-annual assessment in accordance with the conditions of the WUL and National Water Act, during wet and dry session. A report should be compiled after each assessment, total of two assessment will be conducted in a year.

3.8 Documentation Required

a) Medupi Power Station site specific monitoring and sampling protocol;
b) Raw data of all results in excel sheet or WISH format;
c) Laboratory test analyses certificates;
d) Proof registration as Professional Natural Scientists (SACNASP);
e) Submit full risk assessments and method statements of sampling protocol prior to commencement of works;

f) Submit valid fitness medical certificate for personnel who will be collecting samples onsite;
g) Numerical Flow Model report; and
h) The service provider might be required to input the data on the Eskom Laboratory Information Management System (LIMS) system.
i) Should the need arise, a groundwater remediation and management plan.

4. Evaluation criteria

Criteria		**Scoring guidelines (specific to the project and based on scope and User's requirements)**	**Weight**
Company Related Experience	• Professional experience in similar projects (Company and/or Individuals)/Company profile • Proof of at least three (3) verifiable relevant references to be provided for company experience • Proof of previous orders/contracts for similar work	• 5 years experience and above = 40% • Between 4 - 5 years experience = 30% • Between 3 - 4 years experience = 20% • Between 2 - 3 years experience = 10% • 2 years experience and less = 0%	40%
Personnel Experience, Registration & Accreditation	• Al least two CV's of the professional team with relevant Professional Registration • Groundwater specialist • Aquatic ecologist	• No CV provided and no professional registration = 0% • CV with minimum of 3 years' experience but without professional Registration = 15% • CV with above 3 years' experience provided with professional registration = 30%	30%
Sampling methodology/ method statement and analysis	High level proposal of the works including an itemised pricelist:	• Method statement/procedure for carrying out the sampling, biomonitoring and groundwater modelling provided. • Method statement/procedure for carrying out the sampling, biomonitoring and groundwater modelling provided • but does not meet legal requirements provided = 10% • No method statement/procedure submitted = 0%	20%
Laboratory SANAS accreditation	Provide proof of SANAS accreditation certificate	Certificate provided = 10 No certificate = 0	10%
Total			100

5. Acceptance

This document has been seen and accepted by:

Name	Designation
Ntsikie Nani	Chemical Services

6. Revisions

NA

7. Development Team

The following people were involved in the development of this document:

- ✓ Mokgadi Dikgale
- ✓ Hulisani Tshikondela
- ✓ Thabo Khoza

8. Acknowledgements

None