



**AIRPORTS COMPANY**  
SOUTH AFRICA

**AIRPORTS COMPANY SOUTH AFRICA**  
**KING SHAKA INTERNATIONAL AIRPORT**

**CONTRACT NO: DIA23/2017**

**CONSTRUCTION OF EMERGENCY ACCESS  
ROADS AT KING SHAKA INTERNATIONAL  
AIRPORT – FAST TRACK PHASE**

**DESIGN REPORT**

**REVISION F (FINAL) – 22 FEBRUARY 2019**

**PREPARED FOR:**

AIRPORTS COMPANY SOUTH AFRICA SOC LIMITED  
KING SHAKA INTERNATIONAL AIRPORT

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## Abbreviations used

AASHTO	American Association of State Highway and Transportation Officials
ACSA	Airports Company South Africa
APR	Airport Perimeter Road
BOQ	Bill of Quantities
CH	Chainage (Distance along the road)
DCP	Dutch Cone Penetrometer
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessments
FGL	Finished Ground Level
GMG	Geomeasure Group (Environmental Sub-consultant)
iX	iX engineers (Pty) Ltd
KSIA	King Shaka International Airport
LHS	Left Hand Side
MOD	Maximum Optimum Density
MOU	Memorandum of Understanding
NGL	Natural ground level
RESA	Runway End Safety Area
RHS	Right Hand Side
SANRAL	South African National Roads Agency Limited
THD	Tongaat Hulett Developments

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**1. INTRODUCTION**

**1.1 Terms of Reference**

The Airports Company South Africa (ACSA) required the construction of emergency vehicle access roads at King Shaka International Airport (KSIA) to link the ends of the runway to the local municipal roads to the north and south of the airport property.

In October 2017, iX engineers (Pty) Ltd (IX) were appointed to investigate and design the roads according to ACSA requirements. The environmental studies / approvals and land ownership agreements also formed part of this appointment.

**1.2 Scope of The Report**

During the process of negotiating with adjacent landowners, it became clear that the full extent of the requirements of the project could not be met in the short term. The project was divided into 2 portions, namely, portions of the roads that could be constructed now and portions that would need further negotiations regarding rights of way or transfer of land ownership. This was done to allow ACSA / KSIA to meet the majority of their obligations in terms of the civil aviation safety requirements.

This report covers the civil engineering design for the portion of the works to be constructed now, which we have termed Fast Track Phase.

**1.3 Scope of The Design**

The extent of the Fast Track Phase works is:

**Southern Road**

- Surfaced road from the southern end of Runway 06, crossing over the existing airport perimeter road, passing through existing Emergency Gate 3 and terminating at the existing Dube Boulevard.
- Associated stormwater drainage, signage and re-vegetation of disturbed areas

The southern road does not require any further negotiations and the design outlined in this report would be the final design for this portion of the project.

**Northern Road**

- Surfaced road from northern end of Runway 24, passing through a new gate on the restricted area fence, crossing over the existing airport perimeter road, passing through existing Emergency Gate 1 and terminating about 200m north of the fence line.
- Reconstruction of the gravel road from end of the asphalt surfaced section linking to existing gravel road on the north eastern edge of the airport property.
- Associated stormwater drainage, signage and re-vegetation of disturbed areas.

The northern road will, when constructed as described above, constitute a partial completion of ACSA's obligations for the overall project, and the gravel surfaced section is to be considered a temporary or interim solution. To contain costs and minimise abortive works, the asphalt surfacing will terminate at the point beyond which the future alignment of the permanent route is undecided. This section will be completed once the land ownership and Right of Ways to the north are negotiated and agreed.

## 1.4 Locality Sketch

The locality sketch below indicates the position of the two roads forming part of this project



## 2. ADDITIONAL STUDIES

### 2.1 Topographical Survey

A topographical survey was conducted by TWM Surveys (Pty) Ltd during March and April 2018. The survey forms the background to all the layout drawings.

## 2.2 Geotechnical Investigation

Shriram Geotechnical Consulting (Pty) Ltd was been commissioned to conduct the geotechnical investigation. The field work and the laboratory testing have been completed. The results are summarised in this report and the full Geotechnical report is Appended in Appendix A. .

## 2.3 Environmental Investigation

Geomeasure Group (Pty) Ltd (GMG) are subcontracted to IX to conduct the necessary environmental investigations. Their brief includes assistance in obtaining the necessary environmental approvals. This is currently ongoing.

## 2.4 Land Ownership

Geomeasure Group (Pty) Ltd are subcontracted to IX to assist with determining ownership of the affected properties and the process of obtaining the necessary permissions and rights-of-way for the roads. This is currently on-going.

## 3. DESIGN CRITERIA AND STANDARDS

### 3.1 Design Criteria

The following criteria were used in the design process.

<b>Roads</b>	
Required surfaced width	6 m
Design speed	80 km/h
<b>Design Vehicle</b>	
Heaviest design vehicle	52 t (Panther 8x8)
Minimum vehicle turn radius	20 m
<b>Stormwater</b>	
Storm return period	100 years
Storm intensity	250 mm/hour
Storm duration	15 min

Additional requirements:

- Alignments should avoid the RESA as far as possible
- Road surface levels should closely follow the graded strip ground level.

The following 2 vehicles in use at the airport were considered the most onerous in terms of weight and manoeuvrability:

- Rosenbauer Panther 8x8
- Forward Command Post SU

## 3.2 Design Standards and Guides

The following design standards and guides were used or are applicable here:

- COLTO Standard Specifications for Road and Bridge Works for State Road Authorities (1998)
- Technical Recommendations for Highways
  - TRH4: Structural Design of Urban And Rural Roads (1996)
- Urban Transport Guidelines
  - UTG5 Geometric Design of Urban Collector Roads (1988)
  - UTG10 Guidelines for the Geometric Design of Commercial and Industrial Local Streets (1990)
- SANRAL Drainage Manual 5<sup>th</sup> Edition (2006)
- SA Road Traffic Signs Manual 3<sup>RD</sup> Edition (2012)
- ICAO Annexure 14 Aerodromes Vol 1 Aerodrome Design and Operations 5<sup>th</sup> Edition (2009)
- Kwa-Zulu Natal Department of Transport Standard Details

## 4. ROAD DESIGN

### 4.1 Design Criteria

Table 1: Road Design Criteria

Criteria		Value	Exceptions
Design Speed		80km/h	Approaches to gates and intersections with other roads
Road Category		B	
Road widths		6m (2 x 3m lanes)	
Longitudinal grade	Minimum	0.5%	Where road follows airfield graded strip
	Maximum	6%	Northern Road at tie in to existing road
Length of vertical curve	Minimum	20m	At intersections and stop / yield conditions
Cross fall	Nominal	2.0%	Where road follows airfield graded strip
Horizontal radius	Minimum	280m	Topographical constraints, intersections and stop / yield conditions

The following descriptions of the design alignments should be read in conjunction with the relevant layout drawings listed later in this report.

### 4.2 Southern Road

The southern road departs from Runway 06 just to the north of the threshold markings at an angle of 30 degrees to the runway edge. This angle allows the alignment to avoid crossing too far into the RESA. The road follows a gentle curve to the left to line up for the approach to Emergency Gate 3. Due to the short distance between the runway and the fence line and the change in direction required, a design speed of 80km/h is not achievable over the majority of this section.

The first 200m of the road follows the levels of the graded strip, before dropping down into a shallow cutting to tie into the airport perimeter road (APR). The cross fall on this section follows the fall of the graded strip (varying between 1 and 2 %) and stormwater is allowed to flow across the road unimpeded. This is designed to prevent

the necessity for additional drainage structures or channels and thereby obstructions within the graded strip. The maximum depth of water crossing the road will vary from 20mm to 35mm for storm return periods of 5 to 100 years respectively. Regular maintenance of the vegetation adjacent to the surfacing will be required to prevent damming of surface run-off on the road edge. Beyond this 200m point, side drains will be employed to control stormwater.

To eliminate the existing slight drop-off between the APR and Emergency Gate 3, and create a smoother alignment through the gate, the gate will need to be raised by approximately 200mm. This is easily achieved within the modular nature of the existing fence and gate and the current vertical steps in the fence alignment.

The section between the gate and Dube Boulevard is short and given the stop conditions at each end, the design speed criteria was not applied. At the tie into Dube Boulevard, a conventional at-grade bell-mouth intersection will allow for easy entry / egress onto the existing road way.

### **4.3 Northern Road**

The northern road departs from Runway 24 just to the south of the threshold markings at an angle of 20 degrees to the runway edge. While an angle of 30 degrees would have limited the encroachment into the RESA, it would have compromised the ability to achieve the 80km/h design speed and avoid the steep valley / drop-off on the RHS at ±CH 220.

The vertical alignment continues to follow the graded strip levels with a cross fall of between 1 and 2%, up to CH 660. To prevent additional stormwater drains and structures, the storm runoff will be allowed to cross the road surface between CH 0 and CH 420 to limit obstructions in the RESA. The maximum water depth crossing the road will be 10mm for storm return periods of 100 years. Regular maintenance of the vegetation adjacent to the surfacing will be required to prevent damming of surface run-off on the road edge. The existing water course crossing at CH 440 necessitated the installation of a pipe culvert with headwalls. Just beyond this, at CH 470 the road crosses the restricted zone fence line. A new gate will be installed in the existing fence.

Between CH 460 and the APR (CH 660), the alignment deviates from the graded strip levels to smooth out the slight undulations in the existing ground levels. A side drain will divert stormwater towards the water course at CH 440. The alignment crosses the APR and existing Emergency Gate 1 at grade and no adjustments are required to the gate.

The 200m section from the gate to the end of the asphalt surfacing achieves the 80km/h design speed and is designed in accordance to the final (future) alignment. However, the hindrance of the gate and the short surface length makes it unlikely that this speed will be achieved in practice.

The gravel section beyond the asphalt follows the existing gravel alignment to some extent. Realignment to a smoother alignment at this stage was considered and disregarded due to the environmental constraints of pioneering a new route through the water course just to the north of this section. The gravel road ties into the existing gravel road on the eastern side of the ACSA property. This existing gravel road links through to Watson Highway to the north and is in a good condition. The section of this road which crosses Tongaat Hulett's property will be part of a Memorandum of Understanding to secure the route for emergency vehicles until a permanent solution / route is achieved.

### **4.4 Typical Cross-Sections**

The road alignments cover two distinct zones and the typical cross sections were developed to accommodate the limitations / requirements in each zone. With reference to the Construction Details drawing (300713-00-CI-DRD-0001-001):

**TYPICAL ROAD CROSS SECTION:** This is recommended where the road is allowed to deviate from the ground levels and a typical cut / fill scenario is shown. The 1.5m wide verge will allow vehicles to pull over / park without the risk of going down the embankment or obstructing the roadway.

**AIRFIELD PLATFORM ROAD:** This cross section is applied within the graded strip and the levels and cross fall follow the existing ground levels closely. A wide verge area adjacent to the surfacing will be trimmed to help 'blend' the road surface into the surrounding topography and eliminate any steps or sudden changes in grade. This will also assist with allowing stormwater to flow across the road without ponding or causing erosion.

## **5. MATERIALS INVESTIGATION**

### **5.1 Available Data**

No existing data was available.

## 5.2 Extent of investigation

As stated in section 2.2, Shriram Geotechnical Consulting (Pty) Ltd were commissioned to conduct the geotechnical investigation to assess the ground conditions in terms of usage and for subgrade treatment guidelines to be provided. The results are summarised below, and the full Geotechnical report is Appended in Appendix A.

The field work was carried out between 22 August 2018 and 11 September 2018 and comprised of the following:

- 9 x Dynamic Cone Penetrometer (DCP) tests; and
- 9 x Test pits.

The locations of the test positions are shown on Figure 1 and Figure 2. The site was generally found to be underlain by colluvium, or topsoil, and fill which was likely placed when shaping the site during the construction of the airport.

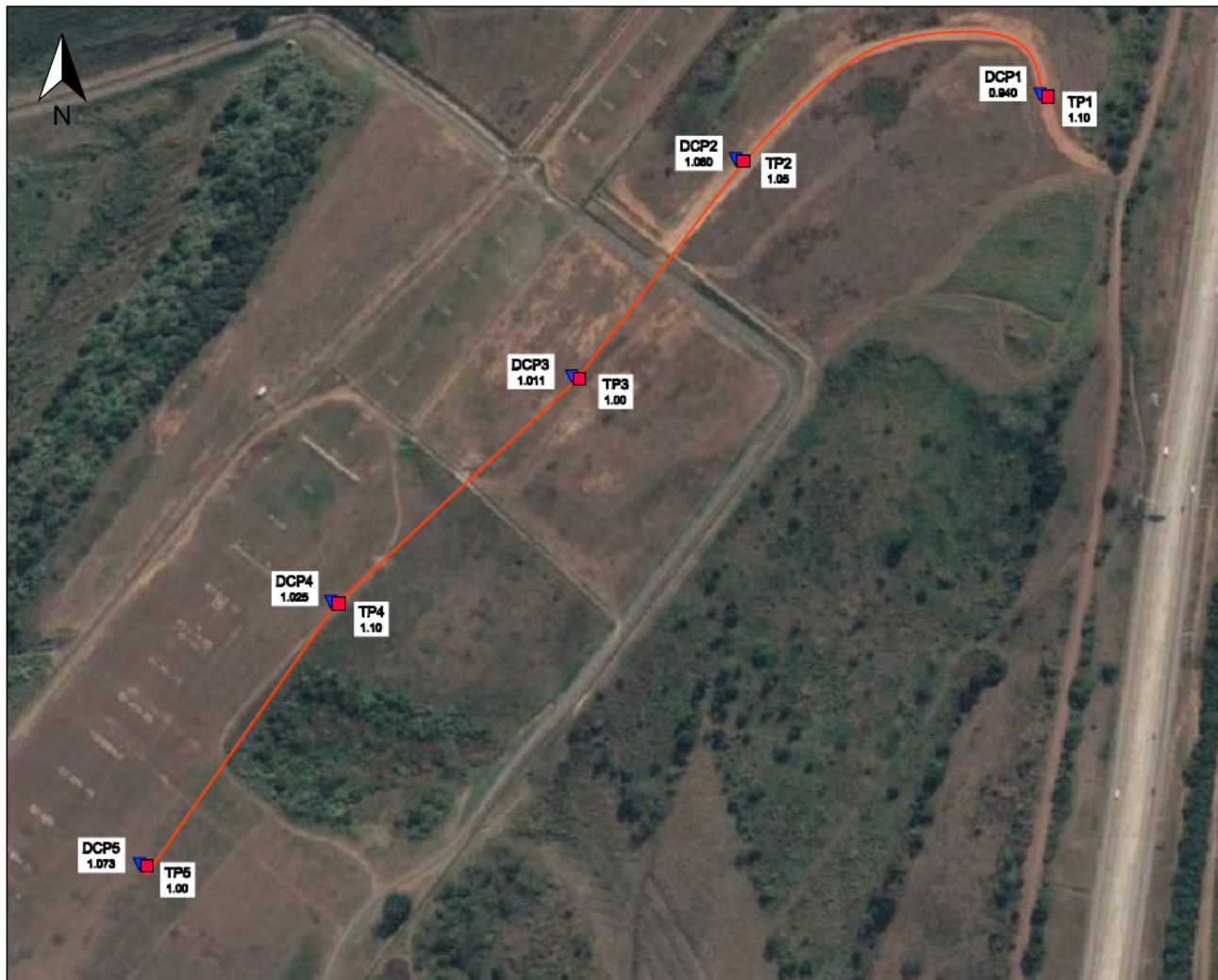


Figure 1: Test pit and DCP locations for the Northern Road



**Figure 2: Test pit and DCP locations for the Southern Road**

A summary of the test pit data is presented in below.

- **Top layer**

Test pits TP1 and TP2 were excavated through the existing gravel road. This road was found to be poorly maintained. A degraded gravel wearing course comprised of sandy fine to course gravel occurred in the upper 5cm of TP2. The gravel wearing course was underlain by brownish orange and brownish red silty sands and clayey sands which were apparently compacted in the upper 0.40 (TP1) to 0.60m (TP2). These materials occurred from surface level in TP1, where the gravel wearing course was absent.

Elsewhere on the site, a colluvial or topsoil layer generally comprised of brown and dark brown of silty and clayey variants of sand with gravelly clays occurring in TP6.

- **Fill**

The colluvial/topsoil layer was underlain by fill. The fill encountered was highly variable comprised silty and clayey sands and gravels with clay rich layers occurring in areas. These fill layers cannot be described as well-defined soil units due to the inconsistent physical characteristics and soil compositions encountered as shown on the test pit profiles.

A summary of the tested material is provided in Table 1.

### 5.3 Groundwater

Groundwater seepage was not encountered in any of the test pits. However, during periods of high rainfall, shallow groundwater seepage could be expected to proliferate particularly where highly permeable soils exist and at the interface between fill layers.

### 5.4 Laboratory Testing

In order to classify the materials on site and to assess their suitability for use, laboratory testing was conducted on selected materials encountered in the test pits. The following tests were scheduled:

- Road indicator tests (Particle size analysis and Atterberg limit determination);
- Modified AASHTO moisture-density (modified AASHTO) tests; and
- California Bearing Ratio, or CBR, strength tests.

The test results are summarised in Figure 3 and Table 1 below, and the detailed result sheets are contained in Appendix A.

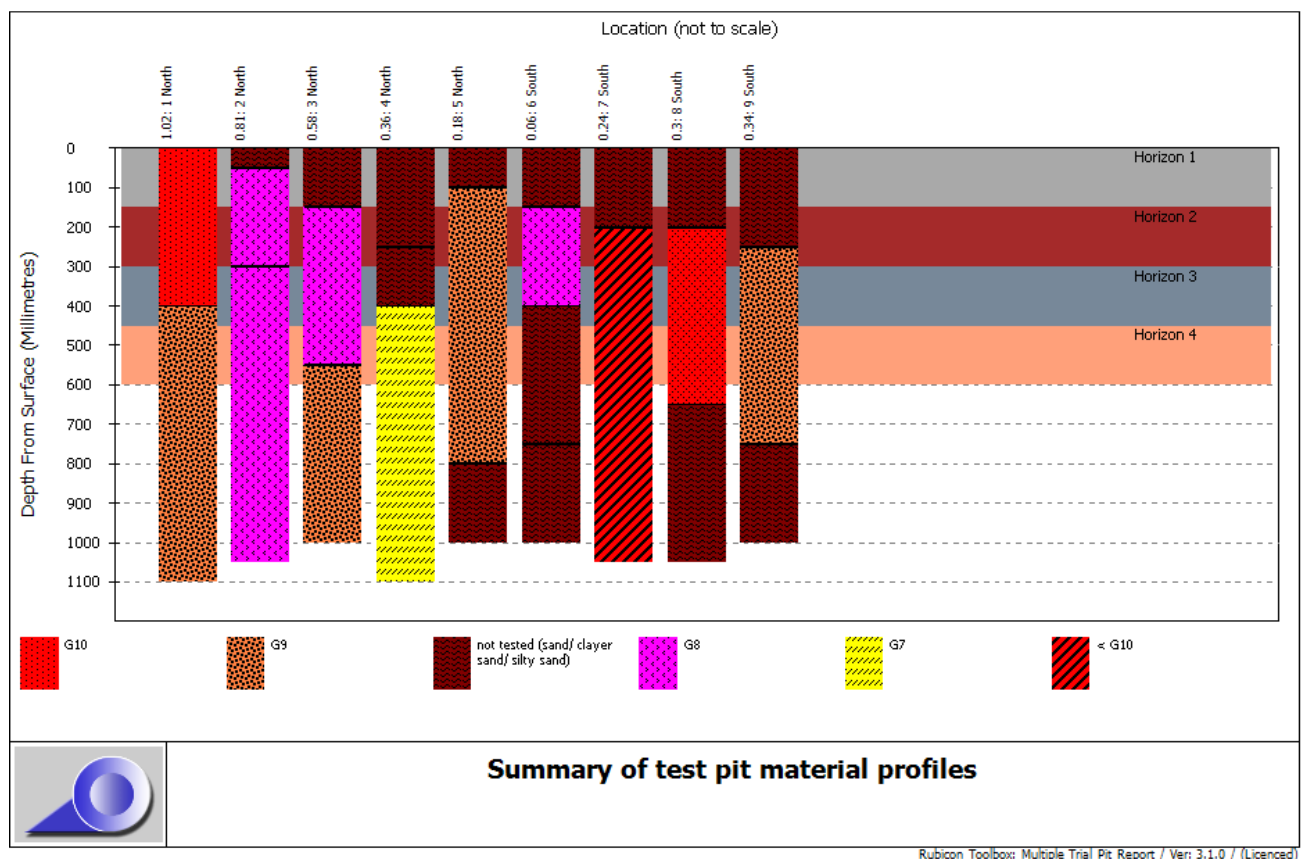


Figure 3: Summary of test pit profiles

**Table 1: Summary of Results of Particle Size Distribution Analysis, Atterberg Limit Determinations and Moisture / Density and CBR Tests**

TP No.	Depth (m)	Description	Particle Size %				Atterberg Limits			GM	Modified AASHTO		CBR Values (%) Compaction MDD (%)						Swell (%)	TRH 14 Classification
			Clay	Silt	Sand	Gravel	LL	PI	LS %		MDD / Proctor (kg/m³)	OMC %	90	93	95	97	98	100		
TP1	0.00-0.40	Dry to slightly moist brownish orange dense intact silty clayey SAND with occasional gravels. Fill likely of Berea Formation origin.	35		65	0	21	6	3.0	0.68	2009	10.9	1	3	7	15	22	47	0.1	G10
TP1	0.40-1.10	Moist brownish red medium dense becoming loose at depth intact clayey SAND. Fill, likely of Berea Formation origin.	29		69	2	CBD	SP	1.5	0.80	2028	9.6	5	7	9	11	12	15	0.2	G9
TP2	0.05-0.30	Slightly moist medium brown occasionally mottled orange brown medium dense intact silty SAND. Fill.	12		84	2	CBD	NP	0.0	0.96	1845	9.9	8	14	21	30	36	52	0.0	G8
TP2	0.30-1.05	Slightly moist to moist orange brown medium dense becoming loose with depth intact silty SAND with zones of clayey SAND. Fill.	15		85	0	CBD	NP	0.0	0.87	1925	7.6	6	12	21	36	48	82	0.0	G8
TP3	0.15-0.55	Moist to very moist light orange mottled and streaked dark brown very loose intact slightly clayey and silty SAND with some sandy CLAY nodules. Fill.	8		91	1	CBD	NP	0.0	1.01	1831	6.3	8	10	11	13	14	16	0.0	G8
TP3	0.55-1.00	Moist reddish brown to orange brown soft intact clayey silty SAND. Fill.	22		78	0	19	3	2.0	0.81	1976	8.7	4	7	11	17	22	34	0.2	G9
TP4	0.40-1.10	Moist light orange brown mottled to blotched brownish red loose intact clayey silty SAND. Fill.	21		79	0	CBD	SP	1.0	0.82	2001	8.5	10	16	22	31	36	49	0.0	G7

TP No.	Depth (m)	Description	Particle Size %			Atterberg Limits			GM	Modified AASHTO		CBR Values (%) Compaction MDD (%)						Swell (%)	TRH 14 Classification
			Clay	Silt	Sand	Gravel	LL	PI		MDD / Proctor (kg/m³)	OMC %	90	93	95	97	98	100		
TP5	0.10-0.80	Slightly moist to moist orange mottled ant blotched brownish yellow, light orange and brownish red loose to medium dense intact clayey SAND with minor gravels and cobbles of mixed origin. Fill.	25	75	0	CBD	SP	1.5	0.78	2011	9.4	5	9	15	23	30	47	0.1	G9
TP6	0.15-0.40	Slightly moist light brownish yellow medium dense intact clayey sandy GRAVEL with abundant cobbles. Apparently poorly compacted fill.	14	15	71	24	11	5.5	2.36	2145	8.6	11	13	15	17	18	20	0.0	G8
TP7	0.20-1.05	Moist red speckled and mottled deep yellow and dark grey soft becoming very soft with depth clayey and silty SAND with minor gravels of mixed origin. Fill.	34	58	8	22	6	3.0	0.91	1951	10.0	1	1	2	2	2	3	2.4	<G10
TP8	0.20-0.65	Slightly moist yellowish orange brown mottled blue grey dense intact clayey sandy GRAVEL with zones of sandy gravelly CLAY and occasional cobble up to 12cm across. Fill.	24	41	35	19	7	3.5	1.56	2139	7.9	5	5	6	7	7	8	0.1	G10
TP9	0.25-0.75	Slightly moist yellowish orange brown mottled blue grey dense intact clayey sandy GRAVEL with occasional cobble up to 12cm across. Fill.	22	27	51	21	7	4.5	1.89	2229	7.7	5	9	13	19	22	31	0.3	G9

## 5.5 DCP results

DCP soundings were conducted in the proximity of the test pits as indicated in Figure 1 and Figure 2. A summary of the DCP data of the material in the test pits is given in Table 2. The detailed DCP sheets are attached in Appendix A.

From Table 2 it can be concluded that the DCP-derived CBR values are comparable to the classification determined from the test pit material results.

**Table 2: Summary of DCP results**

DCP	Location	SV	DCP mm/blow			CBR Classification Range	Material Classification
			10 <sup>th</sup> Percentile	Median	90 <sup>th</sup> Percentile		
1	North	1.02	13.1	16.8	36.9	3 – 17	G7 – G10
2	North	0.81	2.6	3.4	6.9	24 - > 110	G4 – G7
3	North	0.58	5.2	6.2	10.1	6 - 55	G5 – G10
4	North	0.36	3.6	5.8	10.2	6 - 96	G4 – G10
5	North	0.18	4	6.2	16.5	9 - 96	G4 – G9
6	South	0.06	4.6	11.2	20.7	6 - 82	G4 – G9
7	South	0.24	14	27	33	4 - 31	G6 – G10
8	South	0.30	0.8	2.7	5.1	11 - > 110	G4 – G8
9	South	0.34	0.4	2.4	4.2	8 - > 110	G4 – G9

## 5.6 Conclusions from the materials investigation

The in-situ and fill material is variable (silty and clayey sands and gravels with clay rich layers occurring in areas). The quality of the material ranges from G7 to less than G10 quality material. Therefore, it is recommended that a 150mm G7 selected layer be constructed as a foundation for the pavement layers.

## 6. PAVEMENT DESIGN AND EARTHWORKS

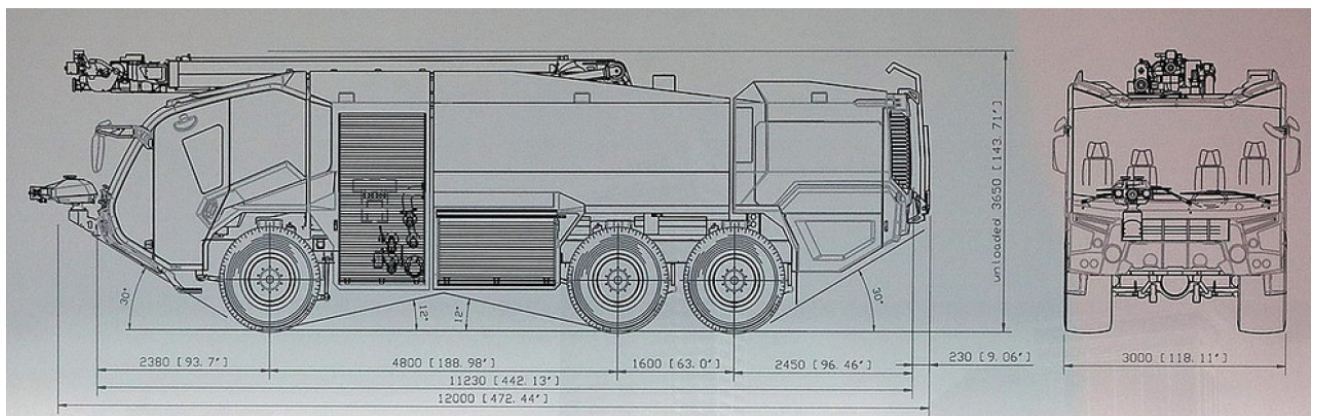
### 6.1 Pavement Design

The criteria given in the brief regarding the loadings on this road is for an 80t vehicle. However, the most common heavy vehicle to utilise this road on a regular basis is the Panther 8x8 emergency response vehicle with a maximum operational weight of 52t, giving a wheel load of 6.5t. This vehicle and its wheel and axle loadings were used in the analysis of the pavement design. A picture of the Panther 8x8 is presented in Figure 4.



**Figure 4: Picture of the design vehicle, the Panther 8x8**

The axle configuration and spacing are important parameters for the determination of the traffic loading in pavement design. From Figure 4 it is observed that the Panther 8X8 has two tandem axles with single wheels. The length x width x height dimensions of the Panther 8x8 are 11,995 x 3,000 x 3,650mm. However, no information on the wheel and axle spacing was available. However, the axle spacing of the Panther 6x6 was available as shown in Figure 5 and it was assumed that the Panther 8x8 axles would be spaced similarly.



**Figure 5: Figure showing axle spacing of the Panther 6x6**

From Figure 5, the axle spacing between the axles of the tandem axle is 1,600mm and the axle width was assumed to be 3,000mm.

A tyre pressure of 1,000kPa was assumed.

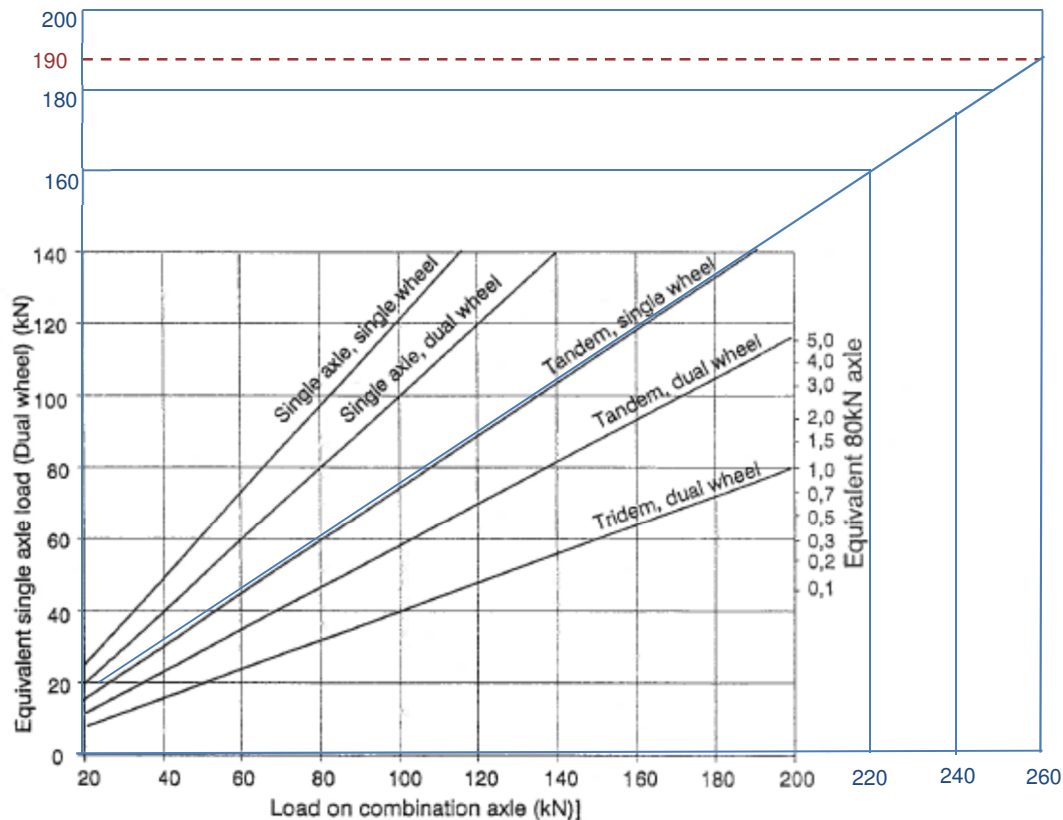
The regular usage of the road will be for emergency drills and the criteria given was approximately one return trip for the Panther 8x8 every 2 days. Since the road is 6m wide, it was assumed that the Panther 8x8 would travel in the centre of the roadway and therefore no directional split was made. Therefore 365 trips were assumed per year.

The initial assessment was based on equivalent standard axle loads of 80kN (approximately 8t) (E80). The design loadings are shown in Table 3 below.

**Table 3: Traffic details based on equivalent standard axle loads (E80's)**

Vehicle type	<b>Panther 8x8</b>
Axle Type	2 tandem axles with single wheels
Vehicle Load	52 tons
Total load/axle (tons)	26 tons
Axle load (kN)	260 kN
Damage factor, n	4.2
LEF (Load equivalency factor) per axle	38 (as calculated below)
E80/HV	76
Total number of trips per annum	365
E80/annum	27,740
E80/design life (20 years) (0% growth)	554,800
MESA	0.55

The Load Equivalency Factor (LEF) was determined in accordance with the Manual M10 - Concrete Pavement Design and Construction: 1995. Figure 6 adapted from the M10 manual was used to convert the load on the tandem axle with single wheels to an equivalent load on a standard single axle with dual wheel configuration.



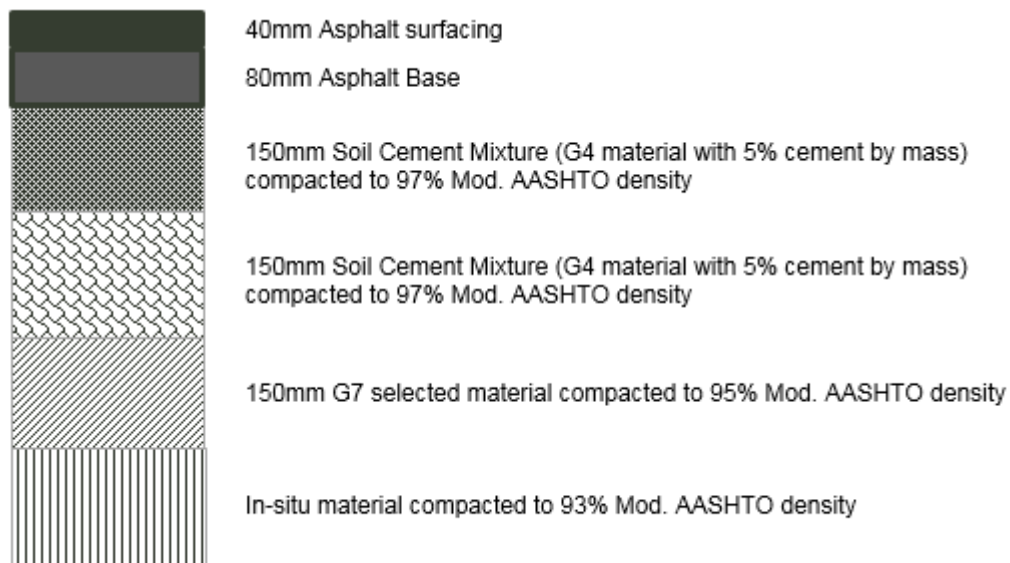
**Figure 6: Curve for converting multi-axle loads to equivalent single axle loads (Manual M10, The Department of Transport, 1995)**

The load determined using Figure 6 was then used to determine the equivalent number of E80's of the tandem axle using the following equation as defined in the M10 manual:

$$LEF = \left( \frac{\text{Axle load from Figure 6}}{80} \right)^{\text{Damage Factor}}$$

$$LEF = \left( \frac{190}{80} \right)^{4.2} = 38$$

The recommended pavement structure is presented in Figure 7 below. The in-situ and fill material is variable, therefore, it is recommended that a 150mm G7 selected layer be constructed as a foundation for the pavement layers. Due to the heavy axles and overloading on the pavement structure, the 2x150mm soil cement mixture layers are recommended. These layers would also allow for quicker construction which is crucial for work in the restricted zones. To further accelerate construction times, the 2x150mm soil cement mixture layers may be constructed as a single 300mm layer. However, the compaction should be checked and achieved in both the lower 150mm and upper 150mm of the layer.



**Figure 7: Recommended pavement design**

The above pavement was analysed using Rubicon Toolbox Software and the design life was calculated at 1.6 MESA. Of the 1.6 MESA, 1.3 MESA is achieved during Phase 1. The Rubicon output is appended in Appendix B.

However, it should be noted that the transfer functions of this design method were not developed for overloaded axles. Therefore, in order to assess the effect of the heavy wheel and axle load, the stress and strain results extracted from Rubicon Toolbox were analysed after a single pass of the actual axle loading. These results are appended in Appendix C. According to published data, the strain at break for a C2 material is 120 microstrain and from the results of Phase 1 in Appendix C, the strain at the bottom of the 300mm C2 layer (critical point) is approximately 113 microstrain. Therefore, this design is adequate. The strain at the bottom of the first 150mm C2 layer during Phase 2 exceeds the strain at break which indicates that the layer will crack and not be able to withstand the load during this phase. Strain at break is not applicable to Phase 3 because the cement stabilised layers are deemed to be in their equivalent granular states.

The design traffic is 0.55 MESA for the 20-year design period and the pavement structure is able to carry 1.3 MESA during Phase 1 according to the analyses.

## 6.2 Restricted Zone Pavement Design

Areas close to the runway have restricted working conditions and times, and additional consideration was given to the design and construction methodology of the road layerworks in these areas. This restricted zone is defined as being within 75m of the runway edge and extending to 75m beyond the end of the RESA.

The available construction time according to ACSA is after the last flight lands at night (normally around 23H30) and before the first aircraft operation in the morning (normally around 05h30). However, a further flight that lands at approximately 03H30 has been added to the schedule. Accommodation of this additional flight will need to be discussed further because it breaks the 'allowed' time period into 2 short periods. Construction of the road would then be severely time constrained.

Within this restricted zone, to accommodate the safety and operational requirements during the remainder of the day, it is a requirement that no excavations are permitted to remain open outside of the construction times. This could entail temporary back filling or covering any excavation so that emergency or other vehicles could traverse the works area without the hindrance or risk associated with open excavations. This means that at the end of each work period, the excavation for the road layerworks would need to be back-filled and then re-excavated at the start of the following work period. This has significant time and cost implications for the contract. These would be termed temporary works as the backfilling and execution would not form part of the final completed works

In order to limit the need to temporary backfilling, the sections completed in a 'shift' are likely to be short (in the order of 20 to 30m) with the subsequent reduction in quality from that normally achieved when longer sections of road (>200m) are constructed.

The process for construction would be:

1. Works completed in 1 shift – approximately 20 to 30m length
  - Excavation to the required depth and compaction to achieve 93% MOD AASHTO density
  - Construction of G7 selected material compacted to 95% MOD AASHTO density
  - Construction of 2x150mm (or 300mm) soil cement layers compacted to 97% MOD AASHTO density
  - Then alternatively
    - Temporary backfill to NGL with a G7, or
    - Trim the adjacent ground such that the maximum deviation from grade is 1:100 or less
2. The Asphalt base and surfacing would be constructed once a number of sections under 1 above have been completed – approximately 200m in length
  - If backfilled in 1 above, remove the backfill material to top of soil cement layer
  - Then alternatively
    - Trim the adjacent ground such that the maximum deviation from grade is 1:100 or less, or
    - If sufficient time remains in the shift, complete the 40mm asphalt surfacing layer
  - If necessary, complete the final asphalt layer on a subsequent or later shift.

While an experienced contractor may achieve the required result easily, it is proposed that trial sections be conducted outside of the restricted zone to allow the contractor to achieve the required work production rates and quality. This will also identify any shortcomings in their methodology prior to committing to working in the restricted zone. It is proposed that 2 trial sections be conducted:

1. The first to be conducted in daylight which will allow for the methodology to be worked through.
2. The second to be conducted at night to help identify particular issues related to working under artificial light conditions.

These trial sections are to be allowed for in the BOQ, but that payment will only be made for the 2 acceptable trial sections. Should the contractor require additional trial sections in order to achieve the required rates of progress and quality (to the satisfaction of the Employer's Agent or ACSA), it will be at the contractor's expense.

### **6.3 Earthworks**

With the alignment criteria of having to follow the existing ground lines over the majority of the length of the road, the construction involves a predominantly cutting operations so that the final road level is approximately ground level.

There are limited areas where the final road levels are significantly above the ground level, and the volumes of material required for filling are very low. This results in a high volume of excess material being generated. With limited opportunity to deposit this within the airport precinct area, it will have to be spoiled off-site at a location to be determined.

According to the geotechnical investigation, the site is underlain by soils of the Berea Formation as well as shale and siltstone of the Vryheid Formation. These materials can perform well as road foundation materials if kept dry. Therefore, it is proposed that a subsoil drain be installed along the full length of the road to prevent the build-up of moisture in the lower layers which can significantly reduce the life span of the road.

## 7. STORMWATER

To limit the impact of additional structures and drainage channels on the graded strip, conventional stormwater infrastructure is only placed where necessary. This is limited to three locations on the project, two of which fall outside of the airport boundary fence.

The stormwater run-off and flow calculations have been conducted in accordance with the SANRAL Drainage Manual. Flows have been checked for up to 100 year return periods. The eThekweni Municipality database of expected rainfall for various return periods and storm durations has been used and the results are shown in the table below:

**Table 4: Stormwater calculation results**

No	Location	Area (Ha)	Run-off Coefficient	Storm intensity (mm/hr)	Storm flow for return periods	Pipe Data		
						Diameter	Capacity	Grade
					1:100	mm	m <sup>3</sup> /s	%
1	Southern Road CH 325	Pipe to be replaced, capacity checked to match existing		252	1.13	2 x 450	1.13	3.0
2	Northern Road CH 448	1.5	0.4		0.42	1 x 600	0.96	2.0
3	Northern Road CH 740	0.1	0.4		0.03	1 x 600	0.96	2.0

The existing pipe at Pipe 1 is a 600mm dia concrete pipe that is too high and there is limited opportunity to ramp over it and still achieve a reasonable road alignment between Emergency Gate 3 and Dube Boulevard. This 600 mm pipe will be replaced by 2 x 450mm dia. pipes which provides the same capacity but reducing the height by 150mm. This will allow sufficient cover over the pipe to prevent damage from wheel loads.

An open grass lined drain will be excavated from the outlet of Pipe 3 to drain the storm run-off toward the existing water course to the north of the site.

All the stormwater pipes are to be Concrete spigot and socket, Class 100D on a Class A (concrete) bedding.

Where possible, a shallow side drain will be used to control the flow of surface water next to the road, and channel it to natural water course or existing drainage systems.

## 8. EXISTING SERVICES

There is limited accurate information available for the position and depth of the underground services. The available information received from ACSA have been added to the design drawings.

When construction commences, the contractor will be tasked with exposing the known services along the road alignment or within the project area before any other works commence. This will be done by careful hand excavation under the supervision of a responsible person or the airport service maintenance department. Once the locations and depths are confirmed, a protection strategy will be implemented, initially / immediately as temporary protection during construction and later a permanent solution will be constructed.

The necessity to introduce temporary protection will be assessed for each service location and can include the following:

- avoidance of working in the area until a permanent solution is constructed,
- construction of temporary earthworks / fill over the service to provide sufficient protection (normally to a level of 1.2m above the service, or
- installation of mechanical protection over the service to avoid vehicle loads directly on or near to the service (eg steel trench plates).

In most cases, this permanent solution, will consist of a concrete slab laid on a sand bedding over length of the service affected. This will spread the impact of imposed wheel loads to the areas adjacent to the service. Should the service need to be relocated or lowered, then this will be done in conjunction with a relevant specialist installer under the guidance of the Employer's Agent and the airport management.

Historically, most of the damage to buried services occurs during the construction phase of a project and the contractor will be made fully aware of the sensitive nature of the services and the consequences if damaged. A comprehensive methodology for working around these services will be agreed and implemented prior to the commencement of construction.

## **9. ENVIRONMENTAL**

As noted above, GMG are subcontracted to fulfil the role of environmental specialist on the design portion of this project. The environmental status or requirements for a construction project are based on a staged approach with triggers being activated depending on the activities / scope being planned. The trigger for this project is the increase in the foot-print of the airport as the portion of the south road will extend out of ACSA's property boundary.

Wetland and ecological studies have been undertaken for the site and it has been concluded that the "wetland" initially identified to possibly trigger the EIA Regulations, is actually a "stormwater wetland". Therefore, no EIA triggers are applicable relating to this wetland.

A request for exemption was forwarded to DEA as the only trigger is for the increase in footprint (900m<sup>2</sup>), which is for the additional area out of ACSA property that the road will occupy. The DEA confirmed that they still require the Basic Assessment Process to be undertaken so that authorisation is received for the Southern Road.

The draft report compilation is underway and will be finalised upon receiving the geotechnical and preliminary design reports. This BA report will be circulated to the registered Interested and Affected Parties for a period of 30 days (on two separate rounds) prior to being submitted to DEA for decision making as per the requirements of the 2014 EIA Regulations (amended).

The report ref is 2017/162 "Basic Assessment Report for the Proposed Construction of the Emergency Access Road at the King Shaka International Airport, KwaZulu Natal"

## **10. LAND OWNERSHIP**

As noted above, GMG have been tasked with assisting with resolving any land ownership issues or rights of ways for this project. The current status of this process is as follows:

### **10.1 Southern Road**

The portion of road between Emergency Gate 3 and Dube Boulevard falls outside of the airport property. This land and Dube Avenue are owned and maintained by La Mercy JV, a joint venture between Dube Tradeport and ACSA. It has been proposed that a servitude be registered across this portion to accommodate the Emergency Road. It is not envisaged that any transfer of ownership of land will be required.

It should be noted that the development of Special Zone 2 of Dube Tradeport will commence soon. The access to this Zone is on the opposite side of Dube Boulevard and may significantly affect the layout of the current intersection. The Servitude will have to take this into account and ensure that the security / alignment of the southern road is not compromised by any future changes or transfer of ownership of any adjacent properties.

## 10.2 Northern Road

The portion of road between Emergency Gate 1 and the existing gravel road to the north fall within the airport property boundary and there are no land issues preventing the construction within the limits proposed in the attached drawings.

However, the issue of a right of way across the Tongaat Hulett Development (THD) land to the north has never been formalised and is essentially based on a verbal agreement / understanding. Attempts to formalise / finalise the route with THD have been rejected, mainly due to the proposed sale of the land (termed uSukela Development) to independent developers. THD will not compromise the value of the property by introducing a permanent right of way or access road into a sale agreement.

THD have agreed, pending the sale, to allow for a MoU to be put in place to allow for airport emergency vehicles to utilise the current gravel road. This will be temporary, and a final agreement or route will have to be determined once the requirements of the future developer or land owner are determined.

The MoU with THD to secure the route for the northern road is currently being drafted and negotiations for the terms of the agreement are to be conducted in due course. It is not envisaged that any transfer of ownership of land will be required now.

## 11. DRAWINGS

The following drawings form part of the project documentation:

DRAWING NUMBER	DESCRIPTION
300713-00-CI-DGA-0001-001	GENERAL ARRANGEMENT
300713-00-CI-DAL-0001-001	ROAD LAYOUT AND LONGITUDINAL SECTION SOUTH
300713-00-CI-DAL-0001-002	ROAD LAYOUT AND LONGITUDINAL SECTION NORTH SHEET 1 OF 3
300713-00-CI-DAL-0001-003	ROAD LAYOUT AND LONGITUDINAL SECTION NORTH SHEET 2 OF 3
300713-00-CI-DAL-0001-004	ROAD LAYOUT AND LONGITUDINAL SECTION NORTH SHEET 3 OF 3
300713-00-CI-DCR-0001-001	SOUTH ROAD CROSS SECTIONS AT 10m INTERVALS SHEET 1 OF 2
300713-00-CI-DCR-0001-002	SOUTH ROAD CROSS SECTIONS AT 10m INTERVALS SHEET 2 OF 2
300713-00-CI-DCR-0001-003	NORTH ROAD CROSS SECTIONS AT 10m INTERVALS SHEET 1 OF 5
300713-00-CI-DCR-0001-004	NORTH ROAD CROSS SECTIONS AT 10m INTERVALS SHEET 2 OF 5
300713-00-CI-DCR-0001-005	NORTH ROAD CROSS SECTIONS AT 10m INTERVALS SHEET 3 OF 5
300713-00-CI-DCR-0001-006	NORTH ROAD CROSS SECTIONS AT 10m INTERVALS SHEET 4 OF 5
300713-00-CI-DCR-0001-007	NORTH ROAD CROSS SECTIONS AT 10m INTERVALS SHEET 5 OF 5
300713-00-CI-DRD-0001-001	CONSTRUCTION DETAILS

## 12. CONSTRUCTION COSTS

The table below reflects the estimated construction costs:

Section	Description	Amount (Rand)
1300	CONTRACTOR'S ESTABLISHMENT ON SITE AND GENERAL OBLIGATIONS	4 310 000.00
1400	HOUSING, OFFICES AND LABORATORY FOR THE ENGINEER'S SITE PERSONNEL	81 400.00
1500	ACCOMMODATION OF TRAFFIC	200 000.00
1600	OVERHAUL	394 500.00
1700	CLEARING AND GRUBBING	474 000.00
2100	DRAINS	1 623 200.00
2200	PREFABRICATED CULVERTS	726 500.00
2300	CONCRETE KERBING, CONCRETE CHANNELLING, CHUTES AND DOWNPIPES, AND CONCRETE LININGS FOR OPEN DRAINS	116 200.00
3300	MASS EARTHWORKS	3 745 000.00
3400	PAVEMENT LAYERS OF GRAVEL MATERIAL	3 955 000.00
3500	STABILIZATION	1 238 000.00
4100	PRIME COAT	150 000.00
4200	ASPHALT BASE AND SURFACING	5 316 100.00
5100	PITCHING, STONEMWORK AND PROTECTION AGAINST EROSION	19 800.00
5200	GABIONS	472 500.00
5400	GUARDRAILS	72 150.00
5500	FENCING	71 000.00
5600	ROAD SIGNS	175 500.00
5700	ROAD MARKINGS	131 500.00
5800	LANDSCAPING AND PLANTING PLANTS	537 000.00
5900	FINISHING THE ROAD AND ROAD RESERVE AND TREATING OLD ROADS	16 000.00
2100	TESTING MATERIALS AND WORKMANSHIP	100 000.00
8400	PAINTING	25 000.00
<b>COST OF WORKS</b>		<b>23 950 350.00</b>
CONTINGENCIES (10% OF COST OF WORKS)		2 395 035.00
SUBTOTAL		26 345 385.00
CONTRACT PRICE ADJUSTMENT (ESTIMATED: 7.0%)		1 844 176.95
<b>CONTRACT VALUE</b>		<b>28 189 561.95</b>
VALUE ADDED TAX (15%)		4 228 434.29
<b>CONTRACT VALUE (INCLUDING VAT)</b>		<b>32 417 996.24</b>

While the cost is high, the rates used are based on recent works with similar items. It must be noted that the nature and location of the works may well induce a further increase in the rates. The effect of how the tenderers will price the restricted work areas / times into account will only be known once formal tenders are received.

A further unknown is the expense that the contractor will be required to outlay to obtain the necessary inductions and permits required to work on the airside. While the base costs are known and will be included in the tender document, the number of employees and plant that permits will be required for is not. We have allowed approximately 20% of the works value for the contractor's establishment and general obligations.

A complete Bill of Quantities with estimated quantities and prices is included in Appendix A.

### **13. SUMMARY**

The project and scope proposed in the design are currently feasible from a civil engineering perspective. The items listed as issues within the report can be solved during construction or with some further investigation ahead of time. The items that will need to be further managed or considered are:

- The environmental issues related to the wetlands / increase in airport footprint and what further studies and approvals are required.
- MoU's for the portions outside the airport property.
- Existing underground services.

## APPENDICES

- A. Geotechnical Investigation
- B. Rubicon Pavement Evaluation
- C. Rubicon Stress and Strain Results
- D. Schedule of Estimated Quantities and Prices

## APPENDIX A – GEOTECHNICAL INVESTIGATION

## APPENDIX B – RUBICON PAVEMENT EVALUATION

## APPENDIX C – RUBICON STRESS AND STRAIN RESULTS

## APPENDIX D – SCHEDULE OF ESTIMATED QUANTITIES AND PRICES