REPORT TO AURECON

ON A

PAVEMENT INVESTIGATION

AND TESTING

FOR THE PROPOSED

SOUTH PORT ROADS COMBINED

PROJECT

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1. INTRODUCTION AND SCOPE OF WORK

Drennan, Maud and Partners was requested by Mr. T Ferreira of Aurecon to submit an investigation proposal and cost estimate for a geotechnical investigation for the South Port Roads Combined Project.

The Scope of Work as determined from Part C3: The Works Information document provided by Transnet National Ports Authority included the following;

- An investigation of the founding conditions for four medium-sized structures.
- An investigation of a pipeline route.
- An investigation of a service duct from the existing Dry Dock to Piers 1 & 2.
- The pavement investigation and testing as itemized in a Bill of Quantities Provided.

An investigation proposal and cost estimate was submitted to Aurecon in our letter reference 91 dated 7th November 2012 .

Drennan, Maud and Partners appointment was subsequently concluded by entering into a subconsultancy agreement with Aurecon on the 11th February 2013.

Notwithstanding the above, details of the required investigations had not yet been concluded between the various consultants and Transnet. However, the design pavement engineers for the roads upgrade, from Aurecon, required information for the proposed upgrade to Bayhead and Langeberg Roads .

This report deals specifically with the pavement investigation and testing requirements as itemized in the bill of quantities provided.

The proposed upgrade which is ± 5kms in length is located in the Bayhead Area and comprises;

- Bayhead Road Section, which is approximately 3km in length and commences at the South Coast Road / Crabtree Road intersection up until it intersects with Langeberg Road, and
- Langeberg Road Section, which is approximately 2km in length and travels northwards towards the Port.

The upgrade proposes the rehabilitation and widening of the existing roads.

2. SITE DESCRIPTION

Bayhead Road is in a good condition and has been well maintained. There are a few slight longitudinal corrugations but no serious signs of distress. Bayhead Road is aligned in a NW-SE direction and generally slopes gently towards the south-easterly direction. Up to Wagtail Road, the road has a slight gradient towards the west, which allows for stormwater drainage into the canal which runs parallel to the road. On the southern side of Wagtail Road, the road has a slight gradient towards the east, allowing for drainage into the Bluff Channel.

Langeberg Road is in a moderate conditions, with signs of distress like crocodile cracks, longitudinal cracks and minor potholes, ie asphalt displacement. Langeberg Road is aligned in a N-S direction and gently slopes towards the south. The road has a slight gradient towards the west, which allows for stormwater to drain towards the Bluff Channel.

3. FIELD WORK

The field work was performed from the 30th May 2013 till 10th June 2013 and involved the manual excavation and logging of 22 inspection pits and the probing of approximately 35 CBR Dynamic Cone Penetrometer tests to investigate the existing road layer works and subgrade as well as the subsoils in the areas to be widened.

3.1 Inspection Pits

A total of 22 inspection pits were excavated manually using picks and shovels.

Ten inspection pits (IP 1to IP 10) were excavated alongside the existing alignment of the route, ie off the road, at the approximate positions shown in Figure 1. The position of these inspection pits were agreed on between Mr. M Hadlow of Drennan, Maud and Partners and Mr.T Ferreira of Aurecon. These were positioned at intervals varying from 150m to 300m apart and excavated to depths of between 1.0 and 2.0m. The inspection pits were excavated by hand up to 1.1 to 2.0 metres. In some instance a hand auger was used at the 1.1m base to explore till 2.0metres. IP 1 to IP 5 were positioned in the Langeberg Road area and IP 6 to IP 10 were positioned alongside Bayhead Road.

Four inspection pits (IP 11 to IP 14) were excavated at the intersection of Langeberg and Bayhead Road, whilst IP 15 was excavated close to the intersection of Bayhead Road and South Coast / Crabtree Road. These inspection pits were excavated to investigate the subsoil conditions found alongside the road. The position of these inspection pits were also agreed on between Mr. M Hadlow of Drennan, Maud and Partners and Mr.T Ferreira of Aurecon

Seven inspection pits, designated TP 1 to TP 7, were excavated in the road at the approximate positions shown in Figure 1. The position of these inspection pits was indicated to Drennan, Maud and Partners by Mr. D Bekker of Aurecon.

All the pits were photographed, examined and described in accordance with the standard method of profiling recommended by Jennings, J.E, Brink, A.B.A and Williams, A.A.B (1973), and SANRAL M1., and the profiles are included in this report as Appendix A. Selected photos of each inspection pit are included with the logs in Appendix A.

3.2 In-situ Testing

A number of in-situ tests were carried out in the inspection pits, as per the requirements in the Bill of Quantities. These included;

- Phenolphthalein and Hydrochloric Acid Testing,
- CBR Dynamic Cone Penetrometer Testing (CBR DCP),
- In-situ Density and Moisture Content Testing (Troxler).

3.2.1 *Phenolphthalein and Hydrochloric Acid Testing*

Phenolphthalein and hydrochloric acid (HCl) testing of the subbase and selected fill road layers, ie in inspection pits TP 1 to TP 7, were also carried out as per Client's request. These tests are part of a Carbonation test kit and are carried out to confirm wether the cement hydration products had completed reacting with carbon dioxide.

As per the NITRR, the principle of the test is as follows;

- lime or cement present; phenolphthalein turns red
- $CaCO_3$ present - HCL will effervesce

This is then interpreted as follows;

- Carbonation Absent

  - $CaCO_3$ absent: Phenolphthalein red, HCl does not effervesce
  - $CaCO_3$ present: Phenolphthalein red, HCl effervesces (in this case partial carbonation cannot be ruled out)

- Complete Carbonation

  - $CaCO_3$ absent - Phenolphthalein no colour, HCl effervesces
  - $CaCO_3$ present - Phenolphthalein no colour, HCl effervesces

- Stabiliser never added

  - CaCO3 absent - Phenolphthalein no colour, HCl does not effervesce
  - CaCO3 present - Phenolphthalein no colour, HCl effervesces (cannot distinguish wether carbonated or stabilizer not added)

Also noted in the other tests is that if a layer has been stabilized with cement the HCL will react as a whitish foam on the layer while with a lime stabilization the material with react with phenolphthalein and become pinkish.

0.5% Phenolphthalein and 32% Hydrochloric acid was used in the field and the results of the tests have been noted in the test pit logs, with all subbase layers testing positive for HCL acid, and the majority testing negative for Phenolphthalein colouration, with the exception of TP 1(slight pink colouration) and TP 7(red to pink colouration). The subbase (crusher run) had been stabilized with majority of the layers having completed carbonation. TP 7 has been stabilized with lime, whilst the other test pits have been stabilized with cement.

3.2.2 *CBR Dynamic Cone Penetrometer Testing (CBR DCP)*

Approximately 35 CBR DCP's were carried out at the approximate positions shown in Figure 1.

Three CBR DCP's were allocated for each of the seven road test pits, with two being carried out just above the subbase, ie crusher run and one carried out at the base of the pit, ie at 1,10m below ground level. These were designated DCP CBR TP1R(N, S and Bs) to DCP CBR TP7R.

Fourteen additional infill CBR DCP's were allocated in the Langeberg Road and these were designated DCP CBR 1 to 14. CBR DCP's were performed to a maximum depth of 1.10m or earlier refusal of the equipment, ie on strongly cemented subbase.

The results were plotted using the CSIR programme and are represented graphically in the DCP Reports in Appendix B. The DCP's which refused early could not be plotted as the programme only allows for readings with depths of up to a minimum of 800mm and a maximum of 1200mm,

3.2.3 *In-situ Density and Moisture Content Testing (Troxler)*

Troxler tests recording in-situ density, as well as moisture content were carried out in each of the seven test pits excavated in the road. These results together with laboratory results for Maximum Dry Density, Optimum Moisture Content as well as Moisture Content for various samples selected are tabulated in Table1 overleaf.

Table 1 : Density and Moisture Readings

Test (depth below subbase)	Density (kg/m3)	Moisture Content %	Laboratory Results (depth ngl) - MDD @ OMC [*MC*]
TP1 0.150 - 0.300 TP1 0.000 - 0.150	2190 2290	3.4 3.3	TP1 (0.41-0.57) 1661 @ 3.7 ***[5.6]*** TP1 (0.21-0.41) 2240 @ 4.6 ***[2.7]***
TP2 0.150 - 0.300 TP2 0.000 - 0.150	21912138	5.3 4.9	TP2 (0.41-0.60) - ***[2.7]*** TP2 (0.30-0.41) 2216 @ 7.2 [***4.2]***
TP3 0.150 - 0.300 TP3 0.000 - 0.150	17391821	6.6 6.4	TP3 (0.47-0.61) 1690 @ 13.6 ***[13.1]*** TP3 (0.315-0.470) - ***[3.5]***
TP4 0.150 - 0.300 TP4 0.000 - 0.150	22332187	4.6 4.7	TP4(0.420-0.61) 2199 @ 6.8 ***[-]*** TP4(0.300-0.42) 2259 @ 5.8 ***[2.3]***
TP5 0.150 - 0.300 TP5 0.000 - 0.150	20812192	6.1 6.4	TP5(0.270-0.390) 2042 @10 ***[6.9]***
TP6 0.150 - 0.300 TP6 0.000 - 0.150	20822089	45	TP6(0.38-0.52)2072 @ 7.2 ***[7.7]*** TP6(0.23-0.38) 2115 @ 6.2 ***[6.2]*** TP6(0.13-0.23)2266 @ 6.7 ***[-]***
TP7 0.150 - 0.300 TP7 0.000 - 0.150	19471978	10.5 10.2	TP7 (0.30-0.52) 2059 @ 8.4 [***9.1]*** TP7 (0.16-0.30) 2117 @ 9.8 ***[3.3]***

3.3 Material Sampling

Bulk soil samples were collected from representative horizons in the inspection pits. These samples were sent to Thekwini Soils Laboratory, as well as Soilco Laboratory, in Durban to determine the following:

1. Moisture Content
2. Grading and Atterberg Limits
3. Modified AASHTO Density
4. CBR
5. Initial Consumption of Lime / cement
6. Unconfined Compressive Strength
7. Indirect Tensile Strength
8. Post Stabilization Indicators
9. Wet/dry Durability Tests

The results of the laboratory testing (1-4) are summarised in the Laboratory Test Summary Table and graphically presented in the Material Analyses all of which are included in Appendix C of this report and discussed in detail under Section 5. Tests (5-8) are still underway and will be reported separately on completion.

4. GEOLOGY

4.1 Regional Geology of Route

The 1:250 000 Geological Series Durban 2930 shows the regional geology to comprise Quaternary estuarine deposits (Qs) and the typically cohesionless soils derived therefrom. The harbour area comprises reclaimed land and therefore is also underlain by hydraulic fill, which overlie the sands known as Harbour Beds.

4.2 Geology & Soils of the Route

The inspection pit profiles (Appendix A) describe the subsoil profiles in detail at their respective positions. The following general material types may be expected;

4.2.1 *Langeberg Road* IP's 1- 5 (off road)

Topsoil / Fill

- Where present is generally 300-600mm thick (IP1-IP3). Thickness can increase to 800-2000m (IP4-IP5)
- Is described as a dark brown to greyish brown, loose to medium dense, silty Sand to gravelly Sand. In some areas is black with bands of orange due to addition of reworked Berea sands.
- Does contain occassional coal, slag, bricks and rubbish.

Harbour Beds

- Found below fill and observed to be the base of the pit.
- Can be described as light brown to yellowish brown speckled white fine grained sand with shells and occassional clods of clay.

4.2.2 *Langeberg Road* TP's 5-7 (road)

Road Surfacing

- Comprises black Asphalt
- Is generally 40-70mm thick

Road Base

- Comprises black bitumen and tar with coarse gravel.
- Is generally 60-95mm thick

Road Subbase	▸	Comprises an upper layer, which is generally 90-150mm thick, and a lower layer which is 120-220mm thick.
	▸	The upper layer is generally pinkish red, cemented sandy gravel (generally G5)
	▸	The lower layer varies from pinkish red to yellowish brown, cemented, sandy gravel (generally G4 to G5)
Road Selected Layer	▸	Found to be in the order of 240 to 260mm thick.
	▸	Can be described as pinkish brown to brown, fine to medium grained, slightly cemented, slightly gravelly sand to Sand (generally G5 to G8).
Road Subgrade	▸	Where observed was found to be in the order of 250 to 380mm thick.
	▸	Can be described as dark brownish grey to brown, gravely clayey sand with coal and slag gravel (generally G7 to G8).
General Fill	▸	Found below subgrade and variable and was found to comprise reworked Harbour Beds, comprising light brown, silty sands with shells or reworked hydraulic fill (greyish brown gravelly sand) or reworked Berea sands (brown to orange gravelly sand. The fills are generally G8.
Harbour Beds	▸	Found at base.
	▸	Is described as a light brown to yellowish and orange brown, loose to medium dense, fine grained Sand with shells. Anticipate G7

4.2.3 *Bayhead Road* IP's 6-10 (off road)

Topsoil / Fill	▸	Where present is generally 900-2000mm thick (IP6-IP10).
	▸	Is described as a dark brown to greyish brown, loose to medium dense, silty Sand to gravelly Sand. containing gravel sized fragments of coal and slag and occasional bricks and rubbish.
Harbour Beds	▸	Found below fill and observed to the base of the hole, except in IP8.
	▸	Can be described as light brown to yellowish brown speckled white fine grained sand with shells and occasional clods of clay.

4.2.4 *Bayhead Road* TP's 1-4 (road)

Road Surfacing
- Comprises black Asphalt
- Is generally 30-90mm thick

Road Base
- Comprises black bitumen and tar with coarse gravel.
- Is generally 120-290mm thick

Road Subbase
- Comprises an upper layer, which is generally 110-200 mm thick, and where it is found a lower layer which is 190mm thick.
- The upper layer is generally pinkish red, cemented sandy gravel (generally G4-G6)
- The lower layer varies from pinkish red to yellowish brown, cemented, sandy gravel (generally G5)

Road Selected Layer
- Found to be in the order of 160 to 200mm thick.
- Can be described as pinkish brown to brown, fine to medium grained, slightly cemented, gravelly sand (G7 to G8) to Sand (generally G5 to G8).

Road Subgrade
- Where observed was found to be in the order of 190 to 380mm thick.
- Can be described as dark brownish grey to brown, gravely clayey sand with coal and slag gravel (generally G7 to G9)

General Fill
- Found below subgrade and variable and was found to comprise reworked Harbour Beds mixed with reworked hydraulic fill, ie greyish brown occasionally yellow, gravelly sand with slag. The fills are generally G7.

Harbour Beds
- Found at base.
- Is described as a light brown to yellowish and orange brown, loose to medium dense, fine grained Sand with shells. Anticipate G7.

4.2.5 *Bayhead and Langeberg Road Intersection IP's 11-14 (off road)*

Topsoil / Fill
- Fill material is highly variable at the intersection, due to services being buried beneath IP11 and IP13.

- Where present is generally 1000-2000mm thick
- In IP11 grades from a fine sand to 600mm, where pipes, are buried to coarser gravel and builders rubble below.
- IP12 and IP14 comprise very coarse fill comprising gravel and boulders, which grade down to crusher run (G7) and gravelly sandy material.

Harbour Beds

- Generally found below fill.
- Can be described as light brown to yellowish brown speckled white fine grained sand with shells

5. LABORATORY TESTING

5.1 Sample Schedule

Depth and description of samples tested are summarised in Table 2 in Appendix D attached.

5.2 Indicator Tests Results and Mod AASHTO Density & CBR Determinations

The results of the full indicator comprising Atterberg Limit and particle size analysis to two micron size, is summarised in Table 3A & 3B attached in Appendix E. Moisture/density and California Bearing Ratio determinations were also carried out and are summarised below.

5.3 In-Situ CBR Dynamic Cone Penetrometer Test Results

The results of the in-situ CBR Dynamic Cone Penetrometer tests are discussed in detail under Section 8.2 below. It must be noted at this stage, that the CBR/DCP probes provides an indication of the consistency of the material and correlates an in-situ CBR value. The probe, obviously does not recognise soil parameters such as PI and swell. Therefore, the results should be used with a degree of caution and in conjunction with the laboratory test results as they reveal the true nature of the material and the CBR parameters which should be applied during design.

6. GROUNDWATER

Sub-surface seepage was encountered in inspection pit IP 6 at 1.4m and the soil was moist to wet in IP 8 at 1.1 to 2.0m. These pits were located in Bayhead Road close to the canal.

7. MATERIALS SUITABILITY

The materials encountered on site have been classified for road layer works in accordance with SABS 1200 (1990) and TRH14 (1985) and are summarised in Table 4 and 5 below.

Table 4 : Materials Suitability for Use in Road Layer works (SABS 1200-1990/TRH 14)

IP №	Material	TRH 14 (1985)	Fill	Road Layer works		
				Lower SL	Upper SL	Subbase
IP1(0.0-0.6), IP2 (0.0-0.6)	Dark brown gravelly sand to sand (Fill)	G8	P	P	P	F (2)
IP1(0.6-1.2), IP2(0.6-1.2) , IP3(0.3-1.2)	Light brown sand (Harbour Beds)	G8/G9	P	P	P	F (2)
IP4(0.45-1.0), IP6(0.9-1.1), IP10(0.25-0.6)	Dark brown gravelly sand (Fill)	G4/G5	P	P	P	P
IP4(1.2-2.0), IP5(0.3-0.8), IP10(0.25-0.6)	Light brown gravelly sand (Fill)	G7/G8	P	P	P	F (2)
IP10(0.9-1.7)	Dark yellowish brown Sand (Harbour Beds)	G7	P	P	P	F (2)
IP5(1.0-1.5), IP6(0.2-0.9),	Dark brown sand to gravelly sand (Fill)	G7/G8	P	P	P	F (2)
IP7(0.0-1.1), IP8(0.2-1.1), IP9(0.15-1.1)	Dark brown gravelly Sand to sandy Gravel (Fill)	G7	P	P	P	F (2)
IP12(0.55-0.75)	Gravel / Crusher Run (Fill)	G7	P	P	P	F (2)
IP8(1.1-2.0),	Sandy Silt (Fill)	<G10	F	F (1)	F (1)	F (1)
IP10(1.7-2.0)	Sandy Clay (harbour Beds)	<G10	F	F (3)	F (3)	F (1,3)

Note:- P = Pass F = Fail

Note:- 1 = Grading Modulus too low 2 = CBR too low

3 = PI to high 4 = CBR swell to high

Note:- SL = Selected Layer

Table 5 : Materials Suitability for Use in Road Layer works (SABS 1200-1990/TRH 14)

IP №	Material	TRH 14 (1985)	Fill	Road Layer works		
				Lower SL	Upper SL	Subbase
TP1(0.21-0.41), TP6 (0.13-0.23)	Pink to red Gravel (Crusher Run)	G4	P	P	P	P
TP2(0.3-0.4), TP2(0.4-0.6) , TP5(0.27-0.39), TP6(0.13-0.23), TP7(0.16-0.3), TP7(0.3-0.52)	Pinkish red Gravel (Crusher Run)	G5	P	P	P	P
TP3(0.15-0.47), TP5(0.06-0.27),	Pinkish red to black BT and Crusher Run blend	G5	P	P	P	P
TP5(0.39-0.63)	Light brown sand (Selected Layer)	G5	P	P	P	P
TP4(0.3-0.42)	Pinkish red Gravel (Crusher Run - CR2)	G6	P	P	P	P
TP6(0.38-0.52)	Pinkish red sand (Selected Layer)	G6	P	P	P	P
TP1(0.57-0.7), TP1(0.70-0.76), TP2(0.60-0.78), TP2(0.78-1.1), TP3(0.47-0.61), TP3(0.61-0.8), TP6(0.52-0.77)	Brown gravelly Sand with slag and occ bricks (Fill / Selected)	G7	P	P	P	F (2)
TP1(0.41-0.57), TP7(0.52-0.73)	Light brown sand (Selected Layer)	G8	P	P	P	F(2)
TP4(0.045-0.3),	Bitumen and Tar (BT)	G8	P	P	P	F (2)
TP4(0.42-0.61)	Dark yellowish brown Gravel (CR waste)	G9	P	P	P	F(2)
TP4(0.61-1.10)	Dark brown gravel and boulders (Fill)	G9	P	P	P	F

Note:- P = Pass F = Fail

Note:- 1 = Grading Modulus too low 2 = CBR too low

3 = PI to high 4 = CBR swell to high

Note:- SL = Selected Layer

8. GEOTECHNICAL CONSIDERATIONS

8.1 Results of Laboratory Soil Testing

Soil samples were taken from test pits and subject to full grading and Mod AASHTO/CBR testing to :-

- Provide indication of the near surface materials suitability for excavation and re-use in the proposed tarred road layer works.
- Identify potentially problematic soil horizons.

The full set of laboratory soil test results are included as Appendix C. Table 3A and 3B above summarises the results of the laboratory soil testing from which the following conclusions are drawn :-

8.1.1 *General Base - BT(Refer Sample TP4 0.045-0.3m)*

- Classifies as an A-1-a type material after the Revised US Roads Classification and G8 type material (after TRH14 1985) and is hence suitable for re-use up to selected layer and subgrade level.

8.1.2 *General Subbase - CR1 (Refer Sample TP1, TP2, TP4, TP5, TP6 and TP7*)

- Classifies as an A-1-a(0) type material after the Revised US Roads Classification and G4 to G6 type material (after TRH14 1985) and is hence, technically speaking, considered suitable for use as subbase to selected layer in road layer works.

8.1.3 *General Subbase - CR2 (Refer Sample TP2, TP4, TP5, TP6 and TP7*)

- Classifies as an A-1-a(0) to A-2-4(0) type material after the Revised US Roads Classification and G4 to G5 type material (after TRH14 1985) and is hence, technically speaking, considered suitable for use as a subbase in road layer works.
- Exception with TP4 which classifies as a G9 and therefore only considered suitable for use as a selected layer and subgrade in road layer works.

8.1.4 *Blended Base & Subbase - BT + CR (Refer Sample TP3 & TP4)*

- Classifies as an A-1-a (0) type material after the Revised US Roads Classification and G5 type material (after TRH14 1985) and theoretically is suitable for re-use as a subbase layer. Suitable for use as a selected layer and subgrade in road layer works.

8.1.5 *General Selected Layer Sands (Refer Sample TP1, TP5, TP6, TP7)*

- Classifies as an A-1-a(0) to A-3(0) type material after the Revised US Roads Classification and G5 to G8 type material (after TRH14 1985) and is hence suitable for use as a selected layer or subgrade in road layer works.

8.1.6 *General Selected Layer Gravelly Sands to Sandy Gravel (Refer Sample TP1, TP2, TP3)*

- Classifies as an A-3(0) type material after the Revised US Roads Classification and G7 type material (after TRH14 1985) and is hence considered suitable for use as a selected layer or subgrade in road layer works.

8.1.7 *General Subgrade / Fill (Refer Sample TP4)*

- Classifies as an A-1-b(0) type material after the Revised US Roads Classification and anticipated as a G10 type material (after TRH14 1985) due to anticipated low CBR values and a high anticipated maximum CBR swell. Hence this material is considered suitable for use as subgrade in road layer works.

8.1.8 *General Fill (Refer Sample IP2, IP4, IP5, IP6, IP7, IP8, IP10)*

- The hydraulic fill found on the site comprising dark brown sands and gravelly sands generally classify as an A-1-b(0) to A-3(0) type material after the Revised US Roads Classification and as a G7 to G8 type material (after TRH14 1985) and hence this material is considered suitable for use as selected layers to subgrade in road layer works
- Better quality hydraulic fill was also found on the site in IP4 and IP10 comprising dark brown sandy gravels to gravelly sands generally classify as an A-1-a(0) to A-1-b(0) type material after the Revised US Roads Classification and as a G4 to G5 type material (after TRH14 1985) and hence this material is considered suitable for use as subbase to selected layers in road layer works.
- Poor quality hydraulic fill was found at the base of IP8(1.1-2.0m) and IP10(1.7-2.0m) on the site and comprised dark brown sandy silt and sandy clays and generally classify as an A-5(10) to A-6(1) type material after the Revised US Roads Classification and was anticipated as a less than G10 type material (after TRH14 1985) and hence this material is not considered suitable for use as subgrade in road layer works.

8.1.9 *Harbour Beds (Refer Sample IP1)*

- Classifies as an A-3(0) type material after the Revised US Roads Classification and G7 to G8 type material (after TRH14 1985) and hence this material is considered suitable for use as selected layer to subgrade in road layer works

In conclusion, the majority of the material encountered is considered suitable for use as subgrade layer work materials, and the existing subbase is considered suitable for re-use as subbase layer works material. The encountered fill comprising sandy Silts (IP8) and sandy Clays (IP10) are typically not considered suitable for use in road layer works design.

8.2 CBR Dynamic Cone Penetrometer Tests

CBR probing to 1.1m depth generally reveals fairly high in-situ CBR values (>10%) for the existing in-situ tar road and subgrade. CBR probes at the base of the pits are also fairly high with a few found to be below 10%.

Correlating the above with the test pitting information shows that the soft spots are associated with the in-situ very loose sands and silts as well as the fill material derived therefrom. This is an indication that these cohesionless materials are likely to have possible liquefaction take places. As such, site drainage should be carefully controlled to avoid wetting of the subgrade.

8.3 Seepage Areas

The road is at a fairly low elevation and is in a reclaimed zone of the harbour. Sub-surface seepage was encountered in inspection pit IP6 at 1.4m and the soil was moist to wet in IP8 at 1.1 to 2.0m. These pits were located in Bayhead Road close to the canal.

The inspection pit IP3 also encountered moist soils at 1.3m. This is as a result of the change in water levels in the nearby Bluff Channel.

Seepage should be dealt with by either raising the level of the road, or subsoil cut-off drains may be installed to prevent seepage affecting layer works. A drainage pioneer layer prior to placing earthworks also aids in this regard.

8.4 Earthworks

The proposed road grade (ie. lowering or raising relative to existing road levels) was not provided at the time of the investigation. However, a general assessment of the excavatability along the route was performed and revealed that excluding the existing tarred and stabilised layers of the existing road, generally soft excavation (after SABS 1200D) to at least 2.0m depth should be achievable across the main roads. The following general recommendations have also been made:

- A material compaction of 95% of Mod AASHTO density is easily achieved for the in-situ materials and the existing road layerwork material.
- For the creation of fill embankments, rock / asphalt fragments greater than two thirds of the layer thickness must be removed to spoil.
- Road platforms should be graded to ensure they are free draining, and side drainage installed as per the Engineers specifications.

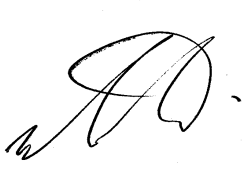
9. CONCLUSION

This report entails the finding of the pavement investigation and testing as itemized in a Bill of Quantities provided by Aurecon for the Southports Road Combined project.

No major geotechnical flaws were noted along the route of the proposed upgrade for Bayhead Road and Langeberg Road. Bayhead Road is maintained by Ethekwini Municipality, whilst Langeberg Road is maintained by Transnet Ports authority, with the latter being observed to be in better quality.

The geology of the site comprises mainly Harbour Bed sands which are overlain by Hydraulic Fill and in the roads an engineered fill for the road pavement layers. Samples of the existing road layers were taken and have been found to be suitable for reuse in the road, with suitability ranging from subbase to selected layers to subgrade. The majority of the material found adjacent to the road was found to be suitable as selected layers and subgrade. The hydraulic fill varies in quality from G7/G8 to G4/G5, whilst the Harbour Bed sands could be recompacted to G7/G8 materials. Clayey and silty soils were found in pits along Bayhead Road adjacent to the canal and were found to be unsuitable as subgrade. Coedmore Quarry in Bellair is the closest quarry to the site for the import of G4/G5 material.

Excavalability along the vast majority of the route is expected to be easy to depths up to 2.0metres. The existing road asphalt may require breakers to be removed. Saturated soils may be encountered along the route due to the close proximity of the canal in Bayhead Road and the Bluff Channel. Trench sidewalls in any saturated, as well as very loose to loose soils may have a collapse potential. All due precautions to ensure worker safety in these conditions must be taken.



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