SCHEDULE 2: ELECTRICAL, CONTROL AND INSTRUMENTATION

ITEM NO	PAYMENT REFERS TO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
D2	**Chapter 4: Particular Specification - Electrical, Control and Instrumentation Part A: Description of Works**	**ELECTRICAL CONTROL & INSTRUMENTATION WORKS**				
	1.4.	**ELECTRICAL CONTROL & INSTRUMENTATION WORKS**				
D2.001	1.4.1	Design Fee	Sum	1.00		
	1.4.2	**Construction/Implementation Cost**				
D2.002		a. MV equipment and Transformers/Minisubs	Sum	1.00		
D2.003		b. MCC's and Local Control Stations	Sum	1.00		
D2.004		c. Emergency Back-up Power system	Sum	1.00		
D2.005		d. Control system including PLC equipment and SCADA complete with all Software and Hardware	Sum	1.00		
D2.006		e. UPS Systems	Sum	1.00		
D2.007		f. MV Cable installation	Sum	1.00		
D2.008		g. LV Cable installation	Sum	1.00		
D2.009		h. Control and Instrumentation Installation	Sum	1.00		
D2.010		i. Access Control, CCTV, Intruder Intruder Alarm and Communication System	Sum	1.00		
		j. Human Machine Interface (HMI)	Sum	1.00		
D2.011		k. Local Isolator, Stop Start and Emergency Stop Stations	Sum	1.00		
	Chapter 4: Particular Specific SANS 1200A PS 8.5 read with 1.5.11	**ELECTRICAL - POWER SUPPLY**				
		Buildings				
D2.012		Interior lighting for all buildings and structures (Battery limit being the electrical meter box on the outside of each building)	Prov Sum	1.00	3,750,000.00	3,750,000.00
D2.013		Charges and profit on interior lighting	%	3,750,000.00		
D2.014		Small power for all buildings and structures (Battery limit being the electrical meter box on the outside of each building). Including DB installations, three phase socket outlets, single-phase outlets, telephone outlets, data point outlets, isolators, powerskirting, etc.	Prov Sum	1.00	2,500,000.00	2,500,000.00
D2.015		Charges and profit on small power	%	2,500,000.00		
Total Carried Forward						

ITEM NO	PAYMENT REFERS TO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
Total Brought Forward						
D2.017		1000/600/400V cable reticulation in buildings (Battery limit being the electrical meter box on the outside of each building). This includes cables, terminations, wireways, etc, all throughout all buildings, structures from distribution kiosks and DBs for all interior lighting and small power circuits.	Prov Sum	1.00	3,500,000.00	3,500,000.00
D2.018		Charges and profit on power distribution in buildings	%	3,500,000.00		
D2.019	1.5.11	**Earthing and Lightning Protection (ELP) of Facility** ELP design is part of the contractors scope of work. Risk assessment to be conducted. Upon confirmation of ELP requirements via a risk assessment, detailed design of ELP to be conducted. Buildings including: •RAS Pump Station •Fire water Pump Station •Service water Pump station •MCC Building 02 •Blower Building 1A & 1B •MCC Building 04 •Chlorine Building •MCC Building 03 •Workshop •Admin/Control Building •Ferric Pump Building •MCC Building 01 •Dewatering Building •Digester Heating Building •Ablution Block •Primary Sludge Pump Station •Scum Pump Station •Sludge Digester Building 1A & 1B	Sum	1.00		
D2.020	1.5.11	Structures including: •Inlet Works •Primary Clarifier 1A & 1B •Balancing Tank & Pinch Valve Chamber •Biological Reactor •Secondary Clarifier 1A & 1B •Thick Sludge Sump •Digested Sludge day Tank •Ferric Storage Bund •Sludge Drying bed •Precipitation tank •Gas Holding tank 1A & 1B •Car Port •Washbay	Sum	1.00		
D2.021	1.5.11	Intake station	Sum	1.00		
TOTAL CARRIED FORWARD TO SUMMARY						

SCHEDULE 1: BUILDING WORKS

ITEM NO	PAYMENT REFERS TO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
E1	**C3.3.5**	**BUILDING WORKS**				
	PS 8.5	**SUM STATED PROVISIONALLY BY ENGINEER**				
E1.001		Building Works Including the following: a.) Main Administration Building: Houses executive offices, conference rooms, human resources, and records management b.) Central SCADA and Control Room: Encloses the centralized computer systems (Supervisory Control and Data Acquisition) to monitor and control real-time plant operations c.) Analytical Laboratory: A fully equipped chemical and microbiological lab required for mandatory daily testing of influent, mixed liquor, and final effluent quality d.) Ablution and Change Rooms: Separate male and female change facilities with showers, lockers, and laundry areas for operational staff e.) Guardhouse or Security Gatehouse: Located at the main vehicle access gate to monitor site entrance, manage access and security activities, and secure the plant perimeter f.) Engineering Workshop and Warehouse: A dedicated workshop area for mechanical and electrical repairs of pumps, aerators, and valves, combined with a warehouse for critical spare parts and tool storage g.) Operational Vehicle Carports: Heavy-duty structural steel or concrete carports with corrugated roofing sheet profiles h.) Staff and Visitor Carports: Standard shaded or roofed parking bays located strictly near the Administration Building, placed upwind from the primary process tanks to limit odour exposure and paint degradation i.) Dedicated Vehicle Washbay: Including heavy-duty reinforced concrete slab with raised perimeter bunding to contain all runoff water. It should also include a steel or brick superstructure with a roof to prevent rainwater from overloading the treatment system. Equipped with high-pressure industrial wash-down pumps, hose reels, and sometimes a localized hot water or steam generator for deep-cleaning heavy sludge skip trucks and honey-suckers.	Prov Sum	1.00	49,800,000.00	49,800,000.00
E1.002		Architectural Design Fees	Prov Sum	1.00	5,976,000.00	5,976,000.00
E1.003		Overheads, charges and profit on item D1.001 and D1.002 above	%	55,776,000.00		
TOTAL CARRIED FORWARD TO SUMMARY						

C4.2 GEOLOGICAL INVESTIGATION

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD

GeoCon

Report number: NP/2000/06/06

Report on the engineering geological investigation:

Proposed Pietersburg/Polokwane Regional Wastewater Purification Works to be located on a portion of the farm Doornbult 624-LS

Compiled by:

F. CALITZ

Northern Province
120 Marshall Street
P.O. Box 2526
PIETERSBURG
0700
Tel. No.:+27 - 15 - 291 1577
Fax. No.:+27 - 15 - 291 1702
e-mail:geocon@pixie.co.za

Gauteng Province
66 Paradissi Street, Highveld X8
Postnet, Suite 12, Private Bag X108
CENTURION
0046
Tel. No.:+27 - 12 - 665 3100
Fax. No.:+27 - 12 - 665 2176
e-mail:geocon@netactive.co.za

Eastern Cape Province
10 Sansom Street, Vincent
Postnet 203, Private Bag X9063
EAST LONDON
5200
Tel. No.:+27 - 43 - 726 2070
Fax. No.:+27 - 43 - 726 9232
e-mail:sageocon@sainet.co.za

Directors: S.J. Pretorius, J.A. Myburgh, F. Calitz, J.J.P. Vivier

Report on the engineering geological investigation:

Proposed Pietersburg/Polokwane Regional Wastewater Purification Works to be located on a portion of the farm Doornbult 624-LS

Conducted on request of:

Pietersburg/Polokwane Transitional Local Council
P.O. Box 111
PIETERSBURG
0700

Mr. A.B. Müller
Tel. No.: (015) 290 2000/1
Fax. No.: (015) 290 2131

Compiled by:

Fred CALITZ Pr.Sci.Nat., MSAIEG, MIAEG
Consulting Engineering Geologist
SACNASP Reg. No.: 400050/96

13 July 2000

Abstract

A detailed engineering geological investigation has been carried out on a portion of the farm Doornbult 624-LS in order to determine the engineering geological characteristics of the material underlying a proposed regional wastewater purification works for the city of Pietersburg/Polokwane. Comments regarding the topography, drainage, climatic regime, current vegetation and geological setting of the study area are made. Nineteen test pits were dug by heavy mechanical excavator and profiled by an engineering geologist. Thirteen disturbed soil samples were taken and submitted to a soil laboratory for the determination of the mechanical properties of the different soil materials that underlies the study area.

The study area is deemed to be underlain by Houtrivier Gneiss that generally exhibits a north-northeastwardly strike direction. Relatively weathered gneiss occurs in the western portion of the study area, with more granitic, relatively homogeneous, solid, unweathered gneiss to the east. Several poorly defined northeastwardly, southeastwardly and northwardly striking dolerite dykes cut through the general area in which the facility will be located.

No problems are foreseen during the excavation of trenches to a depth of at least 0.95 m ***by hand*** or ***mechanical excavator*** throughout the study area. Excavatability problems may, however, be encountered in very localised areas in the southern, southeastern and central portions of the study area at a depth of less than 0.95 m requiring the use of ***power tools***. The soil material occurring within the floodplain near the Sand River can be excavated to a depth of at least 3.4 m ***by hand*** or ***mechanical excavator*** without difficulty. Excavations can be taken to a depth of at least 1.30 m ***by hand*** or ***mechanical excavator*** along the upper reaches of the floodplain, as well as in the northern and northeastern portions of the study area, without difficulty. Thereafter ***power tools*** or ***blasting*** may be required to excavate the hardpan ferricrete or weathered gneiss bedrock. Excavation of the hard bedrock occurring from a depth of at least 0.95 m in the southern, southeastern and central portions of the study area will require the use of ***power tools*** or ***blasting***. The shoring of all excavation sidewalls to be left open for a period in excess of 24 hrs is essential to ensure the safety of workers.

An efficient storm water drainage system should be designed on the upstream-side of the site, as well as within the site and along access roads and buildings.

The soil material underlying the area in question can generally be classified as *slightly permeable*, based on its calculated permeability. The contact zones occurring in the vicinity of the dolerite dyke intrusions are generally deemed to be preferential drainage paths along which groundwater recharge occurs.

No specialised precautions are required to ensure structural integrity against undermining at shallow depth or the formation of surface instability features (sinkholes or subsidences). It is recommended that the loose soil material be completely removed to the level of the weathered bedrock in the southern, southeastern and central portions of the study area, and that foundations be placed directly upon hard bedrock. The construction of structures within the floodplain should incorporate precautionary measures against potentially moderately expansive material with an expected maximum heave of up to 30 mm, and/or against highly collapsible soil material with the total amount of settlement that can be expected exceeding 10 mm. It is recommended that on site inspections of open foundation trenches for the construction of structures be conducted by a qualified engineering geologist or geotechnical engineer in order to identify and evaluate soil conditions at variance with those encountered during the investigation.

Soil material removed during excavations should be stockpiled nearby, and used for the construction of the earth embankments. However, the soil material occurring within the boundaries of the study area is deemed to be prone to surface- and pipe erosion, due to its dispersive character, and remedial measures should be taken to stabilise the soil when used in the construction of embankment dams.

It is recommended that the base and flanks of any ponds be sealed off by the placement of geotextiles or a compacted clay liner (for example: bentonite), in order to prevent any seepage from these ponds into the sub-surface material.

Contents

Contents (continued)

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1. Introduction

1.1 GENERAL

A detailed engineering geological investigation has been carried out on a parcel of land located to the north of the city of Pietersburg/Polokwane in order to determine and evaluate the engineering geological characteristics of the soil material underlying a proposed regional wastewater purification works.

1.2 TERMS OF REFERENCE

The investigation was coordinated by Mr. Etienne du Plessis of the firm Dombo and Du Plessis Consulting Engineers on behalf of the Pietersburg/Polokwane Transitional Local Council, as confirmed in the letter of appointment dated 05 May 2000 (with reference number 16/4/2/1).

1.3 SCOPE OF THE INVESTIGATION

The investigation had the following aims:

- determination of the general succession of soil and rock layers underlying the study area, including:
  - the precise depth at which bedrock occurs
  - bedrock type and character
  - the thickness and composition of the covering layer
- determination of the mechanical properties of the soil material in and on which founding of proposed structures will take place, including:
  - general foundation indicator characteristics (Atterberg Limits, Linear Shrinkage and grading)
  - dispersion potential
  - permeability of the sub-surface material
- detailed engineering geological evaluation of the development potential of the study area with regard to the proposed development
- to recommend necessary precautionary measures during the design and construction of any structures associated with the proposed wastewater treatment works

1.4 LOCATION OF THE STUDY AREA

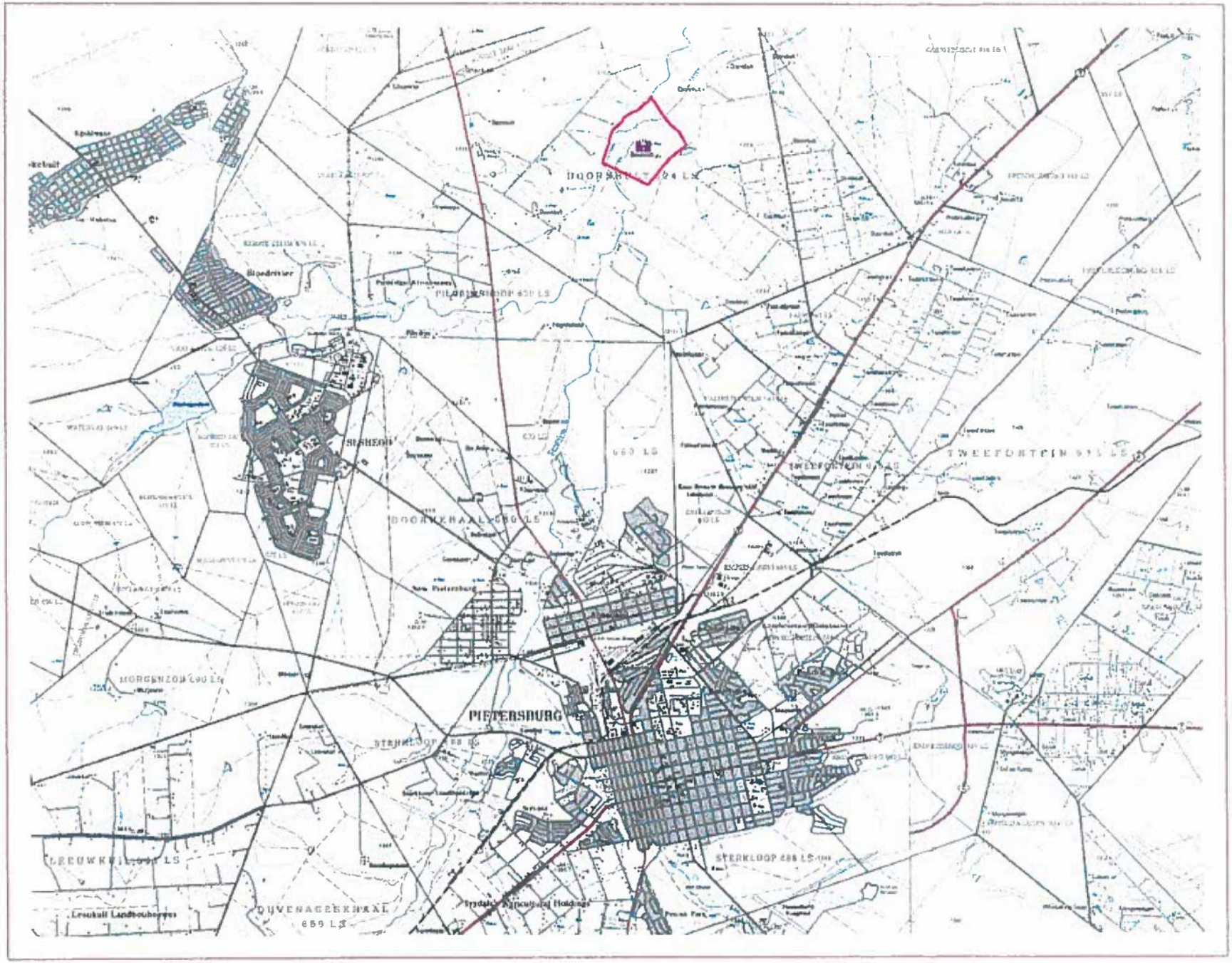
The proposed development is located on a portion of the farm Doornbult 624-LS in the Pietersburg/Polokwane Transitional Local Council Area of the Central District, Northern Province (Figure 1). The study area covers a total area of approximately 122 ha, as delineated by the Project Engineer.

SOUTHERN AFRICA
GEOCONSULTANTS
(PTY) LTD

129 Strauss Street
P.O. Box 2539
PIETERSBURG
0700
Tel. No.: 015 - 291 1677
Fax. No.: 015 - 291 1783
e-mail: pietersburg@geocon.co.za

ENGINEERING GEOLOGICAL INVESTIGATION: PROPOSED PIETERSBURG/POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS

FIGURE 1



Compiled by:

Date: 12/07/2006

Locality map

The study area is located at the following coordinate:

- Latitude: 23° 52' 50.5"
- Longitude: 29° 59' 01.8"

With the exception of an earth-fill dam and two small concrete dams, no recent development has taken place within the boundaries of the study area. The area is currently lying fallow, but was previously utilised for the cultivation of potatoes during which use was made of centre-pivot irrigation systems.

1.5 INFORMATION SOURCES

The following sources of information were used during the investigation:

- **Geological maps**
  - Geological map of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland, 1997; scale 1 : 1 000 000.
  - 2328 PIETERSBURG, 1985; scale 1 : 250 000.
- **Topographical map**
  - 2329CD PIETERSBURG, Second Edition, 1980; scale 1 : 50 000.
  - 2329DC MANKWENG, Second Edition, 1980; scale 1 : 50 000.
- **Aerial photographs**
  - Job 835, strip 2, numbers 9676 and 9677, 22 April 1980; scale 1 : 30 000.
  - Oblique aerial photographs taken by Mr. N.J. van Rensburg of the Pietersburg/Polokwane Transitional Local Council on 22 June 2000.
- **Orthophotographs**
  - 2329CD4 PALMIETFONTEIN, Second Edition, 1988; scale 1 : 10 000.
  - 2329CD5 DOORNBULT, Second Edition, 1988; scale 1 : 10 000.
  - 2329CD9 DOORNBULT, Second Edition, 1988; scale 1 : 10 000.
  - 2329CD10 PALMIETFONTEIN, Second Edition, 1988; scale 1 : 10 000.
- **Site layout plan**
  - Supplied in hardcopy format by Messrs. Bombo and Du Plessis Consulting Engineers, June 2000; scale 1 : 2 500.
  - Supplied in digital format by Messrs. Dombo and Du Plessis on 13 July 2000; not to scale: computer generated image.

2. Site description

2.1 TOPOGRAPHY

The area in which the proposed facility is to be located generally exhibits a gently rolling topography with broad valleys associated with streams and rivers. The most prominent topographical feature of the area is the broad, relatively flat lying, meandering channel of the Sand River. It is proposed that the wastewater treatment works be placed on the southeastern bank of the river.

The northwestern portion of the study area is located on the eastern floodplain of the Sand River, and exhibits a very gentle slope (average 0.5°) to the northwest.

The southeastern portion is located on the sideslope of a localised ridge, and exhibits a gentle slope (average 1.25°) to the north and northwest. The rounded crest of this ridge occurs to the southeast of the study area.

The northern and northeastern portions are located along the broad, relatively flat channel of a northwestwardly flowing, non-perennial stream.

The lowest point is located in the northwest at an elevation of 1 178 m above mean sea level, with the highest point located in the southeast at an elevation of 1 195 m above mean sea level.

2.2 DRAINAGE

The study area is located within the quaternary sub-catchment region A71A (Midgley *et al*, 1994), with the northeastwardly flowing Sand River, that forms the northwestern boundary of the site, being the most important drainage feature. An earth fill dam is located within the channel of the non-perennial stream that occurs in the northern and northeastern portions of the study area.

The study area is drained mainly by means of surface run-off, with surface water collecting along roads and footpaths that cut through the area. The surface water eventually drains into the non-perennial stream that drains the northern portion, while the remainder of the area drains into the Sand River.

Significant surface erosion was not noted within the boundaries of the study area.

2.3 CLIMATE

The study area is located in rainfall zone A7A (Midgley *et al*, 1994), in the summer rainfall area of the Republic of South Africa.

The average annual rainfall is approximately 485 mm, as measured at the Pietersburg Provincial Hospital (weather station 0677-834) located to the south of the study area (Midgley *et al*, 1994).

The climatic N-value (Weinert, 1980) is between 3 and 4; therefore chemical decomposition, rather than mechanical disintegration, of the parent rocks is deemed the principal mode of weathering.

2.4 VEGETATION

According to the Barrie Low *et al* (1996) the natural vegetation occurring in the study area falls in the ***Savanna Biome***, and generally classifies as ***Mixed Bushveld***. The vegetation is characterised as "a dense, short bushveld to a rather open tree savanna", which prefers shallow, coarse, sandy soils originating from granite, quartzite, sandstone or shale.

Those areas underlain by shallow soils are generally characterised by the following general vegetation types:

❑ Trees and shrubs:	Red Bushwillow	*Combretum apiculatum*
	Common Hook-thorn	*Acacia caffra*
	Sicklebush	*Dichrostachys cinerea*
	Live-Long	*Lannea discolor.*
❑ Grasses:	Fingergrass	*Digitaria eriantha*
	Kalahari Sand Quick	*Schmidtia pappophoroides*
	Wool Grass	*Anthephora pubenscens*

The areas underlain by deeper, more sandy soils are characterised by the following general vegetation types:

❑ Trees and shrubs:	Silver Clusterleaf	*Terminalia sericea*
	Peeling Plane	*Ochna pulcra*
	Wild Raisin	*Gweria flava*
❑ Grasses:	Broom Grass	*Eragrostis pallens*
	Purple Spike Cat'stail	*Perotis patens*

It must be noted that the natural vegetation has largely been removed from a large portion of the study area during cultivation of the fields. The sideslope of the localised ridge in the southeast is, however, still covered by relatively pristine natural vegetation that has, however, been infested by declared weeds.

The area in the direct vicinity of the channel of the Sand River is covered by riverine vegetation that is highly infested by alien plants (Kotze *et al*, 2000).

A more detailed description and evaluation of the natural vegetation cover occurring in and around the study area is contained in the ecological report (Kotze *et al*, 2000).

2.5 GEOLOGY

According to the available geological information, the study area is underlain by a leucocratic migmatite and gneiss, grey and pink hornblende and biotite-rich gneiss, grey biotite-rich gneiss, minor muscovite-bearing granite, pegmatite and gneiss, collectively known as the **Houtrivier Gneiss**[1]. This strata generally exhibits a north-northeastwardly strike direction. Relatively weathered gneiss occurs in the western portion of the study area, with more granitic, relatively homogeneous, solid, unweathered gneiss to the east (Figure 2).

Several poorly defined northeastwardly, southeastwardly and northwardly striking **dolerite dykes** cut through the general area in which the facility will be located (Figure 2).

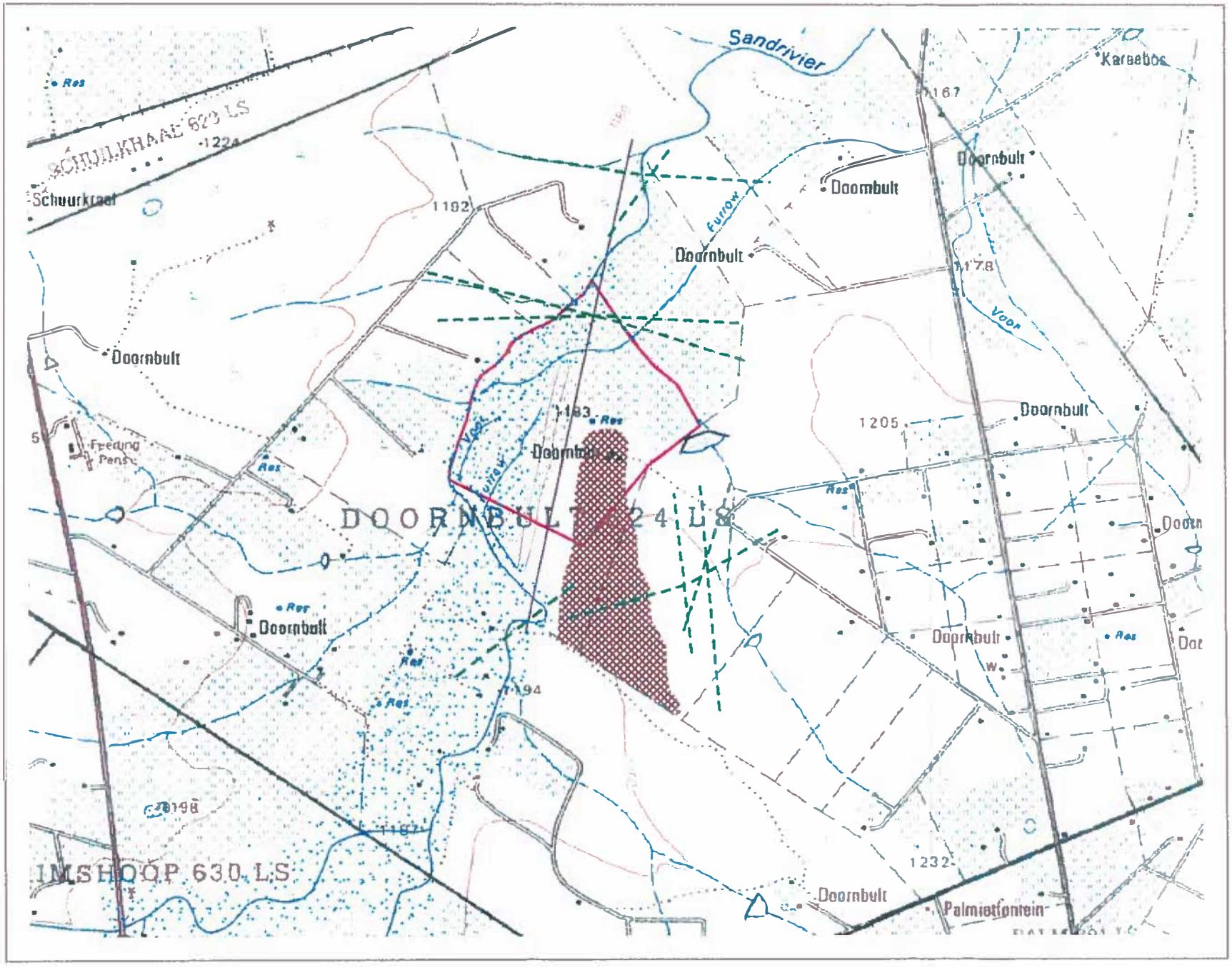
---

[1] Note that this name has not yet been approved by the South Africa Committee on Stratigraphy (SACS).

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
128 Marshall Street
P.O. Box 2826
PIETERSBURG
0700
Tel. No.: 015 - 291 1577
Fax. No.: 015 - 291 1782
e-mail: pietersburg@geocon.co.za

ENGINEERING GEOLOGICAL INVESTIGATION: PROPOSED PIETERSBURG/POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS

FIGURE 2



Geological structures
Linear features
Trend direction
Weathered gneiss boundary
Stratigraphy
Alluvium
Gneiss
Study area

200 0 200 400 Meters
1:25000

N

Compiled by:
Date: 13/07/2006

Regional geological setting

The site does <u>not</u> reflect any risk for the formation of sinkholes or subsidences caused by the presence of water-soluble rocks (dolomite or limestone).

A more detailed geological description is contained in the geohydrological report (Pretorius *et al*, 2000).

<u>*Gneiss*</u> is formed by the high grade regional metamorphism (caused by increases in temperature and pressure due to major structural movements of the Earth's crust) of clayey sediments and granitic rocks. It exhibits well-defined banding, with the dark bands consisting of mica (biotite) and hornblende, and the light bands of quartz and feldspar. The thickness of these bands varies between a few millimetres and a few centimetres, and can be either straight or folded. Gneiss is well foliated, and the hornblende crystals in the dark bands can be lineated (Bell and Wright, 1985). Alternative quartz-rich and granitic zones can be developed in the gneiss.

<u>*Dolerite*</u> is a medium-grained, quartz-poor, entirely crystalline, shallow intrusive igneous rock. It consists of plagioclase feldspar, pyroxene and olivine, and is susceptible to weathering and alteration. Dolerites are usually found as vertical dykes or horizontal sills, and hundreds of dykes may be found in dyke swarms. These relatively hard rocks can give rise to the formation of upstanding masses or ridges.

3. Investigative methodology

The investigation comprised the following steps:

- Desk study
  - collation and evaluation of available information
  - planning of field work phase
- Site visit and field work
  - confirmation of information obtained during desk study
  - on-site inspection of test pits
  - detailed description of succession of soil- and rock layers
  - the taking of soil samples
- Laboratory testing
  - determination of the basic mechanical properties of the different soil materials, including: grading (to 0.002 millimetres), Atterberg Limits and linear shrinkage
  - determination of the dispersiveness potential of the different soil layers
- Reporting phase
  - discussion of all results
  - evaluation of results in terms of aim of proposed development
  - recommendations

A detailed summary of all investigative- and evaluation methodology is included as Appendix A.

4. Results

4.1 DESK STUDY

A literature search revealed that a detailed engineering geological was conducted on another portion of the farm Doornbult 624-LS (Calitz, 1998). This investigation revealed the following regarding the mechanical properties of soil and rock material associated with the Houtrivier Gneiss that occurs in the vicinity of the study area:

- Excavatability was moderate to poor, with test pits refusing on hard bedrock at a depth of between 0.7 and 1.0 m.
- Perched groundwater tables were not encountered during this study.
- No rock outcrops were noted.
- The colluvial cover is composed mainly of sand (approximately 57 %) with significant amounts of gravel (18 %) and silt (17 %), with a minor amount of clay (8 %). This material was found to be only slightly plastic, and is not deemed to be potentially expansive or collapsible. It did, however, test moderately dispersive.
- The totally weathered gneiss is composed mainly of sand (approximately 56 %) with significant amounts of gravel (31 %), with minor amounts of silt (7 %) and clay (8 %). This material was found to be moderately plastic, and is not deemed to be potentially expansive or collapsible. It did, however, test highly dispersive. The weathered gneiss exhibited a measured permeability of approximately 1×10^{-4} cm/sec.
- The totally weathered dolerite is composed mainly of sand (approximately 65 %) with significant amounts of gravel (17 %) and silt (31 %), with a minor amount of clay (5 %). This material was found to be moderately plastic, and is not deemed to be potentially expansive or collapsible. It did, however, test highly dispersive. The weathered dolerite exhibited a measured permeability of approximately 2×10^{-4} cm/sec.

4.2 FIELD WORK

4.2.1 Test pit positions

Nineteen test pits, numbered DSF1 to DSF19, were dug by means of a Daewoo 220LC-V traxcavator on 30 May 2000. It was attempted to excavate the test pits to a depth of at least 4 m in order to determine the composition and thickness of the alluvial cover.

The test pits were placed on a geometric grid within the study area (Figure 3), as identified and marked by the Project Engineer. Test pits DSF1 to DSF8 were placed within the floodplain of the Sand River, while test pits DSF9 to DSF14, and DSF16 to DSF18, were placed along the sideslope of the localised ridge that occurs in the southeast. Test pits DSF15 and DSF19 were placed along the channel of the non-perennial stream that cuts through the northeastern and northern potions of the study area.

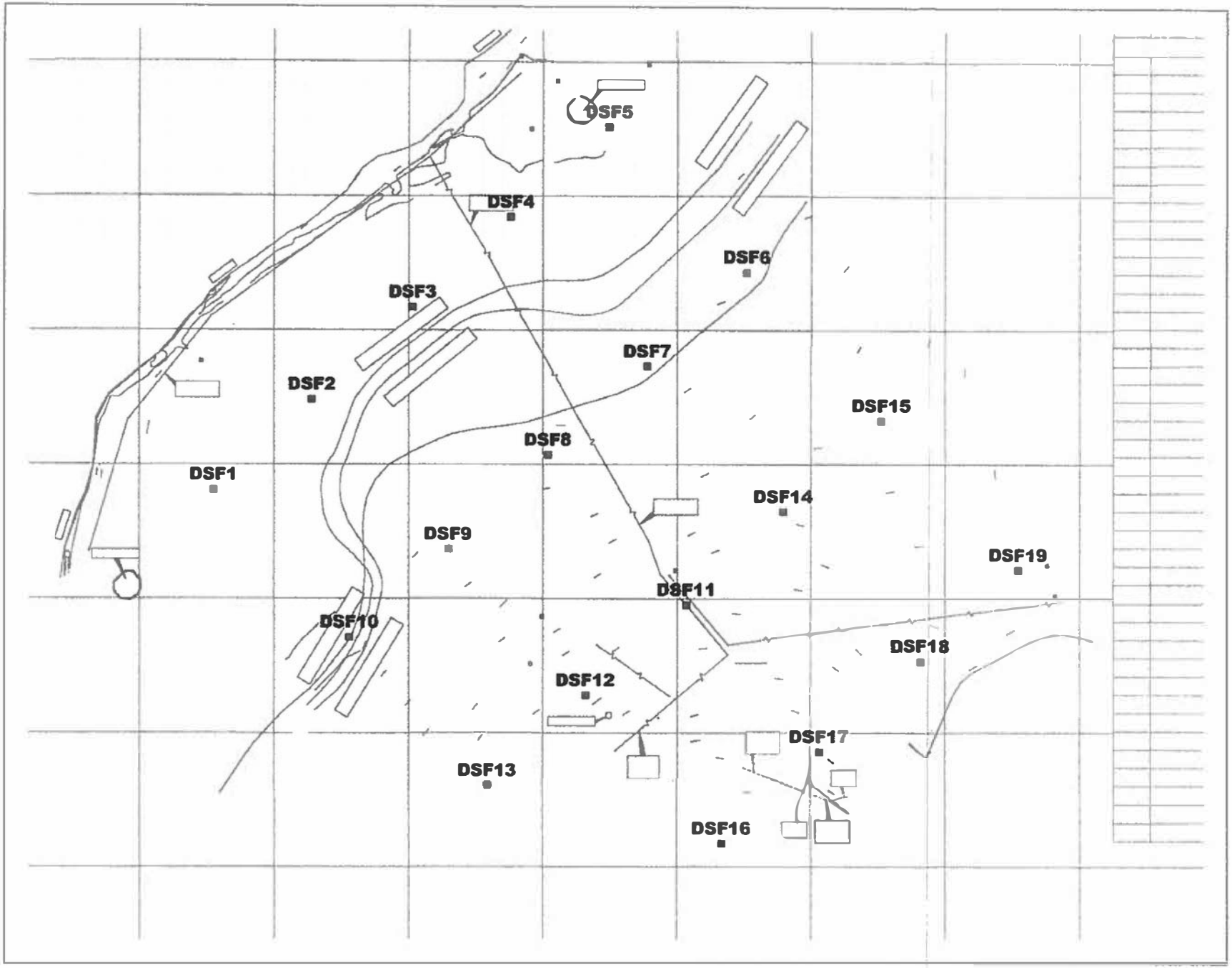
The succession of soil layers exposed in each test pit was described according to the standardised profiling method proposed by Jennings *et al* (1973).

SOUTHERN AFRICA
GEOCONSULTANTS
(PTY) LTD

120 Marshall Street
P.O. Box 2630
PIETERSBURG
0700
Tel. No.: 015 - 291 1677
Fax. No.: 015 - 291 1782
e-mail: pietersburg@...

ENGINEERING GEOLOGICAL INVESTIGATION: PROPOSED PIETERSBURG/POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS

FIGURE 3



Test pits
- Refused
- Stopped

Site layout

Not to scale:
computer generated

N

Compiled by:

Date: 02/05/2008

Detailed site map
with test pit positions

Detailed test pit profiles are included as Appendix B[2].

4.2.2 General engineering geological observations

The following general characteristics were noted during the site visits and field work phases of the investigation:

- **Rock- or pedocrete outcrops**
  - No rock outcrop occurs within the boundaries of the study area.
  - A few scattered gneiss boulders were noted near the crest of the localised ridge that occurs in the southeastern portion of the study area, but these are deemed to have been transported and does not necessarily indicate the presence of rock close to the surface.
- **Excavatability**
  - Excavation of the test pits placed in the floodplain near the channel of the Sand River was stopped at a depth of between 3.40 and 4.10 m (mean: 3.85 m), as the pits reached a sufficient depth.
  - The test pits placed in the higher lying reaches of the floodplain (i.e.: further away from the Sand River) and within the channel of the non-perennial stream in the northeast and north, were excavated to a depth of between 1.30 and 4.00 m (mean: 2.85 m), with the mechanical excavator refusing on hard bedrock or hardpan ferricrete.
  - Excavation of the test pits placed along the sideslope of the ridge that occurs in the southeast had to be abandoned at a depth of between 0.95 and 1.90 m (mean: 1.35 m), due to the presence of hard bedrock.
  - A graphical representation of the excavatability of the study area is given by Figure 4.
- **Sidewall stability**
  - The excavation sidewalls remained stable for the duration of profiling.
  - Localised sidewall failure was noted below the perched water tables.
- **Groundwater strikes**
  - Moderate groundwater seepage was encountered from a depth of between 3.05 and 4.10 m (mean: 3.40 m) within silicified alluvial material in the floodplain near the channel of the Sand River.
  - Slight to moderate groundwater seepage was encountered at a depth of between 1.40 and 2.35 m (mean: 1.90 m) within highly ferruginised alluvium along the higher lying reaches of the floodplain and along the channel of the non-perennial stream in the northeast and north.
  - The test pits were excavated after an exceptionally wet summer rainfall season.

[2] The colours of the soil material were described in a wet condition

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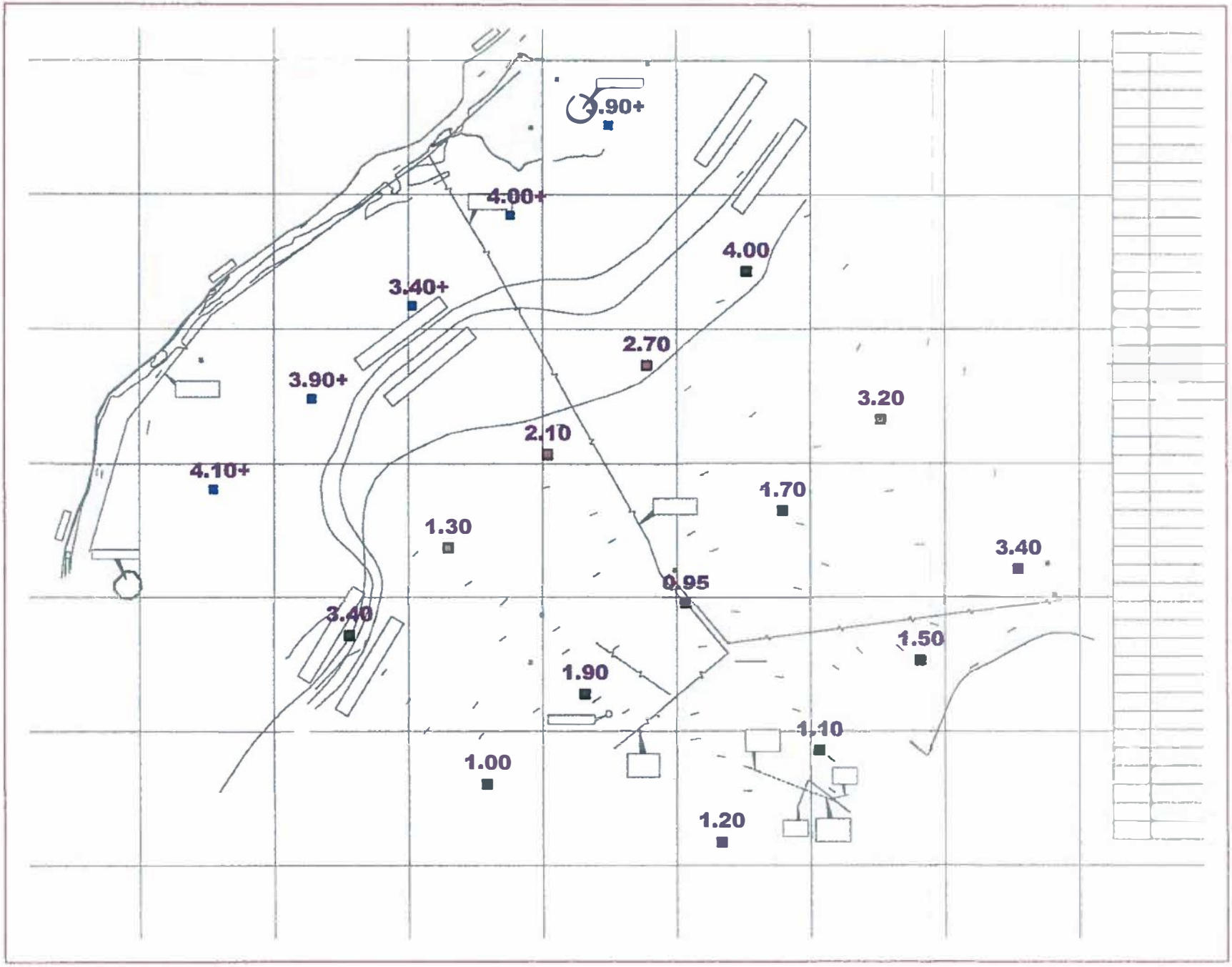
ENGINEERING GEOLOGICAL INVESTIGATION: PROPOSED PIETERSBURG/POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS

FIGURE 4



4.2.3 General soil profile

Note: the soil types noted in the following description are based on field observations, and does not incorporate the results of the laboratory tests.

- **Floodplain near the Sand River**

The floodplain of the Sand River near the channel of the river is underlain by a highly variable succession of soil layers deemed to be of alluvial origin. The upper soil layers are composed mainly of moist clayey sand with a soft to stiff consistency and a shattered and weakly slickensided structure, and can include thin localised layers of moist, loose, intact silty sand. A highly localised pocket of highly ferruginised alluvium was encountered at a depth of between 0.50 and 0.95 m in test pit DSF3, and is deemed to represent soil changes due to irrigation and tilling of the soil during cultivation.

The alluvial material becomes silicified from a depth of between 0.50 and 3.10 m (mean: 1.75 m), and contains frequent loose to moderately well cemented silcrete nodules. Relatively thin layers of well cemented (hardpan) silcrete can occur in localised areas (as encountered from a depth of 3.10 m in test pit DSF5).

Bedrock was not intersected in any of the test pits placed in this area, and is deemed to be located at a depth in excess of 3.40 m.

- **Higher lying reaches of the Sand River floodplain, and the channel of non-perennial stream**

The higher lying reaches of the floodplain of the Sand River, as well as the channel of the non-perennial stream that occurs in the northeast and north, are covered by alluvial material composed of moist, soft, shattered and weakly slickensided, clayey sand. This material exhibits a firm consistency at depth, while pockets of slightly ferruginised material were encountered in localised areas within this layer. A thin layer of silicified alluvium was also encountered from a depth of approximately 2.05 m in test pit DSF6.

The alluvium becomes highly ferruginised from a depth of between 0.90 and 2.05 m (mean: 1.30 m), and has been well cemented to hardpan ferricrete in places.

A pebble marker horizon, ferruginised to hardpan ferricrete, was encountered from a depth of between 1.20 and 3.25 m (mean: 2.30 m).

Moderately weathered, hard gneiss bedrock was encountered directly below the pebble marker horizon from a depth of between 2.80 and 4.00 m (mean: 3.40 m).

- **Ridge sideslope**

The sideslope of the localised ridge that occurs in the southeast is covered by colluvial material (hillwash), that is composed of moist, loose, intact, silty sand with quartz gravel. This layer extends to a depth of between 0.20 and 0.30 m (mean: 0.20 m).

Alluvial material was found to cover the colluvium in the vicinity of test pit DSF18 placed directly to the west of the earth dam in the north. The alluvium extends to a depth of approximately 0.40 m.

The colluvium is underlain by a prominent pebble marker horizon (deemed to represent the contact between the transported cover and residual material). This layer is between 0.20 and 0.30 m (mean: 0.20 m) thick, and is composed of moist, loose, intact, silty sand with quartz

gravel.

The transported cover is generally underlain by, while the remaining areas is underlain by highly weathered gneiss represented by coarse-grained, highly jointed, soft mica-rich rock with wide, filled joints. The joint fillings is generally composed of moist, slightly ferruginised, firm, intact, clayey sand. Thin layers of totally weathered gneiss, present as moist, firm, intact, clayey sand with coarse gravel, occurs in localised areas directly below the pebble marker horizon.

The residual material generally becomes less weathered and relatively hard from a depth of between 0.50 and 1.60 m (mean: 0.95 m), with hard bedrock occurring from a depth of between 0.95 and 1.90 m (mean: 1.30 m).

4.3 LABORATORY RESULTS

Disturbed samples were taken of the following soil layers:

- Alluvial cover: DSF1/1, DSF1/2, DSF2/1, DSF4/1, DSF4/2, DSF5/1, DSF6/1, DSF6/2, DSF7/1, DSF8/1, DSF9/1, DSF15/1, DSF19/1
- Silicified alluvium: DSF1/3, DSF2/2, DSF3/1
- Ferruginised, totally weathered gneiss: DSF12/1

The samples were submitted to Messrs. Matrolab (Pietersburg) for the determination of the grading and mechanical characteristics, and the potential dispersiveness of the different soil materials.

A summary of the results of these tests is given in Table 1, with detailed results included as Appendix C.

The following results were obtained:

4.3.1 Alluvial cover

MEAN PARTICLE SIZE DISTRIBUTION	VIBRATORY COMPACTION POTENTIAL	CLASSIFICATION		MECHANICAL PROPERTIES	MECHANICAL BEHAVIOUR	ESTIMATED PERMEABILITY
		ASTM	AASHTO			
gravel 3 % sand 52 % silt 39 % clay 5 %	Very poor	ML silty sand, SM silty sand with gravel, SC clayey sand, SC-SM silty, clayey sand, or CL sandy lean clay	A-1-b, A-2-4, A-4, A-6, A-7-5, or A-7-6	LL 35 % PI 13 PI' 10 LS 6.0 %	Highly collapsible Dispersive	Slightly permeable

The results of the soil tests performed in the alluvial material encountered along the floodplain clearly reflects the highly variable composition of these deposits.

It must be noted that samples DSF6/1 and DSF6/2 taken from a test pit placed in the channel of the non-perennial stream that cuts through the northeastern and northern portions of the study area, exhibit radically different characteristics to those occurring along the floodplain of the Sand River. It is assumed that this material represent more recent deposits.

TABLE 1 Laboratory results: proposed regional wastewater purification works on Doornbult 624-LS

SAMPLE NUMBER	SAMPLE DEPTH (m - m)	ORIGIN	GRADING ANALYSIS				ATTERBERG LIMITS			LS (%) 3	MATERIALS CLASSIFICATION		POTENTIALLY ADVERSE GEOTECHNICAL CHARACTERISTICS				CALCULATED PERMEABILITY (cm sec^{-1}) 10
			GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LL (%) 1	PI	PP 2		A.S.T.M. 4	A.A.S.H.T.O. 5	EXPANSIVENESS 6	DISPERSIVENESS 7	COLLAPSE 8	COMPRESSIBILITY 9	
DSF1/1	0.95 - 1.35	Alluvium	0	46	47	7	49	23	19	9.5	CL	A-7-6	Low risk	Dispersive	High risk	N/T	2×10^{-5}
DSF1/2	1.35 - 1.60	Alluvium	1	42	52	5	49	20	16	9.5	ML	A-7-6	Low risk	Dispersive	High risk	N/T	3×10^{-5}
DSF1/3	1.75 - 3.10	Silicified alluvium	24	42	33	1	34	11	7	5.5	SC	A-2-6	Low risk	Not dispersive	Low risk	N/T	6×10^{-4}
DSF2/1	0.75 - 1.35	Alluvium	7	44	44	5	54	25	17	11.5	SC	A-7-6	Low risk	Dispersive	Moderate risk	N/T	4×10^{-5}
DSF2/2	1.35 - 2.05	Silicified alluvium	10	56	32	2	44	18	10	8.0	SC	A-2-7	Low risk	Not dispersive	Low risk	N/T	4×10^{-4}
DSF3/1	0.95 - 1.85	Silicified alluvium	18	59	19	4	32	9	5	4.0	SC	A-2-4	Low risk	Dispersive	Low risk	N/T	4×10^{-4}
DSF4/1	0.10 - 0.95	Alluvium	0	51	47	2	28	9	7	4.0	SC	A-4	Low risk	Not dispersive	High risk	N/T	2×10^{-4}
DSF4/2	1.00 - 1.65	Alluvium	18	37	38	7	46	15	10	7.5	SM	A-7-5	Low risk	Dispersive	Low risk	N/T	2×10^{-5}
DSF5/1	0.90 - 1.55	Alluvium	1	41	56	2	39	13	10	5.5	ML	A-6	Low risk	Not dispersive	High risk	N/T	3×10^{-4}
DSF6/1	0.40 - 1.40	Alluvium (recent)	0	46	19	35	36	18	14	8.0	CL	A-6	Moderate risk	Dispersive	Low risk	N/T	$< 1 \times 10^{-4}$
DSF6/2	1.40 - 2.05	Alluvium (recent)	0	36	28	36	39	19	16	8.5	CL	A-6	Moderate risk	Dispersive	Low risk	N/T	$< 1 \times 10^{-4}$
DSF7/1	0.50 - 1.10	Alluvium	0	66	29	5	20	7	5	3.5	SC-SM	A-2-4	Low risk	Dispersive	Moderate risk	N/T	2×10^{-4}
DSF8/1	0.15 - 1.00	Alluvium	0	78	20	2	16	5	2	2.0	SC-SM	A-1-B	Low risk	Not dispersive	Low risk	N/T	9×10^{-4}
DSF9/1	0.10 - 0.90	Alluvium	0	71	21	8	15	6	4	2.0	SC-SM	A-2-4	Low risk	Dispersive	High risk	N/T	1×10^{-3}
DSF12/1	0.40 - 0.90	Weathered gneiss	28	55	11	6	27	11	3	4.0	SC	A-2-6	Low risk	Dispersive	Low risk	N/T	7×10^{-4}
DSF15/1	0.55 - 1.30	Alluvium	3	46	37	14	37	15	11	6.0	CL	A-6	Low risk	Dispersive	Low risk	N/T	$< 1 \times 10^{-4}$
DSF19/1	0.50 - 0.90	Alluvium	0	55	43	2	33	10	7	4.5	SC	A-4	Low risk	Not dispersive	High risk	N/T	2×10^{-4}

1 Liquid Limit
2 Weighted Plasticity Index (corrected to represent the whole sample)
3 Linear Shrinkage

4 Soil classification: the A.S.T.M. Standard on the Unified Soil Classification System
5 Soil classification: the American Association of State Highway and Transportation Officials
N/T Not tested

6 Calculated by means of the method proposed by Van der Merwe (1964)
7 Determined by means of the Double Hydrometer Method
8 Determined by comparing the grain size distribution with grain size limits defined by Knight and Errera
9 Determined by means of special tests
10 Calculated by means of Hazen's permeability equation: $k = 100 \times D_{10}^2$

The following results were obtained for these samples:

MEAN PARTICLE SIZE DISTRIBUTION		VIBRATORY COMPACTION POTENTIAL	CLASSIFICATION		MECHANICAL PROPERTIES		MECHANICAL BEHAVIOUR	ESTIMATED PERMEABILITY
			ASTM	AASHTO				
gravel sand silt clay	0 % 41 % 24 % 36 %	Very poor	CL sandy lean clay	A-6	LL PI PI' LS	38 % 19 15 8.5 %	Moderately expansive Dispersive	Very slightly permeable

4.3.2 Silicified alluvium

MEAN PARTICLE SIZE DISTRIBUTION		VIBRATORY COMPACTION POTENTIAL	CLASSIFICATION		MECHANICAL PROPERTIES		MECHANICAL BEHAVIOUR	ESTIMATED PERMEABILITY
			ASTM	AASHTO				
gravel sand silt clay	17 % 52 % 28 % 2 %	Very poor	SC clayey sand or SC clayey sand with gravel	A-2-4 A-2-6 or A-2-7	LL PI PI' LS	37 % 13 7 6.0 %	Dispersive	Slightly permeable

This material exhibits relatively similar characteristics than the general alluvial material, but contains more gravel (mainly silcrete nodules).

4.3.3 Ferruginised, totally weathered gneiss

MEAN PARTICLE SIZE DISTRIBUTION		VIBRATORY COMPACTION POTENTIAL	CLASSIFICATION		MECHANICAL PROPERTIES		MECHANICAL BEHAVIOUR	ESTIMATED PERMEABILITY
			ASTM	AASHTO				
gravel sand silt clay	28 % 55 % 11 % 6 %	Very poor	SC clayey sand with gravel	A-2-6	LL PI PI' LS	27 % 11 3 4.0 %	Dispersive	Slightly permeable

The results of the tests conducted on the weathered gneiss show that this material is similar to that encountered during the engineering geological investigation conducted on another portion of the farm.

5. Development potential evaluation

5.1 GENERAL

The evaluation of the development potential of the study area is based on the following premises:

- Buildings associated with the proposed purification works will be single- and double-storey masonry structures
- The maximum foundation load will be in the order of 100 kPa
- Foundations will ideally be placed at a depth of between 0.30 and 0.60 m below the current ground surface.

The study area can be classified as follows:

Geotechnical classification system[3]: 2AI 3DE

5.2 ENGINEERING GEOLOGICAL EVALUATION

As the basic mechanical properties (grading and Atterberg Limits) of the weathered gneiss underlying the study area is very similar to those obtained for the weathered gneiss encountered at another portion of the farm Doornbult 624-LS, it is assumed that the in situ permeability of the weathered bedrock will be in the order of 1 x 10^{-4} cm/sec.

5.2.1 Excavatability

- **Trenching**

No problems are foreseen during the excavation of trenches to a depth of at least 0.95 m ***by hand*** or ***mechanical excavator*** throughout the study area. Excavatability problems may, however, be encountered in very localised areas in the southern, southeastern and central portions of the study area where weathered gneiss corestones may occur at shallow depth (i.e.: at a depth of less than 0.95 m), requiring the use of ***power tools***.

The results of the investigation show that the soil material occurring within the floodplain near the Sand River can be excavated to a depth of at least 3.4 m ***by hand*** or ***mechanical excavator*** without difficulty.

Excavations can be taken to a depth of at least 1.30 m ***by hand*** or ***mechanical excavator*** along the upper reaches of the floodplain, as well as in the northern and northeastern portions of the study area, without difficulty. Thereafter ***power tools*** or ***blasting*** may be required to excavate the

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[3] Partridge *et al*, 1993:

2	:	Intermediate Class
A	:	Collapsible horizon(s) totalling a depth of more than 0.75 m in thickness
I	:	Slopes of between 6 and 12°
3	:	Least favourable class
D	:	Excessive soil compressibility expected
E	:	Moderate erodability expected

hardpan ferricrete or weathered gneiss bedrock.

Excavation of the hard bedrock occurring from a depth of at least 0.95 m in the southern, southeastern and central portions of the study area will require the use of ***power tools*** or ***blasting***.

- **Sidewall stability**

  The shoring of all excavation sidewalls to be left open for a period in excess of 24 hrs is essential to ensure the safety of workers.

5.2.2 Slope stability

The natural slopes are not deemed to be unstable.

5.2.3 Surface- and sub-surface drainage

An efficient storm water drainage system should be designed on the upstream-side of the site, as well as within the site and along access roads and buildings, in order to:

- channel surface water around the site
- prevent surface erosion, by reducing the stream flow velocity
- prevent the ponding of storm water at the surface, which may lead to the pollution of surface- and groundwater sources
- prevent the formation of perched water tables at shallow depth, by reducing infiltration of storm water from the surface into the sub-surface material

5.2.4 Environmental impact considerations

It must be kept in mind that the engineering geological investigation does not include a detailed geohydrological study, but relies on a *regional* geohydrological evaluation only. A detailed evaluation of the geohydrological character of the study area and its surrounds is reported separately (Pretorius *et al*, 2000).

The soil material underlying the area in question can generally be classified as *slightly permeable*, based on its calculated permeability.

The available geological information reveals that numerous poorly-defined dolerite dyke has intruded into the bedrock in the vicinity of the study area. It must be noted that the bedrock has been extensively fractured and altered along the contact zones with these intrusions, due to excessive heat and pressure. These contact zones are generally deemed to be preferential drainage paths along which groundwater recharge occurs.

Additionally, it must be noted that the Department of Water Affairs and Forestry has decreed that no activity, other than those associated with the collection of water, should be allowed within a radius of 30 m from an existing surface water source, boreholes or fountains utilised for the abstraction of water for human or animal consumption (Department of Water Affairs and Forestry, 1997).

5.2.5 Construction considerations

No specialised precautions are required to ensure structural integrity against undermining at shallow depth or the formation of surface instability features (sinkholes or subsidences).

It is recommended that the loose soil material be completely removed to the level of the weathered bedrock in the southern, southeastern and central portions of the study area, and that foundations be placed directly upon hard bedrock.

The construction of structures within the floodplain should incorporate precautionary measures against potentially moderately expansive and/or highly collapsible soil material. It is envisaged that the total amount of heave that can be expected along the drainage channel that occurs in the northern and northeastern portions of the study area will be in the order of up to 30 mm. The total amount of settlement that can be expected beneath structures placed on the floodplain will exceed 10 mm.

Soil material removed during excavations should be stockpiled nearby, and used for the construction of the earth embankments. However, the soil material occurring within the boundaries of the study area is deemed to be prone to surface- and pipe erosion, due to its dispersive character. Several authors (for example: Harmse, 1980, and Elges, 1985) propose the following remedial measures to stabilise dispersive soil when used in the construction of embankment dams:

- Stabilisation: obtained by the addition of approximately 2 % gypsum, lime or aluminium sulphate by mass of clay.
- Compaction: lowering the permeability of the soil material by means of compaction at a moisture content of between optimum and 3 % wet of optimum, and a minimum density of 98 % of Standard Proctor maximum dry density. An adequate filter drainage system should also be incorporated.

It is imperative that the base and flanks of any ponds be sealed off by the placement of geotextiles or a compacted clay liner (for example: bentonite), in order to prevent any seepage from these ponds into the sub-surface material.

The installation of a damp coarse layer in the foundations and under the floor slabs of all structures is recommended, as seasonal zones of saturation may occur at shallow depth.

It is recommended that on site inspections of open foundation trenches for the construction of structures be conducted by a qualified engineering geologist or geotechnical engineer in order to identify and evaluate soil conditions at variance with those encountered during the investigation.

6. Conclusions and recommendations

6.1 A detailed engineering geological investigation has been carried out on a parcel of land located to the north of the city of Pietersburg/Polokwane in order to determine and evaluate the engineering geological characteristics of the soil material underlying a proposed regional wastewater purification works.

6.2 The investigation was coordinated by Mr. Etienne du Plessis of the firm Dombo and Du Plessis Consulting Engineers on behalf of the Pietersburg/Polokwane Transitional Local Council.

6.3 The investigation had the following aims:

- determination of the general succession of soil and rock layers underlying the study area, including:
  - the precise depth at which bedrock occurs
  - bedrock type and character
  - the thickness and composition of the covering layer
- determination of the mechanical properties of the soil material in and on which founding of proposed structures will take place, including:
  - general foundation indicator characteristics (Atterberg Limits, Linear Shrinkage and grading)
  - dispersion potential
  - permeability of the sub-surface material
- detailed engineering geological evaluation of the development potential of the study area with regard to the proposed development
- to recommend necessary precautionary measures during the design and construction of any structures associated with the proposed wastewater treatment works

6.4 According to the available geological information, the study area is underlain by a leucocratic migmatite and gneiss, grey and pink hornblende and biotite-rich gneiss, grey biotite-rich gneiss, minor muscovite-bearing granite, pegmatite and gneiss, collectively known as the Houtrivier Gneiss. This strata generally exhibits a north-northeastwardly strike direction. Relatively weathered gneiss occurs in the western portion of the study area, with more granitic, relatively homogeneous, solid, unweathered gneiss to the east. Several poorly defined northeastwardly, southeastwardly and northwardly striking dolerite dykes cut through the general area in which the facility will be located. The site does not reflect any risk for the formation of sinkholes or subsidences caused by the presence of water-soluble rocks (dolomite or limestone).

6.5 The results of a detailed engineering geological that was conducted on another portion of the farm Doornbult 624-LS was utilised to obtain a first impression of the mechanical propertie sof the material

underlying the study area.

Nineteen test pits, placed on a geometric grid within the study area, were dug by means of a traxcavator, and the succession of soil layers exposed in each test pit was described according to a standardised profiling method.

Seventeen disturbed samples were taken for the determination of the grading and mechanical characteristics, and the potential dispersiveness of the different soil materials that underlies the study area.

6.6 The evaluation of the development potential of the study area is based on the following premises:

- Buildings associated with the proposed purification works will be single- and double-storey masonry structures
- The maximum foundation load will be in the order of 100 kPa
- Foundations will ideally be placed at a depth of between 0.30 and 0.60 m below the current ground surface.

6.7 As the basic mechanical properties (grading and Atterberg Limits) of the weathered gneiss underlying the study area is very similar to those obtained for the weathered gneiss encountered at another portion of the farm Doornbult 624-LS, it is assumed that the in situ permeability of the weathered bedrock will be in the order of 1×10^{-4} cm/sec.

6.8 **Trenching**

No problems are foreseen during the excavation of trenches to a depth of at least 0.95 m ***by hand*** or ***mechanical excavator*** throughout the study area. Excavatability problems may, however, be encountered in very localised areas in the southern, southeastern and central portions of the study area where weathered gneiss corestones may occur at shallow depth (i.e.: at a depth of less than 0.95 m), requiring the use of ***power tools***.

The results of the investigation show that the soil material occurring within the floodplain near the Sand River can be excavated to a depth of at least 3.4 m ***by hand*** or ***mechanical excavator*** without difficulty.

Excavations can be taken to a depth of at least 1.30 m ***by hand*** or ***mechanical excavator*** along the upper reaches of the floodplain, as well as in the northern and northeastern portions of the study area, without difficulty. Thereafter ***power tools*** or ***blasting*** may be required to excavate the hardpan ferricrete or weathered gneiss bedrock.

Excavation of the hard bedrock occurring from a depth of at least 0.95 m in the southern, southeastern and central portions of the study area will require the use of ***power tools*** or ***blasting***.

The shoring of all excavation sidewalls to be left open for a period in excess of 24 hrs is essential to ensure the safety of workers.

6.9 **Slope stability**

The natural slopes are not deemed to be unstable.

6.10 **Surface- and sub-surface drainage**

An efficient storm water drainage system should be designed on the upstream-side of the site, as well as within the site and along access roads and buildings.

6.11 **Environmental impact considerations**

The soil material underlying the area in question can generally be classified as *slightly permeable*, based on its calculated permeability.

The available geological information reveals that numerous poorly-defined dolerite dyke has intruded into the bedrock in the vicinity of the study area. It must be noted that the bedrock has been extensively fractured and altered along the contact zones with these intrusions, due to excessive heat and pressure. These contact zones are generally deemed to be preferential drainage paths along which groundwater recharge occurs.

Additionally, it must be noted that the Department of Water Affairs and Forestry has decreed that no activity, other than those associated with the collection of water, should be allowed within a radius of 30 m from an existing surface water source, boreholes or fountains utilised for the abstraction of water for human or animal consumption (Department of Water Affairs and Forestry, 1997).

6.12 **Construction considerations**

No specialised precautions are required to ensure structural integrity against undermining at shallow depth or the formation of surface instability features (sinkholes or subsidences). It is recommended that the loose soil material be completely removed to the level of the weathered bedrock in the southern, southeastern and central portions of the study area, and that foundations be placed directly upon hard bedrock. The construction of structures within the floodplain should incorporate precautionary measures against potentially moderately expansive material with an expected maximum heave of up to 30 mm, and/or against highly collapsible soil material with the total amount of settlement that can be expected exceeding 10 mm. The installation of a damp coarse layer in the foundations and under the floor slabs of all structures is recommended, as seasonal zones of saturation may occur at shallow depth.

Soil material removed during excavations should be stockpiled nearby, and used for the construction of the earth embankments. However, the soil material occurring within the boundaries of the study area is deemed to be prone to surface- and pipe erosion, due to its dispersive character, and remedial measures should be taken to stabilise the soil when used in the construction of embankment dams.

It is imperative that the base and flanks of any ponds be sealed off by the placement of geotextiles or a compacted clay liner (for example: bentonite), in order to prevent any seepage from these ponds into the sub-surface material.

6.13 ***It is recommended that on site inspections of open foundation trenches for the construction of structures be conducted by a qualified engineering geologist or geotechnical engineer in order to identify and evaluate soil conditions at variance with those encountered during the investigation.***

6.14 ***It must be kept in mind that the engineering geological investigation does not include a detailed geohydrological study, but relies on a regional geohydrological evaluation only. A detailed evaluation of the geohydrological character of the study area and its surrounds is reported separately.***

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APPENDIX A

Investigative methodology and techniques

A-1. SITE DESCRIPTION

A-1.1 CLIMATE

Weinert (1980), in his efforts to describe the influence of climate on road building materials, defined the N-value, computed as follows:

$$N = 12 \times E_j / P_a$$

with:
E_j the computed evaporation from a shallow free water surface during the warmest month
P_a the total annual rainfall

The following N-values are significant:

❑	N greater than 10	No significant weathering profile develops, the rock disintegrates to form a thin layer of coarse gravel.
❑	N between 5 and 10	The principle mode of weathering is disintegration of rocks, with limited secondary chemical decomposition of rock forming minerals.
❑	N between 2 and 5	Chemical decomposition predominates with kaolinite and smectitic minerals being the principle weathering products, the weathering profile extends from fresh rock to residual soil.
❑	N less than 2	Secondary chemical decomposition of weathering products occur, kaolinite and oxides of iron being the final products.

Another major climatic phenomenon of interest to the engineering geologist is the prevailing wind direction, as it is of importance during the selection of suitable and aesthetically pleasing liquid and solid waste disposal sites.

A-2 DESK STUDY PHASE

The aim of the desk study phase of an engineering geological investigation is to collect and correlate all existing information relevant to the study area to obtain a first impression of the engineering geological character of a site.

Ideally this includes the study of aerial and orthophotographs, topographical and geological maps, climatic information, reports on previous investigations in or near the study area, and a walkover survey during a site visit. This results in the compilation of a base map on a suitable scale.

A-3. FIELD WORK METHODOLOGY

A-3.1 TEST PITS

The individual soil layers in the test pits are described according to the following parameters, which constitute the soil profiling system proposed by Jennings, Brink and Williams (1973):

❑	Moisture	dry, slightly moist, moist, very moist, wet
❑	Colour	including stains and mottles
❑	Consistency	cohesive material: very soft, soft, firm, stiff, very stiff granular material: very loose, loose, moderately dense, dense, very dense
❑	Structure	intact, fissured, slickensided, shattered, micro-shattered, other
❑	Soil type	boulders, gravel, sand, silt, clay or combinations thereof
❑	Origin	talus, hillwash, alluvium, lacustrine, estuarine, aeolian, littoral, pedogenic, residual material

A-3.2 DYNAMIC CONE PENETROMETER TESTS

The Modulus of Elasticity can be estimated by the use of a Dynamic Cone Penetrometer (DCP). According to Van Vuuren (1969) the Dynamic Cone Penetrometer is a "valuable tool for the rapid determination of *in situ* Californian Bearing Ratio values in the range of 1-50". The Dynamic Cone Penetrometer is usually used for the following purposes:

- to detect soft patches or hollows in earth fills or compacted soils,
- to estimate the density of soil structures without disturbing it.
- to carry out a quick terrain evaluation (if used in conjunction with a hand auger or limited test pits).

The instrument consists of a "10-kilogram hammer sliding on a 16-mm rod dropping through a distance of 460 mm striking an anvil at the lower end of that rod, on the end of which is a 60° hardened steel cone, 20 mm in diameter" (Van Vuuren, 1969). The Dynamic Cone Penetration is driven by blows of the drop hammer and the results of the test are plotted as millimetres penetration per blow versus depth. The resulting penetration curve is then divided into segments, where a change in slope signifies a change in the density of the soil material, defining a new segment representing a different soil layer or soil conditions. The average penetration for each segment is then calculated and the average Californian Bearing Ratio (CBR) value of the *in situ* soil for the depth range of the segment is then read off a scale depicting penetration versus calibrated Californian Bearing Ratio values.

A-4. LABORATORY TESTS

A-4.1 GRADING AND CLASSIFICATION

The grading of a soil is determined by sieve and hydrometer analysis, which facilitates the preparation of cumulative particle size curves. The grading characteristics of a soil with less than 12 percent fines (particles with a diameter of less than 0.074 millimetres according to the A.S.T.M. soil classification system) can be described in the following manner (Holtz and Kovacks, 1981):

- A well graded soil contains a good representation of all the grain sizes and can be identified by a coefficient of curvature (Cc) of between 1 and 3, with a coefficient of uniformity (Cu) greater than 6.
- in contrast, a poorly graded (well sorted) soil exhibits an excess or deficiency in some particle sizes, with a coefficient of curvature (Cc) greater than 3 and a coefficient of uniformity (Cu) less than 6.

This information is of value in the classification of coarse material.

The soils samples are classified according to the A.S.T.M. standard on the Unified Soil Classification System (Howard, 1984), as well as the American Association of State Highway and Transportation Officials (A.A.S.H.T.O.) Classification system (as discussed by Cernica, 1982). These systems are used to describe the soil materials in each mapping unit for easy reference, as well as determining its suitability as construction material sources.

A-4.2 MECHANICAL PROPERTIES

The consistency of a soil is described by means of its Atterberg limits, where the effect of a change in the moisture content on the consistency of a cohesive soil is measured. According to Cernica (1982) these tests are useful "mostly for soil identification and classification". It can also be used to determine the mechanical properties of cohesive soil material. The following limits are defined:

- **Liquid limit** — This value is defined as the moisture content at which point the sample changes from a liquid to a plastic state as moisture is removed, and is given as a percentage. This is measured as the moisture content at which a grooved sample in a standard apparatus, and which was cut by a standard tool, closes along the groove for approximately 13 millimetres when subjected to 25 drops in a standard liquid-limit apparatus.
- **Plasticity limit** — The plasticity limit of a material is the lowest moisture content at which the soil begins to crumble when rolled out into thin threads, approximately 3 millimetres in diameter, i.e. the soil changes from a plastic into a semi-solid state.
- **Plasticity Index** — The plasticity index is defined as the difference between the liquid and plasticity limits.
- The **linear shrinkage** test is preformed by wetting a soil to approximately its liquid limit and drying the resultant paste in a mould. The linear shrinkage is defined as the percentage shrinkage that the soil underwent.

These values can be used to calculate the potential expansiveness of the material, and to evaluate its suitability as construction material sources.

A-4.3 POTENTIAL DISPERSIVENESS

The potential dispersiveness of a soil can be measured by means of several laboratory tests, one of which is the Emmerson Crumb Test where a test specimen, comprising a lightly compressed moist soil sample, is immersed in demineralized water (Elges, 1985). As the sample hydrates the tendency for colloidal-sized particles to deflocculate is noted.

Four reaction grades are defined, namely:

GRADE	OBSERVATION	REACTION	RESULT
I	crumbs may slake, no signs of cloudiness	no reaction	non-dispersive
II	bare hint of cloudiness at surface of crumbs	slight reaction	intermediate
III	easily recognizable cloud of colloids in suspension	moderate reaction	dispersive
IV	colloidal cloud covers whole bottom of beaker	strong reaction	dispersive

Elges (1985) notes that "a dispersive soil may sometimes give a non-dispersive reaction in the crumb test. However if the crumb test indicates dispersion, the soil is probably dispersive".

A-4.4 PERMEABILITY

The permeability of sandy material can be calculated by means of Hazen's permeability equation, which uses the grading of the material as follows (Holtz and Kovacks, 1981):

$$k = 100 \times D_{10}^2$$

with:
k the coefficient of permeability in centimetres per second
D_{10} effective grain size of the finest 10 percent of the sample in centimetres

Holtz and Kovacks (1981) noted that this equation is not very reliable for permeabilities below 10^{-3} centimetres per second.

A-4.5 POTENTIAL EXPANSIVENESS

The potential expansiveness of a soil depends upon its clay content, the type of clay mineral present, its chemical composition and mechanical character. A material is potentially expansive if it exhibits the following properties (Kantey and Brink, 1952):

- a clay content of more than 12 percent
- a plasticity index of more than 12
- a liquid limit of more than 30 percent
- a linear shrinkage of more than 8 percent

The potential expansiveness (low, medium, high, very high) is then calculated by means of Van der Merwe's method (Van der Merwe, 1964), where the equivalent plasticity index (corrected to represent the whole sample, not just the fines fraction) versus the clay content is plotted on a graph divided into heave categories. By plotting the thickness against the depth of occurrence of the potentially expansive layer, the expected amount of heave can be read of a scale bar at the bottom of the graph.

A-4.6 COLLAPSE POTENTIAL

Collapse occurs when the fine particles (iron oxides, calcium carbonates or clay mineral bridges) cementing coarser grains together are disturbed or broken through wetting, increased saturation of loading. This may lead to a large scale decrease of bulk volume when the material becomes saturated.

A first impression of the collapse potential of a soil can be obtained by comparing the grading curve of the material with a series of grading limits defined by the grading curves of materials proven to be collapsible (Knight, 1958, and Errera, 1977).

A-4.7 POTENTIAL COMPRESSIBILITY

When a load is placed upon a soil, compression will take place due to the following (Holtz and Kovacks, 1981):

- the deformation of soil grains,
- the compression of the air and water in the voids, and/or
- the squeezing out of water and air from the voids.

The influence of the deformation of mineral grains caused by small engineering loads on the soil is negligible. The compression of the pore fluids in saturated soils can also be neglected. Therefore the main cause of volume change under loading can be ascribed to the squeezing out of pore water and air, leading to the densification of soil, causing a decrease in volume resulting in surface settlement. The compression of granular material takes place in a relatively short time (mainly during the construction phase of development), while clay-rich materials mainly consolidate more slowly. According to Bell (1987) greater settlement is likely to be experienced when a structure is founded at a level below the ground water level, rather than above it. Additional settlement may occur when a fluctuating ground water level is present, or if the soil is subjected to vibration.

According to Brink (1985) it has been found that estuarine, deltaic and lacustrine deposits in the Republic of South Africa usually exhibit a compressible character.

A-5. SITE EVALUATION

A-5.1 EVALUATION CRITERIA

By grouping together mapping units with the same engineering geological characteristics, the site can be divided into development zones. Each zone is therefore defined as an area with similar geology, topography, drainage, groundwater regime and mechanical characteristics, thus placing similar constraints on development.

Partridge *et al* (1993) proposed the following criteria for the evaluation of an area for the construction of single-storey masonry residential structures:

	CONSTRAINT	MOST FAVOURABLE 1	INTERMEDIATE 2	LEAST FAVOURABLE 3
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 0.75 m in thickness	Any collapsible horizon or consecutive horizons totalling a depth of more than 0.75 m in thickness	A "least favourable" situation for this constraint does not occur
B	Seepage	Permanent or perched water level more than 1.5 m below ground surface	Permanent or perched water level less than 1.5 m below ground surface	Swamps and marshes
C	Active soil	Low soil-heave potential predicted	Moderate soil-heave potential predicted	High soil-heave potential predicted
D	Highly compressible soil	Low soil-compressibility expected	Moderate soil-compressibility expected	High soil-compressibility expected
E	Erodability of soil	Low	Intermediate	High
F	Difficulty of excavation to depth of 1.5 m	Scattered or occasional boulders less than 10% of the total volume	Rock or hardpan pedocretes between 10 and 40% of the total volume	Rock or hardpan pedocretes more than 40% of the total volume
G	Undermined ground	Undermining at a depth greater than 100 m below surface (except where total extraction mining has not occurred)	Undermining to a depth of 100 m below surface where stope closure has ceased	Mining within less than 100 m of surface or where total extraction mining has taken place
H	Instability in areas of soluble rock	Possibly unstable	Probably unstable	Known sinkholes and subsidences
I	Steep slopes	Between 2° and 6°	Between 6° and 12°, and less than 2°	More than 12°
J	Areas of unstable natural slopes	Low risk	Intermediate risk	High risk
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s² within 50 years	Mining induced seismic activity more than 100 cm/s²	Natural seismic activity of more than 100 cm/s²
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur	Areas adjacent to known drainage channel or flood plain with slope less than 1%	Areas within a known drainage channel or flood plain

The above-mentioned system is used to classify the geotechnical properties of a specific area, by allocating a alphanumeric code as follows:

3CL: area underlain by clay soils with a high heave potentiel and which falls within a drainage channel or flood plain

The National Home Builders Registration Council classifies the adverse mechanical properties that the soils underlying a site may exhibit (NHBRC, 1994), as follows (based on the site class designations proposed by the SAICE / I.Struct.E. Code of Practice for Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction):

- **HEAVE**

Estimated total heave	< 7.5mm	Site Class H
	7.5 - 15mm	Site Class H1
	15 - 30mm	Site Class H2
	> 30mm	Site Class H3

- **CONSOLIDATION AND COLLAPSE SETTLEMENT**

Estimated total settlement	< 5mm	Site Class C
	5 - 10mm	Site Class C1
	> 10mm	Site Class C2

- **CONSOLIDATION SETTLEMENT**

Estimated total settlement	< 7.5mm	Site Class S
	7.5 - 15mm	Site Class S1
	> 15mm	Site Class S2

A-5.2 EXCAVATABILITY AND SLOPE STABILITY

Soils exhibiting a loose consistency or collapsible grain structure usually display sidewall instability, making the excavation of trenches or cuttings extremely hazardous. Bell (1987) notes that the following methods can be used to stabilize the sidewalls of excavations or cuttings (the method to be used is determined by the severity of the problem):

- **Excavations**
  - the erection of poling boards where excavations have a stand-up time sufficient to allow for its installation, and
  - the installation of continuous sidewall support using close timber shoring or steel sheeting to the full depth prior to the commencing of excavation.

- **Cuttings**
  - the construction of unretained cuts where the cut angle is less than the angle of internal friction of the material,
  - the construction of hollow, semi-gravity or gravity walls (consisting of reinforced concrete, stone or brick masonry with sufficient weight to prevent sliding or overturning failure), and
  - the construction of cantilever walls (with a heavy reinforced concrete heel portion to prevent failure).

A-5.3 DRAINAGE

According to Brink *et al* (1988) structures built in areas with poor surface drainage or a shallow ground water level can be affected by rising damp. Brink *et al* (1988) states that these problems can be remedied by damp-proofing foundations or the raising of floors, as well as the installation of an effective storm water drainage system throughout the development. This system should incorporate gutters and downpipes to catch runoff water from the roofs of structures, the water then being carried off onto the road or into the local storm water network. An alternative is to construct 1.5-metre wide impermeable aprons around all buildings. Roads should be flanked by impermeable, concrete-lined furrows to collect storm water, after which the water can be channelled off to a central point for disposal (for example: the local purification plant or into lakes, rivers or the ocean).

A-5.4 ERODABILITY

The potential erodability of a soil has to be studied both in built-up areas where stormwater must be discharged from streets and in the adjacent agricultural areas where the natural land is disturbed (Brink *et al*, 1988). By stripping off the organically-enriched topsoil, erosion lowers the quality of the environment of the community. Brink *et al* (1988) also state that soils of low erodability are usually inactive, non-dispersive and of shallow depth, while erodible soils generally consist of fissured clays, highly dispersive materials and thick layers of fine colluvium and residual soils of intermediate texture (specifically granitic in origin). Steep slopes obviously hold the highest erosion hazard.

A-5.5 FOUNDATION CONSIDERATIONS

The following foundation design and building procedures are recommended by the NHBRC:

- **Normal foundations**
  - normally constructed (strip footing or slab-on-the-ground) foundations
  - site drainage and service / plumbing precautions recommended

❑ **Modified normal foundations**
- the construction of lightly reinforced strip footings
- the inclusion of articulation joints at all internal / external doors and openings
- light reinforcement in masonry
- site drainage and service / plumbing precautions recommended

❑ **Compaction of *in situ* soils below individual footings**
- the removal of the *in situ* material to a depth and width of 1.5 times the foundation width or to a competent horizon and replacing it with inert backfill compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content
- normal construction with lightly reinforced strip footings and light reinforcement in masonry
- site drainage and service / plumbing precautions recommended

❑ **Deep strip foundations**
- normal construction with drainage precautions
- founding on a competent horizon below the problem horizon
- if a total settlement of more than 10mm is expected, fabric reinforcement of floor slabs is recommended

❑ **Soil rafts**
- the removal of all or a part of the problem horizon to a distance of 1m beyond the perimeters of the structure and replacing it with inert backfill compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content
- normal construction with lightly reinforced strip footings and light reinforcement in masonry if residual movements less than 7.5mm or construction type appropriate to residual movements
- site drainage and service / plumbing precautions recommended

❑ **Stiffened or cellular rafts**
- stiffened or cellular raft with articulation joints or solid lightly reinforced masonry
- bearing pressure should not exceed 50kPa if soil material undergoes settlement in excess of 10mm
- mesh reinforcement of floor slabs necessary if soil material undergoes settlement in excess of 10mm
- site drainage and plumbing / service precautions recommended

❑ **Piled construction foundations**
- piled foundations with suspended floor slabs with or without ground beams
- site drainage and plumbing / service precautions recommended

❑ **Piled or pier foundations**
- reinforced concrete ground beams or solid slabs on piled or pier foundations
- ground slabs with fabric reinforcement
- site drainage and plumbing / service precautions recommended

❑ **Split construction foundations**
- combination of reinforced brickwork / blockwork and full movement joints
- suspended floors or fabric reinforced ground slabs acting independently from the structure
- site drainage and plumbing / service precautions recommended

A-6. CONSTRUCTION MATERIAL SOURCES

A-6.1 BRICKMAKING CLAYS

According to Schmidt (1980) an ideal brickmaking clay source should contain between 20 and 40 percent non-plastic clay, with a maximum of 38 percent sand.

A-6.2 FINE AGGREGATES

Oberholster (1980) is of the opinion that the single most important physical property of a sand is its grading. Therefore this parameter is used to assess the suitability of sandy material for use as building sand. The ideal types of building sand are defined by specific sets of grading limits according to SABS standards.

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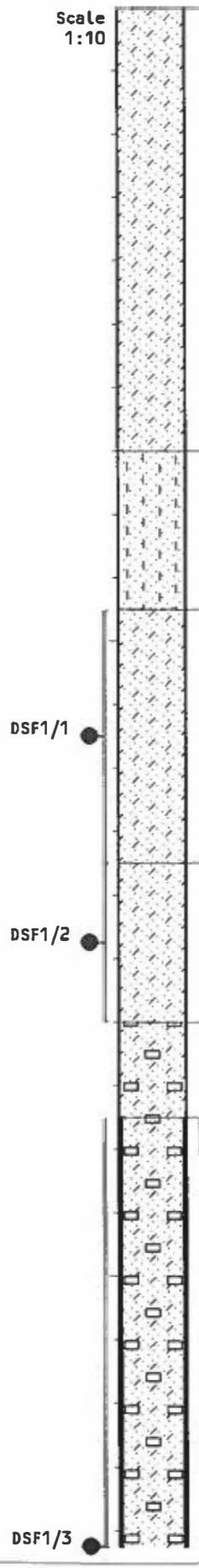
APPENDIX B

Detailed soil profiles

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF1
Sheet 1 of 2

JOB NUMBER: 000



0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled dark yellowish brown and light brown in profile, dusky olive brown when wet, soft, shattered and weakly slickensided, clayey sand.

0.70

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, light reddish brown, loose, intact, silty sand.

0.95

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, dark olive brown in profile, dusky olive brown when wet, stiff, shattered and slickensided, clayey sand.

1.35

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, light reddish brown stained light brown, firm, intact, clayey sand.

1.60

TRANSPORTED MATERIAL: ALLUVIUM.
Slightly moist, stained dusky purplish brown, firm, intact, clayey sand, with frequent mottled creamy white, light grey and dusky pinkish brown, loose, silcrete nodules with a diameter of up to 100mm.

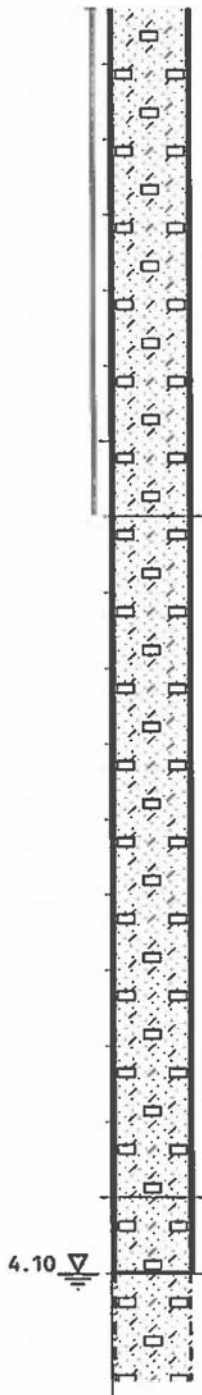
1.75

TRANSPORTED MATERIAL: SILICIFIED ALLUVIUM.
Slightly moist, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand, with frequent weakly to moderately well cemented silcrete nodules with a diameter of up to 100mm.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF1
Sheet 2 of 2

JOB NUMBER: 000



3.10

As above.
stained dusky reddish brown.

4.00

As above.
Very moist.

4.10

EOH
Stopped in silicified clayey sand.

4.10 ▽

NOTES

1) Perched water table was encountered from a depth of 4.10 m (moderate seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF1/1 was taken at 0.95--1.35.

4) Disturbed sample DSF1/2 was taken at 1.35--1.60.

5) Disturbed sample DSF1/3 was taken at 1.75--3.10.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

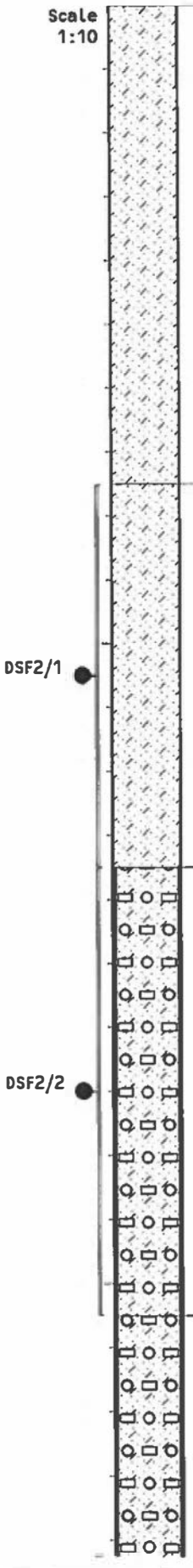
HOLE No: DSF1
DOORNBULT 624-LS

dot.PLOT 3031 J&W Inc

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF2
Sheet 1 of 2

JOB NUMBER: 000



0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled dark yellowish brown and light brown in profile, dusky olive brown when wet, soft, shattered and weakly slickensided, clayey sand.

0.75

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, light reddish brown stained light brown, firm, intact, clayey sand.

1.35

TRANSPORTED MATERIAL: SILICIFIED ALLUVIUM.
Slightly moist, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand, with frequent weakly to moderately well cemented silcrete nodules with a diameter of up to 100mm,
also with frequent sub-angular quartz gravel with a diameter of up to 10mm.

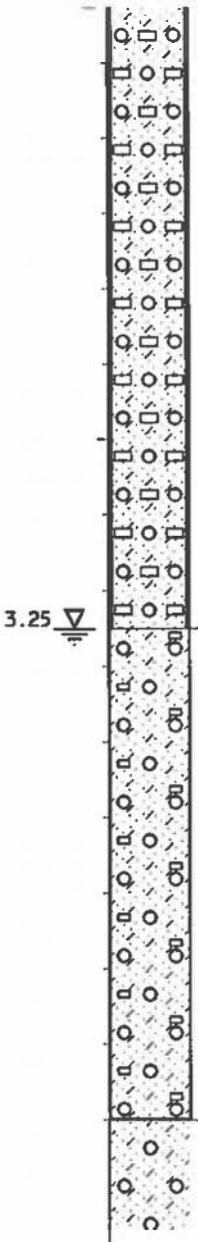
2.05

As above.
Very moist.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF2
Sheet 2 of 2

JOB NUMBER: 000



3.25

TRANSPORTED MATERIAL: WEAKLY SILICIFIED ALLUVIUM.

Wet, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand, with frequent sub- angular quartz gravel with a diameter of up to 10mm,

also with occasional weakly cemented silcrete nodules with a diameter of up to 100mm.)

3.90

EOH

Stopped in weakly silicified clayey sand with gravel.

NOTES

1) Perched water table was encountered from a depth of 3.25 m (moderate seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF2/1 was taken at 0.75--1.35.

4) Disturbed sample DSF2/2 was taken at 1.35—2.05.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

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DIAM :
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DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

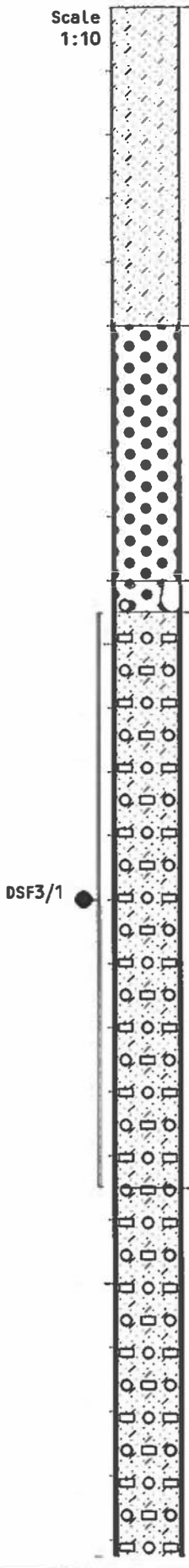
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF2
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF3
Sheet 1 of 2

JOB NUMBER: 000



0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, dark reddish brown stained orange brown, soft, shattered and weakly slickensided, clayey sand.

0.50

PEDOGENIC MATERIAL: NODULAR FERRICRETE (ferruginised alluvium).
Moist, mottled orange brown, brick red and black, well cemented, ferricrete nodules with a diameter of up to 10mm.

0.90

PEDOGENIC MATERIAL: NODULAR FERRICRETE (ferruginised alluvium).
Moist, mottled orange brown, brick red and black, well cemented, ferricrete nodules with a diameter of up to 10mm, with frequent sub-rounded granitic gneiss gravel and cobbles with a diameter of up to 10mm,
also with occasional loose silcrete nodules with a diameter of up to 10mm.

0.95

TRANSPORTED MATERIAL: SILICIFIED ALLUVIUM.
Slightly moist, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand, with frequent moderately well cemented silcrete nodules with a diameter of up to 100mm,
also with frequent sub-angular quartz gravel with a diameter of up to 10mm.

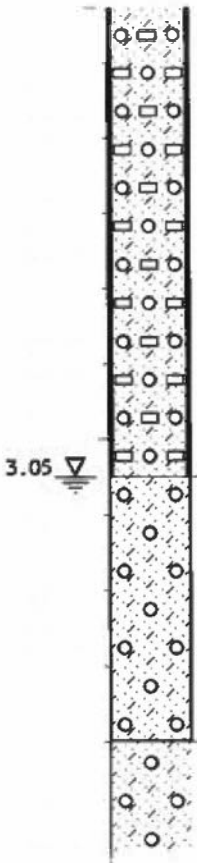
1.85

As above.
Very moist, stained dark brownish red.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF3
Sheet 2 of 2

JOB NUMBER: 000



3.05

TRANSPORTED MATERIAL: SILICIFIED ALLUVIUM.

Wet, dusky yellowish brown stained dark brownish red, firm, intact, clayey sand, with frequent sub-angular quartz gravel with a diameter of up to 10mm,

also with occasional loose silcrete nodules with a diameter of up to 100mm.

3.40

EOH

Stopped in clayey sand with gravel.

NOTES

1) Perched water table was encountered from a depth of 3.05 m (moderate seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF3/1 was taken at 0.95--1.85.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

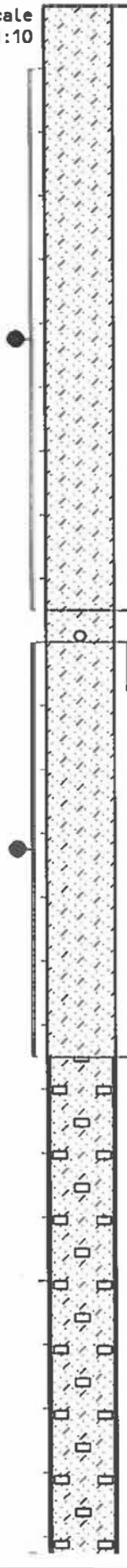
HOLE No: DSF3
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF4
Sheet 1 of 2

JOB NUMBER: 000

Scale 1:10



0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, bright reddish brown stained dark reddish brown, soft, intact, clayey sand.

0.95

As above.
with frequent sub-angular quartz gravel with a diameter of up to 50mm.

1.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, light reddish brown stained light brown, firm, intact, clayey sand,

with pockets of moist, dusky olive brown, stiff, shattered, clayey sand.

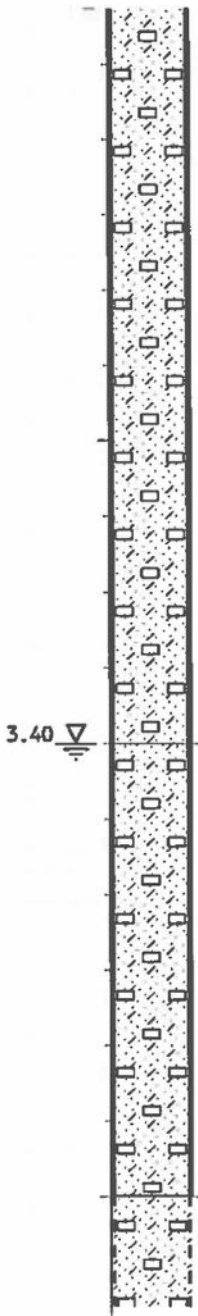
1.65

TRANSPORTED MATERIAL: SILICIFIED ALLUVIUM.
Moist, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand, with frequent weakly to moderately well cemented silcrete nodules with a diameter of up to 100mm.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF4
Sheet 2 of 2

JOB NUMBER: 000



3.40

As above.
Wet.

4.00

EOH
Stopped in silicified clayey sand.

NOTES

1) Perched water table was encountered from a depth of 3.40 m (moderate seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF4/1 was taken at 0.10--0.95.

4) Disturbed sample DSF4/2 was taken at 1.00—1.65.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF4
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF5
Sheet 1 of 2

JOB NUMBER: 000

Scale 1:10

0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled dark yellowish brown and light brown in profile, dusky olive brown when wet, soft, shattered and weakly slickensided, clayey sand.

0.90

TRANSPORTED MATERIAL: ALLUVIUM.
Slightly moist, light orange brown stained dusky orange brown, firm, intact, clayey sand.

1.55

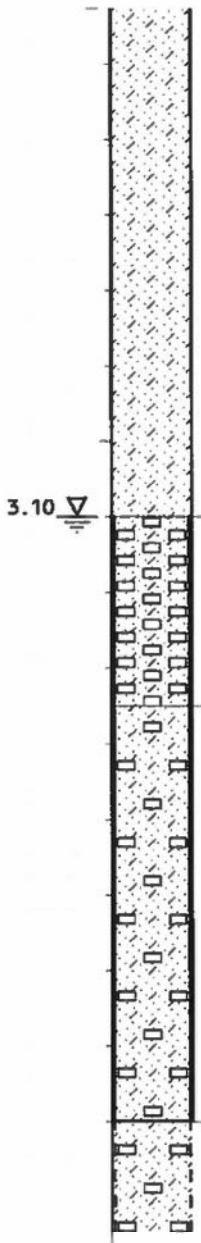
TRANSPORTED MATERIAL: ALLUVIUM.
Moist, light reddish brown stained light brown, firm, intact, clayey sand,

with pockets of moist, dusky olive brown, stiff, shattered, clayey sand.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF5
Sheet 2 of 2

JOB NUMBER: 000



3.10

PEDOGENIC MATERIAL: HARDPAN SILCRETE (silicified alluvium).
Well cemented silcrete nodules with a diameter of up to 100mm, in a matrix of wet, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand.

3.35

TRANSPORTED MATERIAL: SILICIFIED ALLUVIUM.
Wet, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand, with frequent weakly to moderately well cemented silcrete nodules with a diameter of up to 100mm, also with occasional loose ferricrete nodules with a diameter of up to 5mm.

3.90

EOH
Stopped in silicified clayey sand.

NOTES

1) Perched water table was encountered from a depth of 3.10 m (moderate seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF5/1 was taken at 0.90--1.55.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING-1.TXT

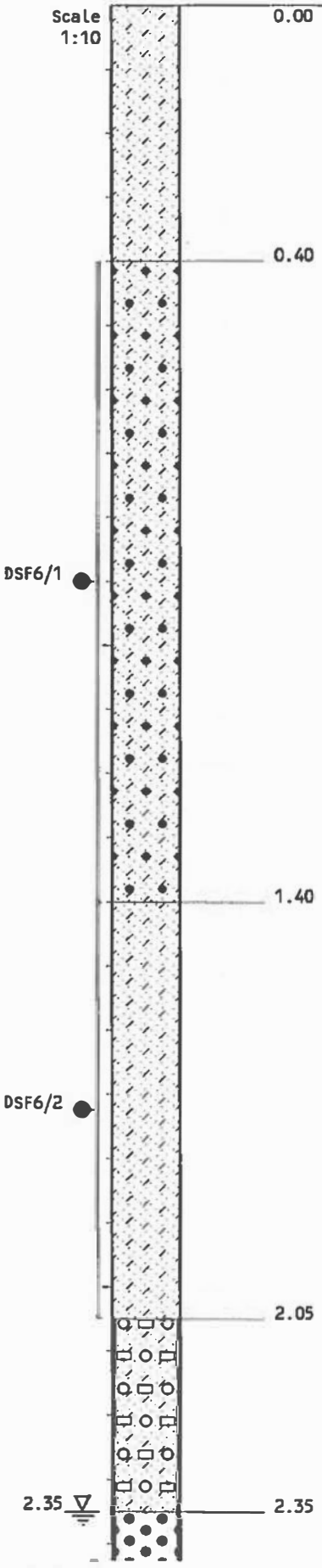
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF5
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF6
Sheet 1 of 2

JOB NUMBER: 000



0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled dark yellowish brown and light brown in profile, dusky olive brown when wet, soft, shattered and weakly slickensided, clayey sand.

0.40

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled brick red and olive brown, soft, shattered and weakly slickensided, clayey sand, with frequent loose ferricrete nodules with a diameter of up to 10mm.

1.40

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled grey and olive brown, firm, shattered and weakly slickensided, clayey sand.

2.05

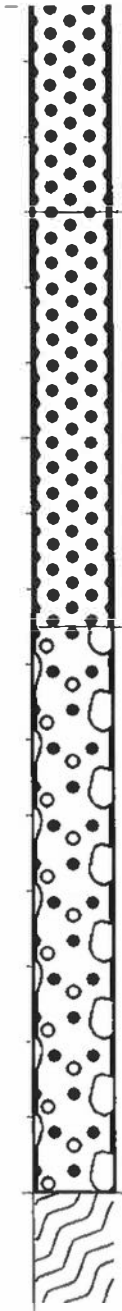
TRANSPORTED MATERIAL: SILICIFIED ALLUVIUM.
Slightly moist, dusky yellowish brown stained dusky reddish brown, firm, intact, clayey sand, with frequent weakly to moderately well cemented silcrete nodules with a diameter of up to 100mm,
also with frequent sub-angular quartz gravel with a diameter of up to 10mm.

2.35

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF6
Sheet 2 of 2

JOB NUMBER: 000



PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised alluvium).
Mottled light olive green, dusky reddish brown, creamy white and black, moderately well cemented ferricrete.

2.70

As above.
well cemented.

3.25

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised pebble marker horizon).
Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete, with frequent sub-rounded quartz, dolerite and gneiss gravel and cobbles with a diameter of up to 150mm.

4.00

EOH
Refused on moderately weathered hard gneiss.

NOTES

1) Perched water table was encountered from a depth of 2.35 m (slight seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF6/1 was taken at 0.40--1.40.

4) Disturbed sample DSF6/2 was taken at 1.40--2.05.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
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TEXT : C :\DOTPLOT\DORING-1.TXT

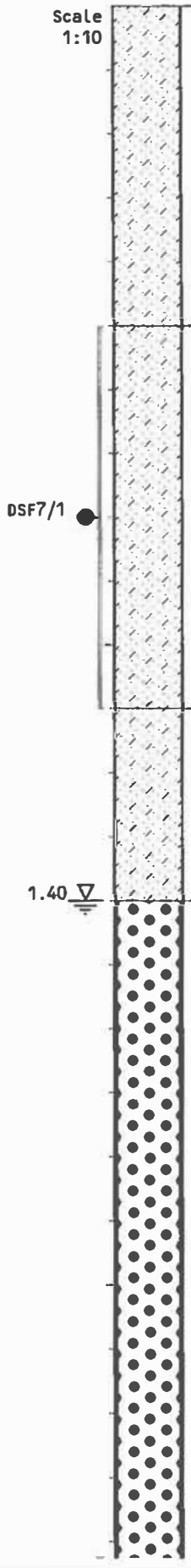
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF6
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF7
Sheet 1 of 2

JOB NUMBER: 000



0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, dark brownish red, soft, intact, clayey sand.

0.50

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, bright brownish red, soft, intact, clayey sand,
with occasional sub-rounded quartz gravel and cobbles with a diameter of up to 100mm.

1.10

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled grey and olive brown, firm, shattered and weakly slickensided, clayey sand,
with occasional rounded quartz gravel with a diameter of up to 20mm, also with very occasional quartz boulders with a diameter of up to 1000mm.

1.40

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised alluvium).
Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF7
Sheet 2 of 2

JOB NUMBER: 000

2.50

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised pebble marker horizon). Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete, with frequent sub-rounded quartz, dolerite and gneiss gravel and cobbles with a diameter of up to 150mm.

2.70

EOH

Refused in hardpan ferricrete with gravel and cobbles.

NOTES

1) Perched water table was encountered from a depth of 1.40 m (slight seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF7/1 was taken at 0.50--1.10.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING-1.TXT

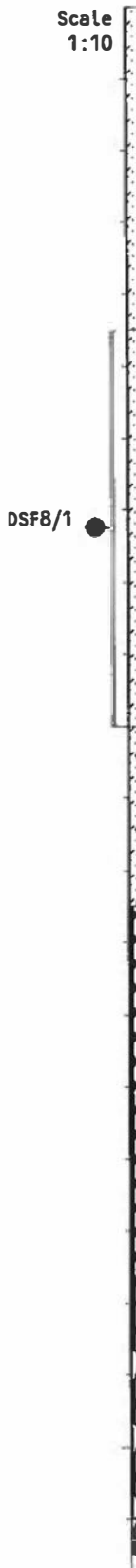
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF7
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF8
Sheet 1 of 1

JOB NUMBER: 000



0.00 **TRANSPORTED MATERIAL: ALLUVIUM.**
Moist, dark brownish red, soft, intact, clayey sand.

0.45 **TRANSPORTED MATERIAL: ALLUVIUM.**
Moist, bright brownish red, soft, intact, clayey sand, with occasional sub-rounded quartz gravel and cobbles with a diameter of up to 100mm.

1.00 **TRANSPORTED MATERIAL: ALLUVIUM.**
Very moist, mottled grey and olive brown, firm, shattered and weakly slickensided, clayey sand, with frequent rounded quartz gravel with a diameter of up to 50mm,
also with occasional loose ferricrete nodules with a diameter of up to 5mm.

1.25 **PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised alluvium).**
Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete.

1.80 **PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised pebble marker horizon).**
Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete, with frequent sub-rounded quartz, dolerite and gneiss gravel and cobbles with a diameter of up to 150mm.

2.10 **EOH**
Refused in hardpan ferricrete with gravel and cobbles.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF8/1 was taken at 0.45--1.00.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING-1.TXT

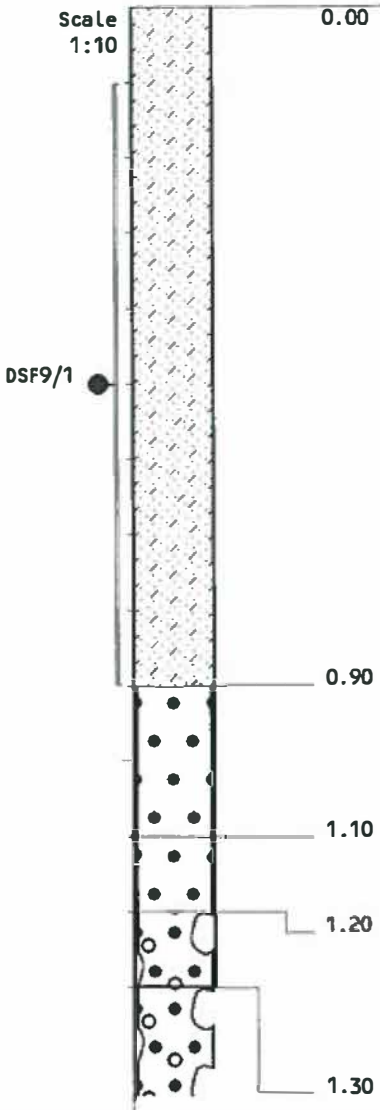
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF8
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF9
Sheet 1 of 1

JOB NUMBER: 000



0.00 — TRANSPORTED MATERIAL: ALLUVIUM.
Moist, bright brownish red, soft, intact, clayey sand, with occasional sub-rounded quartz gravel and cobbles with a diameter of up to 100mm.

0.90 — PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised alluvium).
Mottled light olive green, dusky reddish brown, creamy white and black, moderately well cemented ferricrete.

1.10 — As above.
well cemented.

1.20 — PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised pebble marker horizon).
Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete, with frequent sub-rounded quartz, dolerite and gneiss gravel and cobbles with a diameter of up to 150mm.

1.30 — EOH
Refused in hardpan ferricrete with gravel and cobbles.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF9/1 was taken at 0.10--0.90.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
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TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF9
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF10
Sheet 1 of 2

JOB NUMBER: 000

Scale 1:10

0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, bright brownish red, soft, intact, clayey sand,
with occasional sub-rounded quartz gravel and cobbles with a diameter of up to 100mm.

0.90

As above.
with frequent sub-rounded quartz gravel with a diameter of up to 50mm.

1.10

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised alluvium).
Mottled light olive green, dusky reddish brown, creamy white and black, moderately well cemented ferricrete.

2.00

As above.
well cemented.

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PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF10
Sheet 2 of 2

JOB NUMBER: 000

2.60

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised pebble marker horizon). Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete, with frequent sub-rounded quartz, dolerite and gneiss gravel and cobbles with a diameter of up to 150mm.

3.40

EOH

Refused on moderately weathered hard gneiss.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) No samples were taken.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
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DATE :
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TEXT : C:\DOTPLOT\DORING-1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF10
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF11
Sheet 1 of 1

JOB NUMBER: 000

Scale 1:10

0.00 TRANSPORTED MATERIAL: COLLUVIUM.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.30 TRANSPORTED MATERIAL: PEBBLE MARKER HORIZON.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.40 RESIDUAL MATERIAL: HIGHLY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, soft, mica-rich gneiss,
with wide, filled, medium rough joints.

0.50 As above.
MODERATELY WEATHERED, hard,
with occasional quartz-rich pegmatitic bands.

0.95 EOH
Refused on slightly weathered hard gneiss with quartz-rich pegmatitic bands.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) No samples were taken.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
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DATE :
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TEXT : C:\DOTPLOT\DORING~1.TXT

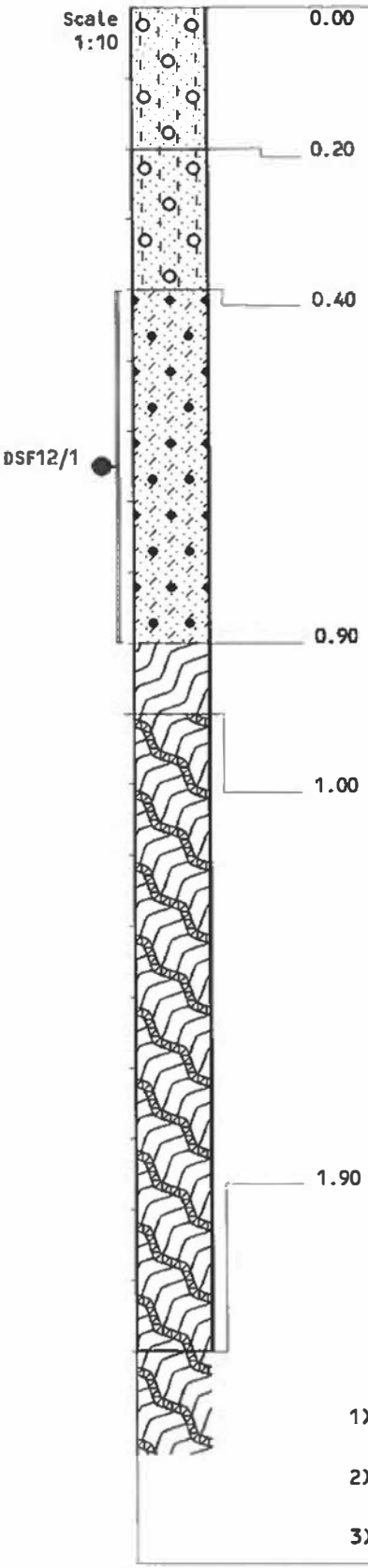
ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF11
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF12
Sheet 1 of 1

JOB NUMBER: 000



0.00 — TRANSPORTED MATERIAL: COLLUVIUM.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.20 — TRANSPORTED MATERIAL: PEBBLE MARKER HORIZON.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.40 — PEDOGENIC MATERIAL: SOFT FERRICRETE (ferruginised totally weathered gneiss).
Moist, mottled dark grey, black and orange brown, soft, intact, clayey sand, with frequent loose ferricrete nodules with a diameter of up to 10mm.

0.90 — RESIDUAL MATERIAL: HIGHLY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, soft, mica-rich gneiss,
with wide, filled, medium rough joints.

1.00 — As above.
MODERATELY WEATHERED, hard,
with occasional quartz-rich pegmatitic bands.

1.90 — EOH
Refused on slightly weathered hard gneiss with quartz-rich pegmatitic bands.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF12/1 was taken at 0.40--0.90.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING-1.TXT

ELEVATION :
X-COORD :
Y-COORD :

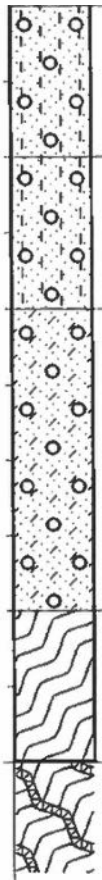
HOLE No: DSF12
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF13
Sheet 1 of 1

JOB NUMBER: 000

Scale 1:10



0.00

TRANSPORTED MATERIAL: COLLUVIUM.
Moist, dark reddish brown, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.20

TRANSPORTED MATERIAL: PEBBLE MARKER HORIZON.
Moist, dark reddish brown, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.40

RESIDUAL MATERIAL: TOTALLY WEATHERED GNEISS.
Moist, bright reddish brown, firm, intact, clayey sand, with frequent sub-angular quartz gravel with a diameter of up to 50mm.

0.80

RESIDUAL MATERIAL: HIGHLY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, soft, mica-rich gneiss, with wide, filled, medium rough joints.

1.00

EOH
Refused on moderately weathered hard gneiss with quartz-rich pegmatitic bands.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) No samples were taken.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF13
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF14
Sheet 1 of 1

JOB NUMBER: 000

0.00

TRANSPORTED MATERIAL: COLLUVIUM.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.20

TRANSPORTED MATERIAL: PEBBLE MARKER HORIZON.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.40

RESIDUAL MATERIAL: TOTALLY WEATHERED GNEISS.
Moist, bright reddish brown, firm, intact, clayey sand, with frequent sub-angular quartz gravel with a diameter of up to 50mm.

0.60

RESIDUAL MATERIAL: HIGHLY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, soft, mica-rich gneiss,
with wide, filled, medium rough joints.

1.60

RESIDUAL MATERIAL: MODERATELY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, hard, mica-rich gneiss, with occasional quartz-rich pegmatitic bands,
with narrow, filled, medium rough joints.

1.70

EOH
Refused on moderately weathered hard gneiss with quartz-rich pegmatitic bands.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) No samples were taken.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING-1.TXT

ELEVATION :
X-COORD :
Y-COORD :

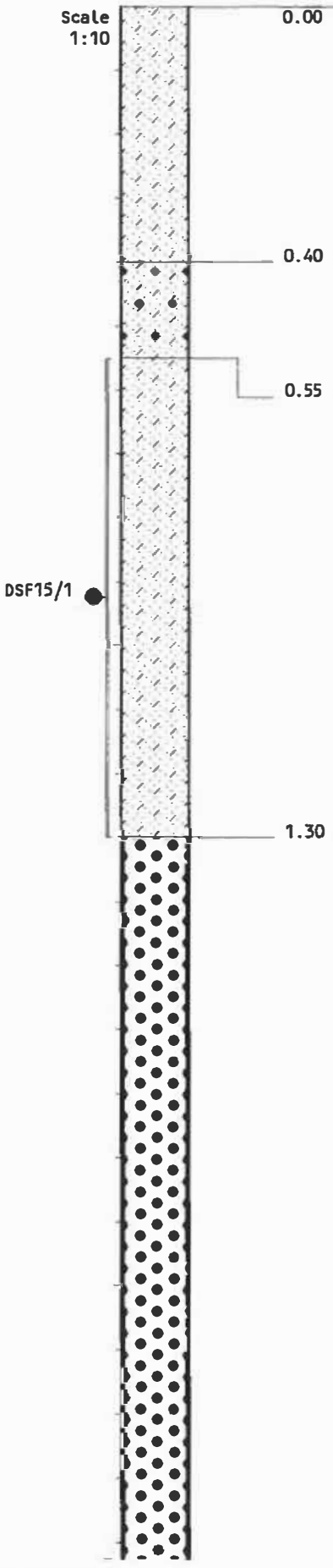
HOLE No: DSF14
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF15
Sheet 1 of 2

JOB NUMBER: 000

Scale 1:10



0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled dark yellowish brown and light brown in profile, dusky olive brown when wet, soft, shattered and weakly slickensided, clayey sand.

0.40

TRANSPORTED MATERIAL: FERRUGINISED ALLUVIUM.
Moist, mottled brick red and olive brown, soft, shattered and weakly slickensided, clayey sand, with frequent rust red and black ferricrete nodules with a diameter of up to 10mm.

0.55

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, light reddish brown stained light brown, firm, intact, clayey sand,

with pockets of moist, dusky olive brown, stiff, shattered, clayey sand.

1.30

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised alluvium).
Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF15
Sheet 2 of 2

JOB NUMBER: 000

3.00

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised pebble marker horizon). Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete, with frequent sub-rounded quartz, dolerite and gneiss gravel and cobbles with a diameter of up to 150mm.

3.20

EOH

Refused in hardpan ferricrete with gravel and cobbles.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF15/1 was taken at 0.55—1.30.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : F. CALITZ
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING-1.TXT

ELEVATION :
X-COORD :
Y-COORD :

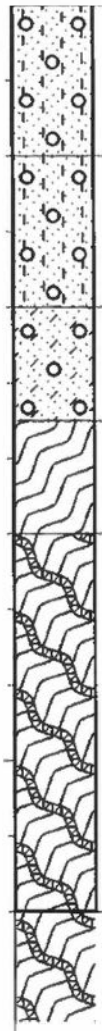
HOLE No: DSF15
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF16
Sheet 1 of 1

JOB NUMBER: 000

Scale 1:10



0.00 TRANSPORTED MATERIAL: COLLUVIUM.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.20 TRANSPORTED MATERIAL: PEBBLE MARKER HORIZON.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.40 RESIDUAL MATERIAL: TOTALLY WEATHERED GNEISS.
Moist, bright reddish brown, firm, intact, clayey sand, with frequent sub-angular quartz gravel with a diameter of up to 50mm.

0.55 RESIDUAL MATERIAL: HIGHLY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, soft, mica-rich gneiss,
with wide, filled, medium rough joints.

0.70 RESIDUAL MATERIAL: MODERATELY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, hard, mica-rich gneiss, with occasional quartz-rich pegmatitic bands,
with narrow, filled, medium rough joints.

1.20 EOH
Refused on moderately weathered hard gneiss with quartz-rich pegmatitic bands.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) No samples were taken.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : R. CROSBY
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING-1.TXT

ELEVATION :
X-COORD :
Y-COORD :

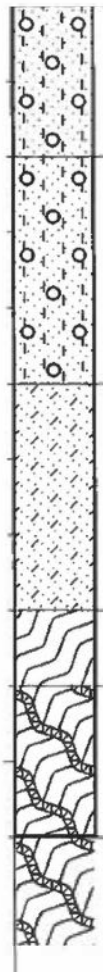
HOLE No: DSF16
DOORNBULT 624-LS

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF17
Sheet 1 of 1

JOB NUMBER: 000

Scale 1:10



0.00 TRANSPORTED MATERIAL: COLLUVIUM.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.20 TRANSPORTED MATERIAL: PEBBLE MARKER HORIZON.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.50 RESIDUAL MATERIAL: TOTALLY WEATHERED GNEISS.
Moist, bright reddish brown, firm, intact, clayey sand,
with occasional sub-angular quartz gravel with a diameter of up to 20mm.

0.80 RESIDUAL MATERIAL: HIGHLY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, soft, mica-rich gneiss,
with wide, filled, medium rough joints.

0.90 RESIDUAL MATERIAL: MODERATELY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, hard, mica-rich gneiss, with occasional quartz-rich pegmatitic bands,
with narrow, filled, medium rough joints.

1.10 EOH
Refused on moderately weathered hard gneiss with quartz-rich pegmatitic bands.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) No samples were taken.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : R. CROSBY
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF17
DOORNBULT 624-LS

dot.PLOT 3031 J&W Inc

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF18
Sheet 1 of 1

JOB NUMBER: 000

Scale 1:10

0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, dark reddish brown, loose, intact, clayey sand.

0.40

TRANSPORTED MATERIAL: COLLUVIUM.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.60

TRANSPORTED MATERIAL: PEBBLE MARKER HORIZON.
Slightly moist, light reddish brown stained dark reddish brown in profile, brown when wet, loose, intact, silty sand, with frequent sub-angular quartz gravel with a diameter of up to 20mm.

0.75

RESIDUAL MATERIAL: HIGHLY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, soft, mica-rich gneiss,
with very wide, filled and ferruginised, medium rough joints.

1.30

RESIDUAL MATERIAL: MODERATELY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, black, colourless and reddish brown, coarse-grained, highly jointed, hard, mica-rich gneiss, with occasional quartz-rich pegmatitic bands,
with narrow, filled, medium rough joints.

1.50

EOH
Refused on moderately weathered hard gneiss with quartz-rich pegmatitic bands.

NOTES

1) No groundwater seepage was encountered.

2) The sidewalls remained stable for the duration of profiling.

3) No samples were taken.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : R. CROSBY
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF18
DOORNBULT 624-LS

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SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF19
Sheet 1 of 2

JOB NUMBER: 000

0.00

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, dark yellowish brown stained dark reddish brown in profile, olive brown when wet, soft, intact, clayey sand.

0.50

TRANSPORTED MATERIAL: ALLUVIUM.
Moist, mottled olive brown and brick red, soft, shattered and slickensided, clayey sand,
with occasional loose ferricrete nodules with a diameter of up to 5mm.

0.90

TRANSPORTED MATERIAL: FERRUGINISED ALLUVIUM (ferruginised alluvium).
Mottled creamy white and olive brown, firm, stratified, clayey sand, with frequent weakly cemented ferricrete nodules with a diameter of up to 5mm.

1.20

As above.
well cemented.

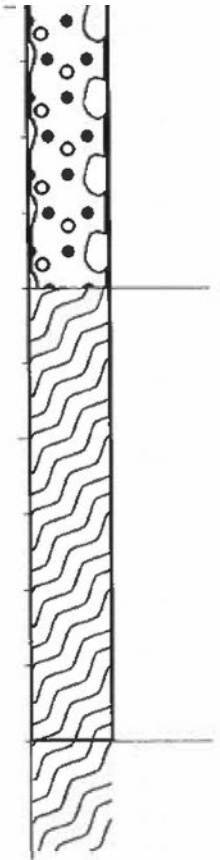
1.90

PEDOGENIC MATERIAL: HARDPAN FERRICRETE (ferruginised pebble marker horizon).
Mottled light olive green, dusky reddish brown, creamy white and black, well cemented ferricrete, with frequent sub-rounded quartz, dolerite and gneiss gravel and cobbles with a diameter of up to 150mm.

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD
PIETERSBURG WASTEWATER PURIFICATION WORKS

HOLE No: DSF19
Sheet 2 of 2

JOB NUMBER: 000



2.80

RESIDUAL MATERIAL: MODERATELY WEATHERED HOUTRIVIER GNEISS.
Mottled creamy white, golden brown, black and colourless, coarse-grained, highly jointed, hard, mica-rich gneiss, with narrow, filled, medium rough joints.

3.40

EOH
Refused on moderately weathered hard gneiss.

NOTES

1) Perched water table was encountered from a depth of 1.90 m (slight seepage).

2) The sidewalls remained stable for the duration of profiling.

3) Disturbed sample DSF19/1 was taken at 0.50--0.90.

CONTRACTOR : ROYTHA CONSTRUCTION
MACHINE : DAEWOO 220LC-V TRAX
DRILLED BY :
PROFILED BY : R. CROSBY
TYPE SET BY : F. CALITZ
SETUP FILE : STANDARD.SET

INCLINATION : TEST PIT
DIAM :
DATE :
DATE : 2000-05-30
DATE : 29/06/00 10:03
TEXT : C:\DOTPLOT\DORING~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: DSF19
DOORNBULT 624-LS

APPENDIX C

Detailed laboratory test results

Matrolab (PTY)LTD trading as

TPT LAB

Siviele Ingenieurslaboratorium / Civil Engineering Laboratory
Reg. No.: 70/15020/07 - BTW / VAT Reg. No.: 4960106096

P.O.Box 112, PIETERSBURG 0700
9A Sapphire Street, SUPERBIA, PIETERSBURG 0699

TEL.: 015-2920511
FAX: 015-2921243

Geocon
P.O.Box 2526
PIETERSBURG
0700

20/6/2000

DISPERSIVENESS BY MEANS OF DOUBLE HYDROMETER

PROJECT: DORINGBULT SEWERAGE WORKS

JOB REQUEST NO.: 0/TPT/78326/20

DATE: 14/6/2000

LAB REF.	SAMPLE REFER.	DEPTH (mm)	DISPERSIVENESS (%)	
			BS (<0.005mm)	ASTM (<0.002mm)
A643	DSF 1/1	950 - 1350	14.4	22.3
A644	DSF 1/2	1350 - 1600	16.9	34.0
A645	DSF 1/3	1750 - 3100	53.7	100.0
A646	DSF 2/1	750 - 1350	15.6	28.8
A647	DSF 2/2	1350 - 2050	25.7	68.6
A648	DSF 3/1	950 - 1850	41.9	28.9
A649	DSF 4/1	100 - 950	29.1	68.8
A650	DSF 4/2	1000 - 1650	30.6	18.2
A651	DSF 5/1	900 - 1550	29.0	68.7
A652	DSF 6/1	400 - 1400	10.3	6.6
A653	DSF 6/2	1400 - 2050	12.4	4.7
A654	DSF 7/1	500 - 1100	22.5	25.0
A655	DSF 8/1	450 - 1000	29.0	50.0
A656	DSF 12/1	100 - 900	30.7	24.3
A657	DSF 12/1	400 - 900	8.0	9.5
A658	DSF 15/1	550 - 1300	9.1	10.5
A659	DSF 19/1	500 - 900	25.7	68.6

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P.O.BOX 112. PIETERSBURG

Tel: 015 2920511/2921243
Fax: 015 2921243/2920511

GEOCON
P.O.BOX 2526
PIETERSBURG
0700

AANDAG :
ATTENTION : FRED CALITZ

PROJEK :
PROJECT : DORINGBULT SEWERAGE WORKS
U VERW. :
YOUR REF. : LETTER
ONS VERW. :
OUR REF. : 78326/20
DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A643 GAT/HOLE NO: DSF 1/1 DIEPTE/DEPTH (mm): 950-1350
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : DK OLIVE BROWN SILTY SAND

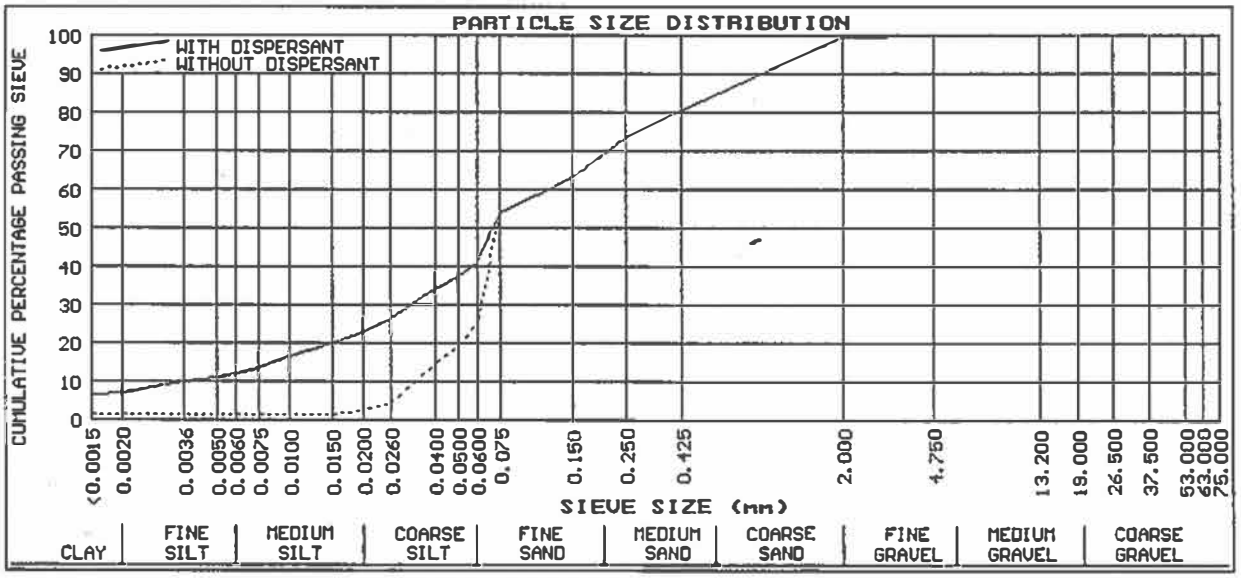
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 49	PERCENTAGE (< 0.002): 7	P.R.A. CLASSIFICATION : A-7-6(10)
PLASTICITY INDEX : 23	PI OF WHOLE SAMPLE : 19	UNIFIED SOIL CLASSIFICATION : CL
LINEAR SHRINKAGE (%) : 9.5	MOISTURE CONTENT (%): -	ACTIVITY : 2.6
GRADING MODULUS : 0.66		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
22.3	7.2	33.6	58.4	0.7	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	99	81	74	63	54

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	40.87	37.45	34.03	26.40	22.80	20.22	16.51	13.70	12.13	11.19	9.88	7.23	6.56
% WITHOUT DISP.	24.82	19.55	14.28	4.41	2.53	1.75	1.61	1.61	1.61	1.61	1.61	1.61	1.61



OPMERKINGS/REMARKS :

VORM/FORM: A6

Program ver 9.0

nms/for TPT LAB

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TPT LAB

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9A SAPPHIRE ST, SUPERBIA, PIETERSBURG
P.O.BOX 112, PIETERSBURG

Tel: 015 2920511/2921243
Fax: 015 2921243/2920511

GEOCON
P.O.BOX 2526
PIETERSBURG
0700

AANDAG :
ATTENTION : FRED CALITZ

PROJEK :
PROJECT : DORINGBULT SEWERAGE WORKS
U VERW. :
YOUR REF. : LETTER
ONS VERW. :
OUR REF. : 78326/20
DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A644 GAT/HOLE NO: DSF 1/2 DIEPTE/DEPTH (mm): 1350-1600
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : LT RD BR WITH LT BR STAINS SANDY SILT

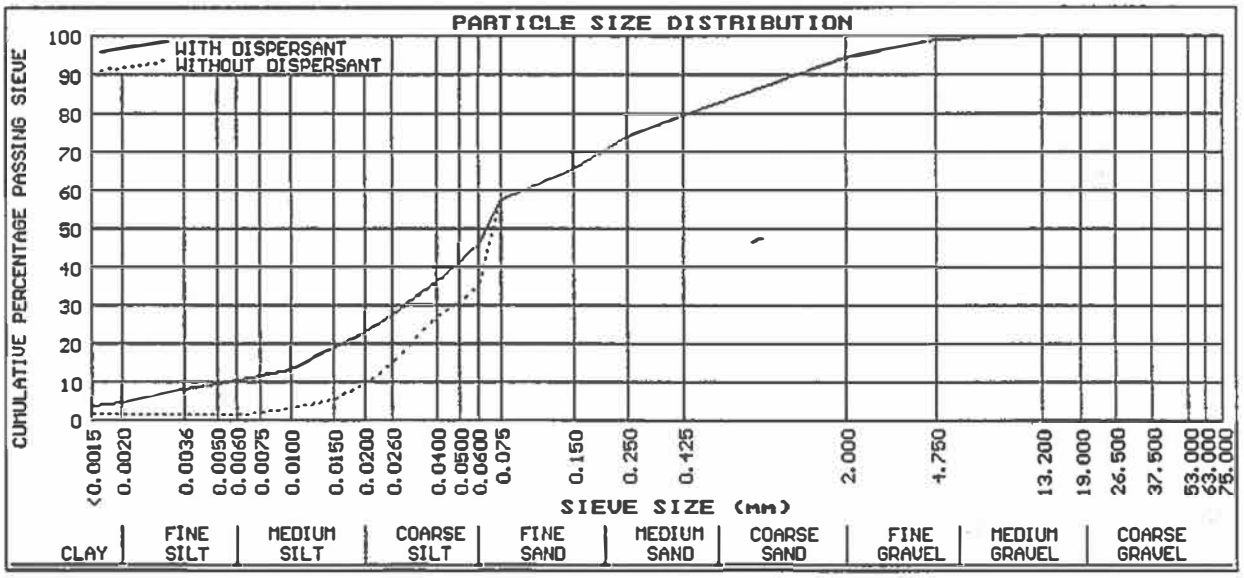
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 49	PERCENTAGE (< 0.002): 5	P.R.A. CLASSIFICATION : A-7-6(10)
PLASTICITY INDEX : 20	PI OF WHOLE SAMPLE : 16	UNIFIED SOIL CLASSIFICATION : OL
LINEAR SHRINKAGE (%) : 9.5	MOISTURE CONTENT (%): -	ACTIVITY : 3.4
GRADING MODULUS : 0.69		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
34.0	4.7	41.2	48.6	5.5	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	99	94	79	74	66	57

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	45.87	40.93	35.99	27.65	23.17	18.84	13.15	11.48	10.32	9.41	8.13	4.67	3.34
% WITHOUT DISP.	35.12	31.12	27.12	15.19	9.70	5.58	3.19	1.82	1.59	1.59	1.59	1.59	1.59



OPMERKINGS/REMARKS :

VORM/FORM: A6

Program ver 9.0

nms/for TPT LAB

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-CIVIL ENGINEERING LABORATORY-

9A SAPPHIRE ST. SUPERBIA. PIETERSBURG
P.O.BOX 112. PIETERSBURG

Tel: 015 2920511/2921243
Fax: 015 2921243/2920511

GEOCON
P.O.BOX 2526
PIETERSBURG
0700

AANDAG :
ATTENTION : FRED CALITZ

PROJEK :
PROJECT : DORINGBULT SEWERAGE WORKS
U VERW. :
YOUR REF. : LETTER
ONS VERW. :
OUR REF. : 78326/20
DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A645 GAT/HOLE NO: DSF 1/3 DIEPTE/DEPTH (mm): 1750-3100
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : DUSKY YEL BR WITH OCCATIONAL DUSKY RD BR STAINS SILTY SAND

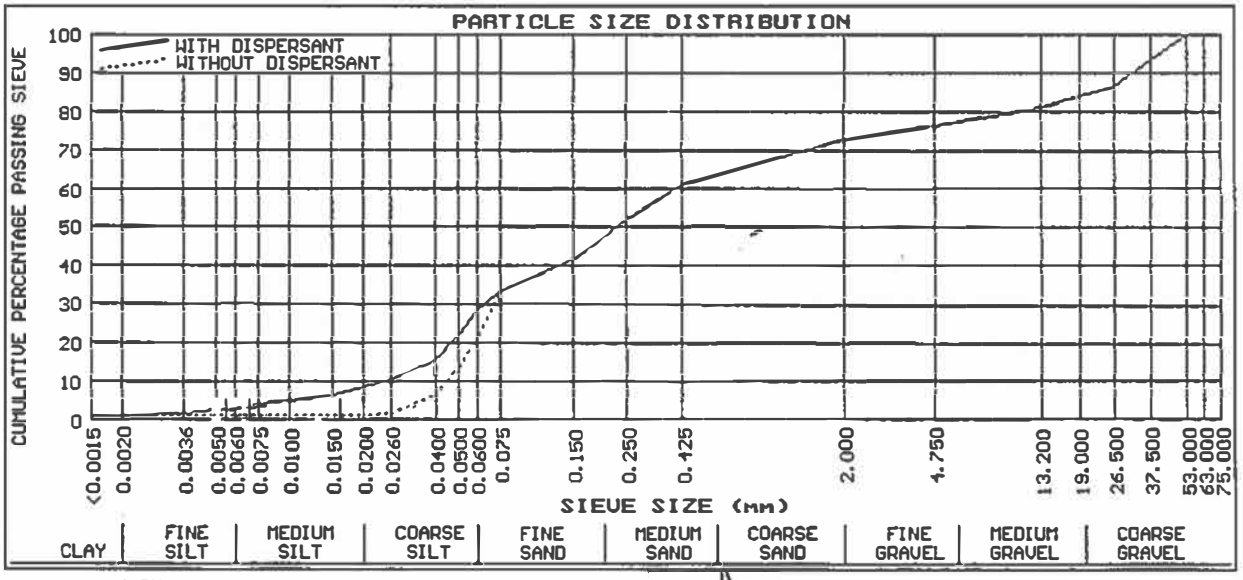
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 34	PERCENTAGE (< 0.002): 1	P.R.A. CLASSIFICATION : A-2-6(0)
PLASTICITY INDEX : 11	PI OF WHOLE SAMPLE : 7	UNIFIED SOIL CLASSIFICATION : SC
LINEAR SHRINKAGE (%) : 5.5	MOISTURE CONTENT (%): -	ACTIVITY : 5.8
GRADING MODULUS : 1.33		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
100.0	1.2	27.3	44.3	27.2	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	93	87	84	81	76	73	61	52	42	34

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	28.54	22.01	15.49	10.38	8.36	6.50	4.91	3.86	2.96	2.27	1.31	1.22	1.22
% WITHOUT DISP.	21.16	13.71	6.26	1.62	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22



OPMERKINGS/REMARKS :

VORM/FORM: A6

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PIETERSBURG
0700

AANDAG :
ATTENTION : FRED CALITZ

PROJEK :
PROJECT : DORINGBULT SEWERAGE WORKS
U VERW. :
YOUR REF. : LETTER
ONS VERW. :
OUR REF. : 78326/20
DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A646 GAT/HOLE NO: DSF 2/1 DIEPTE/DEPTH (mm): 750-1350
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : LT RD BR WITH LT BR STAINS SILTY SAND

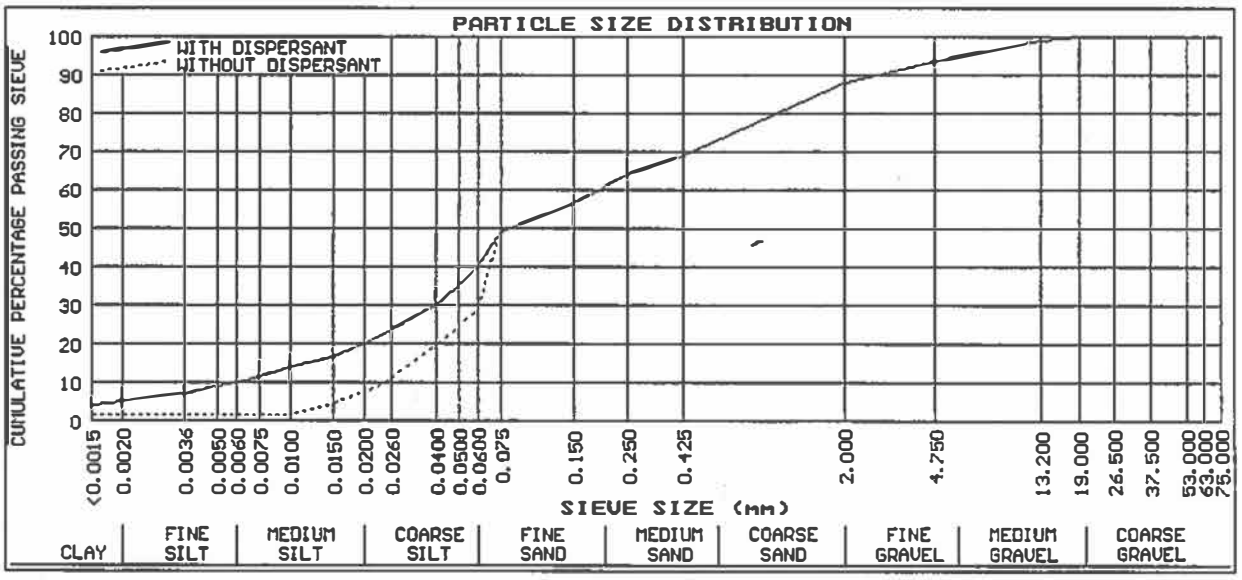
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 54	PERCENTAGE (< 0.002): 5	P.R.A. CLASSIFICATION : A-7-6(9)
PLASTICITY INDEX : 25	PI OF WHOLE SAMPLE : 17	UNIFIED SOIL CLASSIFICATION : SM
LINEAR SHRINKAGE (%) : 11.5	MOISTURE CONTENT (%): -	ACTIVITY : 3.5
GRADING MODULUS : 0.94		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
28.8	4.8	35.2	48.1	11.9	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	99	93	88	69	64	56	49

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	40.03	35.10	30.16	23.62	20.13	16.37	13.96	11.72	10.04	8.83	7.14	4.79	4.22
% WITHOUT DISP.	28.96	24.30	19.63	11.11	7.52	4.70	1.38	1.38	1.38	1.38	1.38	1.38	1.38



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OUR REF. : 78326/20
DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A647 GAT/HOLE NO: DSF 2/2 DIEPTE/DEPTH (mm): 1350-2050
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : DUSKY YEL BRWITH OCCATIONAL DUSKY RD BR STAINS SILTY SAND

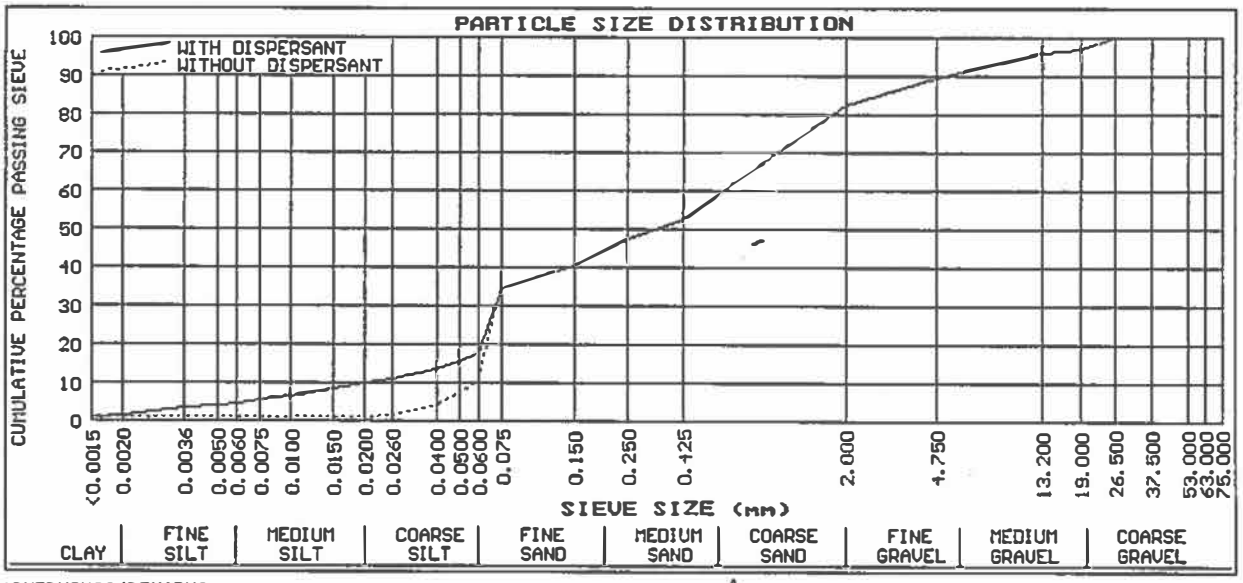
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 44	PERCENTAGE (< 0.002): 2	P.R.A. CLASSIFICATION : A-2-7(2)
PLASTICITY INDEX : 18	PI OF WHOLE SAMPLE : 9	UNIFIED SOIL CLASSIFICATION : SC
LINEAR SHRINKAGE (%) : 8.0	MOISTURE CONTENT (%): -	ACTIVITY : 5.9
GRADING MODULUS : 1.31		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
68.7	1.5	16.0	64.7	17.7	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	97	96	90	82	53	47	40	34

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	17.56	15.45	13.35	10.92	9.77	8.70	6.44	5.46	4.69	4.09	3.25	1.53	1.10
% WITHOUT DISP.	10.51	7.63	4.74	1.40	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05



OPMERKINGS/REMARKS :

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DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A648 GAT/HOLE NO: DSF 3/1 DIEPTE/DEPTH (mm): 950-1850
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : OR BR WITH BRICK+BLACK MOTTLES SILTY SAND

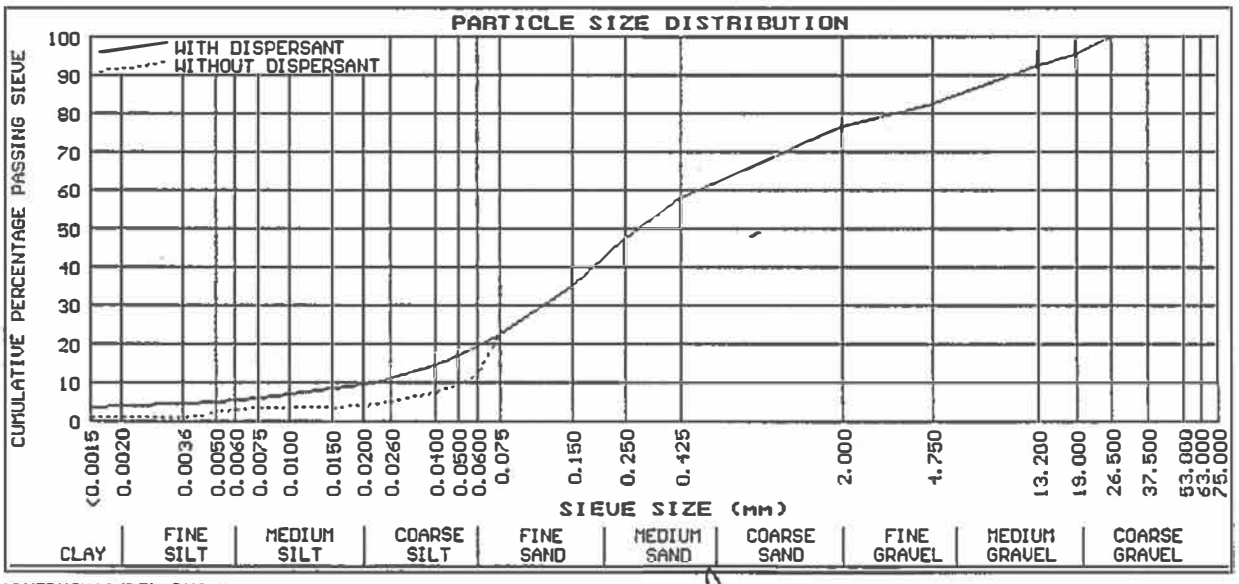
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 32	PERCENTAGE (< 0.002): 4	P.R.A. CLASSIFICATION : A-2-4(0)
PLASTICITY INDEX : 9	PI OF WHOLE SAMPLE : 5	UNIFIED SOIL CLASSIFICATION : SC
LINEAR SHRINKAGE (%) : 4.0	MOISTURE CONTENT (%): -	ACTIVITY : 1.2
GRADING MODULUS : 1.43		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
28.8	4.0	15.3	57.3	23.4	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	96	92	82	77	58	48	35	23

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	19.34	17.02	14.69	11.08	9.58	8.40	7.01	6.02	5.48	5.15	4.69	4.02	3.54
% WITHOUT DISP.	11.91	9.68	7.44	4.95	4.16	3.58	3.47	3.47	2.81	2.16	1.25	1.16	1.16



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DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A649 GAT/HOLE NO: DSF 4/1 DIEPTE/DEPTH (mm): 100-950
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : LT RD BR SILTY SAND

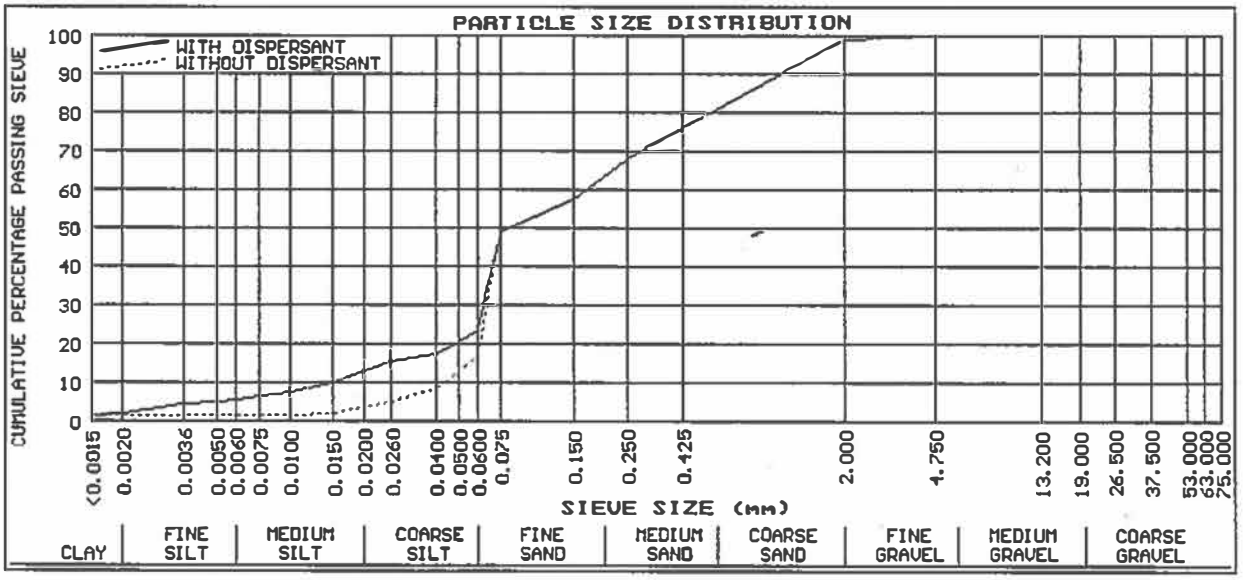
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 28	PERCENTAGE (< 0.002): 2	P.R.A. CLASSIFICATION : A-4(3)
PLASTICITY INDEX : 9	PI OF WHOLE SAMPLE : 7	UNIFIED SOIL CLASSIFICATION : SC
LINEAR SHRINKAGE (%) : 4.0	MOISTURE CONTENT (%): -	ACTIVITY : 3.2
GRADING MODULUS : 0.76		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
68.7	2.2	21.5	75.2	1.1	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	99	76	68	58	49

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	23.74	20.72	17.69	15.49	13.04	9.88	7.67	6.36	5.66	5.23	4.63	2.21	1.59
% WITHOUT DISP.	16.88	12.66	8.44	4.94	3.28	1.78	1.52	1.52	1.52	1.52	1.52	1.52	1.52



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DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A650 GAT/HOLE NO: DSF 4/2 DIEPTE/DEPTH (mm): 1000-1650
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : DK OLIVE BR WITH LT RD BR MATRIX SANDY SILT

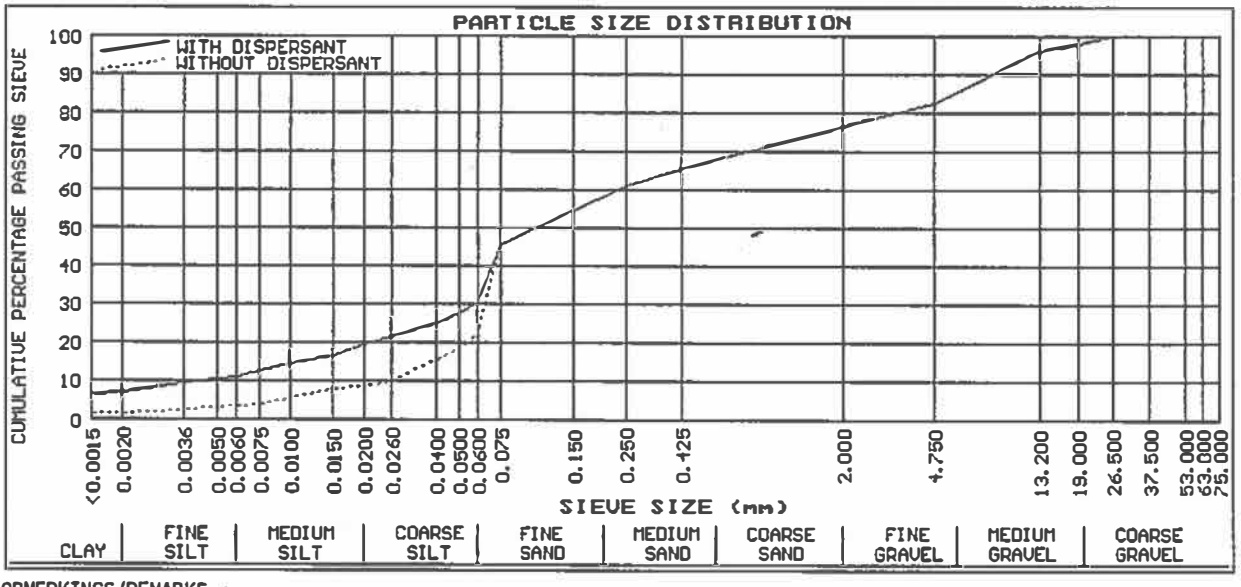
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 46	PERCENTAGE (< 0.002): 7	P.R.A. CLASSIFICATION : A-7-5(4)
PLASTICITY INDEX : 15	PI OF WHOLE SAMPLE : 10	UNIFIED SOIL CLASSIFICATION : SM
LINEAR SHRINKAGE (%) : 7.5	MOISTURE CONTENT (%): -	ACTIVITY : 1.4
GRADING MODULUS : 1.13		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
18.2	7.2	23.2	46.1	23.5	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	98	96	82	77	66	61	55	45

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	30.40	27.65	24.91	21.68	19.50	16.68	14.59	12.49	11.20	10.43	9.36	7.20	6.65
% WITHOUT DISP.	21.83	18.64	15.45	10.07	8.68	8.02	5.35	4.16	3.56	3.19	2.68	1.31	1.31



OPMERKINGS/REMARKS :

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DATUM GERAPPORTEER :
DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A651 GAT/HOLE NO: DSF 5/1 DIEPTE/DEPTH (mm): 900-1550
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : LT OR BR WITH DUSKY OR BR STAINS SANDY SILT

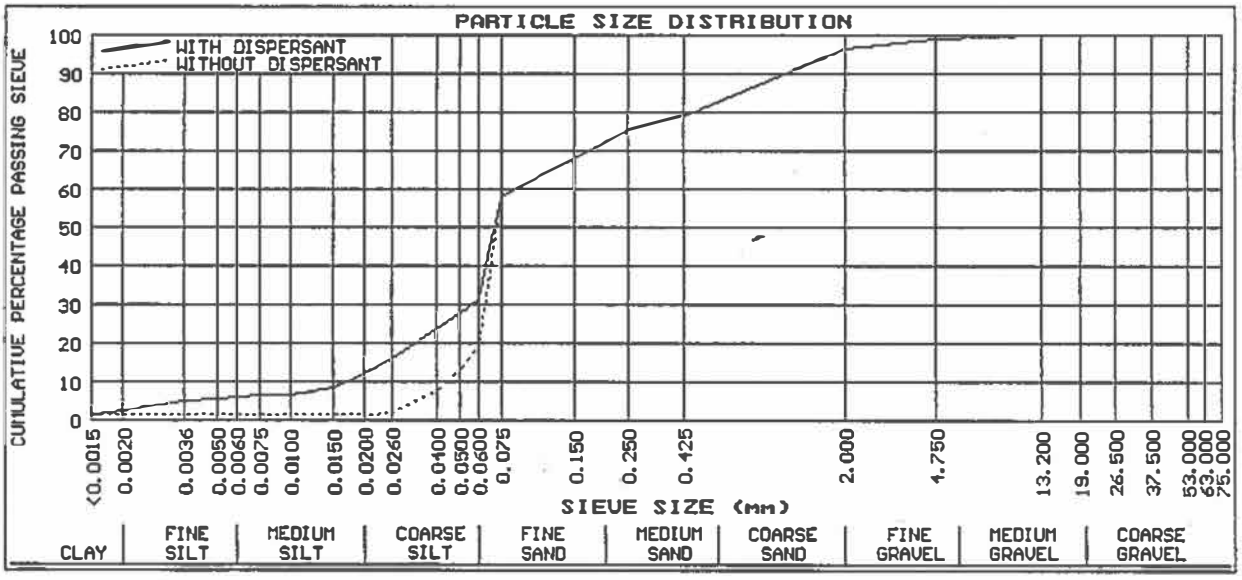
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 39	PERCENTAGE (< 0.002): 2	P.R.A. CLASSIFICATION : A-6(6)
PLASTICITY INDEX : 13	PI OF WHOLE SAMPLE : 10	UNIFIED SOIL CLASSIFICATION : OL
LINEAR SHRINKAGE (%) : 5.5	MOISTURE CONTENT (%): -	ACTIVITY : 4.3
GRADING MODULUS : 0.67		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
68.7	2.3	29.2	64.9	3.6	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	99	96	79	75	68	58

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	31.49	27.56	23.64	15.79	11.92	8.64	6.38	6.32	5.89	5.44	4.81	2.30	1.65
% WITHOUT DISP.	18.83	13.11	7.39	2.10	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58



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MONSTER/SAMPLE NO: A652 GAT/HOLE NO: DSF 6/1 DIEPTE/DEPTH (mm): 400-1400
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : MOT BRICK RED +OLIVE BR STAINS SANDY CLAY

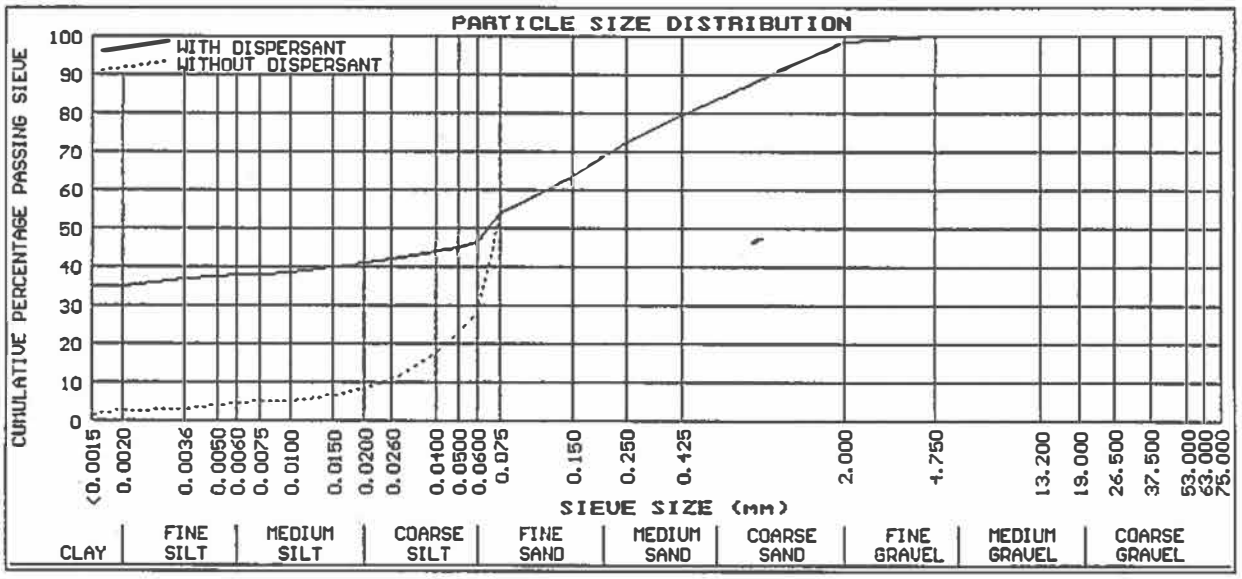
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 36	PERCENTAGE (< 0.002): 35	P.R.A. CLASSIFICATION : A-6(7)
PLASTICITY INDEX : 18	PI OF WHOLE SAMPLE : 14	UNIFIED SOIL CLASSIFICATION : CL
LINEAR SHRINKAGE (%) : 8.0	MOISTURE CONTENT (%): -	ACTIVITY : 0.4
GRADING MODULUS : 0.68		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
6.6	35.0	11.6	52.1	1.4	SANDY CLAY

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	99	79	72	63	54

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	46.55	45.19	43.83	41.96	41.12	40.22	38.70	38.15	38.04	37.54	36.84	34.97	34.97
% WITHOUT DISP.	28.11	22.80	17.48	10.56	8.30	6.70	4.81	4.77	4.32	3.87	3.24	2.31	1.66



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MONSTER/SAMPLE NO: A653 GAT/HOLE NO: DSF 6/2 DIEPTE/DEPTH (mm): 1400-2050
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : MOT GR WITH OR BR STAINS SANDY CLAY

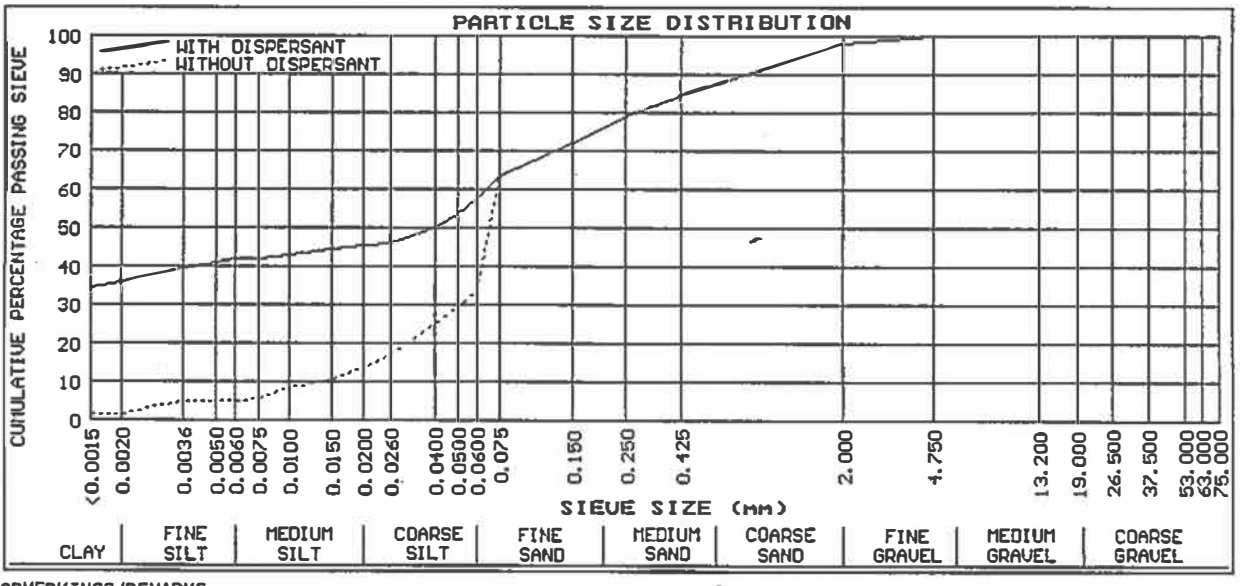
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 39	PERCENTAGE (< 0.002): 36	P.R.A. CLASSIFICATION : A-6(9)
PLASTICITY INDEX : 19	PI OF WHOLE SAMPLE : 16	UNIFIED SOIL CLASSIFICATION : CL
LINEAR SHRINKAGE (%) : 8.5	MOISTURE CONTENT (%): -	ACTIVITY : 0.4
GRADING MODULUS : 0.54		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
4.7	35.9	21.5	40.6	2.0	SANDY CLAY

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	98	84	79	72	64

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	57.46	53.66	49.86	46.21	45.31	44.36	42.77	42.14	41.97	40.89	39.37	35.92	34.35
% WITHOUT DISP.	33.60	29.42	25.23	16.85	13.35	10.75	8.51	5.65	5.06	5.06	5.06	1.69	1.69



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DATE REPORTED : 14/06/00

MONSTER/SAMPLE NO: A654 GAT/HOLE NO: DSF 7/1 DIEPTE/DEPTH (mm): 500-1100
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : BRIGHT BROWNISH RED SILTY SAND

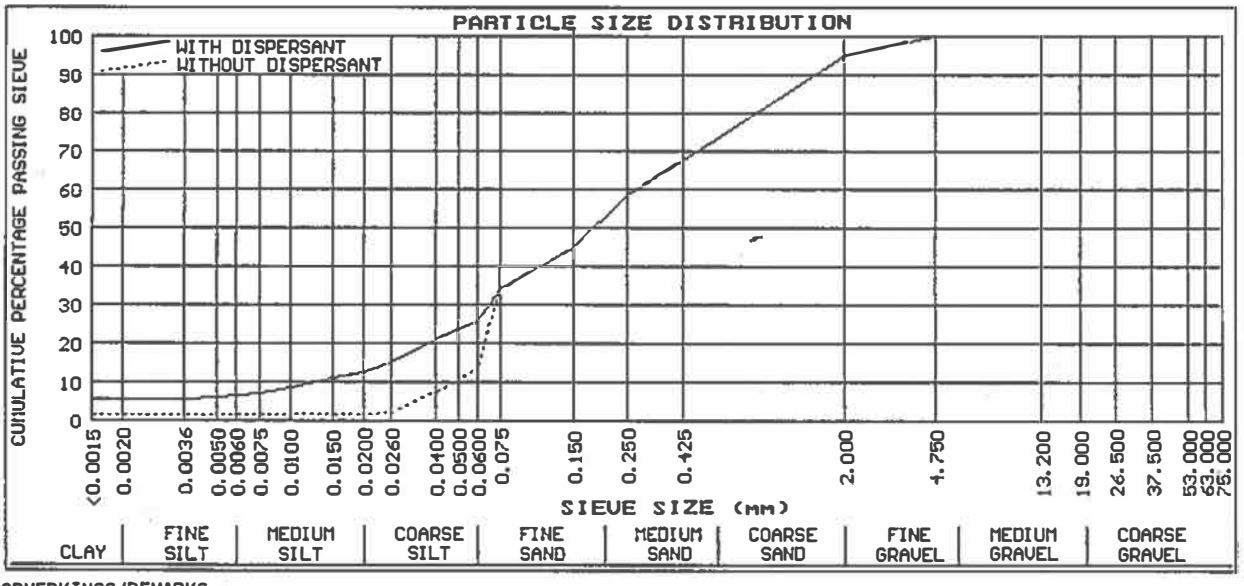
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 20	PERCENTAGE (< 0.002): 5	P.R.A. CLASSIFICATION : A-2-4(0)
PLASTICITY INDEX : 7	PI OF WHOLE SAMPLE : 5	UNIFIED SOIL CLASSIFICATION : SM-SC
LINEAR SHRINKAGE (%) : 3.5	MOISTURE CONTENT (%): -	ACTIVITY : 0.9
GRADING MODULUS : 1.03		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
25.0	5.4	20.1	69.7	4.8	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	95	67	59	45	34

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	25.49	23.31	21.14	14.90	12.55	11.17	8.27	7.02	6.39	6.01	5.47	5.40	5.40
% WITHOUT DISP.	13.70	10.54	7.38	1.95	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35



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MONSTER/SAMPLE NO: A655 GAT/HOLE NO: DSF 8/1 DIEPTE/DEPTH (mm): 450-1000
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : BRIGHT BROWNISH RED SAND

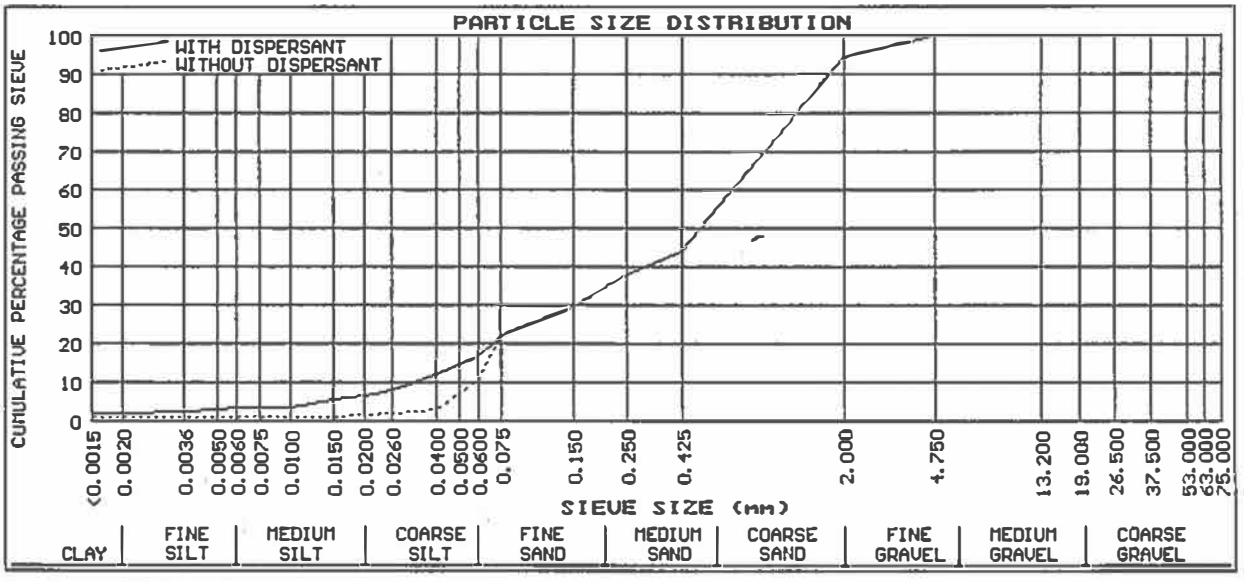
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 16	PERCENTAGE (< 0.002): 2	P.R.A. CLASSIFICATION : A-1-b(0)
PLASTICITY INDEX : 5	PI OF WHOLE SAMPLE : 2	UNIFIED SOIL CLASSIFICATION : SM-SC
LINEAR SHRINKAGE (%) : 2.0	MOISTURE CONTENT (%): -	ACTIVITY : 1.1
GRADING MODULUS : 1.40		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
50.0	1.8	14.8	77.9	5.6	SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	94	44	38	29	22

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	16.55	14.38	12.22	7.85	6.38	5.49	3.59	3.52	3.28	3.03	2.68	1.76	1.76
% WITHOUT DISP.	10.37	6.79	3.22	1.86	1.38	0.95	0.88	0.88	0.88	0.88	0.88	0.88	0.88



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MONSTER/SAMPLE NO: A656 GAT/HOLE NO: DSF 9/1 DIEPTE/DEPTH (mm): 100-900
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : DK BR RED SILTY SAND

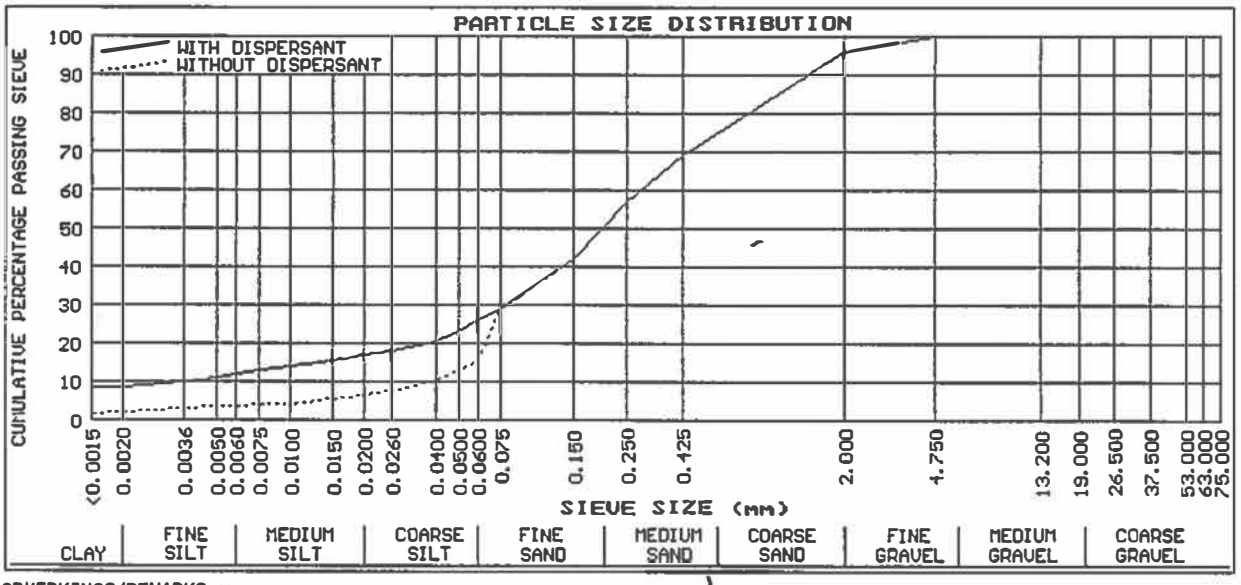
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 15	PERCENTAGE (< 0.002): 8	P.R.A. CLASSIFICATION : A-2-4(0)
PLASTICITY INDEX : 6	PI OF WHOLE SAMPLE : 4	UNIFIED SOIL CLASSIFICATION : SM-SC
LINEAR SHRINKAGE (%) : 2.0	MOISTURE CONTENT (%): -	ACTIVITY : 0.5
GRADING MODULUS : 1.06		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
24.3	8.3	17.7	70.1	3.9	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	96	69	57	42	29

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	25.97	23.17	20.37	18.22	17.05	15.61	13.94	12.76	11.77	10.96	9.83	8.27	8.27
% WITHOUT DISP.	15.67	12.98	10.28	7.29	6.34	5.66	4.17	4.13	3.74	3.36	2.81	2.01	1.44



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MONSTER/SAMPLE NO: A657 GAT/HOLE NO: DSF 12/1 DIEPTE/DEPTH (mm): 400-900
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : DK MOT GR OR BR GRAVELLY SILTY SAND

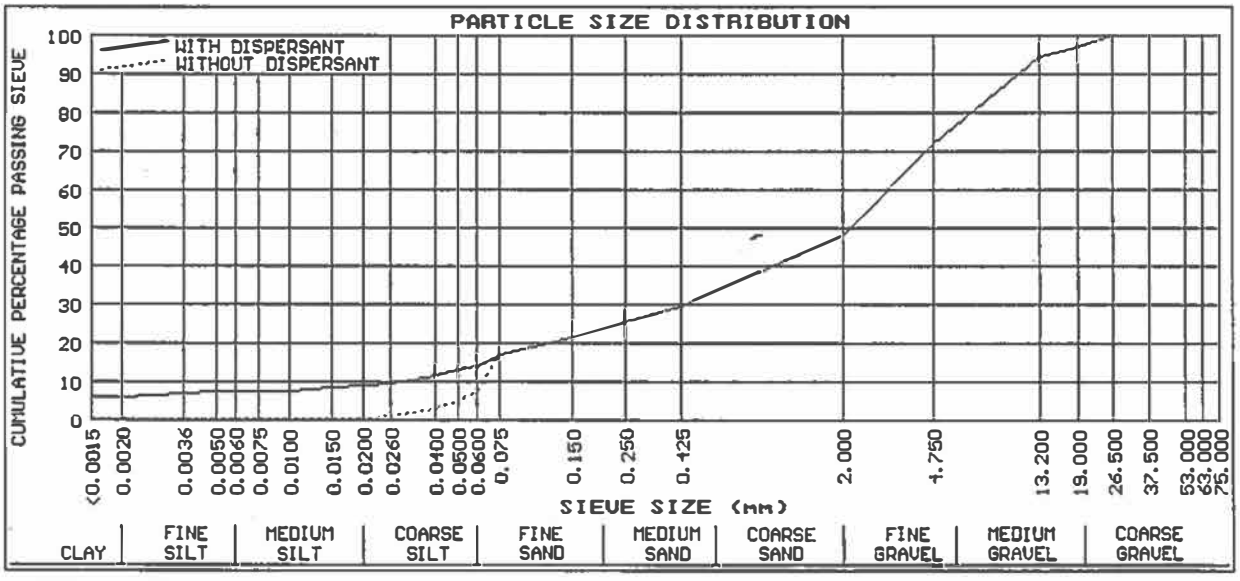
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 27	PERCENTAGE (< 0.002): 6	P.R.A. CLASSIFICATION	: A-2-6(0)
PLASTICITY INDEX : 11	PI OF WHOLE SAMPLE : 3	UNIFIED SOIL CLASSIFICATION	: SC
LINEAR SHRINKAGE (%) : 4.0	MOISTURE CONTENT (%): -	ACTIVITY	: 0.5
GRADING MODULUS : 2.05		HEAVE CLASSIFICATION	: LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
9.5	6.2	8.1	33.9	51.9	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	97	95	72	48	29	26	21	17

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	14.24	12.75	11.27	9.70	9.06	8.43	7.72	7.62	7.51	7.34	7.09	6.18	5.92
% WITHOUT DISP.	7.60	5.20	2.80	0.78	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59



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MONSTER/SAMPLE NO: A658 GAT/HOLE NO: DSF 15/1 DIEPTE/DEPTH (mm): 550-1300
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : DK RD BR SILTY SAND

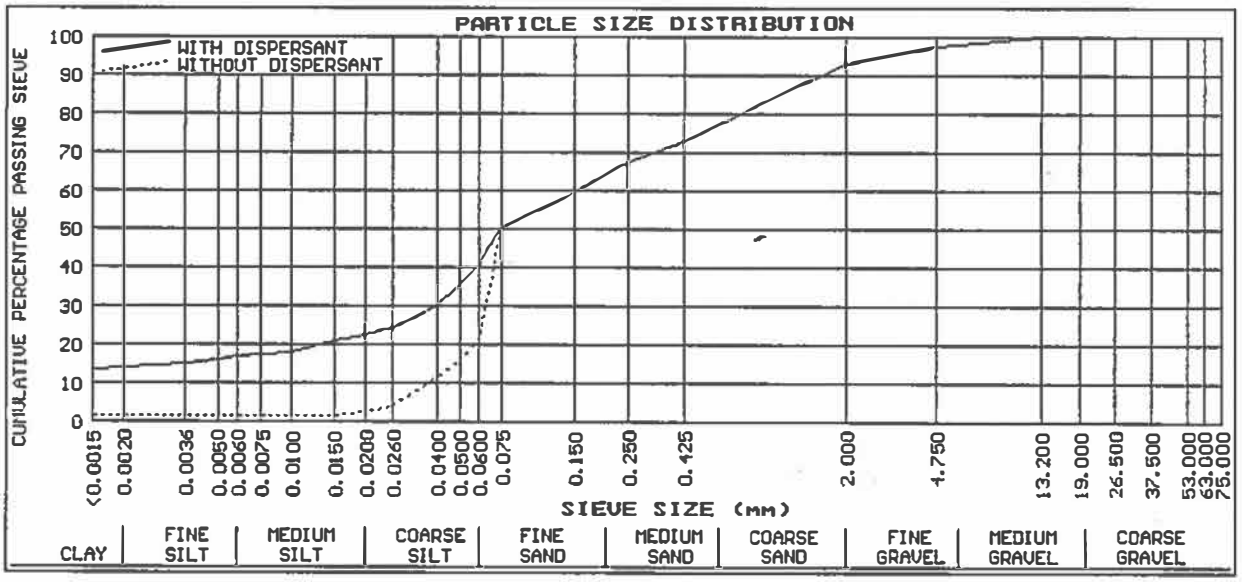
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 37	PERCENTAGE (< 0.002): 14	P.R.A. CLASSIFICATION : A-6(5)
PLASTICITY INDEX : 15	PI OF WHOLE SAMPLE : 11	UNIFIED SOIL CLASSIFICATION : CL
LINEAR SHRINKAGE (%) : 6.0	MOISTURE CONTENT (%): -	ACTIVITY : 0.8
GRADING MODULUS : 0.83		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
10.5	13.9	26.7	52.5	6.9	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	97	93	73	67	59	51

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	40.57	35.41	30.25	24.52	22.52	20.97	17.94	17.49	16.92	16.05	14.83	13.89	13.27
% WITHOUT DISP.	20.87	16.10	11.33	3.79	2.29	1.58	1.46	1.46	1.46	1.46	1.46	1.46	1.46



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MONSTER/SAMPLE NO: A659 GAT/HOLE NO: DSF 19/1 DIEPTE/DEPTH (mm): 500-900
MATERIAAL BESKRYWING/MATERIAL DESCRIPTION : MOT BRICK RD WITH OLIVE BROWN STAINS SILTY SAND

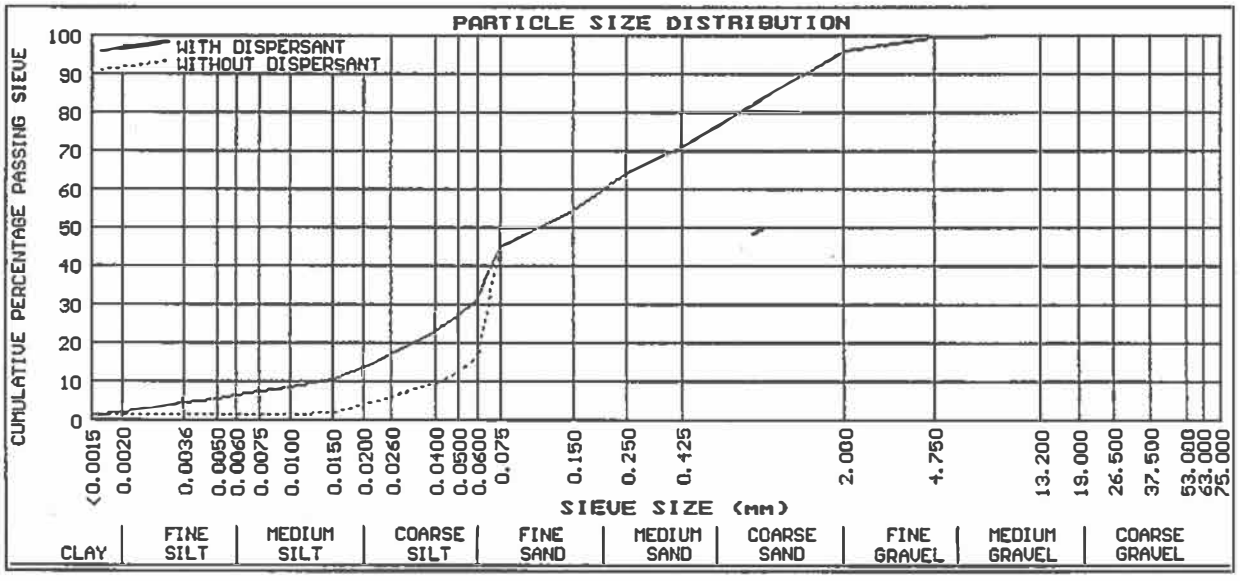
DOUBLE HYDROMETER (ASTM : D422)

LIQUID LIMIT (%) : 33	PERCENTAGE (< 0.002): 2	P.R.A. CLASSIFICATION : A-4(2)
PLASTICITY INDEX : 10	PI OF WHOLE SAMPLE : 7	UNIFIED SOIL CLASSIFICATION : SC
LINEAR SHRINKAGE (%) : 4.5	MOISTURE CONTENT (%): -	ACTIVITY : 3.4
GRADING MODULUS : 0.88		HEAVE CLASSIFICATION : LOW

DISPERSION (%)	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	CLASSIFICATION
68.7	2.1	29.3	64.5	4.1	SILTY SAND

SIEVE SIZE (mm)	75.000	63.000	53.000	37.500	26.500	19.000	13.200	4.750	2.000	0.425	0.250	0.150	0.075
% PASSING SIEVE	100	100	100	100	100	100	100	100	96	71	64	54	45

SIEVE SIZE (mm)	0.0600	0.0500	0.0400	0.0260	0.0200	0.0150	0.0100	0.0075	0.0060	0.0050	0.0036	0.0020	0.0015
% PASSING (STD)	31.39	27.20	23.01	16.84	13.67	10.68	8.60	7.38	6.33	5.52	4.39	2.07	1.48
% WITHOUT DISP.	15.95	12.61	9.26	6.07	3.92	1.78	1.42	1.42	1.42	1.42	1.42	1.42	1.42



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PART C5 ANNEXURES

C4.3 GEOHYDROLOGICAL STATUS REPORT

Technical Report 2016/11/04/GWSA

GEOHYDROLOGICAL STATUS ASSESSMENT & SCOPING REPORT FOR THE PROPOSED POLOKWANE WASTE WATER TREATMENT WORKS: DOORNBULT 624-LS, POLOKWANE, LIMPOPO

August 2015

Prepared for: Mafumu Consulting
Document version: 1.0
Compiled by: R. Crosby

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GEOHYDROLOGICAL STATUS ASSESSMENT & SCOPING REPORT: POLOKWANE WASTE WATER TREATMENT WORKS:
ON THE CADASTRAL FARM DOORNBULT 624-LS

November 2016

Conducted on behalf of:
Mafumu Consulting (Pty) Ltd
P.O. Box 787 141
SANDTON
2146

Compiled by:

R. Crosby *Pr. Sci. Nat*
B.Sc. (Honours) Geohydrology

Project team:

S. J. Pretorius (Ph.D.) *Pr. Sci. Nat.*

R. Crosby (B.Sc. Honours - Geohydrology) *Pr. Sci. Nat.*

A.P. van der Walt (B.Sc. Honours - Geohydrology) *Cert. Sci. Nat.*

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Report no	Date	Version	Status
2016/11/04/GWSA	4 November 2016	1.1	Draft

Amendments

V 1.1 Updated Hydrocensus Results

Review the scoping actions required to assess the geohydrological impacts

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Notations and Terms

Advection is the process by which solutes are transported by the bulk motion of the flowing groundwater.

Anisotropic is an indication of some physical property varying with direction.

Cone of depression is a in the groundwater table or potentiometric surface that has the shape of an inverted cone and develops around a borehole from which water is being withdrawn. It defines the area of influence of a borehole.

A ***confined aquifer*** is a formation in which the groundwater is isolated from the atmosphere at the point of discharge by impermeable geologic formations; confined groundwater is generally subject to pressure greater than atmospheric.

The ***Darcy flux***, is the flow rate per unit area (m/d) in the aquifer and is controlled by the hydraulic conductivity and the piezo-metric gradient.

Dispersion is the measure of spreading and mixing of chemical constituents in groundwater caused by diffusion and mixing due to microscopic variations in velocities within and between pores.

Drawdown is the distance between the static water level and the surface of the cone of depression.

Effective porosity is the percentage of the bulk volume of a rock or soil that is occupied by interstices that are connected.

Groundwater table is the surface between the zone of saturation and the zone of aeration; the surface of an unconfined aquifer.

A ***fault*** is a fracture or a zone of fractures along which there has been displacement.

Hydrodynamic dispersion comprises of processes namely mechanical dispersion and molecular diffusion.

Hydraulic conductivity (**K**) is the volume of water that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area measured perpendicular to the area [L/T]. Hydraulic conductivity is a function of the permeability and the fluid's density and viscosity.

Hydraulic gradient is the rate of change in the total head per unit distance of flow in a given direction.

Heterogeneous indicates non-uniformity in a structure.

Karstic topography is a type of topography that is formed on limestone, gypsum, and other rocks by dissolution, is characterised by sinkholes, caves and underground drainage.

Mechanical dispersion is the process whereby the initially close group of pollutants are spread in a longitudinal as well as a transverse direction because of velocity distributions.

Molecular diffusion is the dispersion of a chemical caused by the kinetic activity of the ionic or molecular constituents.

Observation *borehole* is a borehole drilled in a selected location for the purpose of observing parameters such as water levels.

Permeability is related to hydraulic conductivity, but is independent of the fluid density and viscosity and has the dimensions L^2. Hydraulic conductivity is therefore used in all the calculations.

Piezo-metric head (ϕ) is the sum of the elevation and pressure head. An unconfined aquifer has a water table and a confined aquifer has a *piezo-metric surface*, which represents a pressure head. The piezo-metric head is also referred to as the hydraulic head.

Porosity is the percentage of the bulk volume of a rock or soil that is occupied by interstices, whether isolated or connected.

Pumping tests are conducted to determine aquifer or borehole characteristics.

Recharge is the addition of water to the zone of saturation; also, the amount of water added.

Sandstone is a sedimentary rock composed of abundant rounded or angular fragments of sand set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material.

Shale is a fine-grained sedimentary rock formed by the consolidation of clay, silt or mud. It is characterised by finely laminated structure and is sufficiently indurated so that it will not fall apart on wetting.

Specific storage *(S_0),* of a saturated confined aquifer is the volume of water that a unit volume of aquifer releases from storage under a unit decline in hydraulic head. In the case of an unconfined (phreatic, water-table) aquifer, *specific yield* is the water that is released or drained from storage per unit decline in the water-table.

Static water level is the level of water in a borehole that is not being affected by withdrawal of groundwater.

Storativity is the two-dimensional form of the specific storage and is defined as the specific storage multiplied by the saturated aquifer thickness.

Total dissolved solids (TDS) is a term that expresses the quantity of dissolved material in a sample of water.

Transmissivity *(T)* is the two-dimensional form of hydraulic conductivity and is defined as the hydraulic conductivity multiplied by the saturated thickness.

An ***unconfined, water-table*** *or* ***phreatic aquifer*** is different terms used for the same aquifer type, which is bounded from below by an impermeable layer. The upper boundary is the water table, which is in contact with the atmosphere so that the system is open.

Vadose zone is the zone containing water under pressure less than that of the atmosphere, including soil water, intermediate vadose water, and capillary water. This zone is limited above by the land surface and below by the surface of the zone of saturation, that is, the water table.

Water table is the surface between the vadose zone and the groundwater, that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.

List of Abbreviations

Abbreviation	Description
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ELU	Existing Lawful Water Use
EMPR	Environmental Management Programme Report
mamsl	Meter Above Mean Sea Level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mbdl	Meter Below Datum Level
mbgl	Meter Below Ground Level (i.e. depth)
NEMA	National Environmental Management Act
NWA	National Water Act, Act 36 of 1998
S	Storativity
TDS	Total Dissolved Solids
T	Transmissivity
TWQR	Target Water Quality Range
WULA	Water Use License Application
WWTW	Waste Water Treatment Works

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1 INTRODUCTION

1.1 General

AGES Limpopo was appointed by Mafumu Consulting (Pty) Ltd in June 2016 to conduct a geohydrological and groundwater study for the proposed Waste Water Treatment Works (WWTW) on portion of the cadastral farm Doornbult 624-LS. This study is an extension of a previous study conducted by AGES (previously called South African GeoConsultants) in 2000. The previous investigation is referenced extensively as the study and subsequent report adequately characterised the Doornbult aquifer. Now, some 16 years later, data sets are reviewed and updated with current information, and recommendations that were made regarding the modelling of the aquifer are implemented. This report presents the regional geohydrological setting, recognises the local challenges and identifies the actions required to quantify and qualify the impacts on the groundwater and the interaction between the surface and groundwater regimes.

1.2 Terms of Reference

The groundwater study is conducted as an updating of a 2000 study conducted by AGES, previously Southern Africa GeoConsultants (Calitz et.al, 2000) and will be extended to fulfil the geohydrological requirements for a Water Use License application (WULA).

The appointment was confirmed in an appointment letter dated 13 June 2016. The working relationship between AGES and Mafumu was definite in a Service Level Agreement signed in September 2016.

1.3 Scope of the Investigation

The geohydrological aspects of the assessment have been defined in four distinct phases. The **first** phase, included in this report, sets about defining and current status of the groundwater use in the vicinity and to identify significant impacts that the development of the proposed activity may cause.

The **second** phase of the project will involve the development of a groundwater monitoring network on order to fulfil the legislative requirements for monitoring of the groundwater environment. The second phase may include the drilling and testing of additional boreholes strategically located to monitor not only the water quality in the vicinity, but also the groundwater – surface water interaction due to the release of treated waste water into the Sand River aquifer.

The **third** phase of the project integrates all the available groundwater information and

leads to the development of a conceptual groundwater model. The conceptual model is then used to build and populate a numerical model that can be used to evaluate various scenarios related to the use of groundwater and the interaction between surface and groundwater. The results of the numerical model will lead to the development of a groundwater management plan which will be used to motivate the WULA to DWS.

The **final** phase of the project is the drafting of a WULA with interaction and liaison with officials from DWS and other relevant role players.

1.4 Phase 1 Actions

Phase 1 actions are summarised as:

- Review and evaluate existing geohydrological data, including the various studies conducted on the strategic significance of the SAND River aquifer.
- Conduct a detailed hydrocensus within a 2 km radius and a general strategic hydrocensus within a 5 km radius around proposed WWTW. Previous hydrocensus survey data is verified to confirm the borehole locations, and the current status.
- Identify the actions required that need to be investigated further as a scoping report to quantify the impacts to the groundwater environment. The required actions are based on the conceptual groundwater model and the "gaps" in information required to support the WULA application are identified for further investigation.
- Liaison with the Department of Water and Sanitation (DWS) is an important aspect at this early stage as a pre-application consultation meeting will assist with the definition of studies required by the regulatory authority.

1.5 Location of the study area

The proposed development is located on a portion of the farm Doornbult 624-LS within the Polokwane Municipality of Limpopo (Figure 1). The study area covers a total area of approximately 122 ha, as delineated by the Project Engineer.

The study area is located at approximately the following coordinate:

Latitude: 23° 52’ 50.5”

Longitude: 29° 59’ 01.8”

With the exception of an earth-fill and two concrete dams, no recent development has taken place within the boundaries of the study area. The area is currently lying fallow, but has been used for the cultivation of crops in the past.

1.6 Information Sources

The following sources of information was used:

- **Geological maps**
  - Geological map of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland, 1997; scale 1 : 1 000 000.
  - 2328 PIETERSBURG, 1985; scale 1 : 250 000.
- **Topographical maps**
  - 2329CD PIETERSBURG, second edition; scale 1 : 50 000.
  - 2329DC MANKWENG, second edition; scale 1 : 50 000.
- **Aerial photographs**
  - Job 835, strip 2, numbers 9676 and 9677; scale 1 : 30 000.
  - Oblique aerial photographs taken by Mr. N.J. van Rensburgh of the then Pietersburg/Polokwane Transitional Local Council on 22 June 2000.
- **Google © Satellite Images**
  - Downloaded images dated 31 March 2016 of the site
- **Ortho photographs**
  - 2329CD4 PALMIETFONTEIN, second edition, 1988; scale 1 : 10 000.
  - 2329CD5 DOORNBULT, second edition, 1988; scale 1 : 10 000.
  - 2329CD9 DOORNBULT, second edition, 1988; scale 1 : 10 000.
  - 2329CD10 PALMIETFONTEIN, second edition, 1988; scale 1 : 10 000.
- **Site layout plan**
  - Historical hard copy format originally supplied by Messrs. Dombo and Du Plessis Consulting Engineers, June 2000; scale 1 : 2 500.

1.7 Reference Reports

Calitz, F. (2000). Proposed Pietersburg/Polokwane Regional Waste Water Purification Works to be located on portion of the farm Doornbult 624-LS. Unpublished Report number NP/2000/06/06.

Calitz, F., Vivier, JJP., Pretorius, SJ., and Crosby, R. (2000). Geohydrological investigation for the proposed Pietersburg/ Polokwane Regional Wastewater Treatment Works on a portion of the farm Doornbult 624-LS. Unpublished Report number NP/200008/02.

De Wet, JA., Timm, TD., and Luttig, E., (1992). Water Resource Planning of the Sand River Basin. Volume 2.2: Geology. DWS Report P A700/00/0892.

De Wet, JA., Van Zyl, FC., and Van Niekerk, PH., (1990). Water Resource Planning of the Sand River Basin. Volume 2.4: Soil and Land Capacity. DWS Report P A700/00/.

De Wet, JA., Van Zyl, FC., and Van Niekerk, PH., (1990). Water Resource Planning of the Sand River Basin. Volume 4.2: Agriculture and Forestry. DWS Report P A700/00/.

Haupt, C. (1994). Evaluasie van die Groundwater Potensiaal op Baragwanath Plase, Bloedrivier. Unpublished WSM Report Number 9465/CJH/ES.

Haupt, C. (1994). Evaluering can die Sandrivier / Bloedrivier Grondwaterbron Noord van Pietersburg. Unpublished WSM Report Number 94104/R1/CJH/ES

Mouton, P. (1997). Bloodriver Wellfield Extension. Unpublished WSM Report Number 96072/PW/MH.

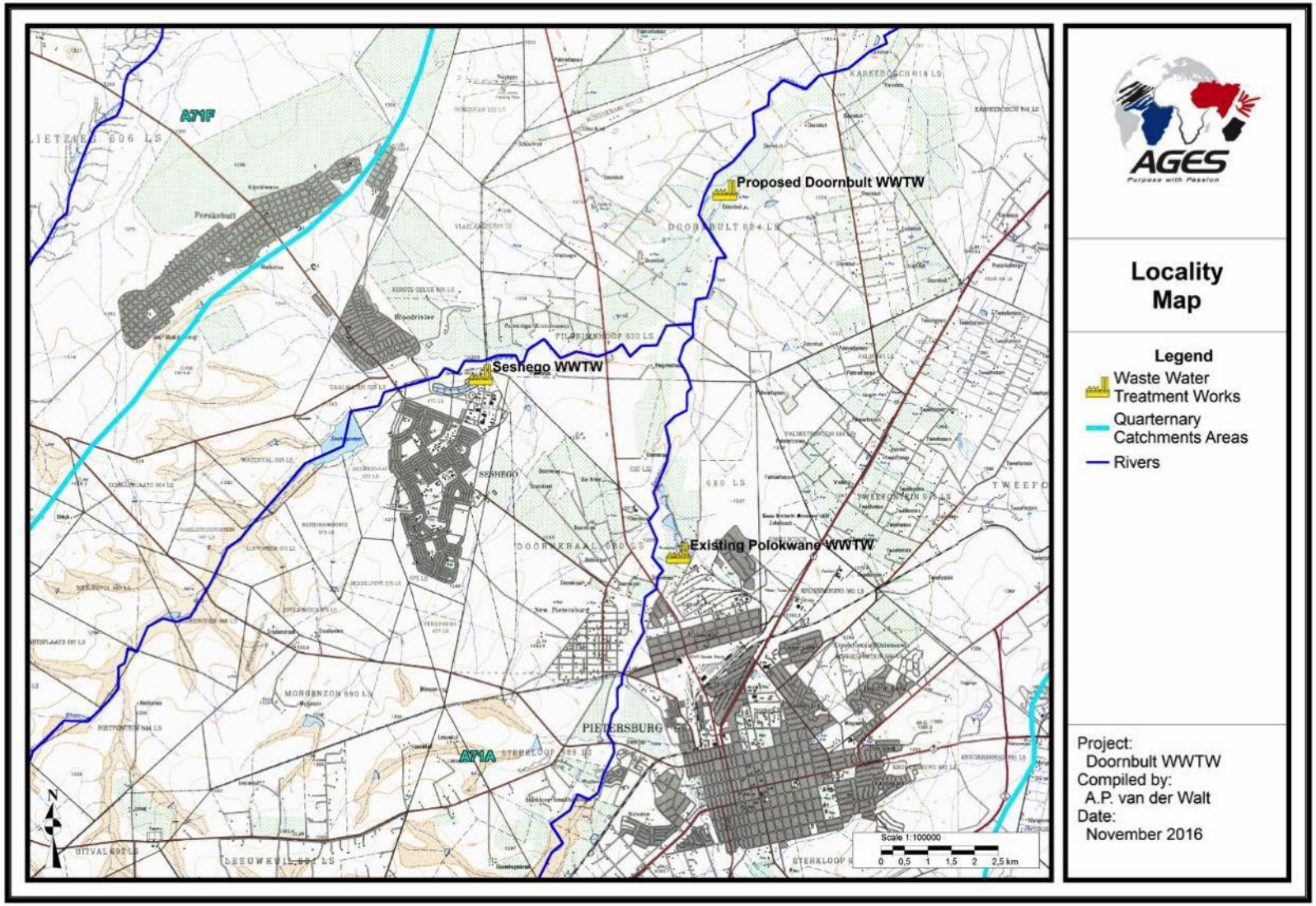
Mouton, P. (1997). Sand/Blood River Groundwater Development. Unpublished WSM Report Number 96013/PW/MH.

Midgley, D.C., Pitmann, W.V. and Middelton, B.J., (1994). Surface Water Resources of South Africa 1990.

Rambuwani, V. (2014). Polokwane Regional Wastewater Treatment Works: Technical Feasibility Report, Version 2. Unpublished DIGES Report Number LPR023.

Republic of South Africa. (2014). A high-level evaluation of the environment associated with the Titano-Magnetite target mineralization on the farms Nooitgedacht 11-JQ and Haakdoring 12-JQ near Northam. Prime Resources Environmental Consultants (Report Number: 140644).

Figure 1: Regional Locality Map



2 METHODOLOGY

2.1 Desktop Study

A desktop study involved the review of historical data available for the SAND RIVER area in the vicinity of Polokwane. The data consists of old reports, topographical maps, geological maps, geohydrological maps, satellite images, meteorological data, and information on historical databases that is relevant to the study area and that can assist in assessing and characterising the groundwater status for the study area.

2.2 Regional Hydro-census

The regional hydro-census consisted of a field survey where the location and status of groundwater and surface water sources are identified and confirmed. Historical information collected as part of the 2000 study was also verified and the status of the use updated. The information from such a survey plays an important role in identifying not only the local and regional geo- and geohydrological character of an area but also defines the relevant role players that may be impacted by the proposed development of a regional waste water treatment works.

2.3 Information Gaps and Scoping to Determine the Geohydrological Impacts

A conceptual groundwater model based on the aquifer characterisation was proposed in the previous study (Calitz, et.al., 2000). The conceptual model shows the groundwater movement and the interaction of the various aquifers with the surface water environment. This conceptual model is used as the basis to determine gaps in information and the additional actions and studies that would be required to quantify and qualify the possible impacts to the groundwater environment.

2.4 Reporting

This report summarises the actions of phase A. The report presents the current geohydrological status, and identifies the scope of further geohydrological investigation in order to quantify and qualify the impact of the proposed waste water treatment facility.

3 SITE DESCRIPTION

3.1 General

This chapter is a description and a delineation of the physical site characteristics. In this section, the topography, geology, geohydrology and surface hydrology of the Doornbult Aquifer and its influence on the occurrence and recharge on groundwater is described.

3.2 Topography

The area in which the proposed facility is to be located generally exhibits a gently rolling topography with broad valleys associated with streams and rivers. The most prominent topographical feature of the area is the broad, relatively flat lying, meandering channel of the Sand River. It is proposed that the wastewater treatment works be placed on the south-eastern bank of the river.

The north-western portion of the study area is located on the eastern floodplain of the Sand River, and exhibits a very gentle slope (average 0.5°) to the northwest.

The south-eastern portion is located on the side slope of a localised ridge, and exhibits a gentle slope (average 1.25°) to the north and northwest. The rounded crest of this ridge occurs to the southeast of the study area.

The northern and north-eastern portions are located along the broad, relatively flat channel of a northwestwardly flowing, non-perennial stream.

The lowest point is located in the northwest at an elevation of 1 178 m above mean sea level, with the highest point located in the southeast at an elevation of approximately 1 195 m above mean sea level.

3.3 Climate and Rainfall

The study area is located in rainfall zone A7A (Midgley et al, 1994), in the summer rainfall area of the Republic of South Africa.

The average annual rainfall is approximately 485 mm, as measured at the Pietersburg Provincial Hospital (weather station 0677 834) located to the south of the study area (Midgley et al, 1994).

The climatic N-value (Weinert, 1980) is between 3 and 4; therefore chemical decomposition, rather than mechanical disintegration, of the parent rocks is deemed the principal mode of weathering.

3.4 Surface Water and Drainage

The study area is located within the quaternary sub-catchment region **A71A** (Midgley et al, 1994), with the northeastwardly flowing Sand River, that forms the north-western boundary of the site, being the most important drainage feature. An earth fill dam is located within the channel of the non-perennial stream that occurs in the northern and north-eastern portions of the study area.

The study area is drained mainly by means of surface run-off, with surface water collecting along roads and footpaths that cut through the area. The surface water eventually drains into the non-perennial stream that drains the northern portion, while the remainder of the area drains into the Sand River.

Significant surface erosion was not noted within the boundaries of the study area.

3.5 Geology

3.5.1 Regional geological setting

In order to better understand the specific geological conditions at the project area, it is important to first focus on the regional geological setting of the study area.

The following three lithological units are of importance:

- Granitic **gneiss** of the Limpopo metamorphic terrain
- **Dolerite** intrusions associated with Karoo age volcanism
- Quaternary **alluvium** deposits associated with drainage courses

The regional geological setting of the study area is depicted graphically by Figure 2.

3.5.2 Granitic gneiss

According to the available geological information, the study area is located near the southern boundary of the Southern Marginal Zone of the Limpopo Mobile Belt. The Limpopo Belt is a zone of highly deformed strata covering most of the province north of Pietersburg, and into neighbouring Zimbabwe. Rocks, altered under several metamorphic events, are highly foliated and exhibit a complex folded and banded character.

The main lithology in such a metamorphic terrain is collectively described as gneiss. Gneiss is formed by the high grade regional metamorphism (caused by increases in temperature and pressure due to major structural movements of the Earth's crust) of clayey sediments and granitic rocks. It exhibits well-defined banding, with the dark bands consisting of mica (biotite) and hornblende, and the light bands of quartz and

feldspar. The thickness of these bands varies between a few millimetres and a few centimetres, and can be either straight or folded. Gneiss is well foliated, and the hornblende crystals in the dark bands can be lineated (Bell and Wright, 1985). Alternative quartz-rich and granitic zones can be developed in the gneiss.

The specific gneiss occurring in the study area covers a vast region from Pietersburg in the south to the Soutpansberg Mountain in the north, and is known as the **Houtrivier Gneiss**. These rocks are essentially granitic in composition and are typically medium to coarse-grained. Coarse-grained pegmatite veins are developed in places. The variation in mineralogical composition, textures and structures within the gneiss, causes the Houtriver Gneiss to vary from a solid, homogeneous granitic rock to a coarse-grained, highly weathered rock in places.

Mechanical weathering dominates in arid environments such as the Northern Province, resulting in the formation of coarse-grained, sandy residual soil consisting of quartz and feldspar aggregates. The two main processes here are sheet weathering and weathering along fractures and joints, as well as along coarse-grained and pegmatite zones within the gneiss. Weathered gneiss and associated residual soils erode easily, particularly where vegetation cover is scarce. This leads to an acceleration of sediment and alluvium build-up in valley depressions and river channels such as the Sand River.

The highly fractured character of certain zones in the gneiss, as well as weathering associated with coarse-grained pegmatite intrusions cause the gneiss to exhibit a relatively high groundwater potential associated with complex secondary aquifers developed in these zones. High transmissivity values, due to major joint sets and fractures, result in high yielding boreholes being very common in this rock type, provided sufficient recharge and storage capacity exist. A storage capacity of approximately 1 % of the aquifer volume can be expected in such fractured rock aquifers.

3.5.3 Dolerite intrusions

Numerous dolerite dykes have intruded the older gneiss and granitic rocks in the region. The dykes are generally green to grey black in colour and fine to medium-grained. Dolerite is a quartz-poor, entirely crystalline, shallow intrusive igneous rock that consists mainly of plagioclase feldspar, pyroxene and olivine. This rock type is generally susceptible to weathering and alteration. Dolerites are usually found as vertical dykes or horizontal sills, and hundreds of dykes may be found in dyke swarms. These relatively hard rocks can give rise to the formation of upstanding masses or ridges. In the Northern Province, near vertical dyke intrusions are the most frequent type of dolerite intrusion. These intrusions have a general north--easterly trend, with

occasional north-westerly and west-northwesterly orientated dykes present in localised areas.

Dolerite is not easily weathered under relatively arid conditions, and generally forms well-rounded boulders and occasionally small angular blocks when exposed at the surface. These intrusions generally have a low groundwater potential, due to its resistive character. This is especially true for more prominent intrusions where rounded boulder-type weathering can be observed. Thinner, usually older, intrusions commonly display a fractured character that results in higher groundwater potential. The contact zones of dolerite intrusions are in most cases fractured and have a definite influence on groundwater movement and storage in the region. Poorly weathered, relatively solid intrusions can also act as barriers that impede groundwater movement and recharge.

3.5.4 Quaternary deposits

Quaternary deposits in Limpopo can be divided into three broad groups:

- Alluvial material
- Colluvial material
- Aeolian material

Only alluvial deposits occur in the region of concern for this study. Thick alluvial deposits are located along rivers like the Sand River. These deposits become more extensive towards the north where more rivers deposit alluvium in the Sand River Basin. These deposits are extremely variable with respect to its lateral extent, composition and grain size, ranging from fine silts through to cobbles and boulders.

Alluvial deposits in the region can be as wide as 350 m and depths of up to 26 m have been reported. The alluvium typically consists of clay (2 to 15 m), sand and a basal gravel layer. Calcrete horizons occur in places.

Considerable volumes of groundwater can be stored in the primary aquifers formed by these alluvial deposits. Borehole yields, which can be as high as 30 L/s, decline typically during drier winter months. Recharge is quick during the rainy season. A storage capacity of 10 % of the aquifer volume can be expected.

There is definite interaction between the shallow, alluvial primary aquifer and the underlying fractured hard rock secondary aquifer, and any assessment of groundwater potential must take both systems into account.

3.5.5 Local geological features

The underlying geology of the Doornbult terrain can be divided into the three main groups of lithologies as described under the regional geological occurrences in the above paragraphs.

The **Houtriver Gneiss** dominates the study area, with alluvium associated with the Sand River being most prominent in the western and north-western portions of the site. The gneiss directly underlying the study area consists of a medium-grained, pink coloured, granitic rock, which tends to become light grey to white in colour towards the west. This is deemed to be indicative of a higher quartz content and hence a more fractured nature. Gneiss intersected in boreholes located to the north of the study area during the drilling program reveals a tendency towards a higher mica content.

Several linear features, generally indicating the presence of **dolerite dyke** intrusions and minor faults, were observed on aerial photographs during a regional geological study. The strata generally exhibit a north-northeastwardly strike direction as observed in outcrops in the direct vicinity of the study area. Weathered gneiss occurs in the western portion of the study area, as indicated on Figure 2 as the area west of the north–northeastwardly trending line that indicates the approximate location where the weathered and fractured gneiss changes into a more solid granitic rock in the east. The weathered nature of the gneiss in the western part of the study area can be ascribed to its coarse-grained and fractured texture. Fracturing was most probably caused by either pegmatite and/or dolerite intrusions and associated structural dis-homogeneities. More granitic, relatively homogeneous, solid, un-weathered gneiss is observed towards the east of the study area. This generally granitic resistant phase in the gneiss causes the rock to be exposed to a much larger extent in this eastern part of the study area (Figure 2).

Several poorly defined north-eastwardly, south-eastwardly and northwardly striking dolerite dykes cut through the general area in which the facility will be located (Figure 2). The main structural direction is north–northeast that probably had an influence on the current flow direction of the Sand River in the vicinity of the study area.

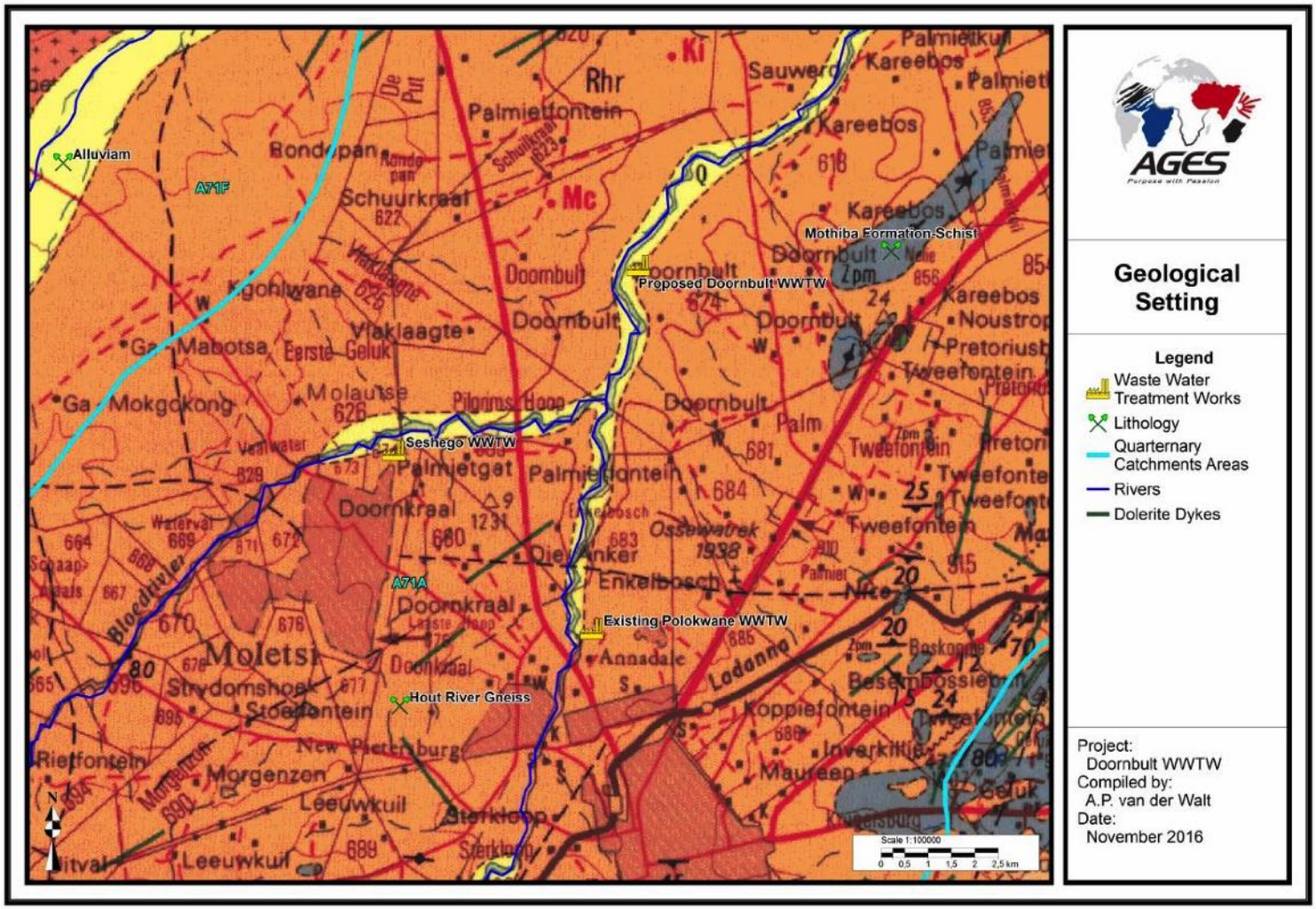
It appears that more than one dolerite dyke follow this direction, and drilling previously conducted within the study area confirmed the presence of at least one such dyke. The east-northeastwardly trending lineaments occurring near the northern boundary of the proposed site are most likely indicative of faulting, as was confirmed by the drilling of boreholes H16-0408 and H16-0409. These boreholes also had relatively high blow yields, which shows that the fault zones exhibit a relatively higher groundwater potential than that associated with dyke intrusion and coarse-grained zones within the

gneiss.

Features that need to be focussed on when characterizing the hydrogeology of the terrain are the following:

- The preferred north-northeasterly orientation of several dolerite dykes, as well as the general trend of lithologies in the study area being the same, will have a definite influence on underground water movement in this direction.
- The highest transmissivities occur in areas associated with east-west trending faults located to the north of the study area. This area is a likely zone for groundwater abstraction.
- The high storage capacity and recharge potential associated with the alluvial primary aquifer that occurs associated with the Sand River, is an important feature which determines the groundwater potential at the site. Shallow groundwater conditions and rapid recharge rates make this portion of the aquifer vulnerable to pollution and over-exploitation.
- The weathered and fractured gneiss that occurs in the west of the study area lies in direct association with the river drainage and associated alluvium. Recharge and storage of groundwater are very prominent in this portion of the study area and precautionary measures against pollution should be focussed in this area. The relatively high groundwater potential of the deeper, hard rock environment is also to be found in this western part of the study area.

Figure 2: Local Geological Setting



3.6 Geohydrological Setting

3.6.1 Local Geohydrological Setting

The Doornbult groundwater reservoir, consists of a composite system of primary and secondary aquifers. According to the 1:500 000 Geohydrological Map of Pietersburg (2326) the study area has both a weathered / fractured aquifer associated with the gneiss, and an intergranular aquifer associated with the alluvium. The primary aquifer is limited to the Sand River and consists of alluvium, which exhibits primary porosity. The alluvial aquifer is approximately 350 m wide and consists of clay (2 to 15 m), sand and basal gravel up to a depth of 26 m.

The secondary aquifer consists of weathered and fractured granitic gneiss and forms the major aquifer. It can be classified as a fractured and weathered medium. The depth of weathering in the granite gneiss varies between 40 m to 50 m increasing towards the Sand River (Pretorius and Wiegmans, 1994).

The north-east trending dolerite dykes may form groundwater compartments in the secondary aquifer. However, the dolerite is weathered near surface and the effects of the dykes will only be at depths greater than 10 m to 12 m below surface.

3.6.2 Geohydrological Setting

The study area is classified as having a **moderate to high potential** for groundwater occurrence with typical borehole yields of greater than 10 L/s being reported. Higher yielding boreholes are usually related to the alluvial material and along linear geological features where there are zones of deeper weathering and fracturing.

3.6.3 Aquifer Classification

The aquifer(s) under laying the study area can be classified by using the aquifer Classification document by the Department of Water Affairs and Forestry & Water Research Commission (1995). According to “A South African Aquifer System Management Classification” an aquifer can be classified as the following:

- Sole Aquifer System: An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.
- **Major Aquifer System**: Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (EC of less than 150 mS/m).

- Minor Aquifer System: These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow for rivers.
- Non-Aquifer System: These are formations with negligible permeability that are regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.

The findings during the hydro census on the private farms gives rise that the current aquifer(s) are classified as a **"Major Aquifer System"** due to the nature of the geohydrological setting, the high number of "In Use" boreholes in the community and that there are significant "Existing Lawful Users" authorised to abstract groundwater based on historical water use. This infers that the Doornbult aquifer requires at least a **moderate** level of protection to adhere to DWS's water quality objectives.

The groundwater risk assessment will be informed by the results obtained from the numeric model, based on both the available and new geohydrological information. The numerical groundwater model will quantify and qualify the risk to Groundwater Pollution posed by the proposed WWTW, and will set the parameters of the management and protection of the groundwater resource.

4 HYDRO-CENSUS

4.1 Historical Data

Borehole data from the Groundwater Resource Information Project (GRIP) database was requested from DWS and forms the basis of the available data on state owned land. Further, the 2000 hydro-census was used to identify possible boreholes on private land. Finally, a number of reports compiled for the municipality in the 1990's was used as a reference for boreholes developed on municipal land.

All borehole information was confirmed and updated during the hydro-census that commenced in August 2016.

4.2 Previous Monitoring Boreholes

Three boreholes were drilled and developed during the 2000 study. These boreholes were drilled to quantify the geological sequence on site, but could be used as monitoring sites once the WWTW is developed.

These boreholes were confirmed in the field, and will be re-tested during the second phase of the investigation as part of the development of a monitoring network for the long-term monitoring and management of the groundwater resource.

4.3 Regional Boreholes

A regional detailed hydro-census was conducted in October 2016 to identify major groundwater abstraction and exploration boreholes within a 2 km radius of the study area. Strategic locations up to 5 km from the site were also visited to confirm water use. A total of **418 boreholes** were identified during the hydro-census phase. A summary of the boreholes is presented in appendix A, and illustrated in Figure 3:

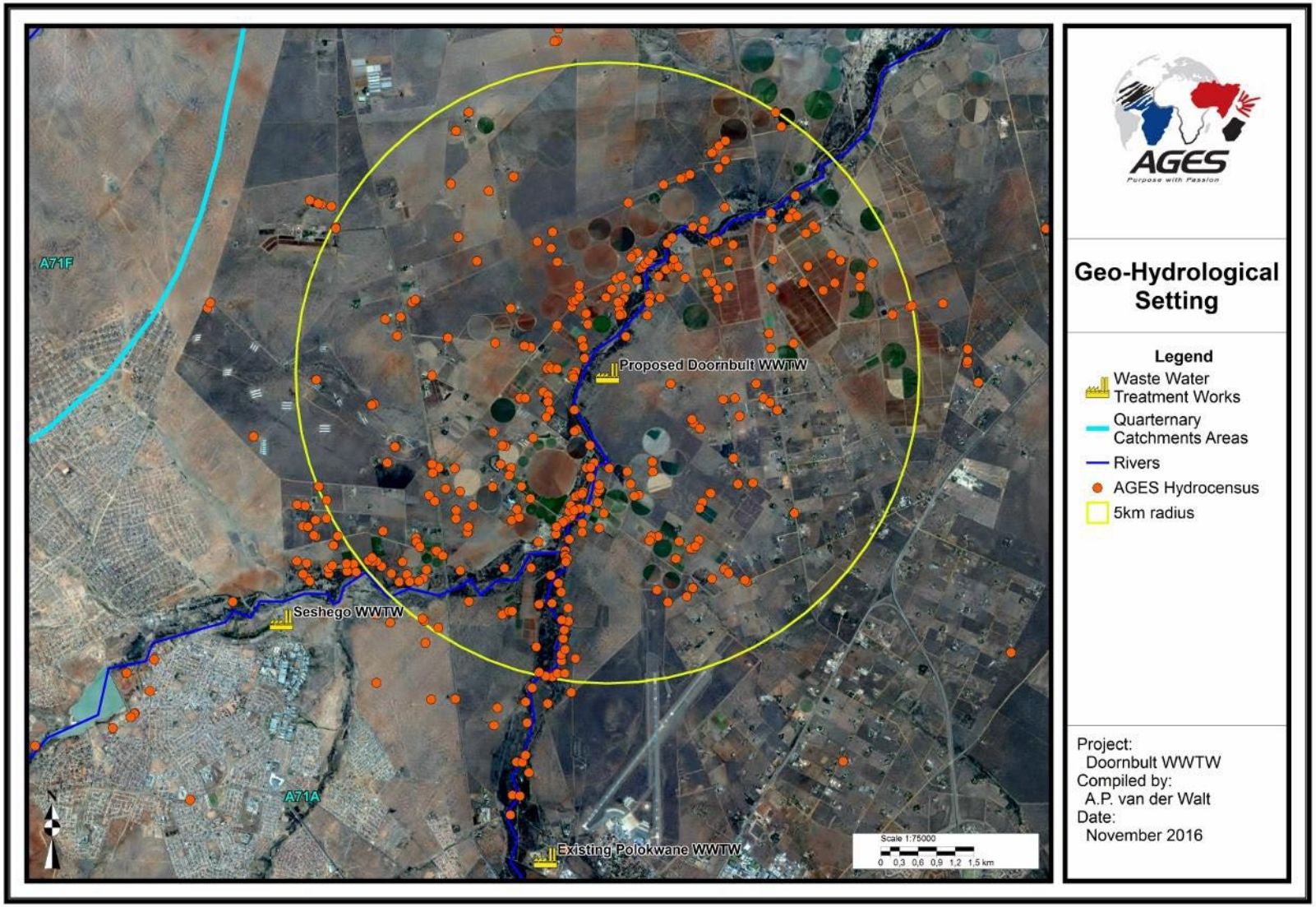
- 214 boreholes are deemed to be "in use"
- 191 borehole are "not in use"
- 8 boreholes are dedicated to monitoring
- 5 boreholes are either dry or destroyed

The depths of the boreholes range between 9 and 230 mbgl while the water level for the boreholes in the vicinity ranges from 0.9 m to more than 76 m.

4.4 Existing Water Use Authorisation

The existing lawful water use (ELU) is currently linked to properties and not unique boreholes. The ELU will be considered in the numerical model as groundwater abstraction and will be identified for the user.

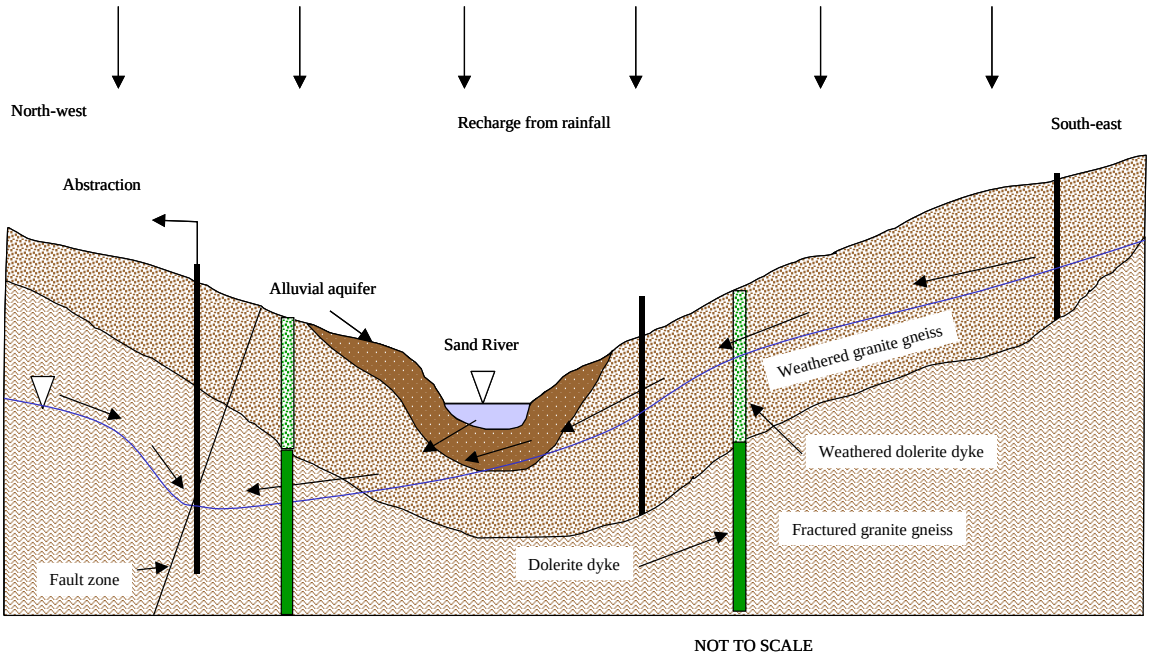
Figure 3: Regional Hydro-Census



5 SCOPING REPORT RECOMMENDATIONS

5.1 Conceptual Groundwater Model

The following conceptual model was proposed after the geohydrological investigation in 2000. The model needs to be re-assessed based on the new hydro-census information and then used as a foundation for the development of the numerical groundwater model.



5.2 Geohydrological Setting

Based on the results of the hydro-census and the conceptual model, the following gaps in information were identified and are required to develop the numerical groundwater model and to formulate the pollution risk assessment and groundwater management plan.

- Confirm the “Existing Lawful Use”, the needs of water users and specific off-take points with DWS
- Determine the Climatic Water Balance
- Confirm the Groundwater Flow Direction
- Determine the background groundwater quality and the variations influenced by the aquifer characteristics
- Delineate the alluvial aquifer along the Sand River
- Confirm the interaction between surface and groundwater

5.3 Development of Additional Monitoring Boreholes

- Geophysical survey to identify 2 additional sites for the development of monitoring boreholes
- Yield testing existing and newly drilled boreholes
- Confirm the aquifer parameters

5.4 Numerical Groundwater Model

The conceptual model together with the data collected will be used to develop the **numerical groundwater model**. The impact of the proposed waste water treatment works and the possible change in the flow regime of the Sand River needs to be determined and quantified.

The results of the groundwater model can then also be used as the basis to support the motivation of the proposed impacts of the WWTW, the water use activity and the WULA.

5.5 Geohydrological Impact Assessment

A **Groundwater Pollution Risk Assessment** will be conducted as part of the geohydrological investigation. The impacts and changes to the water quality will be determined based on the results of the geohydrological and transport model to be developed for the study area. The transport model will the also provide the information needed to determine the pollution risk assessment and possible mitigation and management measures that would be required to monitor and manage the groundwater resource.

5.6 Groundwater Management Plan

A groundwater management plan is to be compiled based on the groundwater status assessment, the conceptual groundwater model, a regional water balance and the groundwater risk assessment. The groundwater management plan is to address the groundwater abstraction and use, an on-site water balance, and the measuring and monitoring of groundwater and groundwater quality.

5.7 Water Use Licensing

An integrated water use license application process is initiated with the objective to supply the Department of Water and Sanitation (DWS) with the necessary information to make an informed decision regarding the issue of a water use license for specific water use:

The licensing process is a requirement of the National Water Act; (Act No 36 of 1998) (NWA).For the purpose of the above mentioned activity the following water use license needs to be obtained:

- **Section 21 (a):** pertaining to**"taking water from a water resource"**
- **Section 21 (f):** pertaining to **"disposing of waste water through a pipe or conduit into a water resource"**
- **Section 21 (g):** pertaining to **"disposing of waste in a manner which may detrimentally impact on a water resource"**

There may also be aspects of the following applications which need to be addressed as the proposed pipeline is developed within the 1:100 year flood line of the water course:

- **Section 21 (c):** pertaining to **"impeding or diverting the flow of water in a watercourse"**
- **Section 21 (i):** pertaining to **"altering the bed, banks. course or characteristics of a watercourse"**

APPENDIX A

Hydro-Census

Data

GRIP borehole Number	Owner	Farm Name	Farm Number	Waterlevel [mbgl]	Status	Equipment
H16-624LS-B1	A.van der Walt	DOORNBULT	LPLS 624	15.26	Not in use	No equipment
H16-624LS-B2	A.van der Walt	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B3	A.van der Walt	DOORNBULT	LPLS 624	15.45	Not in use	No equipment
H16-624LS-B4	A.van der Walt	DOORNBULT	LPLS 624	10.8	Not in use	No equipment
H16-624LS-B5	A.van der Walt	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B6	E.Telekizki	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B7	E.Telekizki	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B8	Gert Swart	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B9	Gert Swart	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B10	Gert Swart	DOORNBULT	LPLS 624	16	Not in use	No equipment
H16-624LS-B11	Gert Swart	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B12	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		Not in use	Mono-type pump
H16-624LS-B13	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B14	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B15	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624	4.92	Not in use	No equipment
H16-624LS-B16	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624	22.16	Not in use	Mono-type pump
H16-624LS-B17	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B18	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624	26.67	In use	Mono-type pump
H16-624LS-B19	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624	25.75	In use	Submersible pump
H16-624LS-B20	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B21	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B22	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B23	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624	21.7	Not in use	No equipment
H16-624LS-B24	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624	10.68	Not in use	No equipment

H16-624LS-B25	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624	9.8	Not in use	No equipment
H16-624LS-B26	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B27	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		Not in use	Mono-type pump
H16-624LS-B28	Jannie van Waveren - Alpha sand	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B29	Braam Prete	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B30	Braam Prete	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B31	Migual	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B32	Jordaan	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B33	Kegler	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B34	M. Devilir	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B35	T.du Toit	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B36	T.Feurre	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B37	T.Feurre	DOORNBULT	LPLS 624	13.9	Not in use	No equipment
H16-624LS-B38	T.Feurre	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B39	T.Feurre	DOORNBULT	LPLS 624	12.57	Not in use	No equipment
H16-624LS-B40	T.Feurre	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B41	T.Feurre	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B42	T.Feurre	DOORNBULT	LPLS 624	12.085	In use	Submersible pump
H16-624LS-B43	T.Feurre	DOORNBULT	LPLS 624	12.85	In use	Submersible pump
H16-624LS-B44	M.Deviters	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B45	M.Deviters	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B46	Peet Venter	DOORNBULT	LPLS 624	38m	In use	Submersible pump
H16-624LS-B47	Peet Venter	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B48	Peet Venter	DOORNBULT	LPLS 624	0.5	Not in use	No equipment
H16-624LS-B49	Peet Venter	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B50	Peet Venter	DOORNBULT	LPLS 624	26.23	In use	Submersible pump

H16-624LS-B51	Brian Smit	DOORNBULT	LPLS 624	4.8	In use	Submersible pump
H16-624LS-B52	Brian Smit	DOORNBULT	LPLS 624	4.17	In use	Submersible pump
H16-624LS-B53	Gert Swart	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B54	Gert Swart	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B55	Gert Swart	DOORNBULT	LPLS 624	18.84	Not in use	No equipment
H16-624LS-B56	Gert Swart	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B57	Gert Swart	DOORNBULT	LPLS 624	17.145	Not in use	No equipment
H16-624LS-B58	Gert Swart	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B59	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B60	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B61	Doornbult Voerkraal	DOORNBULT	LPLS 624	38.5	Not in use	No equipment
H16-624LS-B62	Mike's Chicken	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B63	Mike's Chicken	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B64	Mike's Chicken	DOORNBULT	LPLS 624	11.8	In use	Mono-type pump
H16-624LS-B65	Mike's Chicken	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B66	Mike's Chicken	DOORNBULT	LPLS 624	40.83	In use	Submersible pump
H16-625LS-B1	Mike's Chicken	VLAKLAAGTE	LPLS 625		In use	Submersible pump
H16-624LS-B68	Mike's Chicken	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B69	Mike's Chicken	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B70	Mike's Chicken	DOORNBULT	LPLS 624	39.95	In use	Mono-type pump
H16-625LS-B2	Mike's Chicken	VLAKLAAGTE	LPLS 625		In use	Mono-type pump
H16-625LS-B3	Mike's Chicken	VLAKLAAGTE	LPLS 625		In use	Mono-type pump
H16-624LS-B73	Carel - Mikes Chicken	DOORNBULT	LPLS 624	9.6	In use	Mono-type pump
H16-624LS-B74	Carel - Mikes Chicken	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-625LS-B4	Carel - Mikes Chicken	VLAKLAAGTE	LPLS 625	30.7	In use	Submersible pump
H16-625LS-B5	Mike's Chicken	VLAKLAAGTE	LPLS 625	37	Not in use	No equipment

H16-624LS-B77	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B78	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B79	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B80	Doornbult Voerkraal	DOORNBULT	LPLS 624	10.6	In use	Submersible pump
H16-624LS-B81	Doornbult Voerkraal	DOORNBULT	LPLS 624	7.88	In use	Submersible pump
H16-624LS-B82	Doornbult Voerkraal	DOORNBULT	LPLS 624		Not in use	Mono-type pump
H16-624LS-B83	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B84	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B85	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B86	Doornbult Voerkraal	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B87	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B88	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B89	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
M16-1850	Doornbult Voerkraal	DOORNBULT	LPLS 624		Monitoring	No equipment
H16-624LS-B90	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B91	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B92	Doornbult Voerkraal	DOORNBULT	LPLS 624	10.7	In use	Submersible pump
H16-624LS-B93	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B94	Doornbult Voerkraal	DOORNBULT	LPLS 624	26.89	In use	Submersible pump
H16-624LS-B95	Doornbult Voerkraal	DOORNBULT	LPLS 624	24.9	Not in use	No equipment
H16-624LS-B96	Doornbult Voerkraal	DOORNBULT	LPLS 624	21.62	Not in use	No equipment
H16-624LS-B97	Doornbult Voerkraal	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B98	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B99	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B100	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B101	Doornbult Voerkraal	DOORNBULT	LPLS 624	26	Not in use	No equipment

H16-624LS-B102	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B103	Doornbult Voerkraal	DOORNBULT	LPLS 624	27.58	In use	Submersible pump
H16-1155	Doornbult Voerkraal	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-1156	Doornbult Voerkraal	DOORNBULT	LPLS 624		Not in use	No equipment
H16-1116	Doornbult Voerkraal	PELGRIMS HOOP	LPLS 630	8.8	Not in use	No equipment
H16-2358	Doornbult Voerkraal	PELGRIMS HOOP	LPLS 630	10.08	Not in use	No equipment
H16-630LS-B1	Theo Goosen	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
H16-630LS-B2	Theo Goosen	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
H16-630LS-B3	Theo Goosen	PELGRIMS HOOP	LPLS 630	12.09	In use	Submersible pump
H16-630LS-B4	Theo Goosen	PELGRIMS HOOP	LPLS 630	31.95	Not in use	No equipment
H16-630LS-B5	Theo Goosen	PELGRIMS HOOP	LPLS 630	16.88	Not in use	No equipment
H16-630LS-B6	T.Goosen	PELGRIMS HOOP	LPLS 630	15.24	Not in use	No equipment
H16-630LS-B7	T.Goosen	PELGRIMS HOOP	LPLS 630	15.55	Not in use	No equipment
H16-630LS-B8	T.Goosen	PELGRIMS HOOP	LPLS 630	15.64	Not in use	No equipment
H16-630LS-B9	T.Goosen	PELGRIMS HOOP	LPLS 630		Not in use	Windpump
H16-630LS-B10	T.Goosen	PELGRIMS HOOP	LPLS 630	18.75	Not in use	No equipment
H16-630LS-B11	J.van Waveren	PELGRIMS HOOP 20	LPLS 630		In use	Mono-type pump
H16-630LS-B12	J.van Waveren	PELGRIMS HOOP 21	LPLS 630	16.65	Not in use	Mono-type pump
H16-630LS-B13	J.Otto	PELGRIMS HOOP 22	LPLS 630		In use	Submersible pump
H16-630LS-B14	J.Otto	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B15	J.Otto	PELGRIMS HOOP	LPLS 630		Not in use	Mono-type pump
H16-630LS-B16	J.Otto	PELGRIMS HOOP	LPLS 630	11	Not in use	No equipment
H16-1942	J.Otto	PELGRIMS HOOP	LPLS 630		Monitoring	No equipment
M16-1822	J.Otto	DOORNBULT	LPLS 624	6.88	Monitoring	No equipment
H16-1157	J.Otto	DOORNBULT	LPLS 624		In use	Mono-type pump
M16-1831	Dawie Botes	PELGRIMS HOOP 19	LPLS 630	11.52	Not in use	No equipment

H16-630LS-B17	Dawie Botes	PELGRIMS HOOP	LPLS 630	10.8	Not in use	No equipment
H16-630LS-B18	Dawie Botes	PELGRIMS HOOP	LPLS 630	9.14	Not in use	No equipment
H16-630LS-B19	Dawie Botes	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
M16-1851	D. Korf	PELGRIMS HOOP	LPLS 630		Monitoring	No equipment
H16-630LS-B20	D. Korf	PELGRIMS HOOP	LPLS 630	16.27	Not in use	No equipment
H16-630LS-B21	D. Korf	PELGRIMS HOOP	LPLS 630	16.5	Not in use	No equipment
H16-630LS-B22	D. Korf	PELGRIMS HOOP	LPLS 630	16.45	Not in use	No equipment
H16-630LS-B23	D. Korf	PELGRIMS HOOP	LPLS 630	16.35	Not in use	No equipment
H16-630LS-B24	J.van Waveren	PELGRIMS HOOP	LPLS 630		Not in use	No equipment
H16-630LS-B25	J.van Waveren	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B26	J.van Waveren	PELGRIMS HOOP	LPLS 630		Not in use	No equipment
H16-630LS-B27	J.van Waveren	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
H16-630LS-B28	J.van Waveren	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
H16-630LS-B29	J.van Waveren	PELGRIMS HOOP	LPLS 630		Not in use	No equipment
H16-630LS-B31	J.van Waveren	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
H16-630LS-B32	Malherbe	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
H16-630LS-B33	Brown	PELGRIMS HOOP	LPLS 630		Not in use	No equipment
H16-630LS-B34	Brown	PELGRIMS HOOP	LPLS 630	22.3	Not in use	No equipment
H16-630LS-B35	Brown	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B36	Brown	PELGRIMS HOOP	LPLS 630	26.5	Not in use	No equipment
H16-630LS-B37	Brown	PELGRIMS HOOP	LPLS 630	1.6	Not in use	No equipment
H16-630LS-B38	Moringo	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B39	Moringo	PELGRIMS HOOP	LPLS 630	25.25	In use	Submersible pump
H16-630LS-B40	Van de Merwe	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B41	Van de Merwe	PELGRIMS HOOP	LPLS 630	26.6	Not in use	No equipment
H16-630LS-B42	Van de Merwe	PELGRIMS HOOP	LPLS 630		In use	Submersible pump

H16-630LS-B43	Van de Merwe	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B44	Jack Maake	PELGRIMS HOOP	LPLS 630	29.66	Not in use	No equipment
H16-630LS-B45	Jack Maake	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B46	Jack Maake	PELGRIMS HOOP	LPLS 630	16.6	Not in use	No equipment
H16-630LS-B47	T.Gerhard	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B48	T.Gerhard	PELGRIMS HOOP	LPLS 630	14.6	Not in use	No equipment
H16-630LS-B49	T.Gerhard	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B50	T.Gerhard	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H16-630LS-B51	T.Gerhard	PELGRIMS HOOP	LPLS 630	28.1	Not in use	No equipment
H16-624LS-B156	T.Gerhard	DOORNBULT	LPLS 624		Not in use	Submersible pump
H16-624LS-B157	T.Gerhard	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B158	T.Gerhard	DOORNBULT	LPLS 624	29.2	Not in use	No equipment
H16-623LS-B1	M. Ledwaba	SCHUILKRAAL	LPLS 623		In use	Submersible pump
H16-623LS-B2	M. Ledwaba	SCHUILKRAAL	LPLS 623		In use	Submersible pump
H16-624LS-B161	L. de Jager	DOORNBULT	LPLS 624	31.42	Not in use	No equipment
H16-624LS-B162	L. de Jager	DOORNBULT	LPLS 624	27.4	In use	Submersible pump
H16-624LS-B163	L. de Jager	DOORNBULT	LPLS 624	23.56	In use	Submersible pump
H16-624LS-B164	L. de Jager	DOORNBULT	LPLS 624	21.75	Not in use	No equipment
H16-624LS-B165	L. de Jager	DOORNBULT	LPLS 624	16.4	Not in use	No equipment
H16-624LS-B166	L. de Jager	DOORNBULT	LPLS 624	32.8	Not in use	No equipment
H16-624LS-B167	L. de Jager	DOORNBULT	LPLS 624	37.07	Not in use	No equipment
H16-624LS-B168	L. de Jager	DOORNBULT	LPLS 624	37	Not in use	No equipment
H16-624LS-B169	L. de Jager	DOORNBULT	LPLS 624	33.6	Not in use	No equipment
H16-624LS-B170	L. de Jager	DOORNBULT	LPLS 624	36.65	Not in use	No equipment
H16-624LS-B171	L. de Jager	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B172	L. de Jager	DOORNBULT	LPLS 624		In use	Submersible pump

H16-624LS-B173	L. de Jager	DOORNBULT	LPLS 624	32.1	In use	Submersible pump
H16-624LS-B174	L. de Jager	DOORNBULT	LPLS 624	22.5	Not in use	No equipment
H16-624LS-B175	L. de Jager	DOORNBULT	LPLS 624	31.3	Not in use	No equipment
H16-624LS-B176	L. de Jager	DOORNBULT	LPLS 624	44.49	Not in use	No equipment
H16-624LS-B177	L. de Jager	DOORNBULT	LPLS 624		Not in use	No equipment
H16-618LS-B1	Hennie Smit	KAREEBOSCH	LPLS 618	45.52	Not in use	No equipment
H16-618LS-B2	Hennie Smit	KAREEBOSCH	LPLS 618		In use	Submersible pump
H16-618LS-B3	Hennie Smit	KAREEBOSCH	LPLS 618		In use	Submersible pump
H16-618LS-B4	Hennie Smit	KAREEBOSCH	LPLS 618		In use	Mono-type pump
H16-618LS-B5	Hennie Smit	KAREEBOSCH	LPLS 618		In use	Submersible pump
H16-618LS-B6	Hennie Smit	KAREEBOSCH	LPLS 618		In use	Submersible pump
H16-618LS-B7	Hennie Smit	KAREEBOSCH	LPLS 618		In use	Mono-type pump
H16-618LS-B8	Hennie Smit	KAREEBOSCH	LPLS 618	39.5	Not in use	No equipment
H16-624LS-B186	Municipality	DOORNBULT	LPLS 624	7	Not in use	No equipment
H16-0409	Municipality	DOORNBULT	LPLS 624	5.4	Not in use	No equipment
H16-1285	Municipality	DOORNBULT	LPLS 624	5.62	Not in use	No equipment
H16-0405	Municipality	DOORNBULT	LPLS 624	5.38	Not in use	No equipment
H16-624LS-B190	Municipality	DOORNBULT	LPLS 624	5.56	Not in use	No equipment
H16-0408	Municipality	DOORNBULT	LPLS 624	4.15	Not in use	No equipment
H16-0410	Municipality	DOORNBULT	LPLS 624	4.85	Not in use	No equipment
H16-1273	Municipality	DOORNBULT	LPLS 624		In use	Submersible pump
H16-1899	Municipality	DOORNBULT	LPLS 624	43.5	Not in use	No equipment
H16-1159	Municipality	PELGRIMSHOOP	LPLS 630	8.66	Not in use	No equipment
H16-624LS-B196	Municipality	DOORNBULT	LPLS 624	6.6	Not in use	No equipment
H16-1124	Municipality	DOORNBULT	LPLS 624	5.7	Not in use	No equipment
H16-1125	Municipality	DOORNBULT	LPLS 624	6.05	Not in use	No equipment

H16-1126	Municipality	DOORNBULT	LPLS 624	6.73	Not in use	No equipment
H16-624LS-B200	Municipality	DOORNBULT	LPLS 624	5.58	Not in use	No equipment
H16-1160	Municipality	PELGRIMSHOOP	LPLS 630		Not in use	Windpump
H16-1161	Municipality	PELGRIMSHOOP	LPLS 630	15	Not in use	Windpump
H16-1162	Municipality	PELGRIMSHOOP	LPLS 630		In use	Submersible pump
H16-1171	Municipality	PELGRIMSHOOP	LPLS 630	10.25	In use	Submersible pump
H16-1114	Municipality	PELGRIMSHOOP	LPLS 630		Not in use	Windpump
H04-629LS-B1	Municipality	VAALWATER	LPLS 629		In use	Mono-type pump
H04-2241	Municipality	DOORNDRAAI	LPLS 750		Monitoring	No equipment
H04-750LS-B1	Municipality	DOORNDRAAI	LPLS 750		Not in use	Mono-type pump
H04-1918	Municipality	DOORNDRAAI	LPLS 750		In use	Submersible pump
H04-626LS-B1	Municipality	EERSTE GELUK	LPLS 626	5.24	Not in use	No equipment
H16-2371	Municipality	PELGRIMSHOOP	LPLS 630	15.8	Not in use	No equipment
H16-2367	Municipality	DOORNKRAAL	LPLS 680	12.55	Not in use	No equipment
H16-2369	Municipality	PELGRIMSHOOP	LPLS 630	19.74	Not in use	No equipment
H16-2364	Municipality	PELGRIMSHOOP	LPLS 630		Not in use	No equipment
H16-2363	Municipality	PELGRIMSHOOP	LPLS 630	11.58	Not in use	No equipment
H16-2362	Municipality	PELGRIMSHOOP	LPLS 630	9.75	Not in use	No equipment
H16-2361	Municipality	PELGRIMSHOOP	LPLS 630	9.05	Not in use	No equipment
H16-2368	Municipality	PELGRIMSHOOP	LPLS 630	3.3	Not in use	No equipment
H16-1180	Municipality	PELGRIMSHOOP	LPLS 630	11.5	Not in use	No equipment
H16-1174	Municipality	PELGRIMSHOOP	LPLS 630	3.88	Not in use	No equipment
H16-2372	Municipality	PELGRIMSHOOP	LPLS 630	10.6	Not in use	No equipment
H16-1175	Municipality	PELGRIMSHOOP	LPLS 630	4.75	Not in use	No equipment
H16-1179	Municipality	PELGRIMSHOOP	LPLS 630	5.5	Not in use	No equipment
H16-1177	Municipality	PELGRIMSHOOP	LPLS 630	5.05	Not in use	No equipment

H16-624LS-B225	Private	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B226	Private	DOORNBULT	LPLS 624	46.52	Not in use	No equipment
H16-624LS-B227	Moropa Madisha	DOORNBULT	LPLS 624	34.45	In use	No equipment
H16-624LS-B228	Moropa Madisha	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B229	Sun	DOORNBULT	LPLS 624	32.28	Not in use	No equipment
H16-624LS-B230	Sun	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B231	Moolman	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B232	Zietsman	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B233	Zietsman	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B234	Zietsman	DOORNBULT	LPLS 624	17.37	Not in use	No equipment
H16-624LS-B235	Zietsman	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B236	S.Vermaak	DOORNBULT	LPLS 624	9	In use	Submersible pump
H16-624LS-B237	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B238	S.Vermaak	DOORNBULT	LPLS 624	9.6	In use	Submersible pump
H16-624LS-B239	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B240	S.Vermaak	DOORNBULT	LPLS 624	5.4	Not in use	No equipment
H16-624LS-B241	S.Vermaak	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B242	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B243	S.Vermaak	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B244	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B245	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B246	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B247	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B248	S.Vermaak	DOORNBULT	LPLS 624	30.3	Not in use	No equipment
H16-624LS-B249	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B250	S.Vermaak	DOORNBULT	LPLS 624	32.56	Not in use	No equipment

H16-624LS-B251	S.Vermaak	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B252	S.Vermaak	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B253	Fourie	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B254	Fourie	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B255	Fourie	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-680LS-B1	Municipality	DOORNKRAAL	LPLS 680	7.36	Not in use	No equipment
A7N0586	Municipality	DOORNKRAAL	LPLS 680		Monitoring	No equipment
H16-2242	Municipality	DOORNKRAAL	LPLS 680	11	Not in use	No equipment
H16-624LS-B259	George Dusando's	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B260	George Dusando's	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B261	George Dusando's	DOORNBULT	LPLS 624	27.76	Not in use	No equipment
H16-624LS-B262	De Lange	DOORNBULT	LPLS 624	30.58	Not in use	No equipment
H16-624LS-B263	De Lange	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B264	De Lange	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B265	Rabe	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B266	Rabe	DOORNBULT	LPLS 624		Not in use	Mono-type pump
H16-624LS-B267	Rabe	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B268	Knoetze	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B269	Knoetze	DOORNBULT	LPLS 624		Not in use	No equipment
H16-624LS-B270	Knoetze	DOORNBULT	LPLS 624	33.73	Not in use	No equipment
H16-624LS-B271	Knoetze	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B272	Knoetze	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B273	Knoetze	DOORNBULT	LPLS 624		In use	Mono-type pump
H16-624LS-B274	Knoetze	DOORNBULT	LPLS 624	45.8	Not in use	No equipment
H16-624LS-B275	Deon	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B276	Deon	DOORNBULT	LPLS 624		In use	Submersible pump

H16-624LS-B277	Skyn	DOORNBULT	LPLS 624		In use	Submersible pump
H16-1357	Khoza	DOORNBULT	LPLS 624		In use	Submersible pump
H16-624LS-B279	H.J. van Niekerk	DOORNBULT	LPLS 624	49.5	Not in use	No equipment
H16-624LS-B280	H.J. van Niekerk	DOORNBULT	LPLS 624		In use	Submersible pump
H16-1178	Municipality	PELGRIMSHOOP	LPLS 630	4.9	Not in use	No equipment
H16-1153	Municipality	DOORNKRAAL	LPLS 680	7.25	Not in use	Submersible pump
H16-1181	Municipality	DOORNKRAAL	LPLS 680	8	In use	Mono-type pump
H16-1182	Municipality	DOORNKRAAL	LPLS 680	12.63	In use	Mono-type pump
H16-1151	Municipality	DOORNKRAAL	LPLS 680		Not in use	No equipment
H16-1150	Municipality	DOORNKRAAL	LPLS 680		In use	Mono-type pump
H16-680LS-B2	Municipality	DOORNKRAAL	LPLS 680	6.85	In use	Mono-type pump
H16-1148	Municipality	DOORNKRAAL	LPLS 680	8.11	Not in use	Mono-type pump
H16-1146	Municipality	DOORNKRAAL	LPLS 680	7.55	In use	Mono-type pump
H16-1145	Municipality	DOORNKRAAL	LPLS 680		In use	Mono-type pump
H16-1929	Municipality	DOORNKRAAL	LPLS 680	6.77	Not in use	No equipment
H16-1147	Municipality	DOORNKRAAL	LPLS 680	6.66	Monitoring	No equipment
H16-1144	Municipality	DOORNKRAAL	LPLS 680		Destroyed	
H16-1142	Municipality	DOORNKRAAL	LPLS 680	18.89	In use	Mono-type pump
H16-1141	Municipality	DOORNKRAAL	LPLS 680		In use	Mono-type pump
H16-1143	Municipality	DOORNKRAAL	LPLS 680	20.85	In use	Mono-type pump
M16-1140	Municipality	DOORNKRAAL	LPLS 680		Not in use	No equipment
H16-1139	Municipality	DOORNKRAAL	LPLS 680		In use	Mono-type pump
H16-1138	Municipality	DOORNKRAAL	LPLS 680	14.66	In use	Mono-type pump
H16-1137	Municipality	PELGRIMSHOOP	LPLS 630	16.5	In use	Mono-type pump
H16-1136	Municipality	PELGRIMSHOOP	LPLS 630	13.38	Not in use	No equipment
H16-1135	Municipality	PELGRIMSHOOP	LPLS 630		Destroyed	

H16-1134	Municipality	PELGRIMS HOOP	LPLS 630		Not in use	No equipment
H16-1133	Municipality	PELGRIMS HOOP	LPLS 630		Destroyed	
H16-1132	Municipality	PELGRIMS HOOP	LPLS 630	9.48	In use	Mono-type pump
H16-1131	Municipality	PELGRIMS HOOP	LPLS 630		Not in use	Mono-type pump
H16-1130	Municipality	PELGRIMS HOOP	LPLS 630	8.69	In use	Mono-type pump
H16-1932	Municipality	PELGRIMS HOOP	LPLS 630	6.22	Not in use	No equipment
H16-1122	Municipality	DOORNBULT	LPLS 624	5.45	In use	Mono-type pump
H16-624LS-B310	Municipality	DOORNBULT	LPLS 624	6.35	Not in use	No equipment
H16-1121	Municipality	PELGRIMS HOOP	LPLS 630	10	In use	Mono-type pump
H16-1120	Municipality	PELGRIMS HOOP	LPLS 630	6.69	Not in use	No equipment
H16-1119	Municipality	PELGRIMS HOOP	LPLS 630	7.66	In use	Mono-type pump
H16-1164	Municipality	PELGRIMS HOOP	LPLS 630	7.19	In use	Mono-type pump
H16-1163	Municipality	PELGRIMS HOOP	LPLS 630		Destroyed	
H16-1172	Municipality	PELGRIMS HOOP	LPLS 630		In use	Mono-type pump
H16-1171	Municipality	PELGRIMS HOOP	LPLS 630		In use	Submersible pump
H04-750LS-B2	Municipality	DOORNDRAAI	LPLS 750		In use	Mono-type pump
H04-750LS-B3	Municipality	DOORNDRAAI	LPLS 750		In use	Mono-type pump
H04-750LS-B4	Municipality	DOORNDRAAI	LPLS 750		In use	Mono-type pump
H04-750LS-B5	Municipality	DOORNDRAAI	LPLS 750		In use	Mono-type pump
H04-750LS-B6	Municipality	DOORNDRAAI	LPLS 750		In use	Mono-type pump
H04-750LS-B7	Municipality	DOORNDRAAI	LPLS 750		In use	Mono-type pump
H04-629LS-B2	Municipality	VAALWATER	LPLS 626		In use	Mono-type pump
H04-1922	Municipality	DOORNDRAAI	LPLS 750		In use	Mono-type pump
H16-620LS-B1	Marlo Roses	PALMIETFONTEIN	LPLS 620	24.7	In use	Submersible pump
H16-620LS-B2	Marlo Roses	PALMIETFONTEIN	LPLS 620	15	In use	Submersible pump
H16-SAK2	SAKKOR	KRUGERSBURG	LPLS 685	20.49	Not in use	Submersible pump

H16-915LS-B1	Andries Engelbrecht	TWEEFONTEIN	LPLS 915	56	In use	Submersible pump
H16-853LS-B1	Private	PALMIETKUIL	LPLS 853	17.6	Not in use	No equipment
H16-915LS-B2	VSA Leboa	TWEEFONTEIN	LPLS 915	49.25	Not in use	No equipment
H16-622LS-B1	Vencor	RONDEPAN	LPLS 622	76.89	Not in use	No equipment
H16-622LS-B2	Vencor	RONDEPAN	LPLS 622	74.8	In use	Mono-type pump
H16-622LS-B3	Vencor	RONDEPAN	LPLS 622	68.26	Not in use	No equipment
H16-622LS-B4	Vencor	RONDEPAN	LPLS 622		In use	Submersible pump
H16-622LS-B5	Vencor	RONDEPAN	LPLS 622		In use	Submersible pump
H16-622LS-B6	Vencor	RONDEPAN	LPLS 622	75.85	Not in use	No equipment
H16-620LS-B3	Vencor	PALMIETFONTEIN	LPLS 620	65.1	Not in use	No equipment
H16-620LS-B4	Vencor	PALMIETFONTEIN	LPLS 620		In use	Submersible pump
H16-620LS-B5	Vencor	PALMIETFONTEIN	LPLS 620		In use	Mono-type pump
H16-620LS-B6	Vencor	PALMIETFONTEIN	LPLS 620	25.75	Not in use	No equipment
H16-620LS-B7	Vencor	PALMIETFONTEIN	LPLS 620	26	Not in use	No equipment
H16-620LS-B8	Vencor	PALMIETFONTEIN	LPLS 620		In use	Submersible pump
H16-620LS-B9	Vencor	PALMIETFONTEIN	LPLS 620	26.64	Not in use	No equipment
H16-620LS-B10	Vencor	PALMIETFONTEIN	LPLS 620	25	Not in use	No equipment
H16-620LS-B11	Vencor	PALMIETFONTEIN	LPLS 620	26.8	Not in use	No equipment
H16-620LS-B12	Vencor	PALMIETFONTEIN	LPLS 620	29.34	Not in use	No equipment
H16-623LS-B3	Vencor	SCHUILKRAAL	LPLS 623	36.4	In use	No equipment
H16-623LS-B4	Vencor	SCHUILKRAAL	LPLS 623	38.38	Not in use	No equipment
H16-620LS-B13	Vencor	PALMIETFONTEIN	LPLS 620	38.6	Not in use	No equipment
H16-623LS-B5	Vencor	SCHUILKRAAL	LPLS 623	7.1	Not in use	No equipment
H16-623LS-B6	Vencor	SCHUILKRAAL	LPLS 623	38.16	Not in use	No equipment
H16-623LS-B7	Vencor	SCHUILKRAAL	LPLS 623	40.36	Not in use	No equipment
H16-623LS-B8	Vencor	SCHUILKRAAL	LPLS 623	21.28	Not in use	No equipment

H16-623LS-B9	Vencor	SCHUILKRAAL	LPLS 623	38.14	Not in use	No equipment
H16-623LS-B10	Vencor	SCHUILKRAAL	LPLS 623	50	Not in use	No equipment
Boet Haumann	ZZ2	DOORNBULT	LPLS 624	10.2	In Use	Electrical
DT Blok 8B	ZZ2	DOORNBULT	LPLS 624	22.5	Monitoring	No equipment
DT 03	ZZ2	DOORNBULT	LPLS 624	15	In Use	Electrical
DT 04	ZZ2	DOORNBULT	LPLS 624	12.5	Not in use	No equipment
DT 09	ZZ2	DOORNBULT	LPLS 624	4	In Use	Electrical
DT 10	ZZ2	DOORNBULT	LPLS 624		In Use	Electrical
DT 10B	ZZ2	DOORNBULT	LPLS 624	13.2	Not in use	No equipment
DT 11	ZZ2	DOORNBULT	LPLS 624	3	Not in use	No equipment
DT 12	ZZ2	DOORNBULT	LPLS 624	12	In Use	Electrical
DT 13	ZZ2	DOORNBULT	LPLS 624	4.5	In Use	Electrical
DT 8	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
DT Blok 2A	ZZ2	DOORNBULT	LPLS 624	8.4	Not in use	No equipment
DT Sementdam	ZZ2	DOORNBULT	LPLS 624	18.5	Not in use	No equipment
Eben Barnard Huis	ZZ2	DOORNBULT	LPLS 624	21	Not in use	No equipment
Griesel Blok 2B	ZZ2	DOORNBULT	LPLS 624	4.5	Not in use	No equipment
Griesel Blok 4B	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
Griesel Blok 8A	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
K 10	ZZ2	DOORNBULT	LPLS 624	5	In Use	Electrical
K 14	ZZ2	DOORNBULT	LPLS 624	7.8	Not in use	No equipment
K 17	ZZ2	DOORNBULT	LPLS 624	20	In Use	Electrical
K 19	ZZ2	DOORNBULT	LPLS 624	17.2	Not in use	No equipment
K 1A	ZZ2	DOORNBULT	LPLS 624	18	In Use	Electrical
K 1B	ZZ2	DOORNBULT	LPLS 624	18	In Use	Electrical
K 2	ZZ2	DOORNBULT	LPLS 624	18.2	In Use	Electrical

Kallie 1	ZZ2	DOORNBULT	LPLS 624	22.8	In Use	Electrical
Kallie 2	ZZ2	DOORNBULT	LPLS 624	21	In Use	Electrical
Kallie 3	ZZ2	DOORNBULT	LPLS 624	18	In Use	Electrical
Kallie 4	ZZ2	DOORNBULT	LPLS 624	38	In Use	Electrical
Kallie 5	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
Kallie 6	ZZ2	DOORNBULT	LPLS 624	40	Not in use	No equipment
Kallie 7	ZZ2	DOORNBULT	LPLS 624	41	Not in use	No equipment
Kallie 7B	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
Kallie 8	ZZ2	DOORNBULT	LPLS 624	41	Not in use	No equipment
Kallie 9	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
KB 18	ZZ2	DOORNBULT	LPLS 624	4.5	Not in use	No equipment
KB 19	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
KB 21	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
KB 24	ZZ2	DOORNBULT	LPLS 624	5	In Use	Electrical
KB 29	ZZ2	DOORNBULT	LPLS 624	25	Not in use	No equipment
KB 30	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
Klipgat	ZZ2	DOORNBULT	LPLS 624	27.5	In Use	Electrical
Kratergat	ZZ2	DOORNBULT	LPLS 624	6	In Use	Electrical
Louis se Gat	ZZ2	DOORNBULT	LPLS 624		Dry	
Melkery	ZZ2	DOORNBULT	LPLS 624	8.6	In Use	Electrical
Paalstasie 2	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
Paalstasie 1	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
Plot 17	ZZ2	DOORNBULT	LPLS 624	16	In Use	Electrical
Plot 18	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment
Rivier 1	ZZ2	DOORNBULT	LPLS 624	6	Not in use	No equipment
Rivier 2	ZZ2	DOORNBULT	LPLS 624		Not in use	No equipment

Rivier 3	ZZ2	DOORNBULT	LPLS 624	6	In Use	Electrical
Rivier 4	ZZ2	DOORNBULT	LPLS 624	9	Not in use	No equipment
Rivier 5	ZZ2	DOORNBULT	LPLS 624	5.5	Not in use	No equipment
Sterkgat	ZZ2	DOORNBULT	LPLS 624	9	In Use	Electrical

POLOKWANE MUNICIPALITY

CONSTRUCTION, OPERATIONS AND MAINTENANCE OF THE POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS (PRWWTW): PHASE 2B

PART C5 ANNEXURES

POLOKWANE MUNICIPALITY

CONSTRUCTION, OPERATIONS AND MAINTENANCE OF THE POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS (PRWWTW): PHASE 2B

C5.1 WATER USE LICENSE

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Private Bag X313, Pretoria, 0001, Sedibeng Building, 185 Francis Baard Street, Pretoria,
Tel: (012) 336 7500 Fax (012) 323-4472 / (012) 326 - 2715

LICENCE IN TERMS OF CHAPTER 4 OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998) (THE ACT)

I, ***Trevor Balzer,*** in my capacity as Deputy Director-General: Special Projects in the Department of Water and Sanitation and acting under authority of the powers sub-delegated to me by the Acting Director-General of Water and Sanitation, hereby authorizes the following water uses in respect of this licence.

SIGNED: .....

DATE: 4/12/2018

LICENCE NO: 07/A71A/ACEFGI/8207
FILE NO: 27/2/2/A171/18/1

1.	**Licensee**	**Polokwane Regional Waste Water Treatment Works**
	Postal Address	PO Box 111 Polokwane, 0700

2. Water Uses

2.1	Section 21(c) of the Act:	Impeding or diverting the flow of water in a watercourse, subject to conditions as set out in Appendices I and IV.
2.2	Section 21(e) of the Act:	Engaging in a controlled activity, subject to conditions as set out in Appendices I and IV.
2.3	Section 21(f) of the Act:	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit, subject to conditions as set out in Appendices I and V.
2.4	Section 21(g) of the Act:	Disposing of waste in a manner which may detrimentally impact on a water resource, subject to conditions as set out in Appendices I and V.
2.5	Section 21(i) of the Act:	Altering the bed, banks, course or characteristics of a watercourse, subject to the conditions as set out in Appendices I and IV.

B08502

3. Properties is respect of which this licence is issued

3.1 Portion 8 and 15 of the farm Pelgrimshoop 630 LS, portion 28 and 55 of the farm Doornkraal 680 LS, portion 2, 93, 95, 151 and 156 of the farm Doornbult 624 LS.

4. Registered owners of the Properties

Table 1: Registered owners of the Properties

Property Name	Property Owner	Title deeds number
Portion 28 of the farm Doornkraal 680 LS	Polokwane Municipality	T9186/931
Portion 151 of the farm Doornbult 624 LS	Mr. WJJ Zietsman	T41556/1976
Portion 8 of the farm Pelgrimshoop 630 LS	Giel Jansen Trust	T66791/1997
Portion 55 of the farm Doornkraal 680 LS	Polokwane Municipality	T44122/1984
Portion 156 of the farm Doornbult 624 LS	Polokwane Municipality	T85479/1996
Portion 15 of the farm Pelgrimshoop 630 LS	Polokwane Municipality	T66791/1997
Portion 2, 28, 93 and 95 of the farm Doornbult 624 LS	Polokwane Municipality	T80892/1996

5. Licence and Review Period

This licence is valid for a period of twenty (20) years from the date of issuance and it may be reviewed at intervals of not more than five (5) years.

6. Definitions

Any terms, words and expressions as defined in the National Water Act, 1998 (Act 36 of 1998) shall bear the same meaning when used in this licence.

"The Regional Head" means the Head of Provincial Operations: Limpopo Private Bag X9506, Polokwane, 0700

"Extent of the watercourse" means the outer edge of the 1:100 year floodline or the delineated riparian habitat, whichever is the greatest.

"Regulated area of a wetland" is the use of water for section 21 c and i water uses within 500m radius from the boundary of any wetland.

A wetland means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

The characteristics of a watercourse/s mean the flow regime, water quality, habitat (including the physical structure of the watercourse/s and associated vegetation) and biota found within the extent of the watercourse/s. The Resource Quality characteristics as defined in the National Water Act, 1998 (Act 36 of 1998).

7. Description of activity

This licence authorises **Polokwane Regional Waste Water Treatment Works** for the water use in terms of section 21 (a), (c), (e), (f), (g) & (i) of the National Water Act, 1998 (Act 36 of 1998). The water use activities include: proposed Polokwane Regional Waste Water Treatment Works and Sewer Outfall A, B, and C. The activity is located in quaternary catchment A71A which falls within Limpopo Water Management Area.

APPENDIX I

General Conditions for the Licence

1. This licence is subject to all applicable provisions of the National Water Act, 1998 (Act 36 of 1998).

2. The responsibility for complying with the provisions of the licence is vested in the Licensee and not any other person or body.

3. The Licensee must immediately inform the Provincial Head of any change of name, address, premises and/or legal status.

4. If the property in respect of which this licence is issued is subdivided or consolidated, the Licensee must provide full details of all changes in respect of the properties to the Provincial Head within 60 days of the said change taking place.

5. If a Water User Association is established in the area to manage the resource, membership of the Licensee to the Association is compulsory. Rules, regulations and water management stipulation of such association must be adhered to.

6. The Licensee shall be responsible for any water use charges and/or levies imposed by a Responsible Authority.

7. While effect must be given to the Reserve as determined in terms of the Act, where a lower confidence determination of the Reserve has been used in issuance of this licence, the licence conditions may be amended should a higher confidence reserve be conducted.

8. The licence shall not be construed as exempting the Licensee from compliance with the provisions of any other applicable Act, Ordinance, Regulation or By-law.

9. The licence and amendment of this licence are also subject to all the applicable procedural requirements and other provisions of the Act, as amended from time to time.

10. The Licensee shall conduct an annual internal audit on compliance with the conditions of this licence. A report on the audit shall be submitted to the Provincial Head within one month of the finalization of the audit.

11. The Licensee shall appoint an independent external auditor to conduct an annual audit on compliance with the conditions of this licence. Both these audits may be subjected to external audit.

12. Any incident that causes or may cause water pollution must be reported to the Provincial Head or a designated representative within 24 hours.

13. The Department accepts no liability for any damage, loss or inconvenience, of whatever nature, suffered as a result of / amongst other things.

    13.1 Shortage of water;
    13.2 Inundation of flood;
    13.3 Any *force majeur* event;
    13.4 Siltation of the river or dam basin; and
    13.5 Required Reserve releases.

APPENDIX II

Section 21(c) of the Act: **Impeding or diverting the flow of water in a watercourse**
and
Section 21(i) of the Act: **Altering the bed, banks, course or characteristic of a watercourse**

1. GENERAL

1.1 This licence authorises Polokwane Regional Waste Water Treatment Works for Section 21(c) and (i) water use activities for the construction facilities as set out in Table 2.within quaternary catchment A71A and in the water use licence application reports submitted to the Department (refer condition 1.2):

Table 2: Water Use Activities

Activity	Properties	Demission/ Capacity	Co-ordinates
WWTW- Sewer Outfall B-East1	Remainder of portion 28, Doornbult 624 LS	1500 mm	S23°50′11.01″ E29°26′45.36″
WWTW- Sewer Outfall B-East2	Remainder of portion 28, Doornbult 624 LS	1500 mm	S23°50′28.85″ E29°26′34.79″
WWTW- Sewer Outfall A1	Portion 15 Pelgrimshoop 630 LS	1350 mm	S23°49′41.05″ E29°25′20.59″
WWTW- Sewer Outfall B-East3	Remainder of portion 28, Doornbult 624 LS	1500 mm	S23°51′21.78″ E29°26′28.66″
WWTW- Sewer Outfall C2-Pipe Bridge	Portion 156 of the farm Doornbulty 624 LS	1850 mm	S23°49′14.69″ E29°26′38.65″
WWTW- Sewer Outfall C1	Portion 156 of the farm Doornbulty 624 LS	1850 mm	S23°48′58.11″ E29°27′09.14″
WWTW- Sewer Outfall B-East5	Remainder of portion 28, Doornbult 624 LS	1350 mm	S23°51′29.35″ E29°26′30.72″
WWTW- Sewer Outfall A2	Portion 8 Pelgrimshoop 630 LS	1350 mm	S23°49′56.16″ E29°24′32.78″
WWTW- Sewer Outfall B-East4	Remainder of portion 28, Doornbult 624 LS	1350 mm	S23°51′32.11″ E29°25′59.09″
WWTW- Sewer Outfall B-East1	Remainder of portion 28, Doornbult 624 LS	1350 mm	S23°51′35.68″ E29°26′35.03″

1.2. The Licensee must carry out and complete all the activities listed under condition 1.1 according to the following:

1.2.1 Reports submitted to the Department or the Provincial Head, specifically:

1.2.1.1 Polokwane Regional Waste Water Treatment Works: Integrated Water Use Licence Application by Ages dated April 2018;
1.2.1.2 Wetland assessment report for the proposed development of WWTW dated March 2018 by Exigo sustainability (Pty)Ltd.
1.2.1.3 Rehabilitation plan for the drainage crossings dated July 2018 by Exigo.
1.2.1.4 EMPR dated April 2017 by Tekplan.

1.3 Conditions of this licence; and

1.4 Any other written direction issued by the Provincial Head in relation to this licence.

1.5 No activity must take place within the 1:100 year flood line or the delineated riparian habitat, whichever is the greatest, or within 500 m radius from the boundary of any wetland unless authorised by this licence.

1.6 The conditions of the authorisation must be brought to the attention of all persons (employees, sub-consultants, contractors etc.) associated with the undertaking of these activities and the Licensee must take such measures that are necessary to bind such persons to the conditions of this licence.

1.7 A copy of the water use licence and reports set out under condition 1.2 of this Appendix must be on site at all times.

1.8 A suitably qualified person(s), appointed by the Licensee, and approved in writing by the Provincial Head, must be responsible for ensuring that the activities are undertaken in compliance with the specifications as set out in reports submitted to the Department or the Provincial Head and the conditions of this licence.

1.9 Buffers of 30m must be implemented between the wetland and the irrigation area and the pasture area.

1.10 Ecological class of rivers and wetlands (PES of B) must not to be lowered. Recommended Ecological Class (REC) for wetland must be set as class B.

1.11 A layout plan confirming that the 1:100 year floodline of the watercourse upstream of the dam wall do not affect any public property must be submitted to the Department within 30 days of issuance of water use licence.

2. FURTHER STUDIES AND INFORMATION REQUIREMENTS

2.1 For water use activities in Table 4:

2.1.1 Detailed design drawings of all the infrastructure of impeding and/or diverting flow of watercourses on the property must be submitted to the Provincial Head within three (3) months of date the issuance. The foregoing must indicate the regulated activities, marking the limits of disturbance in relation to the impacted watercourse; morphology of the watercourse; site specific impacts; and environmental management, particularly erosion and sediment, controls and measures;

2.1.2 No fundamental alterations of the site design plan(s) and drawings are allowed, unless a modification is requested and granted by the Provincial Head in writing; and

2.1.3 No site activities must occur beyond the proposed site location of the erosion and sedimentation controls and marked limits of disturbance.

2.2 If the Licensee is not the end user/beneficiary of the water use related infrastructure and will not be responsible for long term maintenance and management of the infrastructure, the Licensee must provide a programme for hand over to the successor-in-title including a brief management/maintenance plan and the agreement for infrastructure along with allocation of responsibilities, within three (3) months of the date of issuance of this licence.

2.3 An Environmental Management Plan (EMP) and rehabilitation plan for the decommissioning of any of the water use activities listed in Table 1 must be submitted five (5) years before commencing with closure to the Provincial Head for a written approval.

2.4 For all the activities listed under condition 1.1, Table 4, "as-built" plan(s) and engineering drawing(s) prepared by a registered professional engineer, must be submitted to the Provincial Head within three (3) months of the date of issuance of this licence. These plan(s) and drawing(s) must indicate the watercourse including wetland boundaries and layout and structure location(s) of all infrastructure a impeding and/or diverting flow of the watercourse as well as alterations to the watercourse on the property.

2.5 A Storm Water Management Plan must be updated and drawn up on A1 paper and submitted to the Provincial Head for written approval within 3 months of licence being issued. Clean water dirty water must be separated.

2.6 Storm Water management plan should be designed in a way that aims to ensure that post-development run-off does not exceed pre-development values in:

2.6.1 Peak discharge for any given storm,
2.6.2 Total volume of run-off for any given storm,
2.6.3 Frequency of run-off volumes,
2.6.4 Pollutant and debris concentrations reaching watercourses,
2.6.5 Demonstrate minimal soil and vegetation clearance practices,
2.6.6 Demonstrate an effective re-vegetation campaign for bare areas,
2.6.7 Velocity of outgoing storm water shall not exceed the velocities of incoming water in order to reduce erosion impacts, and
2.6.8 Increase in run-off due to a higher water table resulting from tree clearing practices.

3. PROTECTIVE MEASURES

3.1 Storm Water Management

3.1.1 Storm water management practices must be constructed, operated and maintained in a sustainable manner throughout the project and for the water use activities set out in condition 1.1 and must include but are not limited to the following:

3.1.1.1 Increased runoff due to vegetation clearance (promoting limiting vegetation clearance at all times) and/or soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the watercourse(s);

3.1.1.2 Storm water must be diverted from construction works, access roads, linear infrastructure and reptile ponds and must be managed in such a manner as to disperse runoff and to prevent the concentration of storm water flow; and

3.1.1.3 The velocity of storm water discharges must be attenuated and the banks of the watercourses protected;

3.2 Structures and Materials

3.2.1 Necessary erosion prevention measures must be employed to ensure the sustainability of all structures.

3.2.2 The height, width and length of structures must be limited to the minimum dimension necessary to accomplish the intended function.

3.2.3 Structures must not be damaged by floods exceeding the magnitude of floods occurring on average once in every 100 years.

3.2.4 Structures must be non-erosive, structurally stable and must not induce any flooding or safety hazard.

3.2.5 Structures must be inspected regularly for accumulation of debris, blockage, erosion of abutments and overflow areas - debris must be removed and damages must be repaired and reinforced immediately.

3.2.6 Any access roads, bridges, pathways or other linear crossings should be:

3.2.6.1 Non-erosive, structurally stable and should not induce any flooding or safety hazard;
3.2.6.2 Any damage is repaired immediately to prevent further damage;
3.2.6.3 Non-polluting with respect to silt and litter that can be deposited into a watercourse;
3.2.6.4 Watercourse crossings to facilitate the movement of aquatic and non-aquatic organisms and fauna;
3.2.6.6 Crossing surfaces must be tarred, paved or concreted along the extent of the watercourse and extent at least 100m beyond the extent of the watercourse to minimise impacts on the characteristics of the watercourse;
3.2.6.7 Where any road is within the 100m buffer zone of the watercourse, this portion of the road shall be concreted, paved or tarred; and
3.2.6.8 Not consist of any polluting material.

3.2.7 Landscape maintenance plan must be submitted for approval by Provincial Head within 6 months of licence being issued.

3.3 Water Quality

3.3.1 The Licensee shall sample the water quality monthly for the mentioned variables (Table 3) at least at the monitoring points both upstream and downstream of the activities (Table 3) and report to the Provincial Head within thirty (30) days after the results of each sampling event is received:

Table 3: Water quality parameters relevant for sampling.

Variable	Limit
Flow (ℓ/s)	Condition 3.4.8
Temperature (ºC)	<10% variation
pH	6.0 – 8.5
Electrical conductivity (EC) (mS/m)	<70
Suspended solids (SS) (mg/ℓ)	<25
Dissolved oxygen (mg/ℓ)	≥6
Turbidity (NTU)	<5
Alkalinity (mg $CaCO_3$/ℓ)	<100
PO_4 (mg/ℓ)	<0.5
NO_3/NO_2 (as N) (mg/ℓ)	<6
NH_3 (as N) (mg/ℓ)	<10
BTEX, TPH (mg/ℓ)	<1

Faecal coliforms (counts/100mℓ)	<130

The variables may be amended on discretion of the Provincial Head. Only an accredited (SANS 17025) laboratory to be used for analysis.

3.3.2 Monitoring must continue for three (3) years after the issuance of this licence for the activities listed in condition 1.1

3.3.3 Monitoring must be undertaken as set out in section 5.

3.3.4 Activities that lead to elevated levels of turbidity of any watercourse(s) must be prevented, reduced, or otherwise remediated. Activities must be scheduled to take place during the dry seasons when flows are lowest where reasonably possible. If this is not possible and if management measures have not been provided for in the reports submitted to the Provincial Head, the Licensee must submit such to the Provincial Head for a written approval before these activities commence. Natural in stream hydrology is to be used to determine which months constitute the low flow months.

3.3.5 The Licensee must ensure that the quality of the water to downstream water users does not decrease because of the of the water use activities listed under condition 1.1.

3.3.6 Pollution of and disposal/spillage of any material into the watercourse must be prevented, reduced, or otherwise remediated through proper operation, maintenance and effective protective measures.

3.3.7 Vehicles and other machinery must be serviced well above the 1:100 year flood line or delineated riparian habitat, whichever is the greatest. Oils and other potential pollutants must be disposed off at an appropriate licensed site, with the necessary agreement from the owner of such a site.

3.3.8 Any hazardous substances must be handled according to the relevant legislation relating to transport, storage and use of the substance and all storage facilities must be equipped with large, clearly readable Material Safety Data Sheets (MSDS).

3.3.9 All reagent storage tanks and reaction units must be supplied with a bunded area built to cater for at least 110% of the capacity of the facility and provided with sumps and pumps to return the spilled material back into the system. The system must be maintained in a state of good repair and standby pumps must be provided.

3.3.10 The Licensee shall actively participate in any Catchment Management Agency's related activity.

3.3.11 The Licensee has to indicate to the Responsible Authority within sixty (60) days after issuance of this licence, the strategic placement of bio-swale, bio-filters, silt, litter and hydrocarbon (oil) traps to minimise the risk of pollutants entering the natural drainage system of the area.

3.4 Flow

3.4.1 The Licensee must determine flood lines (1:50 and 1:100 year) to ensure risks are adequately managed. Flood lines must be clearly indicated on the site plan(s) and drawings along with all wetland boundaries.

3.4.2 The activities must be conducted in a manner that does not negatively affect catchment yield, hydrology and hydraulics. The Licensee must ensure that the overall magnitude and frequency of flow in the watercourse(s) does not decrease, other than for natural evaporative losses and authorised attenuation volumes.

3.4.3 Appropriate design and mitigation measures must be developed to minimise impacts on the natural flow regime of the watercourse i.e. through placement of structures/supports and to minimise turbulent flow in the watercourse.

3.4.4 Structures must be designed in a way to prevent the damming of stream/river water and not impact on the flow of the water, during the construction and operational phases of all developments.

3.4.5 The development may not impede natural drainage lines.

3.4.6 The diversion structures may not restrict river flows by reducing the overall river width or obstructing river flow.

3.4.7 The characteristics of streambed are likely to be altered locally. In particular the rock and rubble created during the construction process is likely to have sharp edges, and not smooth surfaces that are typically associated with river rocks and pebbles. All rock and rubble must be removed from the watercourse once construction has been completed. Any rock placed in the watercourse to enhance the dissolved oxygen content of the water must adhere to the same criteria, namely only smooth rock surfaces to be placed within the watercourse.

3.4.8 The Licensee shall determine flow requirements for endemic aquatic organisms and the associated habitat (riparian and in-stream) by a registered, professional, independent and qualified aquatic ecologist and hydrologist within one (1) year after the issuance of this licence and submit the report to the Provincial Head for a written approval. Reporting on the flow requirements as per condition 3.3.1 of this Appendix.

3.5 Riparian and Instream Habitat (Vegetation and Morphology)

3.5.1 Activities (including spill clean-up) must start up-stream and proceed into a down-stream direction, so that the recovery processes can start immediately, without further disturbance from upstream works.

3.5.2 Operation and storage of equipment must not take place within the 1:100 year flood line or delineated riparian habitat, whichever is the greatest unless authorised in this license.

3.5.3 Activities must not occur in sensitive riffle habitats.

3.5.4 Indigenous riparian vegetation, including dead trees, outside the limits of disturbance indicated in the site plans must not be removed from the area.

3.5.5 Alien and invader vegetation must not be allowed to further colonise the area, and all new alien vegetation recruitment must be sustainably eradicated or controlled according to a respective management plan as formally approved by the Provincial Head in writing within one (1) month after the issuance date of this licence.

3.5.6 Existing vegetation composition must be maintained or improved by maintaining the natural variability in flow fluctuations. Rehabilitated areas shall have vegetation basal cover of at least 15% at all times.

3.5.7 Recruitment and maintaining of a range of size classes of dominant riparian species in perennial channels must be stimulated.

3.5.8 Encroachment of additional exotic species and terrestrial species in riparian zones must be discouraged.

3.5.9 Accumulation of woody debris on terraces by periodic flooding must be discouraged.

3.5.10 Existing flood terraces and deposition of sediments on these terraces to ensure optimum growth, spread and recruitment of these species must be maintained.

3.5.11 All reasonable steps must be taken to minimise noise and mechanical vibrations in the vicinity of the watercourse. Noise levels (noise resulting from the activities listed in Table 2 and associated activities) to be below 35dB from 18:00 – 06:00 daily.

3.5.12 Necessary erosion prevention mechanisms must be employed to ensure the sustainability of all structures and activities and to prevent instream sedimentation.

3.5.13 Soils that have become compacted through the water use activities must be loosened to an appropriate depth to allow seed germination.

3.5.14 Slope/bank stabilisation measures must be implemented with a 1:3 ratio or flatter and vegetated with indigenous vegetation immediately after the shaping.

3.5.15 Stockpiling of removed soil and sand must be stored outside of the 1:100 flood line or delineated riparian habitat, whichever is the greatest, to prevent being washed into the river and must be covered to prevent wind and rain erosion.

3.5.16 The indiscriminate use of machinery within the instream and riparian habitat will lead to compaction of soils and vegetation and must therefore be strictly controlled.

3.5.17 The overall macro-channel structures and mosaic of cobbles and gravels must be maintained by ensuring a balance (equilibrium) between sediment deposition and sediment conveyance maintained. A natural flooding and sedimentation regime must thus be ensured as far as reasonably possible.

3.5.18 As much indigenous vegetation growth as possible should be promoted within the proposed development area in order to protect soil and to reduce the percentage of the surface area which is paved/hardened/compacted.

3.5.19 Run-off from paved/hardened/compacted surfaces should be slowed down by the strategic placement of berms.

3.5.20 The Licensee shall protect the banks of the watercourse against instability and erosion and ensure a healthy and sufficient bank side vegetation cover. A specific management program addressing this concern shall be developed by a professional, qualified, independent and registered ecologist and aquatic specialist and submitted to the Provincial Head for written approval within three (3) months after the issuance of this licence.

3.5.21 Plant Species Plan must be drawn up in conjunction with a landscape architect or botanist and approved by Provincial Head and implemented within 6 months of licence being issued.

3.6 BIOTA

3.6.1 The Licensee must take all reasonable steps to allow movement of aquatic species, including migratory species. The Licensee shall appoint a professional, qualified, independent and registered ecologist and aquatic specialist to determine the impact of the weirs on aquatic biota migration and submit a report for written approval to the Provincial Head within six (6) months after the issuance of the licence. The Licensee shall implement the recommendations endorsed by the Provincial Head. Reporting on biota component must be captured separately in the reporting requirement of condition 5.1 of Appendix IV. The report must also assess the reintroduction of endemic aquatic species in this environment (note condition 5.1 REC value).

3.6.2 All reasonable steps must be taken not to disturb the breeding, nesting and/or feeding habitats and natural movement patterns of aquatic biota.

3.6.3 The current level of diversity of biotopes and communities of animals, plants and microorganisms must be maintained.

4 REHABILITATION AND MANAGEMENT

4.1 The Licensee must embark on a systematic long-term rehabilitation programme to restore the watercourse to environmentally acceptable and sustainable conditions, which must include, but not be limited to the rehabilitation of disturbed and degraded riparian areas to restore and upgrade the riparian habitat integrity to sustain a bio-diverse riparian ecosystem.

4.2 All disturbed areas must be re-vegetated with an indigenous seed mix in consultation with an indigenous plant expert, ensuring that during rehabilitation only indigenous shrubs, trees and grasses are used in restoring the biodiversity.

4.3 An active campaign for controlling invasive species must be implemented within disturbed zones to ensure that it does not become a conduit for the propagation and spread of invasive exotic plants.

4.4 Rehabilitation must be concurrent with construction.

4.5 Topsoil must be stripped and redistributed.

4.6 Compacted and disturbed areas must be shaped to natural forms and to follow the original contour. In general cut and fill slopes and other disturbed areas must not exceed 1:3 (v:h) ratio, it must be protected, vegetated, ripped and scarified parallel with the contour.

4.7 The Provincial Head must sign a release form indicating that rehabilitation was done satisfactory according to specifications as per this license.

4.8 A photographic record must be kept as follows and submitted with reports as set out in section 5:

4.8.1 Dated photographs of all the sites to be impacted before construction commences;

4.8.2 Dated photographs of all the sites during construction on a monthly basis; and

4.8.3 Dated photographs of all the sites after completion of construction, seasonally.

4.9 Rehabilitation structures must be inspected regularly for the accumulation of debris, blockages instabilities and erosion with concomitant remedial and maintenance actions.

4.10 Rehabilitation Plan must be updated and drawn on a drawing for approval by provincial Head within 6 months of licence being issued.

4.11 Experienced environmental rehabilitation personnel as well as the correct equipment for environmental rehabilitation must be available.

5 MONITORING AND REPORTING

5.1 A comprehensive and appropriate environmental assessment and monitoring programme (including bio-monitoring and eco-toxicology) to determine the impact, change, deterioration and improvement of the aquatic system associated with the activities listed under condition

1.1 and other existing activities as well as compliance to these water use licence conditions must be developed and submitted to the Provincial Head for a written approval before commencement and must subsequently be implemented

5.2 Six (6) monthly monitoring reports for Groundwater and surface water must be submitted to the Provincial Head until otherwise agreed in writing with the Provincial Head.

5.3 A qualified and responsible scientist must be retained by the Licensee who must give effect to the various licence conditions and to ensure compliance thereof pertaining to all activities impeding and/or diverting flow of watercourses as well as alterations to watercourses on the property as set out in condition 1.1.

5.4 The Licensee shall conduct an internal and external audit as per condition 11 and 12 of Appendix 1 and the audit report must include:

5.4.1 Reporting in respect of the monitoring programme referred to in condition 5.1 of Appendix IV and all other reporting and compliance conditions outlined in this licence;
5.4.2 A record of implementation of all mitigation measures including a record of corrective actions; and
5.4.3 Compensation measures for damage where mitigation measures have failed to adequately protect the in-stream and riparian habitat or any other characteristic of the watercourses.

5.5 The Licensee must apply in writing to the Provincial Head for alternative reporting arrangements for which written approval must be provided.

5.6 A comprehensive ground water and surface water monitoring and remediation plan must be provided within 6 months of licence being issued. Such plan must detail how the possible pollution effects from the dirty water impoundment facilities that do not have a barriers system that complies with the requirements of the current Regulations will be remediated and how future pollution from the same facilities will be prevented, in accordance with the requirements of section 19 of the National Water Act (1998).

6 OTHER WATER USERS

6.1 The Licensee must attempt to prevent adverse affect on other water users. All complaints must be investigated by a suitable qualified person and if investigations prove that the Licensee has impaired the rights of other water users, the Licensee must initiate suitable compensative measures.

7. POLLUTION PREVENTION, INCIDENTS AND MALFUNCTIONS

7.1 If surface and/or groundwater pollution has occurred or may possibly occur, the Licensee must conduct, and/or appoint specialists to conduct necessary investigations and implement additional monitoring, pollution prevention and remediation measures to the satisfaction of the Provincial Head.

7.2 The Licensee shall keep all records relating to the compliance or non-compliance with the conditions of this licence in good order. Such records shall be made available to the Provincial Head within 14 (fourteen) days of receipt of a written request by the Department for such records.

7.3 The Licensee shall keep an incident report and complaints register, which must be made available to any external auditors and the Department.

8 BUDGETARY PROVISIONS

8.1 The water user must ensure that there is a budget sufficient to complete and maintain the water use and for successful implementation of the rehabilitation programme as set out in this licence.

8.2 The Department may at any stage of the process request proof of budgetary provisions for rehabilitation and closure of project.

9. SITE SPECIFIC CONDITIONS

9.1 The master plan must be updated to show the sewer works outside the river and 1:100 year floodline.

9.2 A plant Species Plan must be drawn up by a landscape architect or botanist to enhance the PES/EIS.

9.3 Aliens must be eradicated.

9.4 The discharge point must be designed as a bio retention pond outside the river.

9.5 Phyto remediation must be implemented and shown on the Master Plan before discharge or re-use as drinking water takes place.

9.6 Special water quality standards must be adhered to.

9.7 Bridge crossing must be above the 1:00 year floodline.

9.8 The Concrete sewer pipes must be HDPE line.

9.9 An Emergency Preparedness plan must be submitted for approval.

9.10 The trench crossing must be at an acceptable depth below river bed and protected with rock mattress.

9.11 The REC for the watercourses must be set class C.

9.12 A Monitoring Plan must be submitted for approval.

9.13 A Maintenance Plan must be submitted for approval.

9.14 The Engineers certificate of completion at the end of construction confirms the WWTWs facilities as built are in accordance with the design criteria and performance specified in the preliminary design and,

9.15 The new bridge design for the Sand River watercourse crossing at the alignment of the existing crossing is placed on record post feasibility design to confirm the foundation and deck design as adequate to withstand 1:100 year flood event.

APPENDIX III

Section 21 (e) of the Act: Engaging in a controlled activity; irrigation of any land with waste or water containing waste

1. QUANTITY OF WATER CONTAINING WASTE FOR IRRIGATION

1.1 This licence authorises irrigation of 20 ha of garden and nursery using treated effluent as detailed in Table 4.

Table 4: Water use activities

Activity	Purpose / Description	Properties	Volume(m^3/a)	Co-ordinates
Section 21 (e)				
Irrigation using treated effluent	Irrigation of 20 ha of garden and nursery	Portion 2,93 and 95 of farm Doornbult 624 LS	140 000	S23°47'43.72" E29°27'16.77"

1.2 The quantity of wastewater authorised to be irrigated in terms of this licence must not be exceeded.

2. CROP TYPE AND AREA IRRIGATED

2.1 This licence authorises to irrigate a total surface area of 20 hectares of garden and nursery.

3. QUALITY OF WATER TO BE IRRIGATED.

The quality of the waste water to irrigate with must not exceed special effluent standard (GNR 10 991) detailed in Table 5.

Table 5: Quality of waste water to irrigate

Parameter	Limits
pH	6.5-8.5 pH
Electrical Conductivity	70 mS/m
Suspended solids	25 mg/l
Chemical oxygen demand (COD)	75 mg/l
Orthophosphates (as Ortho-P)	1.0 mg/l
Nitrate (as N)	$\leq$ 6 mg/l
Ammonia (as N)	1.5 mg/l
Residual Chlorine	0.1 mg/l
E.coli (counts/100ml)	0 cfu/100 ml

4. MONITORING

4.1 Quantity

4.1.1 The quantity of water containing waste irrigated must be metered and recorded daily.

4.1.2 Monitoring for the quantity of the water containing waste for irrigation must be done at the point where the effluent is piped into the irrigation dam.

4.1.3 Water quantity measuring, recording and integrating devices must be maintained in a sound state of repair and calibrated by a competent person at intervals of not less

than two years. Calibration certificates must be available for inspection by the Provincial Head or his/her representative upon request.

4.2 Quality

4.2.1 Monitoring points for quality must be at the outlet point of the irrigation dam where the wastewater will be abstracted for irrigation.

4.2.2 The date, time and monitoring point in respect of each sample taken must be recorded together with the results of the analysis.

4.2.3 Monitoring points must not be changed prior to notification to and written approval by the Head of Provincial Operation.

4.2.4 The samples taken at outlet point of the irrigation dam shall be analysed for the variables at the following required frequencies:

Table 6: Monitoring variables and frequency

Variable	Frequency
pH	Monthly
Electrical Conductivity (EC) (ms/m)	Monthly
Chemical oxygen demand (COD) (mg/l)	Monthly
Faecal Coliforms(as FCU)(count/100ml)	Monthly
Ammonia (as N) (mg/l)	Monthly
Nitrate (as N)(mg/l)	Monthly
Ortho-Phosphate (as P) (mg/l)	Monthly
Residual Chlorine	Monthly
Suspended solids (mg/l)	Monthly

4.3 Ground water monitoring shall be undertaken as set out in condition 4.2 of Appendix VI.

5. GENERAL IRRIGATION PRACTICES

5.1 Irrigation shall be practiced in accordance with the guidelines prescribed in the document titled "*Guide: Permissible Utilisation and Disposal of Treated Sewage Effluent*", issued by the former Department of Health under reference 11/2/5/3 and dated 30 May 1978, or in accordance with any relevant regulations promulgated under section 26 of the Act.

5.2. Irrigation with waste shall be practiced in a systematic manner and precautions shall be taken so as to prevent -

5.2.1 Water logging and pooling of waste in any location
5.2.2 Pollution of underground water or surface water due to seepage or otherwise
5.2.3 Fly breeding, public health hazard, odour or secondary pollution
5.2.4 Runoff from the irrigation area because of wet weather or any other conditions whatsoever and
5.2.5 The site of the irrigation area shall be adequately fenced to prevent the entry of animals and unauthorised persons.

5.3 Notices manufactured of durable weatherproof material prohibiting unauthorised entry and warning against the use of water containing waste for drinking and washing purposes shall be displayed at prominent places along the fence and at entrance gates. Such notices shall be worded in the official languages applicable in the area.

6. PIPELINES

6.1 Pipelines used for the conveyance of waste shall be painted in a conspicuous colour or manufactured of a coloured material distinctly different from the colour of the pipelines in which drinking water is flowing to avoid the possibility of any cross-connections of the different pipelines.

6.2 All stop-valves and taps on the pipelines conveying the effluent shall be of a type that can be opened and closed by means of a loose wrench. This wrench shall be in the safekeeping of a responsible member of the staff to prevent unauthorised use thereof.

6.3 Notices manufactured of a durable weatherproof material warning against the use of water containing waste for drinking and washing purposes shall be displayed at prominent places where the waste is being reused and at all taps. Such notices shall be worded in the official languages applicable in the area.

APPENDIX IV

Section 21(f) of the Act: Discharging waste or water containing waste into a water resource

1. QUANTITY OF WASTEWATER TO BE DISCHARGED

1.1 This licence authorises the discharge of a maximum quantity of 29 200 000 m^3/a (twenty nine million two hundred thousand cubic metres per annum) of treated effluent from the Polokwane Regional Waste Water Treatment Works.

1.2 The quantity of treated wastewater authorised to be discharged in terms of this licence must not be exceeded.

2. QUALITY OF WATER CONTAINING WASTE DISCHARGED

2.1 The quality of the wastewater discharged into the Sand River may not exceed the limits as set out in Table 7.

Table 7: Quality of wastewater to be discharged

Parameter	Limits
pH	6.5-8.5 pH
Electrical Conductivity	70 mS/m
Suspended solids	25 mg/l
Chemical oxygen demand (COD)	75 mg/l
Orthophosphates (as Ortho-P)	1.0 mg/l
Nitrate (as N)	$\leq$ 6 mg/l
Ammonia (as N)	1.5 mg/l
Residual Chlorine	0.1 mg/l
E.coli (counts/100ml)	0 cfu/100 ml

3. MONITORING

3.1. Quantity

3.1.1. The quantity of the water containing waste discharged into the Sand River shall be metered and recorded daily.

3.1.2. Monitoring for the quantity of water containing waste shall be done at the point at the inlet.

3.1.3. Flow metering, recording and integrating devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than two (2) years. Calibration certificates shall be available for inspection by the Provincial Head or his / her representative upon request.

3.2 Quality

3.2.1 Water quality monitoring points must be at the outlet of the WWTWs, upstream and downstream of the discharge point in the Sand River.

3.2.2 The monitoring points must be identified in consultation with and approved by the Provincial Head or his representative.

3.2.3 The date, time and monitoring point in respect of each sample taken must be recorded together with the results of the analyses.

3.2.4 The samples taken at the outlet and at the Sand River upstream and downstream of the WWTWs must be analysed for the variables and the required frequencies as shown in Table 8.

Table 8: Variables and monitoring frequency for outlet and points upstream and downstream of works

Variable	Frequency
pH	Monthly
Electrical Conductivity (EC) (mS/m)	Monthly
Chemical Oxygen Demand (COD) (mg/ℓ)	Monthly
Suspended Solids	Monthly
Ammonia (ionised and un-ionised) as Nitrogen (NH_3 as N) (mg/ℓ)	Monthly
Nitrate/Nitrite as Nitrogen (NO_3/NO_2 as N) (mg/ℓ)	Monthly
Ortho-Phosphate as Phosphorous (PO_4 as P) (mg/ℓ)	Monthly
Typical (faecal) coli	Monthly

3.3 Flow

3.3.1 Flow metering, recording and integrating devices must be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than two (2) years. Calibration certificates must be available for inspection by the Provincial Head or his / her representative upon request.

3.3.2 The date, time and monitoring point in respect of each sample taken must be recorded together with the results of the analysis.

3.4 Bio-monitoring

3.4.1. The Licensee must develop and submit to the Provincial Head within six (6) months of issuance of the licence a bio-monitoring programme that will include the compilation of an initial database from which the scope and frequency of future bio-monitoring can be developed. This initial assessment must lead to the establishment of a reliable site-specific long-term bio-monitoring programme. This programme must be able to qualify and quantify the impact on biological systems in the water environment in the area directly affected by the waste water treatment works activities as well as downstream from these activities.

3.4.2 A competent and capable aquatic scientist must be appointed by the Licensee to submit a monitoring programme for aquatic macro-invertebrates and habitat integrity. Aquatic macro-invertebrates must be sampled using the latest SASS (South African Scoring System) method. Habitat Integrity must be assessed using the Rapid Bio-assessment Analysis (C.J. Kleynhans 1999) method described by the Department (SASS 2002).

3.4.3 After any incident, SASS surveys must be conducted annually in autumn, spring and summer at a site upstream and downstream of the disturbance until the impacts of the incident are not noticeable anymore. An annual report on the SASS surveys must be submitted to the Provincial Head.

4. METHODS OF SAMPLING AND ANALYSIS

4.1 Sampling and analysis shall, wherever applicable, be carried out in accordance with methods prescribed by, and obtainable from, the South African Bureau of Standards (SABS), in terms of the Standards Act, 2008 (Act 8 of 2008), or any other method approved in writing by the Provincial Head.

4.2 The methods of analysis shall not be changed without prior notification to, and written approval by the Provincial Head.

4.3 Sample analysis must be conducted by a recognized analytical laboratory, accredited to analyze the relevant constituents in the wastewater, or approved by the Provincial Head to perform the analyses.

5. STORM WATER MANAGEMENT

5.1 Storm water leaving the Licensee's premises must in no way be contaminated by any substance, whether such substance is a solid, liquid, vapour or gas of a combination thereof which is produced, used, stored dumped or spilled on the premises.

5.2 Increased runoff due to vegetation clearance and soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the streams.

5.3 The Licensee must ensure that no stormwater will ingress into the wastewater system and that no wastewater ingress into the stormwater system.

5.4 Wastewater impoundments must be designed, constructed and managed to ensure that there is sufficient capacity to contain the 1:50 year flood event, with a minimum of 0.8 m freeboard. Freeboard will be defined as the difference between the water level and the crest of the overflow.

5.5 Stormwater must be diverted from the impoundments and roads, and must be managed in such a manner as to disperse runoff and to prevent the concentration of the stormwater flow.

5.6 Cut-off drains must be provided around the WWTWs to prevent storm-water ingress into the surrounding of the works. These drains must be designed to contain the maximum runoff, which could be expected over a period of 24 hours with a frequency of once in every 20 years.

5.7 The Licensee must conduct gulley inspections upstream to ensure that stormwater does not ingress into the wastewater system.

6. OPERATIONS

6.1 The WWTWs must be supervised and controlled by suitably qualified and experienced employees of the Licensee who must have under his/her control an adequate number of operators who have been classified in terms of Regulation 2834 dated 27 December 1985 in terms of the Water Act, 1956 (Act 54 of 1956) or any update thereafter and in terms of section 26 of the National Water Act, 1998 (Act 36 of 1998) to ensure proper functioning of the works and processes at all times.

6.2 Suitably qualified and experienced mechanical and electrical artisans shall be available to be called in for inspection and maintenance of the works.

6.3 No waste, which may deleteriously affect the efficient functioning of the works, shall be received in the sewage purification works. The Licensee shall take all steps possible to

prevent discharge of any substance into the waste water treatment works, which could have a deleterious effect on the operation of works and/or final waste.

6.4 The areas used to compost dry sludge should be lined with appropriate liners as approved by the Regional Head to prevent groundwater contamination.

7. PIPELINES

7.1 The pipelines used for the conveyance of waste or water containing waste shall be painted in a conspicuous colour or manufactured of a coloured material distinctly different from the colour of the pipelines in which drinking water is flowing to avoid the possibility of any cross-connections of the different pipelines.

7.2 All stop-valves and taps on the pipelines conveying the waste or water containing waste shall be of a type that can be opened and closed by means of a loose wrench. This wrench shall be in the safekeeping of a responsible member of the staff to prevent unauthorised use thereof.

7.3 Notices manufactured of a durable weatherproof material warning against the use of water containing waste for drinking and washing purposes shall be displayed at prominent places where the water containing waste is being reused and at all taps. Such notices shall be worded in the official languages applicable in the area.

7.4 The Licensee must inspect the pipelines conveying the water containing waste and the pumping facilities on a weekly basis to check for leaks or malfunctions and records shall be kept of such inspections.

7.5 The Licensee shall have the full length of the pipeline surveyed on an annual basis to monitor the integrity of the pipeline. The results of the survey shall be reported in writing to the Provincial Head.

8. PUMP STATIONS

8.1 The Licensee shall develop and implement a scheduled monitoring and maintenance plan for all wastewater pump stations and manholes under its control.

8.2 All pump stations shall have an emergency containment facility with sufficient capacity to ensure untreated effluent retention up to a 24-hour period.

9. MANHOLES

9.1 The Licensee must ensure that:

9.1.1 Manholes are covered at all times with a suitable cover that cannot be removed by unauthorised persons;

9.1.2 Manhole covers of a material that is less prone to theft are used.

9.1.3 No new WWTWs lines and manholes are constructed in the 1:100 year flood line and

9.1.4 Existing WWTWs lines and manholes situated within the 1:100 year flood lines are sealed adequately to ensure minimal ingress of water during any rainfall event.

10. FENCING, NOTICES AND DRAINS

10.1 The site of the waste water treatment works shall be adequately fenced to prevent entry of animals and unauthorised persons.

10.2 Notices manufactured of durable weatherproof material prohibiting unauthorised entry and warning against the use of water containing waste for drinking and washing purposes shall be displayed at prominent places along the fence and at entrance gates. Such notices shall be worded in the official languages applicable in the area.

10.3 Cut-off drains shall be provided around the sewage purification works to prevent stormwater ingress into the surrounding of the works. These drains shall be so designed to contain the maximum runoff, which could be expected over a period of twenty four (24) hours with a frequency of once in every twenty (20) years.

11 POLLUTION PREVENTION, INCIDENTS AND MALFUNCTIONS

11.1 Pollution caused by spills either accidental or from mechanical or electrical breakdown or power disruptions must be prevented through proper maintenance and effective protective measures.

11.2. All reagent and chemical storage areas must be supplied with a bunded area built to the capacity of the facility and provided with sumps and pumps to contain the spilled material. The system shall be maintained in a state of good repair and standby pumps must be provided.

11.3. Any hazardous substances must be handled according to the relevant legislation relating to the transport, storage and use of the substance.

11.4 Pollution incidents shall be dealt with in accordance with the Act.

11.5 The Licensee must, within fourteen (14) days, or a shorter period of time, as specified by the Provincial Head, from the occurrence or detection of any incident referred above, submit an action plan, which must include a detailed time schedule, to the satisfaction of the Provincial Head of measures taken to:

11.5.1 correct the impacts resulting from the incident;
11.5.2 prevent the incident from causing any further impacts; and
11.5.3 prevent a recurrence of a similar incident.

11.6 The Licensee shall keep all records relating to the compliance or non-compliance with the conditions of this licence in good order. Such records shall be made available to the Provincial Head within fourteen (14) days of receipt of a written request by the Provincial Head for such records.

11.7 The Licensee shall keep an incident report and complaints register, which must be made available to any external auditors and the Provincial Head.

12. CONTINGENCY PLANS AND INCIDENT REPORTING

12.1 The Licensee must develop and implement an emergency and contingency plan.

12.2 The Licensee must implement and promote an environmental call and reporting system where the following can be reported:

12.2.1 illegal disposal of waste and/or littering;
12.2.2 broken, ruptured or leaking pipelines wasting potable water;

12.2.3 open or leaking taps on the property of the Licensee;
12.2.4 open manholes;
12.2.5 leaking or broken sewerage lines and pipes;
12.2.6 overflowing manholes and pump stations;
12.2.7 possible offenders of any environmental regulations, by-laws and/or ordinances; and
12.2.8 any other aspect that might hamper the effective management of the water resources.

12.3 The Licensee must compile an environmental call and reporting centre protocol, that must be included in the Plan, and which will investigate every complaint within twenty four (24) hours of it being reported.

12.4 The Licensee must rectify all valid issues reported within seven (7) days of the issue being reported to the Licensee. All incidents shall be recorded in an incident register which will include reasons for non-rectification of issues raised

12.5 A summary of malfunctions and incidents shall be included in the annual external audit report.

13. REPORTING

13.1 The information required in terms of condition 3 of appendix II must be submitted monthly to the Provincial Head under Reference number 27/2/2/A921/13/9.

13.2 The Licensee must compile an annual Waste Water Management Report (Annual Report) including Management Plans that must be submitted during July, annually; indicating compliance with the conditions of this licence, corrective measures to address non-compliance, as well as the results of the monitoring programmes.

13.3 Information and data must also be submitted in a digital format as required by the Provincial Head in the prescribed format to be included in the regional database.

APPENDIX V

Section 21(g) of the Act: Disposing of waste in a manner which may detrimentally impact on a water resource

1 QUANTITY OF WASTE TO BE DISPOSED

1.1 This Licensee is authorised to dispose treated wastewater in to oxidation ponds, in terms of water uses activities detailed in Table 9.

Table 9: Water use activities

Activity	Purpose / Description	Properties	Demission/ Capacity	Co-ordinates
Disposal of waste	Sludge handling Area	Portion 3 of farm Doornbult 624 LS	21 000 m^2	S23°47'52.59" E29°27'19.07"
Disposal of waste	Maturation pond 1	Portion 3 of farm Doornbult 624 LS	27 336 m^3	S23°47'35.67" E29°27'04.77"
Disposal of waste	Maturation pond 2	Portion 3 of farm Doornbult 624 LS	22 644 m^3	S23°47'29.33" E29°27'14.72"
Disposal of waste	Maturation pond 3	Portion 3 of farm Doornbult 624 LS	23 460 m^3	S23°47'52.59" E29°27'19.07"
Disposal of waste	Maturation pond 4	Portion 3 of farm Doornbult 624 LS	23 460 m^3	S23°47'29.88" E29°27'09.00"
Disposal of waste	Maturation pond 5	Portion 3 of farm Doornbult 624 LS	23 310 m^3	S23°47'33.94" E29°27'14.23"
Disposal of waste	Maturation pond 6	Portion 3 of farm Doornbult 624 LS	27 744 m^3	S23°47'52.59" E29°27'19.07"

1.2 The quantity of waste/wastewater authorised to be disposed of in terms of this licence must not be exceeded.

2.2. Groundwater Monitoring

2.2.1 The Licensee shall conduct ground water monitoring on a quarterly basis for the variables shown in Table 10 and the results must be submitted to the Provincial Head.

Table 10: Monitoring Frequency

Variables	Frequency
Electrical Conductivity (mS/m)	Quarterly
Sodium (mg/l)	Quarterly
Magnesium (mg/l)	Quarterly
Calcium (mg/l)	Quarterly
Chloride (mg/l)	Quarterly
Sulphate (mg/l)	Quarterly
Nitrate (mg/l)	Quarterly
Fluoride (mg/l)	Quarterly
pH	Quarterly
Ecoli	Count/100ml
Ortho-Phosphate (as P) (mg/l)	Monthly
Ammonia (as N) (mg/l)	Monthly

2.2.2 Monitoring network must be set up as an early warning system to detect any polluted seepage that might occur from the wastewater system.

2.2.3 If ground water pollution have occurred or may possibly occur, the Licensee must conduct necessary investigations and implement additional monitoring and rehabilitation measures which must be to the satisfaction of the Provincial Head.

3.3 Sludge Management

3.3.1 Solid sewage waste such as grit and screenings shall be handled, stored and disposed in a manner as not to cause any nuisance and health hazard.

3.3.2 Sludge emanating from the treatment process must be quantified, analysed and classified in accordance with the Guidelines for the Utilisation and Disposal of wastewater sludge (vol 1-5), dated March 2006. Furthermore, it must be dealt with according to the requirements of Chapter 5 of the NEM: WA (Act 59 of 2008).

4. STORMWATER

4.1 Storm water leaving the Licensee's premises shall in no way be contaminated by any substance, whether such substance is a solid, liquid, vapour or gas of a combination thereof which is produced, used, stored dumped of spilled on the premises.

4.2 Increased runoff due to vegetation clearance and soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the streams.

4.3 The Licensee shall ensure that no stormwater will ingress into the wastewater system and that no wastewater ingress into the stormwater system.

4.4 Wastewater impoundments must be designed, constructed and managed to ensure that there is sufficient capacity to contain the 1:50 year flood event, with a minimum of 0.8 m freeboard. Freeboard will be defined as the difference between the water level and the crest of the overflow.

4.5 Wastewater systems must be properly maintained on a continuous basis.

4.6 Storm water shall be diverted from the impoundments and roads and shall be managed in such a manner as to disperse runoff and to prevent the concentration of the stormwater flow.

4.7 Cut-off drains shall be provided around the properties to prevent storm-water ingress into the surrounding of the works. These drains shall be designed to contain the maximum runoff, which could be expected over a period of 24 hours with a frequency of once in every 20 years.

4.8 The Licensee shall conduct regular inspections upstream to ensure that stormwater does not ingress into the wastewater system.

5. MALFUNCTIONS/ABNORMAL CONDITIONS

5.1 Accurate and up-to-date records must be kept of all system malfunctions resulting in non-compliance with the requirements of this licence. The records must be available for inspection by the Provincial Head upon request.

5.2 The records shall be tabulated under the following headings with a full explanation of all the contributory circumstances:

5.2.1 Operating errors
5.2.2 Mechanical failures (including design, installation or maintenance)
5.2.3 Environmental factors (e.g. floods)
5.2.4 Loss of supply services (e.g. power failure)
5.2.5 Other causes

5.3 The Licensee must, within 14 days, or a shorter period of time, as specified by the Provincial Head, from the occurrence or detection of any incident referred above, submit an action plan, which must include a detailed time schedule, to the satisfaction of the Provincial Head of measures taken to:

13.3.1 Correct the impacts resulting from the incident;
13.3.2 Prevent the incident from causing any further impacts; and
13.3.3 Prevent a recurrence of a similar incident.

5.4 The Licensee must notify by the Provincial Head within 24 hours of the occurrence or potential occurrence of any incident which has the potential to cause, or has caused water and environmental pollution, health risks or which is a contravention of the licence conditions

6. CONTINGENCY PLANS AND INCIDENT REPORTING

6.1 The Licensee must develop and implement an Emergency and Contingency Plan.

6.2 The Licensee must implement and promote an environmental call and reporting centre where the following can be reported:

6.2.1 Illegal disposals of waste and/or littering;
6.2.2 Broken, ruptured or leaking pipelines wasting potable water;
6.2.3 Open or leaking taps on the property of the Licensee;
6.2.4 Open manholes;
6.2.5 Leaking or broken sewerage lines and pipes;
6.2.6 Overflowing manholes and pump stations;
6.2.7 Possible offenders of any environmental regulations, by-laws and/or ordinances; and
6.2.8 Any other aspect that might hamper the effective management of the water resources.

6.3 The Licensee must compile an environmental call and reporting centre protocol, that must be included in the Plan, and which will investigate every complaint within 24 hours of it being reported.

6.4 The Licensee must rectify all valid issues reported within 7 days of the issue being reported to the Licensee. All incidents shall be recorded in an incident register which will include reasons for non-rectification of issues raised.

6.5 Statistical summary of malfunctions and incidents shall be included in the Annual Report.

7. ACCESS CONTROL, FENCING AND NOTICES

7.1 The sites must be adequately fenced to prevent entry of animals and unauthorised persons.

7.2 Strict access procedures must be followed in order to gain access to property. Access must be limited to authorised employees of the Licensee and their Contractors only.

7.3 Notices manufactured of durable weatherproof material prohibiting unauthorised entry and warning against the use of water containing waste for drinking and washing purposes must be displayed at prominent places along all fences and at entrance gates. Such notices must be worded in the official languages applicable in the area.

8 SITE SPECIFIC CONDITIONS

8.1 The licensee shall implement the Groundwater Monitoring and Management Plan for the proposed polokwane waste water treatment works: doornbult 624-ls, polokwane, Limpopo dated July 2018 by AGES.

END OF LICENCE

POLOKWANE MUNICIPALITY

CONSTRUCTION, OPERATIONS AND MAINTENANCE OF THE POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS (PRWWTW): PHASE 2B

C5.2 ENVIRONMENTAL MANAGEMENT PLAN

EXECUTIVE SUMMARY

The Polokwane City area is served by three Wastewater Treatment Works (WWTW), namely Polokwane, Seshego, and Mankweng WWTWs.

The existing WWTWs do not have sufficient treatment capacity to handle current sewage flows and are thus not equipped to handle projected increased in wastewater flows.

Polokwane Municipality resolved to commission the first phase of the Polokwane Regional Wastewater Treatment Works (PRWWTW) in order to have adequate wastewater treatment capacity for future developments.

The first phase will comprise the preparation of engineering designs for a 40Ml/d WWTW as well as the designs of the outfall sewers from the existing Seshego and Polokwane WWTWs.

The upgraded works will be located on Portions 2, 93 & 95 of the farm Doornbult 624-LS (alongside the Sand river, approximately 7,5 km North of the existing Polokwane Waste Water Treatment works) – known as the "Doornbult site".

This site is deemed suitable to accommodate the regional wastewater treatment works and is situated in such a way that gravity outfall sewers (to convey the sewage to the site) can be constructed. The site also lends itself to gravitational flow through the treatment plant.

The results of the numerical (geohydrological) model provisionally confirms that the Sand River is a losing stream, and that the sustainability of the groundwater in the vicinity is dependent on the releases of treated waste water into the Sand River Alluvium. Specific impacts are being defined and quantified and are to be addressed in a groundwater management plan.

Following in-depth investigations, the following recommendations were made by the project engineers:

- The new regional wastewater treatment works must be established with a first phase of 40Ml/d and allowance for a total treatment capacity of 100Ml/d;

- As part of the preliminary process design, SMEC civil engineers reviewed several treatment process types for the Polokwane RWWTW. Initial design calculations indicated that conventional biological nutrient removal (BNR) would be the preferred process option.

- The requirement for water reuse and advancement of technology however prompted the Polokwane Municipality to opt for the so-called ***Membrane Treatment option.***

Membrane based treatment approaches for wastewater make it possible to adhere to effluent discharge conditions (standards). Restrictive discharge limits driven by total maximum daily loads (TMDL) and low effluent discharge requirements for nutrients such as phosphorus are becoming increasingly common. These conditions call for high levels of wastewater treatment, which membranes provide.

- To date, the Process Design Report for the RWWTW has been finalised and accepted by the Polokwane Municipality. The Detailed Design Report for the membrane process will be prepared once designs have been finalised.

- The Seshego Wastewater Treatment Works will eventually be closed down and all flow transferred to the new regional wastewater treatment works;

- The existing Polokwane Wastewater Treatment Works will still be used to treat effluent, in order for the municipality to fulfil its contractual obligations regarding the provision of effluent to Anglo Platinum. Additional flows as well as primary and waste activated sludge will be bypassed to the new works;

- The SA Breweries effluent is a high strength, easily biodegradable COD effluent. It is recommended that it also be transferred to the new site where it can be beneficially used in the biological nutrient removing processes;

- A maturation pond system will be installed at the new plant providing five day retention in shallow ponds. This will greatly reduce the chlorine demand. The life cycle costing of this approach of disinfection will be to the benefit of the municipality;

- The utilisation of biogas generated during the anaerobic digestion of primary sludge for energy generation was investigated. This is anticipated to be a stand-alone concession type agreement with the suppliers of CHP plants (turnkey basis). Only if it is mutually beneficial will it be implemented. There is no final decision on whether this will indeed be done. If it does proceed, the required applications for environmental authorisation will be submitted then.

- Project timescale:

    - 15 months for detail design and procurement; and
    - 36 months for construction.

- During 2001 an Environmental Authorisation was issued for the then proposed “Pietersburg Regional Waste Water treatment works”.

- The mentioned authorization was issued under the former Environmental Conservation Act (Act 73 of 1989) – reference no: 16/1/8-6.

- The mentioned authorization would have expired in 2011, had it not been for a part of the project having commenced prior to 2011 (a section of the associated outfall sewer pipeline had been constructed).

- In view of this, the Limpopo Dept. of Economic Development, Environment & Tourism (LEDET) deemed it sufficient that application be made for "amendment" of the previously issued Environmental authorization.

APPLICATION FOR AMENDMENT OF ENVIRONMENTAL AUTHORISATION: REF. 16/1/8-6 DATED 6 JUNE 2001, IN TERMS OF SECTIONS 31 & 32 OF THE 2014 EIA REGULATIONS (AS AMENDED IN GOVERNMENT GAZETTE NO. 40772 ON 7 APRIL 2017)

SECTION 1. DETAILS OF EAP AND APPLICANT

1.1 ENVIRONMENTAL ASSESSMENT PRACTITIONER

The above application will be handled on the behalf of the applicant by:

TEKPLAN Environmental
P.O. Box 55714
POLOKWANE
0700

Tel: (015) 291 4177
Fax: 086 218 3267
Email: tecoplan@mweb.co.za

Contact person: Mr. Theo Kotze CEAPSA

1.2 APPLICANT

In this instance the details of the applicant are as follows:

Project Applicant:	POLOKWANE LOCAL MUNICIPALITY		
Trading Name (if any):	As above		
Representative:	Mr N. Sikhauli (Director Engineering services)		
Physical Address:	Polokwane municipality offices, Office 106, Civic centre, Corner Landros Mare and Bodenstein Streets, Polokwane, 0699		
Postal Address:	Box 111, Polokwane, 0700		
Postal Code:	0700	Cell:	None
Telephone:	015 – 290 2214	Fax:	None
E-mail:	NditsheniS@polokwane.gov.za or ParadiseS@polokwane.gov.za		

SECTION 2: ENVIRONMENTAL MANAGEMENT AND MITIGATION PLAN

2. ENVIRONMENTAL IMPACT MANAGEMENT AND MITIGATION

2.1 INTRODUCTION

Mitigation seeks to find better ways of doing things, minimise or eliminate negative impacts, enhance project benefits and protect public and individual rights. The applicant / proponent has a responsibility to avoid or minimise impacts, and plan for managing impacts.

This section of the report serves to prescribe measures to reduce, limit, eliminate or compensate for impacts, to acceptable/insignificant levels. The term 'mitigate' means to 'allay, moderate, palliate, temper, intensify'. In environmental terminology this term is used as follows:

- mitigation of a negative impact;
- to reduce the significance of an impact;
- mitigation/optimization of a positive impact;
- to increase the significance of the impact.

Recommendations are arranged in order of sequence i.e. Planning, Construction and Operational Phases. Mitigation should permeate through all stages of the development process. It is also essential that the mitigation plan be monitored during construction (which includes maintenance and upgrading) and operation, to ensure compliance - with strict penalties for non-compliance).

The stipulations of this report should be conveyed to contractors and persons responsible for upgrading/maintenance. This mitigation section should be issued as a stand along document to all parties involved with the planning, implementation and operation of the proposed facility.

2.2 PLANNING PHASE MITIGATION GUIDELINES

2.2.1 Implementation recommendations

During planning and design stages, the municipality and its planning consultants and contractors, should take into account the recommendations of this Environmental Impact Assessment Report, so that it is positively utilised on a pro-active basis to aid in the mitigation of impacts.

2.2.2 Incorporate recommendations into construction contracts

Construction or maintenance/upgrading-phase mitigation guidelines and clauses should be written into contract documents as specifications, in addition to the minimum requirements as set out in the SABS Standardised Specification for Civil Engineering Construction.

Additional clauses should be added as necessary in response to specific impacts that may be identified during the detailed design stage. All contractors should adhere to these conditions and their compliance should be monitored on a continual basis.

2.2.3 The destruction of natural vegetation and temporary displacement of fauna from the area during initial investigations)

Mitigation:

When visiting the site during the planning phase, use should be made of existing access roads. During the environmental impact study, sampling of vegetation rather than outright removal of existing plant material should take place (and then only if essential).

2.2.4 Concern about extent of project (who will benefit and who won't? - what negative effects will result from the Works?)

Mitigation:

Public participation during the conducting of the EIA, should be effective. Effective dissemination of information regarding the intention of the local authority should take place throughout the area.

The possibility of establishing a Project Steering Committee, which includes members of the public, to oversee and give input into all aspects related to the project (e.g. local employment, procurement etc.), should be considered by the Local Authority.

2.2.5 Visual impact of the works

Mitigation:

The planting of trees alongside structures at the works can minimise the "zone of visual influence". When painting, rather use dull non-reflective colours. Lighting at the works site should focus inward onto site, not towards adjacent properties.

2.2.6 Design

New (future) facilities at the sewerage works should be designed to prevent pollution of the underground aquifer.

2.2.7 Insects

The potential for the establishment of black-fly and mosquito populations over areas of permanent water should be minimised. The operator of the proposed facility should adhere as closely as possible to the revised water quality parameters regarding desired values for aquatic ecosystems.

Making use of accepted legal chemical control measures/practices should control the occurrence of psychoda flies.

2.3 CONSTRUCTION PHASE MITIGATION GUIDELINES

2.3.1 Impacts on the physical environment

2.3.1.1 Earthworks

Mitigation:

All excavation activities for any purpose whatsoever, should be preceded by selective stripping and stockpiling of vegetative (humus) and soil materials in the order of their horizons as found on site, for the purpose of replacement in the appropriate horizon order, after the completion of construction. These activities should include:

- ☞ trenching for the installation of services (e.g. electricity),
- ☞ foundations,
- ☞ access road construction,
- ☞ site clearance,
- ☞ borrow pits,
- ☞ yards or laydown areas or any other areas affecting the natural environment.

Replacement and rehabilitation should be progressive with the construction and not left until the end. Temporary topsoil stockpiles should be seeded, or protected in a manner acceptable to the environmental planner, so as to avoid erosion by rain or wind.

Stockpiled topsoil and subsoils should be protected from contamination e.g. by fuel spillages etc.

When conducting excavations, all excavation sidewalls should be left open for a period in excess of 24 hours to ensure the safety of workers.

2.3.1.2 Vehicular access and movement of construction vehicles

Damping down of unsurfaced roads should take place to limit dust - route planning should be done. Posting of relevant traffic signage should take place in order to inform motorists of the turning movements of construction vehicles.

2.3.1.3 Contractors' yards

Material delivery and storage areas should be demarcated in co-ordination with the contractor. Material should not be brought onto a site prematurely, which could result in additional areas being cleared or affected.

2.3.1.4 Rehabilitate compacted soils

Soils compacted by construction activity shall be deep ripped to loosen compacted layers and graded evenly. Topsoil shall be re-spread upon completion of construction activities.

2.3.1.5 Toilet facilities

The use of portable chemical toilets for use by the labour force, is essential to avoid pollution and attraction of vermin and flies (which could become a nuisance or a health hazard).

2.3.1.6 Waste handling

Contractors should remove all waste generated by themselves during construction and it should be disposed of at a suitable solid waste disposal venue – "dumping in the bush" should not take place. No materials or pollutants, etc. shall be dumped on site, adjacent thereto, or in any other place. Waste material will be in designated areas and not remain on site for a period longer than 90 days before it is disposed off.

2.3.1.7 Mixing cement

Where cement and concrete, etc. is mixed on site, this shall be done in specified areas on concrete aprons or on protected plastic linings and provision shall be made to contain spillage or overflows onto soils.

2.3.1.8 Mixing of chemicals

The mixing of any solvents, asphalt, sealants, adhesives, paints, chemicals or other noxious materials shall only be undertaken in designated areas on concrete aprons that have spillage control channels and separate storage areas. The mixing of materials will not be permitted in the general areas of the site. All surplus or waste materials are to be removed from the site. All these operations shall only be allowed on site under strict observations of the manufacturers' instructions.

2.3.1.9 Stormwater and erosion control

Stormwater shall be diverted away from all construction or site areas in cut-off drains. Measures will be taken to reduce water velocity. Emphasis should be placed on in the management of stormwater.

When soil is cleared cleared of vegetation, management techniques to prevent water and wind erosion should be employed e.g. seeding of topsoil and subsoil and stockpiles, brush packing and contour channels/berms (to reduce water velocity and divert surface water runoff downslope).

2.3.1.10 Pollution of groundwater

Controlled use and or storage of all materials, fuels and chemicals which, could potentially leach into underground water, should take place. Adequate fuel containment facilities to be used. Site activities should be properly managed. Adequate sanitary facilities and ablutions must be provided for construction workers.

No activity, other than those associated with the collection of water, should be allowed within a radius of 30 m from adjacent surface water sources and/or boreholes.

2.3.1.11 Storage of fuel

If fuel is to be stored on site during construction, it shall be allocated to specific areas and safeguards shall be implemented to control and contain spillages for the complete extent of the time that the material stored. The necessary firefighting equipment will also be maintained on site to deal with any fire incidents. All residue from spillages will be removed from the site by contractors.

2.3.1.12 Silencing of plant

All equipment and vehicles on the site will be equipped with noise suppressing measures and kept in proper working order. Where working at the site noise levels must be within ambient noise level so as not to cause a nuisance to adjacent areas of residence.

Contractors should control site activities - working hours to be controlled by site engineer. Residents of adjacent properties should be informed if any unusually noisy activities are planned.

2.3.1.13 Fires

No fires will be permitted on site without the authority of the resident engineer or project manager.

2.3.1.14 Cleanliness

The site is to be maintained in a sanitary condition and all toilet facilities shall be maintained in good order. Food cooking will only be permitted in designated areas.

2.3.1.15 Impact of air pollution – dust and smoke

Damping down of access roads and cleared areas should take place. Control over cooking fires by site foremen/engineer. Topsoil should be seeded to prevent wind erosion. As much natural vegetation should be retained as is possible. Careful pre-planning of trees that are to be retained should be done.

2.3.1.16 Visual impact of construction

Retain as many existing trees as possible to screen construction works and camps.

2.3.2 Impacts on the biological environment

2.3.2.1 Terrestrial ecology – vegetation

Construction activities within the riparian zone should be avoided. If construction activity has to take place within this zone, it should be in accordance with the stipulations of the Water Use License that is issued to the municipality.

Rehabilitation of construction areas at stream crossings has to be done with hydro-seeding and cover netting to limit future erosion.

Only trees within the construction site should be removed. Indigenous trees should be planted on the site of the new WWTW at locations where it does not interfere with operations.

Unnecessary removing of vegetation from areas, which will not be utilised, should be avoided. Pre-planning of trees that are to be removed should be done. Existing indigenous trees to be retained where possible. Excessive loss of vegetation (especially grass cover), should be avoided. Vehicular access should be restricted to essential areas only. Trees should only be removed where these interfere with construction.

Compacted soils should be deep-ripped after the construction process in order to facilitate the re-establishment of vegetation.

Colonization of disturbed soil by weeds, need to be controlled.

Areas which have been traversed by heavy vehicles (compacted) should be deep-ripped (500mm), after maintenance, upgrading and/or construction activities.

2.3.2.2 Terrestrial ecology - fauna

Disturbance and snaring of animals during construction should be prohibited through clear demarcation of the construction area. Any fauna disturbed as a result of construction must be noted, so that translocation can take place if necessary.

Fauna (especially avifauna) may also be temporarily displaced from the area during construction due to the noise and activity. The immediate proximity of other available habitat means that this impact is of low significance.

2.3.2.3 Aquatic ecology & riparian zone

The Aquatic specialist recommended the following mitigation measures -

1) The proposed construction of the PRWWTW footprint should not encroach on areas that have been identified as wetland and the related riverine floodplains, in order to minimise loss of habitat.

2) The project engineers should therefor ensure that all infrastructure at the works is located outside possible floodline areas.

3) The prevention/management of erosion that could result from the activities at the PRWWTW construction site should receive attention. Construction and related activities will also mobilise sediment during earthworks resulting in siltation of the water resource. Care must be taken to prevent storm water run-off result in erosion of the wetlands, terrestrial habitat and the river banks, as this will have a negative impact to the water resource downstream of the WWTW. Siting and design of the Works should be considered early – taking this potential impact into consideration. Structures and impermeable surfaces to be built outside 1:100 year floodline area. Effective stormwater dissapating methods to be employed where collected runoff is discharged into stream channel.

4) Possible contaminants from spills and the leakage of hazardous substances from the construction area, including the camp site could impact on the wetland and the related riverine floodplain. Adequate containment structures to be installed for use during construction period (e.g. bunding of areas containing hazardous / noxious / toxic substances).

5) It is critical to ensure that effective storm water management strategies are enforced during construction of the facility and during the operational phase of the WWTW. It is important to remember that increased run-off water is generated on the hard surfaces and associated infrastructure of the facility. During construction storm water runoff must be directed away from active earthworks and it is important to dissipate flow velocities at the site in order to avoid channelled discharge points. These channelled discharge points increase velocity and therefore the erosion potential. In addition, care must be taken to protect the river bank from storm water discharge and the associated erosion risk of these waters.

6) No hazardous materials and waste should be stored near the adjacent watercourse and wetland.

2.3.3 Impacts on the social and socio-economic environment

2.3.3.1 Safety on site

Implementation of an Occupational Health and Safety management system to be required of contractors. Safety measures and work procedures to be communicated to construction workers. First aid facilities to be on hand at all times. Medical screening of employees.

Contractors shall implement adequate and mandatory safety precautions relating to all aspects of the operation. Warning and advisory signage should also be implemented (also with regards to vehicular movement along public roads).

2.3.3.2 Clean construction camp

The construction camp should be kept in a neat and tidy condition. All litter and arisings from the construction camp shall be collected and removed on a continuous basis to avoid a build up.

2.3.3.3 Cultural and/or archaeological sites

Any historical or archaeological relics unearthed on a site, during the course of construction, must be reported to the nearest South African Heritage Resources Agency (SAHRA) Office (to comply with the National Heritage Resources Act, 25 of 1999), so that an assessment of the development site can be conducted and mitigatory action taken.

2.3.3.4 Optimisation of the local economy

Where appropriate, use should be made of labour intensive construction methods - local emerging contractors should be used. Advertisement of opportunities for local emerging contractors should be done, before the project commences.

Optimal benefit can be derived in the local economy by the preferential employment of local tradesmen and sub-contractors. Where opportunities arise, local sub-contractors should be set up and assisted by sub-contractors from outside the area, to create a more permanent skills and entrepreneurial base.

Sourcing of raw materials and construction materials should take place in the local and sub-regional economy.

2.3.3.5 Unsocial activities on site

Implementation of security on site (guards etc.) is necessary. Only authorised persons should have access to the site. The site needs to be properly secured for the duration of the construction period and strict control of labour implemented.

Prostitution, drinking, crime, vandalism etc. generally only arise where labourers are away from home. If the majority of the labour force is recruited locally, incidence of prostitution and other un-social activities could be reduced.

Transportation of labour to and from the site, should take place in an orderly manner to discourage loitering on adjacent areas and possible increase in crime. An unfenced, undeveloped site may present a greater security risk in the medium term than a fenced, secure construction site.

2.4 OPERATIONAL PHASE MITIGATION GUIDELINES

The following section will address a range of mitigation actions that might manage the predicted impacts associated with the operation of the different components of the development.

According to SMEC Consulting engineers (March 2017), it was found that the design of the WWTW would not only achieve DWS's General Standards in terms of outflow quality, but that the following effluent standards could be achieved –

- Ortho-phosphate as phosphorus less than 1mg/l;
- COD less than 50mg/l;
- Nitrate less than 10mg/l;
- Free and saline ammonia less than1mg/l; and
- Suspended solids 10mg/l.

Achieving the above effluent standards will be beneficial to the receiving environment and more importantly it will retain the possibility for advanced re-use of the effluent, including use as potable water.

2.4.1 Water quality management (groundwater & surface water resources)

The development of a groundwater monitoring network (in order to fulfil the legislative requirements for monitoring of the groundwater environment) shall be undertaken. This shall include the drilling and testing of strategically located boreholes to monitor,

- the baseline ground water quality (prior to operation), &
- ground water quality (periodic monitoring during entire operational period) – specific focus to be placed on the groundwater/surface water interaction due to the release of treated waste water into the Sand River aquifer.

Monitoring programme to be implemented according to DWS guidelines stipulated in the approved Water Use License of the PRWWTW. Compliance standards for E-coli and other constituents will be set by DWS in the eventual Water Use License that will be issued to the PRWWTW – this shall form part of the monitoring programme.

The existing Polokwane Wastewater Treatment Works also has a Water Use License (issued by the Dept. of Water & Sanitation) – see Annexure AA (Water Use License for existing Polokwane Wastewater Treatment Works).

According to SMEC Consulting engineers, the Water Use license of the existing Polokwane Waste Water Treatment works stipulates the effluent standards that must be achieved. The wastewater discharge limits shown in Table 8 below must be adopted (as the licence is the final directive and overrules the so-called General Standards that would have applied otherwise).

TABLE 8: EFFLUENT STANDARDS THAT MUST BE ACHIEVED AT THE POLOKWANE WASTE WATER TREATMENT WORKS

PARAMETER	UNITS	OUTFALL
Faecal Coliforms	per 100ml	1000
pH		5.5 – 9.5
Free saline Ammonia as Nitrogen	mg/l	1
Chemical Oxygen Demand	mg/l	75
Nitrate / Nitrite as Nitrogen	mg/l	10

Achieving the above effluent standards will be beneficial to the receiving environment and more importantly it will retain the possibility for advanced re-use of the effluent, including use as potable water.

The following measures are recommended to minimize the risk of surface water pollution in the Sand River:

- The close proximity of the Sand River would need the determination of the flood-line by a hydrological engineer. The proposed development should have a buffer zone of about 32 meters from the flood-line to prevent any accidental overflows of the maturation ponds during high rainfall events.

- An efficient storm water drainage system must be installed around the Works to effectively prevent storm water from entering the wastewater treatment facility.
- The site exhibits a High risk that surface flows may reach the Sand river. e.g. from spillage during high rainfall periods and/or plant malfunctions at the wastewater treatment works – therefor, the area down-gradient of the Works should be landscaped (soil berm or similar) to provide a containment area from which accidental spillage from the Works may be reintroduced to the system.
- Provision should be made in the designing of the Works seasonal variations in the amount of inflows (e.g. during high rainfall events).
- No irrigation should take place below the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering. The quantity must be metered regularly and the quality monitored monthly by means of grab sampling at the point at which the wastewater enters the Sand river (implementation of a surface water monitoring programme on a regular schedule is imperative - see recommendations by hydro-geologist).

2.4.2 Waste

Inorganic grid waste should be disposed of at a registered landfill site. Ideally such waste shall be buried at the mentioned landfill site. Suitability of the landfill site for burial of such waste shall be confirmed by a geohydrologist.

The most suitable location for sludge (future) drying beds and sludge stockpiling areas should be determined by the geo-hydrological specialist.

Long term stockpiling of sludge on the site of the PRWWTW shall not take place. Ideally dried sludge should be stabilised and made available for agricultural use to farmers. If this is found not to be suitable, dried sludge should be disposed of at a registered landfill site. Ideally such waste shall be buried at the mentioned landfill site. Suitability of the landfill site for burial of such waste shall be confirmed by a geohydrologist.

The “Sludge disposal guidelines” of the Dept. of Health should serve as the minimum requirement in respect of sludge handling methodology at the proposed PRWWTW (see Annexure T - Department of National Health – Sludge disposal guidelines).

2.4.3 Odours

The Air Quality and Odour Assessment study recommends the following –

a) It is recommended that, based on the potentially significant health and odour impacts associated with hydrogen sulphide emissions from the proposed WWTW, ambient passive diffusive hydrogen sulphide sampling be conducted around the WWTW once operational.
b) The most effective way of controlling odour releases during the various process at the inlet works, is to fully enclose the head of works within a building. It is recommended that the contained air be exhausted through an effective abatement control unit avoid odour nuisance.
c) Once the Works is operational, it is recommended that the inlet wastewater composition be analysed specifically for hydrogen sulphide. Due to potential health and odour impacts, an emissions inventory, dispersion model and impact assessment update should be undertaken.
d) According to the *Air Quality and Odour Assessment study*, Phase 1 of the proposed Regional WWTW is likely to result in potential health risks and odour impacts up to approximately 3.7 km from the site if mitigation measures are NOT implemented. With mitigation in place at the main air pollution processes (e.g. the degritter), impacts can significantly be reduced.

See Annexure Y (Air Quality and Odour Assessment report).

2.4.4 Maintenance of construction areas

Once the Works is operational, the areas where construction have taken place should be kept free of invaders/weeds.

2.4.5 Use of treated water for irrigation purposes

Sufficient agricultural land is available adjacent to the site to irrigate crops. The treated effluent is typically rich in ammonia nitrogen, which will could promote the growth of crops. The process effluent has to be treated to a standard that is acceptable for irrigation.

The following precautionary measures are recommended to minimize the risk of surface water pollution resulting from irrigation activities:

- No irrigation with return water should take place below the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering.
- The quantity must be metered regularly and the quality monitored monthly by means of grab sampling at the point at which the wastewater enters the irrigation system and analysed for geohydrological parameters.

- In view of the potential that exists for pollution of surface water sources (Sand river) as well as the underground aquifer, it is recommended that the ponds from where irrigation water is obtained, be lined (impermeable) so as to minimise any possible infiltration of effluent into underground.
- It is also recommended that the actions as described in the geo-environmental assessment report be implemented as part of an ongoing monitoring programme that will last for the entire operational phase of the proposed facility.

- There must be no irrigation in times of high rainfall - this could lead to contaminated stormwater runoff.
- A monitoring program shall be implemented to ensure that long-term irrigation disposal does not affect soil and ground water quality. The irrigation site(s) should be chosen and/or designed so that the crop/soil system can assimilate the wastes and maintain the hydraulic balance so that surface runoff does not occur.
- Vegetated buffer zones will help protect watercourses from potentially contaminated runoff.

In terms of the Department of Water Affairs guidelines, the use of treated sewage water for irrigation in crop production is permitted only on the following crops:

- Food crops that are consumed as dry edible product by humans after they are cooked
- Forage crops, if it is not going to be fed to dairy animals
- Ornamental crops

The treated water should not be used for food crops that are consumed directly by humans (e.g. horticultural crops such as fruits and vegetables). The following crops can be irrigated with the treated sewage water:

- Maize production
- Wheat production
- Potato production
- Lucerne production
- Sunflower production

2.4.6 Riparian zone & wetland area

1) The quality of the “partially treated water” that is discharged into the Sand River, must comply with the DWS General Limit Values (as high nutrient concentrations in the final effluent could lead to the eutrophication).

2) The final effluent from the WWTW must comply with the General Limit Values for the disposal of wastewater and/or treated effluent to a water resource. The final effluent quality must be constantly monitored for nutrient loading. In the final effluent nitrogen and phosphorous levels in particular must not exceed the natural assimilative capacity of the river system.

3) The footprint of the facility will result in large areas under paving or roads. Storm water run-off generated on-site (i.e. higher volumes and velocities), could have impacts on water quality in the adjacent freshwater habitats (Sand River and wetlands identified). A well-designed Storm water Management Plan must be in place to accommodate all additional water generated on the facility and ensure that the velocity is effectively dissipated to lower the risk of erosion.

4) The use of chlorine gas as the primary disinfectant for discharged (return) water must be carefully. The correct dosage must be tested during each shift to ensure that the bacterial threat is eliminated and that the residual value of the chlorine doesn't exceed the value of 0.3mg/l. Ideally there should be no residual chlorine in the treated water that is released into the river.

5) The operator(s) of the proposed facility should adhere as closely as possible to the (revised) water quality parameters regarding desired values for aquatic ecosystems, so as to minimise eutrophication and nutrient loading.

6) Reed beds create additional natural habitats for numerous invertebrates and vertebrates and should be protected.

2.4.7 Existing Polokwane WWTW

Current high levels of nutrients from the existing WWTW could result in the receiving environment becoming chronically eutrophic to hypertrophic during relatively small increases in nutrient loads from new Works. This would result in disproportionate impacts on the ecological health of the ecosystem with health threats to water users downstream.

According to SMEC Consulting engineers, the Water Use license of the existing Polokwane Waste Water Treatment works stipulates the effluent standards that must be achieved. The wastewater discharge limits shown in the Table 8 above must be adopted (as the licence is the final directive and overrules the so-called General Standards that would have applied otherwise).

2.5 MONITORING AND REPORTING

2.5.1 Monitoring

As no monitoring has occurred in the past it is advised that a proper management and monitoring programme be implemented to ensure that the ground & surface water resources are not impacted negatively.

It is recommended that the following monitoring program be implemented at the facility (once operational):

- Drill monitoring boreholes down-gradient of the proposed works
- Position: To be informed by hydrogeologist
- Depth: 30m
- Development: Install a slotted PVC casing to a depth of 20m.
- Install suitable borehole protection to prevent the ingress of surface water.
- Allocate a DWA H12- number, mark and cap the borehole according to the specification of DWA.
- Monthly water samples should be taken at the monitoring boreholes to determine the macro-chemical and bacteriological groundwater quality increases, if any.
- The water level at the monitoring boreholes should also be measured and recorded on a monthly basis.
- Return water shall be sampled weekly and analysed to ensure that the water quality general limits are maintained.
- The water quality results should be compiled into a bi-annual monitoring report.
- This monitoring report shall be commissioned by and submitted to the Manager of the Environmental Health Department of the municipality. The mentioned report shall also be submitted to the Department of Water Affairs.

2.5.2 Environmental incidents & complaints

- The proponent shall keep a documented complaints register. See Annexure W (Complaints register).
- For the purposes of receiving complaints, the contact details of the proponent shall be clearly displayed at the main entrance to the site.
- The nature of complaints that are received shall be brought to the attention of LEDET & DWS and all contractor(s) if present.
- A suitable written response shall be given, by the proponent to complainants, where required. The reader is referred to Annexure X - Register of responses to complainants.
- In an instance where an "environmental incident" is recorded, the proponent shall take appropriate action to correct the "environmental incident". Such action shall be in accordance with the nature and scale of the recorded incident. Such corrective action shall be implemented as soon as possible after the occurrence of the incident. "Corrective action" undertaken by the proponent shall also include the rehabilitation of secondary environmental disturbance/damage resulting from undertaking corrective action.
- The re-occurrence of an environmental incident shall be avoided through the implementing of suitable precautionary measures to prevent the recurrence of such.
- The proponent and all appointed contractors shall document "environmental incidents" on an "Environmental Incident Report Sheet" (EIRS) within 1 day (24 hours) from the time that the incident has occurred. Supplementary documentation can be attached to the EIRS. See Annexure V - Environmental Incident Report Sheet.
- During the Operational phase of the Works, environmental incidents shall be reported to the Manager of the Environmental Health Department of the municipality on a daily basis. A course of action shall then be decided upon jointly (as a precautionary measure to avoid the re-occurrence of these types of incidents).
- The proponent shall conduct inspections of the construction site on a weekly basis. The following persons shall attend such inspections - the site engineer, the contractor & the proponent.
- The proponent shall document the findings of his monitoring actions.
- The proponent shall report to LEDET & DWS on a monthly basis.

FINAL REMARK

Mitigation seeks to find better ways of doing things, minimise or eliminate negative impacts, enhance project benefits and protect public and individual rights. The applicant / proponent has a responsibility to avoid or minimise impacts, and plan for managing impacts.

This report serves to prescribe measures to reduce, limit, eliminate or compensate for impacts, to acceptable/insignificant levels. Mitigation recommendations in this report are arranged in order of sequence i.e. Planning, Construction and Operational Phases. Mitigation should permeate through all stages of the development process. It is also essential that the mitigation plan be monitored during construction (which includes maintenance and upgrading) and operation, to ensure compliance - with strict penalties for non-compliance). The stipulations of this report should be conveyed to contractors and persons responsible for upgrading/maintenance. This mitigation section should be issued as a stand along document to all parties involved with the planning, implementation and operation of the proposed facility.

_____ 4 Nov 2017 _____

Signed Date

Signed by: Theo Kotze CEAPSA

Enquires can be directed to:

The Director
TEKPLAN Environmental
P.O. Box 55714, Polokwane, 0700
Tel: (015) 291 4177
Fax: (015) 291 4961
email: tecoplan@mweb.co.za
Attention: Mr. T Kotze

POLOKWANE MUNICIPALITY

CONSTRUCTION, OPERATIONS AND MAINTENANCE OF THE POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS (PRWWTW): PHASE 2B

C5.3 OHS SPECIFICATION

POLOKWANE MUNICIPALITY
Coherent Health & Safety Specifications

Polokwane Integrated Wastewater Treatment Works

FOREWORD

These health & safety specifications have been compiled in terms of the Occupational Health & Safety Act no. 85 of 1993 and Construction Regulations of 7 February 2014 as amended. It must be clear that this document is a management tool and should be used by the Principal Contractor and Contractors in order to comply with the aforementioned Act and regulations.

Should there be any contradiction between this document and the Act; the Act must take preference except where explicitly stated.

Similarly where this document is silent on a specific health & safety requirement, the Act must be used as the minimum requirement.

Should you be unclear about anything set out in this document, please contact this office.

These specifications are site specific and include all works to be done by the principal contractor. The principal contractor will be responsible for all the work on site.

COHERENT HEALTH AND SAFETY SPECIFICATIONS FOR

Polokwane Integrated Wastewater Treatment Works:

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1. INTRODUCTION AND BACKGROUND

1.1 The Construction Regulations (February 2014) places the onus on the Client to prepare coherent health & safety specifications, highlighting risks not successfully eliminated during design. The Client also has the opportunity to set the tone and standard of occupational health & safety on the construction site.

1.2 Responsibility and Accountability

It is imperative to understand the process of determining legal accountability, as the OHS-Act is the only criminal Act still administered by the Department of Labour. It *assumes* that the CEO is overall accountable even though he may delegate some of his responsibilities. This principal is entrenched in Section 37(1) of the Act and copied
below for your benefit. This is generally referred to as the REASONABLE MAN TEST. SECTION 37: Acts or omissions by employees or Mandataries

Occupational Health and Safety Act of 1993
AND CONSTRUCTION REGULATIONS 2014

REQUIREMENTS:

1. Your attention is drawn to “General Duties of Employers to their Employees” as required by Section 8 of the Act.

2. You are required to:

2.1 Sign a written “Agreement with Mandatary” as required by Sect 37(1) (2) of the Act before commencing any work on site.

2.2 Ensure that all your employees receive the necessary Induction Training and have proof thereof.
Note: You must ensure that all employees under your control are informed, instructed and trained by a competent person regarding any hazard and the related work procedures before any work commences.

2.3 Ensure the provision of Welfare Facilities for your employees as per Construction Regulation 30.

2.4 Provide the Client/Principal Contractor with your SHE Plan and Specifications

2.5 Ensure that Method Statements, Risk Assessments and Safe Work Procedures are done and available.

2.6 Provide the Client/Principal Contractor with written appointment of the person who is going to supervise the Construction Work per Construction Reg. 8(1).

2.7 Provide the Client/Principal Contractor with written designation of your nominated Health and Safety Representative as per Section 17(1).
Note: Your Health and Safety Representative will be expected to attend the Client/Principal Contractor safety meetings.

2.8 If you employ more than five (5) persons, you are required to provide your own First Aid Box (GSR 3(2)).

2.9 If you employ more than ten (10) persons, you are required to provide your own qualified First Aider as per GSR 3(4)
Note: If you have difficulty in complying with items 2.7 and 2.8 above, you may arrange/come to an agreement with the Client/Principal Contractor to make use of his First Aid facilities in case of injury. You will be expected to communicate such an agreement to your employees.

2.10 When working with Hazardous Chemical Substances, comply with HCS Reg. 3
Note: Asbestos and Lead Regulations are separate.

2.11 When doing blasting to comply with Explosives Regulations Chapter 10

2.12 When doing Excavation Work, comply with Construction Reg. 13

2.13 When using Construction Vehicles, comply with Construction Reg. 23

2.14 Ensure that good Housekeeping, Stacking and Storage principles are applied on this project as per Construction Reg. 27 and 28

2.15 Ensure that appropriate measures are taken to avoid the risk of Fire/Explosion and comply with requirements of Reg. 29

3. You are responsible for providing your own legal safety documents and registers to comply with the Act's requirements.
A copy of the OHS Act of 1993 and the Construction Regulations; 2014 will be available for perusal in the Principal Contractor's site office.

4. You are required to comply with General Safety Regulations 2(1) to (7) and provide your employees with: personal protective equipment which will allow them to carry out their work in a safe manner, e.g. hard hats, gloves, safe footwear, eye protection, ear protection, waterproof clothing etc.

5. Reporting of Incidents of Occupational Diseases shall be done as per General Admin. Regulation 8 (Also see Sect 24 of the Act)

6. Compensation for Occupational Injuries and Diseases Act (No 130 of 1993) You are required to provide the Client/Principal Contractor with proof of registration with the Compensation Commissioner/Federated Employer(s) Mutual when signing this agreement. If you are not registered, the Client/Principal Contractor may deduct the necessary amounts from your progress payments and pay it over to the Commissioner to ensure that you are insured. See Section 80 and 89 of the COID Act.

Signature:_____
(Client/Agent of Client or Principal Contractor)

Signature _____
(Principal Contractor or Contractor)

AGREEMENT WITH MANDATARY
IN TERMS OF SECTION 37(1) AND (2)

DEFINITION OF MANDATARY

Includes an agent, a contractor or sub-contractor for work, but without derogating from his status in his own right as an employer or user

SECTION 37(1)

Whenever an employee does or omits to do any act which it would be an offence in terms of this Act for the employer of such employee or a user to do or omit to do, then, unless it is provided that –

(a) in doing or omitting to do that act the employee was acting without the connivance of permission of the employer or any such user;

(b) it was not under any condition or in any circumstance within the scope of the authority of the employee to do or omit to do an act, whether lawful or unlawful, of the character of the act or omission charged; and

(c) all reasonable steps were taken by the employer or any such user to prevent any act or omission of the kind in question, the employer or any such user himself shall be presumed to have done or omitted to do that act, and shall be liable to be convicted and sentenced in respect thereof; and the fact that he issued instructions forbidding any act or omission of the kind in question shall not, in itself, be accepted as sufficient proof that he took all reasonable steps to prevent the act or omission.

SECTION 37(2)

The provisions of subsection (1) shall mutates mutandis apply in the case of a mandatary of any employer or user, except if the parties have agreed in writing to the arrangements and procedures between them to ensure compliance by the mandatary with the provisions of this Act.

ACCEPTANCE BY MANDATARY

In terms of the provisions of Section 37(2) of the Occupational Health and Safety Act 1993

I,_____

acting for and on behalf of _____

(Company/Close Corporation/Enterprise/Owner/User) undertake to ensure that the requirements and provisions of the Act and Regulations are complied with.

Signature: _____

Print Name: _____
(Principal Contractor or Contractor)

Designation: _____

Date: _____

Mandatary-Workmen's Compensation/Federated Employers Mutual No.:

_____

Signature: _____ Print Name: _____
(Client/Agent of Client or Principal Contractor)

Designation: _____ Date: _____

Company: _____

Project/Site: _____

OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993
CONSTRUCTION REGULATIONS 2014
CONTRACTOR

CONSTRUCTION REGULATION 7

7(3): A principal contractor shall be responsible for the following:

(a) to provide any contractor who is making a bid or is appointed to perform construction work for the principal contractor, with the relevant sections of the health and safety specifications pertaining to the construction work that has to be performed;

(b) to appoint each contractor contemplated in paragraph (a) in writing for the part of the project on a construction site

APPOINTMENT

Contractor, _____ (name)

of: _____
(Company/Close Corporation/Enterprise/Owner/and Labour Only Contractor)

is hereby appointed to perform construction work at:

Project/Site: _____

Company: _____
(Principal Contractor)

Job/Safety specifications: _____

_____

You are reminded that:

1. your documented Health and Safety plan based on the relevant applicable sections of the Principal Contractors Health and Safety Specifications, are provided to the Principal Contractor before commencing work on site

2. the Principal Contractor will discuss/negotiate with you regarding the contents of the Health and Safety Plan to approve it for implementation

3. a Health and Safety File, which shall include all documentation required in terms of the provisions of the Act and Regulations are kept available on site for inspection (Risk Assessments)

4. should you appoint another Contractor to perform or assist you with Construction Work, the responsibilities as required by the Construction Regulations shall apply to you as if you were the Principal Contractor

5. you promptly provide the Principal Contractor with any information which might affect the Health and Safety of any person at work carrying out Construction Work or any person who might be affected by the work of such a person at work or which might justify a review of the Health and Safety Plan

6. per Regulation 5(c) audits of your Health and Safety Plan will be undertaken on at least a monthly basis.

7. all your Employees have to undergo Safety Induction before starting work

Signature:_____ Date: _____
(Principal Contractor)

Designation: _____

ACCEPTANCE OF APPOINTMENT

I, _____ accept and understand the requirements of this appointment

Signature:_____ Date: _____
(Contractor)

Designation: _____

1.3 Purpose of the Health and Safety Specifications

The purpose of the H&S specifications document is to assist in achieving compliance with the Occupational Health & Safety Act 85/1993 (OHS Act) and the now promulgated Construction Regulations (February 2014) in order to prevent or as far as possible, reduce incidents and injuries. These specifications should act as the basis for the drafting of the Principal Contractor and Contractors' coherent health & safety plans. The health & safety specifications set out the requirements to be followed by the Principal Contractor and other Contractors (BASE – LINE RISK ASSESSMENT) so that the health & safety of all persons, including the public potentially at risk may receive the same priority as other facets of the project e.g. cost, program, environment, quality, etc.

1.4 Implementation of the Health and Safety Specifications (Drafting of the coherent Health & Safety Plan)

These health & safety specifications document forms an integral part of the contract, and the Principal Contractor is expected to use it when compiling its project-specific coherent health & safety plan. The Principal Contractor must forward a copy of these specifications to all Contractors at their bidding stage so that they can in turn prepare coherent health & safety plans relating to their operations.

2. OCCUPATIONAL HEALTH & SAFETY MANAGEMENT SYSTEM ELEMENTS

2.1 Scope of the Project

These Specifications set out the requirements for eliminating or if this is not possible, for minimising as far as reasonably practicable, the risk of incidents and injuries occurring at Polokwane Municipality**. This document covers work to be undertaken of the project and sets out the rules and procedures for engagement on the project.** The scope also addresses legal compliance, Polokwane Municipality standards, hazard identification and risk assessment, risk control, and the promotion of a health and safety culture amongst those working

on the project. The health & safety specifications also make provision for the protection of those persons other than employees.

The Extent of the works:

The construction of Outfall Sewers to Polokwane Integrated Waste Water Treatment Works includes the following:

- Establishment of the Contractor's Camp Site
- Site clearance
- Traffic control and temporary signage during construction
- Location, exposing and protection of existing services
- Excavation, trench preparation and compaction
- Drop structures
- Connection structures with air vents and access
- Manholes
- Supply, bedding and laying of sewer outfall pipes described above.
- Backfilling of trenches and testing of installation
- Provision and installation of manholes
- Construction of drop structures
- Construction of Pipe bridge crossing the sand river
- Reinstatement of surfaces to original condition
- Connections into existing pump stations

The Contractor's obligations shall also include strict compliance with any Environmental requirements and/or reports deemed to form part of this Contract as well as any Occupational Health and Safety requirements.

This description of the works is not necessarily complete and shall not limit the work to be carried out by the Contractor under the Contract. Approximate quantities of each type of work are given in the Schedule of Quantities.

2.2 Interpretations

2.2.1 Application

This specifications document is a legal compliance document compiled in terms of the OHS Act & Construction Regulations 2014 and is therefore binding. The document must be read in conjunction with other relevant legislation.

2.2.2 Definitions

The definitions as listed in the OHS Act 85/1993 and Construction Regulations (February 2014) shall apply.

2.3 Minimum Administrative Requirements

2.3.1 Notification of Intention to Commence Construction Work

The Principal Contractor must notify the Provincial Director of the Department of Labour in writing before construction work commences. A copy of this notification must be held in the Principal Contractor's health & safety file on site. The fax transmission slip will serve as proof of notification.
See attached **Annexure "F"**

2.3.2 Assignment of the Principal Contractor's / Contractors' Responsible Persons to Supervise and Co-ordinate Health and Safety on Site

The Principal Contractor and all Contractors must make supervisory appointments as well as other relevant appointments in writing (as stipulated by the OHS Act and Construction Regulations 2014). See attached **Annexure 'B'** for more detail on what health & safety management appointments are relevant on this project.

2.3.3 Competence of the Principal Contractor's / Contractors' Appointed Competent Persons

The Principal Contractor and Contractors' competent persons for the various risk management portfolios must fulfill the criteria as stipulated in terms of the definition 'Competent' in accordance with the Construction Regulations (February 2014).

2.3.4 Compensation for Occupational Injuries and Diseases Act 130 of 1993 (COIDA)

The Principal Contractor must have in its possession a letter of good standing issued by its Compensation Assuror as proof of registration. Contractors must also hold proof of workman's compensation assurance registration in the form of a letter of good standing and forward a copy to the Principal Contractor before they begin work on site. Contractors must be in good standing at all times while carrying out work on site.

2.3.5 Health and Safety Organogram

Including all appointed risk management competent persons. In cases where appointments have not yet been made, the organogram shall reflect the intended positions.

The organogram must be updated when there are changes in the Site Management Structure, and dated accordingly. The organogram merely

serves as a quick reference to who is responsible for what risk portfolio in what area.

2.3.6 Preliminary Hazard Identification and Risk Assessments, Progress Hazard Identification and Risk Assessments Reviews.

The Principal Contractor must cause preliminary hazard identification and risk assessment to be performed under the leadership of a competent person before commencement of construction work. On this project detailed task-specific risk assessments based on the proposed sequence of work (method of work) must be compiled. Generic risk assessments will not be accepted.

The assessed risks, together with written safe work procedures for the 'medium & high-risk' rated activities must form part of the coherent site specific health and safety plan submitted for approval by House of Safety. The risk assessments must include:

a) A list of hazards identified as well as potentially hazardous tasks;
b) The risks which may result based on the list of hazards and tasks;
c) A set of safe work procedures to be implemented with the aim of eliminating or if this is not possible, reducing and/or controlling the risks as far as reasonably practicable to ALARP (as low as reasonably practicable);
d) A monitoring and review procedure of the risk assessments as they change i.e. how will the risk assessments be reviewed, when will they be reviewed and by whom.

The Principal Contractor must ensure that all Contractors inform, instruct and train their workers regarding any hazards, the associated risks and the related safe work procedures to be implemented before any work commences and thereafter at regular intervals as the risks change and as new risks develop. This training should be carried out in the form of toolbox health & safety talks. Contractors must conduct their own toolbox talks and submit proof of these talks in the form of attendance registers to the Principal Contractor at least every two weeks. Every worker on site must undergo such toolbox safety talks with the attendance registers kept in the Principal Contractor's safety file.
Contractors must conduct their own hazard identifications and risk assessments specific to their operations and forward a copy to the Principal Contractor.
The Principal Contractor when required must report on the status of these Contractor risk assessments to the Client i.e. at audits.

2.3.7 General Record Keeping

The Principal Contractor and all Contractors must keep and maintain all the necessary Health and Safety records to demonstrate compliance with these Coherent Specifications, the OHS Act 85/1993, and the Construction Regulations (February 2014). The Principal Contractor must also ensure that all records of incidents/injuries, emergency procedures, training,

planned maintenance inspections, monthly contractor audits, etc. are kept in the health & safety file(s) held in the site office. The Principal Contractor must ensure that every Contractor keeps its own health & safety file, maintains the file and makes it available on request (the file must include the Contractor's health & safety plan and all relevant records). Such 'Contractor safety files' must be audited by the Principal Contractor on a monthly basis with audit reports kept as proof.

2.3.8 Injury / Incident Reporting and Investigation

Injuries are to be categorised into first aid; medical; disabling (lost day); and fatal. When reporting injuries to the Client, these categories must be used. The Principal Contractor must investigate all injuries. All Contractors must report injuries to the Principal Contractor immediately and the

Principal Contractor must inform the Client immediately. All incidents reportable in terms of the provisions of Section 24 of the OHS Act must be reported to the local Dept. of Labour in the prescribed manner.

2.3.9 Consolidation of Health & Safety Documentation

It is the duty of the Principal Contractor to ensure that all documentation required to be kept or generated during the construction phase is consolidated into one set of documents that must be handed over to the Client upon completion of the construction work. This consolidated safety file(s) should include instructions from the design team that will be required for the continued safe operation and maintenance of the new structure(s).

2.3.10 Offences and Penalties

Penalties may be imposed on the Principal Contractor and Contractors for ongoing non-compliance with the provisions of the Client's coherent health & safety specifications, the Principal Contractor's coherent health & safety plan, site health & safety procedures and rules. Non-compliances identified during safety agent audits and visits will be categorised into one of three levels based on severity. These will be as follows: Life threatening situation - a prohibition order will be issued by means of a written instruction in the site instruction book or an explanation in an audit report. This activity must be seized immediately and corrective measures taken. Serious injury possible – a contravention notice will be issued with a time frame for compliance stipulated. Minor or no injury may result – an improvement notice will be issued. The corrective measures stipulated in the audit report must be taken. The methodology used to decide the above levels will be directly linked to the risk assessments of the Principal Contractor and contractors, Polokwane Municipality Standards. The decision of the safety Agent will be final.

2.4 Principal Contractors, Contractors and Sub-contractors

2.4.1 Principal Contractor's and Contractors' Requirements

The Principal Contractor must ensure that all Contractors appointed by them comply with these Specifications, the Principal coherent health & safety plan as well as the OHS Act, Construction Regulations (February 2014), and other relevant legislation that may relate to the activities directly or indirectly. A Contractor, when appointing other Contractors as 'Sub-contractors', shall mutatis mutandis ensure compliance as if it was the Principal Contractor.

The Principal Contractor may only allow a Contractor to begin work on site after receiving a coherent health & safety plan which must include a project specific hazard identification, risk assessments and safety measures. The Principal Contractor must test competency and finally approve his sub – contractor coherent site specific health and safety plan. The Principal Contractor must audit each of its contractors on a monthly basis, with audit reports kept in the health & safety file on site. The audit must include an administrative assessment as well as a physical inspection of the contractor's site activities. *The Principal Contractor must stop any Contractor from carrying out construction work that is not in accordance with the Principal Contractor's and/or Contractor's health & safety plan or if there is an immediate threat to the health and safety of persons.*

The Principal Contractor shall take all reasonable steps necessary to ensure co-operation between all contractors to enable each of those contractors to comply with the provisions of the Construction Regulations;

The Principal Contractor shall take all reasonable steps to ensure that each contractor's coherent health and safety plan is implemented and maintained on the construction site: Provided that the steps taken shall include periodic audits at intervals mutually agreed upon between the Principal Contractor and contractors, but at least once every month;

The Principal Contractor must ensure that where changes are brought about to the design and construction, that sufficient health and safety information and appropriate resources are made available to contractors so as to allow them to execute the work safely;

The Principal Contractor must ensure that every contractor is registered and in good standing with a recognised compensation fund or with a licensed compensation insurer prior to work commencing on site;

The Principal Contractor must ensure that potential contractors submitting tenders have made provision for the cost of health and safety measures during the construction process;

The Principal Contractor shall discuss and negotiate with the contractor the contents of the coherent health and safety plan and shall finally approve that plan for implementation;

The Principal Contractor shall hand over a consolidated health and safety file to the client upon completion of the construction work and shall include a record of all drawings, designs, materials used and other similar information concerning the completed structure;

The Principal Contractor may only appoint a contractor to perform construction work when such Principal Contractor is reasonably satisfied that the contractor he or she intends to appoint, has the necessary competencies and resources to perform the construction work safely and that the contractor is an approved Polokwane Municipality contractor.

2.4.2 Principal Contractor / Contractor Competency Assessment

The Principal Contractor must be reasonably satisfied that the contractors it intends to appoint have the necessary competencies and resources to safely conduct the work they will be appointed for. This should be established at tender stage and before appointments are made. One of the preferred ways of determining whether a contractor is competent is to make sure the contractor is an accredited contractor for Polokwane Municipality. Once the contractor is appointed, but before it begins work on site a site-specific safety plan must be discussed and negotiated with the Principal Contractor. Such safety plan must be approved for implementation by the Principal Contractor.

The Principal Contractor and Contractors should submit the following documentation for perusal and verification by the Client and Principal Contractor respectively:

- Coherent health & safety plan as compiled for this project; (including Risk assessments, safe work procedures, fall protection plan, PTW Issuer/PTW Holder certificates
- Management Structure as envisaged at tender (organogram); Letter of Good Standing with the Compensation Commissioner or FEM;
- Proof of health & safety training and other related training; (CV and certificates) Legislative appointment letters
- Notification of Construction work; (proof notification was done)

2.4.3 Pricing for Occupational Health & Safety Compliance

All parties bidding to do work on this construction project must ensure that they have made provision for the cost of complying with this Specifications document as well as with the OHS Act and incorporated Regulations as a minimum requirement in their tender documentation. It must also be taken into consideration that time is money, which implies that sufficient time must be allowed for the implementation of the minimum OHS standards. No additional claims will be entertained at a later stage should a compliance requirement be prescribed in the OHS Act, incorporated regulations or in this Specifications document.

Annexure:

2.4.4 Contractors' Coherent Health & Safety Plans [Construction Regulations 7]

1. Introduction:

   The Construction Regulations (2014) aims to improve overall management and co-ordination of Health, Safety and Welfare throughout the Construction Phase and reduce the large number of serious and fatal injuries and cases of ill health, which occur every year in the Construction Industry.
   In terms of the Construction Regulations (2014), the Principal Contractor is required to develop a Health and Safety Plan before work commences on site and review it throughout the Construction Phase. The degree of detail required in the Health and Safety Plan and the time and effort in preparing it should be in proportion to the nature, size and level of Health and Safety risks involved in the project. Projects involving minimal risks will call for simple, straightforward plans. Large projects or those involving significant risks such as this project will need much more detail.
   Annexure:

2. What should the construction health & safety plan cover?

   The Construction Health and Safety Plan should set out the arrangements for ensuring the Health and Safety of everyone carrying out the construction work as well as all other persons who may be affected by it. The index of this plan must be in line with Annexure:

2.4.5 Communication and Management of the work

The Principal Contractor must indicate in its health and safety management plan that it has made provision for the following:

a. Management structure and responsibilities

b. Health and Safety goals for the project and arrangements for monitoring and review of Health and Safety performance i.e. safety meetings; contractor meetings; risk assessment review, etc

c. Arrangement for:

   i. Regular liaison between parties on site i.e. meetings

   ii. Consultation with the work force i.e. toolbox talks

   iii. The exchange of design information between the Client, designers, and Contractors on site

   iv. Selection and control of Contractors i.e. selection criteria; inspections; audits, etc.

v. Site health & safety induction and onsite training i.e. toolbox talks

vi. Welfare facilities, first aid, emergency planning and fire prevention strategy

vii. The reporting and investigation of injuries and incidents including near misses what the intended system will be

viii. The production, approval and review of risk assessments, safe work procedures and method statements and how does the company's risk assessment system work.

d. Site specific rules and procedures.

2.5 Client identified Hazards and Potentially Hazardous Situations

2.5.1 Client identified Hazards

RISK: Excavations				RISK ASSESSMENT	
REVISION NUMBER	01	WRITTEN BY	REVIEWED BY	APPROVED BY	
NAME		H.Heyneke			
SIGNATURE					
DATE WRITTEN			Document No		
REVIEW DATE			Contract No		

A	INJURY SEVERITY	B	FREQUENCY of OCCURENCE	RATING	
				RISK CLASSIFICATION	RISK VALUE
0	No injury	0	Has not occurred in last two years		
2	Minor laceration, wound (first aid case)	2	Occurs very seldom	LOW	0-6
4	More severe injury medical attention	4	Occurs occasionally	MEDIUM	6-16
8	Serious injuries, broken bones, amputation etc	8	Occurs often	HIGH	16-32
10	Loss of life / fatality	10	Could / has happened	CRITICAL	32-40

C	POTENTIAL DAMAGE / LOSS	D	ENVIRONMENT		ACTION REQUIRED		
0	No damage, minimal costs R10 – 100	0	No effect	Spillage, noise, water, dust/ vapours/ fauna and flora	LOW	Supervision, training, certification, method/risk assessments, safe work procedures training, toolbox talks.	Good instruction.
2	Minor damage, small costs R100 – 1000	2	Minor effect		MEDIUM	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
4	Med damage, stoppage (On site repair) medium cost R1000 – 5000	4	Serious effect (Short term)		HIGH	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
8	More serious damage / / loss / delay < R5000 - +	8	Very serious effect (Long Term)		CRITICAL	Close competent supervision, training certification, method/risk assessments, safe work procedures, PJO's, work permits, training and toolbox talks.	Intolerable, change method, transfer risk.
10	Severe damage, long term stoppage, high costs	10	Catastrophic effect				

ACTIVITY	POTENTIAL HAZARD	POSSIBLE RESULT	RISK EVALUATION A	B	C	D	R	PREVENTATIVE MEASURES	CONTROLS	PJO RIGHT	PJO WRONG
1. Inspect work area	Energy sources identified/ unidentified	• Electrocution • Injuries to employees • Fatality • Damage to plant/ equipment • Loss of production	8	2	8	0	**18**	• Determine as far as reasonably practicable the location & nature of electricity, water, gas or similar services, which may in any way be effected by work to be performed. • Barricading to be utilized to safeguard employees, plant/ equipment within the work area.	Supervisor		
2. Operator commences operating with a hydraulic TLB	Operator do not adhere to RA/SWP	• Potential physical injuries to employees • Fatality • Damage to plant/ equipment and machinery • Loss of production	8	2	8	0	**18**	• Adhere to RA/SWP • Secure work area/ excavation with barricading; implement and maintained barricading.	Supervisor		
3. Operator commence excavating/ positioning of material	Man machine interface.	• Potential physical injuries to employees • Fatality • Damage to plant equipment and machinery • Loss of production.	8	2	8	0	**18**	• Adhere to RA/SWP • Excess/ spoiled/ redundant material to be piled 3m away from excavation (minimum).	Supervisor		
4. Excavate in dry weather/ windy conditions	Dust/ poor visibility	• Dust inhalation • Potential damage to lungs. • Unable to identify hazard.	2	2	2	0	**6**	• Water spray (dust suppression), dust masks, report concentration of dust immediately. • Water spray; check for high concentrates of dust and high wind speeds and report matter to the foreman.	Supervisor		

5. Excavate in excessive heat conditions	Exposure to UV rays/ or high temperatures during task activity	• Dehydration • Heat stress • Heat stroke • Skin cancer	4	2	4	0	**10**	• Supervisor to ensure an adequate supply of drinking water is available. • Personnel to ensure that they remain properly hydrated by drinking enough water and use sun screen against UV rays.	Supervisor		
6. Surveying	Surveying pegs are not visible, barricaded or marked.	• Slip, trip, fall hazard due to the pegs not being visible. • Potential physical injuries as trip and fall and machine strike worker	4	2	4	0	**10**	• Survey pegs to be barricaded or marked with approved system. • The surveyor and all workers are to ensure visual marked or barricades of all pegs to prevent tripping.	Supervisor		
7. Operating TLB	Operator not adhere to SWP and operators Manual Man machine interface.	• Potential physical injuries to employees • Fatality • Damage to plant/ equipment and machinery. • Production loss	8	2	8	0	**18**	• Inspections shall be done on a daily basis and monthly inspections must be done by a appointed competent person. Defects must be logged and corrective action implemented. • Only the appointed TLB operator to complete daily checklists and appointed machinery inspector to complete monthly checklist. • Operator shall be trained and found competent after assessment by certified and accredited training company and assessor.	Supervisor		

8. Manual excavation	Congested area Defective hand tools Exposure to UV rays/ or high temperatures during task activity Dust	• Potential physical injuries to employees. • Dehydration • Heat stress • Heat stroke • Skin cancer • Dust in halation • Potential damage to lungs • Back injuries	4	2	4	0	**10**	• Employees to be spread evenly to prevent them to injured each other. • Water spray, dust mask, report concentration of dust immediately. • Personnel to ensure they remain properly hydrated by drinking enough water and use sun screen against UV rays. • Supervisor to make sure employees is spread evenly to prevent them injuring each other.	Supervisor		

RISK: Site Establishment			RISK ASSESSMENT	
REVISION NUMBER	01	WRITTEN BY	REVIEWED BY	APPROVED BY
NAME		H.Heyneke		
SIGNATURE				
DATE WRITTEN			Document No	
REVIEW DATE			Contract No	

A	INJURY SEVERITY
0	No injury
2	Minor laceration, wound (first aid case)
4	More severe injury medical attention
8	Serious injuries, broken bones, amputation etc
10	Loss of life / fatality

B	FREQUENCY of OCCURENCE
0	Has not occurred in last two years
2	Occurs very seldom
4	Occurs occasionally
8	Occurs often
10	Could / has happened

RATING	
RISK CLASSIFICATION	RISK VALUE
LOW	0-6
MEDIUM	6-16
HIGH	16-32
CRITICAL	32-40

C	POTENTIAL DAMAGE / LOSS
0	No damage, minimal costs R10 – 100
2	Minor damage, small costs R100 – 1000
4	Med damage, stoppage (On site repair) medium cost R1000 – 5000
8	More serious damage / / loss / delay < R5000 - +
10	Severe damage, long term stoppage, high costs

D	ENVIRONMENT	
0	No effect	Spillage, noise, water, dust/ vapours/ fauna and flora
2	Minor effect	
4	Serious effect (Short term)	
8	Very serious effect (Long Term)	
10	Catastrophic effect	

ACTION REQUIRED		
LOW	Supervision, training, certification, method/risk assessments, safe work procedures training, toolbox talks.	Good instruction.
MEDIUM	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
HIGH	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
CRITICAL	Close competent supervision, training certification, method/risk assessments, safe work procedures, PJO's, work permits, training and toolbox talks.	Intolerable, change method, transfer risk.

ACTIVITY	POTENTIAL HAZARD	POSSIBLE RESULT	RISK EVALUATION A	B	C	D	R	PREVENTATIVE MEASURES	CONTROLS	PJO RIGHT	PJO WRONG
1. Transport of plant & equipment by low bed & truck.	Plant falling off in transit.	Fatality / Injury. Damage to property.	8	2	8	0	18H	• Certified tie-down tackle. Correct tie-down methods.	Competent staff. Skills training / toolbox talk.		
	Traffic accident.	Fatality / Injury. Damage to property.	8	2	8	0	18H	• Toolbox talk.	Competent driver.		
	Preparing low bed for load.	Head & hand injuries. Back strain.	4	2	4	0	10M	• Wear correct PPE. Skills training / toolbox talk.	Issue of PPE & enforce PPE rule. Direct supervision.		
	Machine running off during loading / unloading.	Fatality / Injury. Damage to property.	8	2	8	0	18H	• Ensure loading / unloading on level surface.	Direct supervision.		
	Slippery underfoot / high climbing.	Injury - fractures.	4	2	4	0	10M	• PPE - . Skills training / toolbox talk. Check for mud or obstacles. Stand & step firm & use both hands when climbing.	Enforce PPE rule. Direct supervision. Demarcated access points to plant.		
	Heavy weights.	Bodily injuries / back strain.	4	2	4	0	10M	• Wear correct PPE. Skills training / toolbox talk.	Induction. Direct supervision.		
	Failure of lifting equipment & tackle.	Fatality / Injury. Damage to property.	8	2	8	0	18H	• Certified lifting equipment & tackle. Skills training / toolbox talk.	Direct supervision. Competent staff. Demarcated no person's area.		
2. Preparation of office & accommodation area.	Moving machinery.	Pedestrian &/or traffic accident. Fatality / injury.	8	2	8	0	18H	• Correct PPE to be worn. Plant & vehicles fitted with flashing beacons & hooters. Toolbox talk.	Competent staff. Enforce PPE rule.		
	Dust.	Occupational illness. Eye irritation/injury.	4	2	4	0	10M	• Wear correct PPE. Use dust suppression methods.	Issue of PPE. Water to be sprayed at work area.		
	Use of hand tools - saws, picks etc.	Hand &/or eye injuries.	2	2	2	0	6L	• Wear correct PPE. Tools in good condition. Skills training / toolbox talk.	Enforce PPE rule. Inspection of tools.		

3. Erection of perimeter fence.	TLB digging of stay poles.	Pedestrian &/or traffic accident. Fatality / injury	4	2	4	0	**10M**	• Correct PPE to be worn. Plant & vehicles fitted with flashing beacons & hooters. Toolbox talk.	Competent staff. Enforce PPE rule.		
	Dust / dry cement dust.	Occupational illness. Eye irritation/injury.	4	2	4	0	**10M**	• Wear correct PPE. Use dust suppression methods.	Issue of PPE. Water to be sprayed at work area.		
	Use of hand tools - picks, shovels, etc.	Hand &/or eye injuries.	2	2	2	0	**6L**	• Wear correct PPE. Tools in good condition. Skills training / toolbox talk.	Enforce PPE rule. Inspection of tools.		
4. Certificate of Compliance on completion of installations.	Improper installations.	Fire. Electrical shock. Damage to property.	0	2	4	2	**8M**	• Only an Accredited person may issue certificate.	Competent qualified staff only. Audit.		
5. Water reticulation.	Pipes not deep enough.	Loss of water. Unnecessary downtime.	0	2	4	0	**6L**	• Buried at least 300mm deep.	Direct supervision. Skills training / toolbox talk.		
	Use of hand tools - picks, shovels, etc.	Hand &/or eye injuries.	2	2	2	0	**6L**	• Wear correct PPE. Tools in good condition. Skills training / toolbox talk.	Enforce PPE rule. Inspection of tools.		
	Slippery underfoot / high climbing.	Slip & fall fractures & sprains. Serious bodily injuries.	4	2	4	0	**10M**	• Wear correct PPE. Fall prevention & protection equipment. Skills training / toolbox talks.	Fall protection & prevention plan drawn up & implemented. Direct supervision.		

RISK: Manual Material Handling			RISK ASSESSMENT	
REVISION NUMBER	01	WRITTEN BY	REVIEWED BY	APPROVED BY
NAME		H.Heyneke		
SIGNATURE				
DATE WRITTEN			Document No	
REVIEW DATE			Contract No	

A	INJURY SEVERITY	B	FREQUENCY of OCCURENCE	RATING	
				RISK CLASSIFICATION	RISK VALUE
0	No injury	0	Has not occurred in last two years		
2	Minor laceration, wound (first aid case)	2	Occurs very seldom	LOW	0-6
4	More severe injury medical attention	4	Occurs occasionally	MEDIUM	6-16
8	Serious injuries, broken bones, amputation etc	8	Occurs often	HIGH	16-32
10	Loss of life / fatality	10	Could / has happened	CRITICAL	32-40

C	POTENTIAL DAMAGE / LOSS	D	ENVIRONMENT		ACTION REQUIRED		
0	No damage, minimal costs R10 – 100	0	No effect	Spillage, Noise, Water, Dust / vapours / fauna and flora.	LOW	Supervision, training, certification, method/risk assessments, safe work procedures training, toolbox talks.	Good Instruction.
2	Minor damage, small costs R100 – 1000	2	Minor effect		MEDIUM	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, Mitigate.
4	Med damage, stoppage (On site repair) medium cost R1000 – 5000	4	Serious effect (Short term)		HIGH	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, Mitigated.
8	More serious damage / / loss / delay < R5000 - +	8	Very serious effect (Long Term)		CRITICAL	Close competent supervision, training certification, method/risk assessments, safe work procedures, PJO's, work permits, training and toolbox talks.	Intolerable, change method, transfer risk.
10	Severe damage, long term stoppage, high costs	10	Catastrophic effect				

ACTIVITY	POTENTIAL HAZARD	POSSIBLE RESULT	RISK EVALUATION A	B	C	D	R	PREVENTATIVE MEASURES	CONTROLS	PJO RIGHT	PJO WRONG
1. Inspect the Loading or offloading area.	No unsafe access to working area used.	• Damage to delivery truck	2	2	4	0	**6L**	• Make sure that all Objects like stones, planks are clear from the loading & Offloading area • Supervisor must be at all times visible on site (loading & offloading area.)	Supervisor.		
2. Positioning the delivery truck or site light vehicle at the loading & offloading area.	Unsafe reverse actions by driver.	• Collide with the buildings, structures, equipment, plant, or people.	4	2	4	2	**12M**	• Flagmen to ensure visual contact is maintained with driver in the driver side mirror. • Flagmen not to walk or stand behind the delivery truck or Light vehicle.	Supervisor.		
	Fail to switch off the engine of the delivery truck or light vehicle and apply the hand brake and isolate.	• The delivery truck or light vehicle moves whilst busy with the offloading process. • Unplanned movement. • Unauthorized use.	4	2	4	0	**10M**	• The driver of the delivery truck or light vehicle must be switch off the engine, remove the keys from the ignition and apply the hand brake. • Assistant to place stop blocks in front and behind one of the rear wheels.	Supervisor.		
	Fail to install shop blocks/chocks.	• The delivery truck moves whilst busy with the offloading process. • Drives over people. • Collide with other vehicles.	8	2	8	0	**18H**	• The assistant must install one stop block in front and behind one of the rear wheels.	Supervisor.		
3. Manual Loading & Offloading of tools and equipment	No or unsafe access onto delivery truck or Light Vehicle.	• Falling from delivery truck or light vehicle.	4	2	2	0	**6L**	• The ladder must be secured when ascending and descending by a person holding the ladder.	Supervisor.		

from a truck or light vehicle.	Using an unsecure Ladder.	• Falling from ladder.	4	2	4	0	**6L**	• The ladder must be secured by a person standing on the ground when employee ascend or descend.	Supervisor.		
	Using sub-standard ladder.	• Ladder collapsing and employee falling. • Serious injury.	8	2	8	0	**18H**	• Ladder must be inspected and comply with site requirements. • Defective ladders will be withdrawn from the service immediately.	Supervisor.		
	Incorrect method used to manhandle tools and equipment.	• Back, neck & knee injuries.	2	4	2	0	**4L**	• All employees will be trained on the correct manual handling and lifting method. • Lift with your knees and not your back. • No employees are allowed to lift more than 25 KG or a 1/3 of his body weight. • Rather use mechanical equipment to lift heavy objects or ask for assistance.	Supervisor.		
	Heavy equipment lifted by a single person.(load Insufficient employees to load or offload)	• Neck, back and knee injuries. • Damage to equipment, delivery truck or light vehicle.	4	2	4	0	**10M**	• No employees are allowed to lift more than 25 KG or a 1/3 of his body weight. • Rather use mechanical equipment to lift heavy objects or ask for assistance.	Supervisor.		
	Unsafe positioning of hands and fingers when loading and offloading.	• Hand and finger injuries.	4	2	4	0	**10M**	• Employees will be made aware of nip and pinch points between the object and the delivery truck or LIGHT VEHICLE in and that they must keep their hands and fingers clear from under any object.	Supervisor.		

	Not using gloves when loading and offloading.	• Hand and fingers injuries.	4	2	4	0	**10M**	• All employees will be trained on the use and maintenance of PPE. • Gloves will be used when offloading equipment.	Supervisor.		
	Throwing material to or from heights or to each other.	• Employees can get stricken by tools or equipment.	2	2	2	0	**6L**	• No throwing of material to or from heights will be allowed to throw any object to each other.	Supervisor.		
	Poor communication.	• Hand and finger injuries. • Damage to tools or equipment.	4	2	4	0	**10M**	• Ensure effective communication between all involved.	Supervisor.		
	Uneven terrain, lose objects in walkways.	• Tripping, slipping and falling over objects.	4	2	4	0	**10M**	• Pre determine path to be followed when plan to carry material: remove tripping hazards as far possible. • Always ensure that you are able to see where you are walking when carrying material.	Supervisor.		
	Long length of equipment carried by a single person.	• Hit other employees or persons with the object being carried when turning.	4	2	4	0	**10M**	• Single person to avoid carrying long length material on shoulder, rather carry hip height. • If 2 persons carry as close to both ends as possible to avoid hitting other when carrying or turning.	Supervisor.		

	Workers in Contact sharp edges and nip points.	• Cuts and pinching to hand or body.	2	4	2	0	**6L**	• Identify and cover sharp edges that could cause harm, wear full PPE. • Place object on dunnage's to avoid fingers nipped. Wear gloves and make use of gwalas to lift off ground and place object to support prior to entering hands between an object and ground or possible nip points.	Supervisor.		
	Heavy equipment lifted by a single person.	• Neck, back & knee injuries.	4	2	4	0	**10M**	• No employees are allowed to lift more than 25 KG or a 1/3 of his body weight. • Rather use mechanical equipment to lift heavy objects or ask for assistance.	Supervisor.		
4. Stacking of material.	Stacked material not barricaded.	• Tripping over material or. • Plant collides with material.	4	2	4	0	**10M**	• All stacked material are to be barricade with snow netting, barricading are to be tagged, on register and daily inspected by appointed responsible person.	Supervisor.		
	Stored energy, unplanned movement.	• Materials fall from stack on person. • Round equipment starts rolling.	8	2	8	0	**10M**	• Always remove material only from top if stacked, do not pull anything from the middle or bottom of a pile. • Make use of wooden wedges to support round items and prevent unplanned movement. • Attempt to stack same size, shape and type of material with each other, do not stack material to high and ensure all stacked material on heights are secured to avoid falling to lower levels.	Supervisor.		

	No safe walkways between materials.	• Slip or trip when walk on stacked material, ankle sprain ect.	4	2	4	0	**10M**	• During stacking always provide safe walkways between material, no tripping hazard and no protruding material.	Supervisor.		
	Snakes under or between materials.	• Snakebites could cause fatality or serious injury.	10	2	10	0	**22H**	• Always be aware that snakes and insects/ spiders could be present under stacked material. • Avoid placing hands where you cannot see, wear full PPE at all time when handling material.	Supervisor.		
	Poor housekeeping.	• Environmental impact, trip hazards, fire hazard.	2	2	2	2	**6L**	• Keep work areas clean and neat at all times.	Supervisor.		

RISK: Backfilling				RISK ASSESSMENT
REVISION NUMBER	01	WRITTEN BY	REVIEWED BY	APPROVED BY
NAME		H.Heyneke		
SIGNATURE				
DATE WRITTEN			Document No	
REVIEW DATE			Contract No	

A	INJURY SEVERITY	B	FREQUENCY of OCCURENCE	RATING	
				RISK CLASSIFICATION	RISK VALUE
0	No injury	0	Has not occurred in last two years		
2	Minor laceration, wound (first aid case)	2	Occurs very seldom	LOW	0-6
4	More severe injury medical attention	4	Occurs occasionally	MEDIUM	6-16
8	Serious injuries, broken bones, amputation etc	8	Occurs often	HIGH	16-32
10	Loss of life / fatality	10	Could / has happened	CRITICAL	32-40

C	POTENTIAL DAMAGE / LOSS	D	ENVIRONMENT		ACTION REQUIRED		
0	No damage, minimal costs R10 – 100	0	No effect	Spillage, noise, water, dust/ vapors/ fauna and flora	LOW	Supervision, training, certification, method/risk assessments, safe work procedures training, toolbox talks.	Good instruction.
2	Minor damage, small costs R100 – 1000	2	Minor effect		MEDIUM	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
4	Med damage, stoppage (On site repair) medium cost R1000 – 5000	4	Serious effect (Short term)		HIGH	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
8	More serious damage / / loss / delay < R5000 - +	8	Very serious effect (Long Term)		CRITICAL	Close competent supervision, training certification, method/risk assessments, safe work procedures, PJO's, work permits, training and toolbox talks.	Intolerable, change method, transfer risk.
10	Severe damage, long term stoppage, high costs	10	Catastrophic effect				

ACTIVITY	POTENTIAL HAZARD	POSSIBLE RESULT	RISK EVALUATION A	B	C	D	R	PREVENTATIVE MEASURES	CONTROLS	PJO RIGHT	PJO WRONG
Tipping of fill material.	Public traffic.	Obstruct & / or collision.	4	2	4	0	10M	Correct prominent signage with flagmen. Safety devices fitted to trucks & in good order.	Traffic safety officer & flagmen. Competent Operator & Skills training.		
	Dust.	Occupational illness. Eye irritation & injury.	4	2	4	4	14M	Wear correct PPE. Use dust suppression methods.	Issue of PPE. Water-tankers spraying work-area.		
	Pile to close to road.	Stones on road. Vehicles colliding with pile - injury / fatality.	8	2	8	0	18H	Supervisor to designate tipping area. Flagmen to assist driver.	Competent Driver & Skills training.		
Placing of fill material.	Plant hits / runs over staff member.	Injury / fatality.	8	2	8	0	18H	Wear correct PPE. Safety devices fitted to plant and in good order. Toolbox talk.	Issue of PPE. Plant daily checklist inspection. Competent Operator & skills training.		
	Dust.	Occupational disease. Eye irritation / injury.	4	2	4	4	14M	Wear correct PPE. Use dust suppression methods.	Issue of PPE. Water to be sprayed on material.		
	Dust.	Visibility impaired - plant falls into excavation. Injury / fatality.	8	2	8	4	20H	Flagman to be designated to assist operator. No persons to be in excavation. Toolbox talk.	Competent Operator. Skills training. Flagman to monitor & enforce rule.		
	Collapse of excavation.	Injury / fatality. Damage to plant.	8	2	8	0	18H	Loose material removed. Plant and people to stay 1m away from edge. Toolbox talk.	Daily excavation inspection. Flagman to monitor & enforce rule. Competent Operator & skills training.		
Compaction of fill.	Collapse of excavation.	Injury / fatality. Damage to plant.	8	2	8	0	18H	Loose material removed. Toolbox talk.	Daily excavation inspection. Roll-call of all persons in excavation. Competent Operator & skills training.		

	Plant hits / runs over staff member.	Injury / fatality.	8	2	8	0	**18H**	Wear correct PPE. Safety devices fitted to plant and in good order. Toolbox talk.	Issue of PPE. Plant daily checklist inspection. Competent Operator & skills training.		
	Noise.	Hearing impairment.	4	4	4	2	**14M**	Wear correct PPE. Plant in good order. Toolbox talk.	Issue of PPE. Plant daily checklist inspection. Competent Operator.		
	Vibrations & / or rough ride.	Operator kidney problems.	4	2	4	0	**8M**	Wear kidney belt.	Issue of PPE.		

RISK: Masonry and brickwork				RISK ASSESSMENT	
REVISION NUMBER	01	WRITTEN BY	REVIEWED BY	APPROVED BY	
NAME		H.Heyneke			
SIGNATURE					
DATE WRITTEN			Document No		
REVIEWDATE			Contract No		

A	INJURY SEVERITY
0	No injury
2	Minor laceration, wound (first aid case)
4	More severe injury medical attention
8	Serious injuries, broken bones, amputation etc
10	Loss of life / fatality

B	FREQUENCY of OCCURENCE
0	Has not occurred in last two years
2	Occurs very seldom
4	Occurs occasionally
8	Occurs often
10	Could / has happened

RATING	
RISK CLASSIFICATION	RISK VALUE
LOW	0-6
MEDIUM	6-16
HIGH	16-32
CRITICAL	32-40

C	POTENTIAL DAMAGE / LOSS
0	No damage, minimal costs R10 – 100
2	Minor damage, small costs R100 – 1000
4	Med damage, stoppage (On site repair) medium cost R1000 – 5000
8	More serious damage / / loss / delay < R5000 - +
10	Severe damage, long term stoppage, high costs

D	ENVIRONMENT	
0	No effect	Spillage, noise, water, dust/ vapours/ fauna and flora
2	Minor effect	
4	Serious effect (Short term)	
8	Very serious effect (Long Term)	
10	Catastrophic effect	

ACTION REQUIRED		
LOW	Supervision, training, certification, method/risk assessments, safe work procedures training, toolbox talks.	Good instruction.
MEDIUM	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
HIGH	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
CRITICAL	Close competent supervision, training certification, method/risk assessments, safe work procedures, PJO's, work permits, training and toolbox talks.	Intolerable, change method, transfer risk.

ACTIVITY	POTENTIAL HAZARD	POSSIBLE RESULT	RISK EVALUATION A	B	C	D	R	PREVENTATIVE MEASURES	CONTROLS	PJO RIGHT	PJO WRONG
1. Delivery of bricks and cement on site	Driver not aware of site Hazards	Driver can cause an accident	2	2	2	0	**6**	• The supervisor must ensure that the vehicle driver undergoes visitor's induction • The supervisor must ensure that the driver of the delivery of truck sign the applicable Risk-Assessment. • The supervisor must ensure that the truck driver is in possession of minimum required PPE.	Supervisor		
	Substandard delivery truck	The truck can fail resulting in accidents	2	2	2	2	**8**	• The Supervisor must ensure that the delivery truck is inspected. • The supervisor must ensure that the lifting device on the truck must be accompanied by the test certificate and operator's company certificate. • The supervisor must ensure that the bricks being delivered are wrapped to prevent any objects from falling.	Supervisor		
	No flagman to escort the delivery vehicle	Other vehicles can drive into the truck or the truck can drive over pedestrians	2	2	4	0	**8**	• The supervisor must ensure that the flagman escorts the truck to the delivery point. • After completing the offloading process the flagman must escorts the vehicle out to nearest exit point. • The flagman must adhere to the 5m radius at all times while escorting the vehicle to the delivery point.	Supervisor		

	Uncontrolled off-loading	The truck can fall over or the operator can place the bricks on top of other employees in the area	4	2	2	0	**8**	• The supervisor must ensure that the delivery truck is set up on stable ground conditions and that the park brake is engaged and stop blocks placed under the wheels. • The supervisor must ensure that only single stacking of pellets of bricks is being done. • No stacking of pallets on top of each other. • Only competent person may operate the off loading device and that the person doing the task is wearing the Safety Belt on the Operators seat. • Any person not involved in the off loading process must keep to the 5m radius. • After off loading is done the area needs to be barricaded and the relevant signage displayed.	Supervisor		
2. Transporting bricks to work area in a wheelbarrow	Substandard wheelbarrow	The wheelbarrow can break	2	4	2	0	**8**	• The supervisor must ensure that the wheelbarrow was inspected and found fit for use. • The load on the wheelbarrow may not exceed 25 kg \t any given time.	Supervisor		
	Not wearing PPE	Hand and fingers can get caught between the bricks	2	4	2	0	**8**	• The supervisor must ensure that the person off-loading the wheelbarrow is wearing the required PPE. • The person off-loading the bricks use keeps his hands clear of the line of fire when stacking it in the required area. • No throwing of bricks will be allowed.	Supervisor		

	Unsafe stacking	The material can fall over	4	2	2	0	**8**	• The person off-loading the bricks just keeps his hands clear of the line of fire when stacking it in the required area. • No throwing of bricks will be allowed. • The area where the bricks are being stacked must be barricaded.	Supervisor		
3. Transporting bricks to work area with TLB with lifting forks	Load to heavy	The TLB can fail mechanically on the lifting section of the TLB	4	2	4	0	**10**	• The supervisor must ensure that only one pellet of bricks is transported at 'n time.	Supervisor		
	Unsecured load	Bricks can fall causing damage	2	2	4	0	**8**	• The supervisor must ensure that the spotter escorts the vehicle while travelling.	Supervisor		
	No spotter to direct traffic	Being run over or vehicle accident	8	0	10	0	**18**	• The supervisor must ensure that a spotter escorts the vehicle while travelling.	Supervisor		
4. Mixing mortar by hand and transporting by means of a wheel-barrow	Splashing of mortar in eyes	Eye injuries	2	2	2	0	**6**	• The supervisor shall ensure to provide the employees with proper safety glasses for application.	Supervisor		
	Cement dust inhalation during mixing	Respiratory tract infections or irritation	4	4	2	0	**10**	• The supervisor shall ensure to provide the employees with proper dust mask for application.	Supervisor		
	Over –excretion	Person can get tired and cause injuries to help them self's	2	2	2	0	**6**	• The supervisor shall ensure to divide the mixing of mortar into teams as to allow sufficient rest for employees.	Supervisor		

	Substandard hand tools-Shovels used	Hand and finger related injuries(personal)	2	2	2	0	**6**	• The supervisor shall ensure that the hand tools provided is of sufficient quality and purpose fit for the application. • The supervisor will ensure that the tools were pre-inspected prior to work.	Supervisor		
	Uneven access route	The wheel can get struck causing the wheelbarrow to fall over	2	2	2	0	**6**	• The supervisor shall ensure that there is an access way available, free from obstructions, for the purpose of moving material with the wheel barrow.	Supervisor		
	Manual handling and pushing of wheel barrow	If wheelbarrow is loaded to heavy it can cause back injury to person pushing it	2	4	2	0	**8**	• The supervisor shall ensure that no wheelbarrow is overloaded and restrict manual lifting to 25kg per person.	Supervisor		
	Spillage to soil	Environmental pollution	0	2	2	2	**6**	• The Supervisor shall ensure to place a plastic ground cover mix mortar on to avoid contamination of soil. • Any contaminated soil shall be treated as nt.	Supervisor		

5. Bricklaying while standing on the ground including staking of bricks and transporting by means of wheel barrow	Tripping hazard	The operator can bump into other equipment	2	4	2	0	**8**	• The supervisor shall proper gang ways left between brick laying area and stacking area to allow persons to move freely.	Supervisor		
	Falling objects	The stacker material can fall over or collapse	4	2	2	0	**8**	• The supervisor shall ensure that bricks are stacked not higher that 3X the base width.	Supervisor		
	Throwing of bricks	Bricks can fall out of hand or the person might not be able to catch it	2	4	2	0	**8**	• The supervisor to ensure that no brick throwing from one person to another shall take place.	Supervisor		
	Placing mortar with sub skin when placing mortar	Derma illness to employees; hands and lower arms	2	4	2	0	**8**	• The supervisor shall to ensure to provide employees with proper PVC gloves for the application.	Supervisor		
	Overexertion	Person can injure their back	4	2	2	0	**8**	• The supervisor to ensure that there are laying teams to allow adequate short rest breaks.	Supervisor		
	Bricks slipping from hands	Hand and finger injuries	2	2	2	0	**6**	• The supervisor shall ensure to discuss with the brick layers a methodology to handle bricks.	Supervisor		
	Nip or pinch points	Hand and finger injuries	2	4	2	0	**8**	• The supervisor shall ensure to discuss with the brick layers a methodology to handle bricks.	Supervisor		
6. Cutting or resizing of bricks to suite/fit	Uncontrolled flying Objects	Eye injuries	2	2	2	0	**6**	• The supervisor shall ensure to discuss with the employees a safe method of using a brick chisel and hammer away from the body. • The supervisor shall ensure to provide employees with proper safety glasses for the application.	Supervisor		

	Substandard chisels	Puncture wounds. Eye injury	4	2	2	0	**8**	• The supervisor shall ensure that any mushroom lead chisel is removed from site immediately and replaced with a proper new one for application.	Supervisor		
	Subs-standard hammer and brick chisel	Hand and finger injuries	2	2	2	0	**6**	• The supervisor ensures to provide proper tools for the application.	Supervisor		
	Using a trowel as a brick chisel	Hand and finger injuries	2	4	2	0	**8**	• The supervisor shall ensure to instruct brick layers that no trowel shall be used as a brick chisel or a tool to size bricks	Supervisor		
	Nip points	Hand and finger injuries	2	2	2	o	**6**	• The supervisor to shall discuss a methodology for employees to hand bricklaying as to prevent their fingers being caught between bricks.	Supervisor		
7. Handling of bricks force and placement of profiles	Uncontrolled movement of roll when placing	Hand and finger injuries	2	4	2	0	**8**	• The supervisor shall ensure that two persons assist in the installation of bricks force. • The supervisor shall ensure to make use of proper hold don method, by means of a clamp, to keep brick force down. • The employees doing this task will wear the required PPE. • No bricks shall be allowed to keep brick force down. • The supervisor must ensure that when profiles are placed at elevated positions that these equipment is tied down with a lanyard to prevent it falling different levels.	Supervisor		

	Flying objects	Eye injuries	4	2	2	0	**8**	• The supervisor shall ensure to explain to employees to cut wires away from the body. • The supervisor shall ensure to provide employees with proper safety glasses for the application.	Supervisor		
	Manual handling of mortar containers	Hand and finger injuries	2	4	2	0	**8**	• The supervisor shall ensure that manual lifting is limited to 25kg per person. • The supervisor must ensure the containers used are stacked on proper dun age. • The supervisor must ensure that no bricks are used to stack any material or equipment onto.	Supervisor		
	Mortar failing from heights	Can fall on top of other workers	4	2	4	0	**10**	• The supervisor to ensure to barricade the working area as to prevent ant lower level access beneath work.	Supervisor		

RISK: Fire Prevention				RISK ASSESSMENT
REVISION NUMBER	01	WRITTEN BY	REVIEWED BY	APPROVED BY
NAME		H.Heyneke		
SIGNATURE				
DATE WRITTEN			Document No	
REVIEWDATE			Contract No	

A	INJURY SEVERITY	B	FREQUENCY of OCCURENCE	RATING	
				RISK CLASSIFICATION	RISK VALUE
0	No injury	0	Has not occurred in last two years		
2	Minor laceration, wound (first aid case)	2	Occurs very seldom	LOW	0-6
4	More severe injury medical attention	4	Occurs occasionally	MEDIUM	6-16
8	Serious injuries, broken bones, amputation etc	8	Occurs often	HIGH	16-32
10	Loss of life / fatality	10	Could / has happened	CRITICAL	32-40

C	POTENTIAL DAMAGE / LOSS	D	ENVIRONMENT		ACTION REQUIRED		
0	No damage, minimal costs R10 – 100	0	No effect	Spillage, noise, water, dust/ vapours/ fauna and flora	LOW	Supervision, training, certification, method/risk assessments, safe work procedures training, toolbox talks.	Good instruction.
2	Minor damage, small costs R100 – 1000	2	Minor effect		MEDIUM	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
4	Med damage, stoppage (On site repair) medium cost R1000 – 5000	4	Serious effect (Short term)		HIGH	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
8	More serious damage / / loss / delay < R5000 - +	8	Very serious effect (Long Term)		CRITICAL	Close competent supervision, training certification, method/risk assessments, safe	Intolerable, change

10	Severe damage, long term stoppage, high costs	**10**	Catastrophic effect			work procedures, PJO's, work permits, training and toolbox talks.	method, transfer risk.

ACTIVITY	POTENTIAL HAZARD	POSSIBLE RESULT	RISK EVALUATION A	B	C	D	R	PREVENTATIVE MEASURES	CONTROLS	PJO RIGHT	PJO WRONG
1,Adequate equipment to be provided in the working area and shall be of suitable capacity and located in suitable areas.	Inadequate and wrongly placed fire equipment can cause a delay in dealing with fire should it occur.	Fire getting out of control injuries to persons and damage to property.	4	2	2	2	**10**	• Adequate fire equipment to be provided and placed at suitable locations.	Visual and physical inspections.		
2. Fire equipment must be unobstructed at all times and regularly inspected and serviced.	Non-availability of equipment	Loss of life and extensive damage property	10	2	8	0	**20**	• Monthly checklist of all equipment.	Visual and physical inspections to be done by fire warden		
3. Fire fighting team on site should be trained in the operation of fire fighting equipment and should be familiar with fire equipment locations.	Untrained personnel using wrong type of equipment to extinguish the fire. Delays in searching for fire extinguishers	Injury to employees and damage to property.	2	2	4	2	**10**	• Provide training and have fire drills periodically	Supervisor / Safety Officer control.		

4. Water based fire extinguisher shall not be used on electrical equipment or burning liquids	Electrocution. Increased spread of fire. Explosions	Fatality/Injury to employees and damage to property.	10	2	8	0	**20**	• Trained personnel.	Induction by supervisor.		
5. Fire alarms to be tested to make sure that it is working and that it can be heard everywhere on site.	Fire alarm not functional or inaudible.	Fatality/Injury to persons and damage to property.	10	2	8	0	**20**	• Monthly checklist.	Fire warden to control.		
6. All combustible materials to be stored in appropriate storage places.	Fire can occur.	Injury to people and damage to property.	4	2	2	0	**8**	• Induct workers on usage and storage of combustible materials.	Supervisor to check that this is done.		
7. Storage of any material against the exterior of buildings is prohibited as it interferes with access.	Access blocked and people trapped inside; Fire fighting team not able to obtain access.	Fatality/Injury to people and damage to property.	10	2	8	0	**20**	• Store material in demarcated areas.	Supervisor to control on daily basis.		

8. Cigarettes to be extinguished properly and not thrown into rubbish bins.	Fire can occur in the bins.	Damage to property.	0	2	4	2	**6**	• Ash trays and waste bins to be emptied daily. Induct all personnel.	Site agent/manager to control.		
9. Persons misusing or wilfully damaging fire equipment to be disciplined.	Shortage or non-operation of fire fighting equipment in the case of fire.	Injury to people and damage to property.	4	2	4	0	**10**	• Supervisor to enforce.	Induction by supervisor.		
10. Enough exits to be provided for every person to get out safely and easily.	Overcrowding at exit points during fire.	Bruises, cuts, broken limb even fatalities.	8	2	4	0	**14**	• Fire escape routes and assembly points to be determined and clearly marked.	Supervisor to check.		

RISK: Elevated positions				RISK ASSESSMENT
REVISION NUMBER	01	WRITTEN BY	REVIEWED BY	APPROVED BY
NAME		H.Heyneke		
SIGNATURE				
DATE WRITTEN			Document No	
REVIEWDATE			Contract No	

A	INJURY SEVERITY	B	FREQUENCY of OCCURENCE	RATING	
				RISK CLASSIFICATION	RISK VALUE
0	No injury	0	Has not occurred in last two years		
2	Minor laceration, wound (first aid case)	2	Occurs very seldom	LOW	0-6
4	More severe injury medical attention	4	Occurs occasionally	MEDIUM	6-16
8	Serious injuries, broken bones, amputation etc	8	Occurs often	HIGH	16-32
10	Loss of life / fatality	10	Could / has happened	CRITICAL	32-40

C	POTENTIAL DAMAGE / LOSS	D	ENVIRONMENT		ACTION REQUIRED		
0	No damage, minimal costs R10 – 100	0	No effect	Spillage, noise, water, dust/ vapours/ fauna and flora	LOW	Supervision, training, certification, method/risk assessments, safe work procedures training, toolbox talks.	Good instruction.
2	Minor damage, small costs R100 – 1000	2	Minor effect		MEDIUM	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
4	Med damage, stoppage (On site repair) medium cost R1000 – 5000	4	Serious effect (Short term)		HIGH	Competent supervision, training certification, method/risk assessments, safe work procedures training, toolbox talks.	Change method, mitigate.
8	More serious damage / / loss / delay < R5000 - +	8	Very serious effect (Long Term)		CRITICAL	Close competent supervision, training certification, method/risk assessments, safe work procedures, PJO's, work permits, training and toolbox talks.	Intolerable, change method, transfer risk.
10	Severe damage, long term stoppage, high costs	10	Catastrophic effect				

ACTIVITY	POTENTIAL HAZARD	POSSIBLE RESULT	RISK EVALUATION A	B	C	D	R	PREVENTATIVE MEASURES	CONTROLS	PJO RIGHT	PJO WRONG
1. No gear, debris or other material shall be dropped from heights.	Falling objects.	Injury to employees, possible fatal injuries and damage to property.	4	2	4	0	**10**	All material and equipment must be lowered or by means of a chute to lower levels.	Appointed Competent Person daily inspections. Skills training, induction and toolbox talks.		
2. Openings in floor shall be boarded over, covered or barricaded off.	Employees could trip and fall into openings. Debris or tools and equipment may fall through openings.	Bruises, scratches, fractures, fatality or permanent disability and damage to equipment.	8	2	8	0	**18**	Demarcate, barricade and cover all openings to avoid unnecessary incidents. Put kickboards on scaffold to prevent items falling off scaffolds.	Appointed Competent Person to develop Fall Protection plan and do daily inspections. Skills training, induction and toolbox talks.		

3. Sides and edges of slabs must be fitted with guardrails.	Employees may fall over edge of building.	Bruises, scratches, fractures, fatality or permanent disability.	8	2	8	0	**18**	Place handrails around all edges of slab (use scaffolding or 8 gauge galvanized wire). Do not allow cranes to position closer than 3m from edge of slab during lifting operation.	Charge hand, supervisor to control. Induct employees on safe work procedures. All employees working on edge of slab to wear safety belts and tie onto structure or guard rail.		
4. Safety belts / harness must be worn at all times.	Not hooking safety belt catch to anchor point. Anchor point not secure or strong enough.	Bruises, scratches, fractures, fatality or permanent disability.	8	2	8	0	**18**	Ensure anchor point is secure and can hold the weight. Ensure all safety belt catches are hooked onto anchor points. If there is no place to hook a safety belt – a lifeline must be supplied.	Supervisor to induct all employees on hazards. Monthly check done on all safety belts and registers kept up to date.		

5. Safety nets to be used to protect against falling objects.	Deliberately dropping materials or equipment will damage the net.	Net not strong enough to hold the weight, could cause injury to employees working below and damage to property.	4	2	4	0	**10**	Ensure correct safety net is used. Ensure net is not damaged. Avoid not being exposed to sharp edges or rough surfaces, etc.	Competent person to inspect safety regularly. All defects to be reported to supervisor.		
6. Areas below elevated work area to be kept clear and clean.	Poor housekeeping can cause scaffold to destabilize.	Bodily injuries / fatality. Damage to property.	8	2	8	0	**18**	Skills training and toolbox talks to ensure good standard of housekeeping.	Competent person to inspect safety regularly. All defects to be reported to supervisor.		
7. Do not stand on empty drums as scaffolds or trestles.	Drum may buckle or break.	Injury to employee. Poor quality of work.	2	2	2	0	**6**	Ensure sufficient amount of scaffolding and trestles available.	Skills training and toolbox talks.		

Other possible risks you need to consider.

1. Existing services
2. Interface with the public – roads and pavements
3. Hazardous chemical such as solvents, cleaning agents, cement, fuels, oils, epoxies, etc.
4. Connections
5. Electrical installations (temporary and permanent)
6. Site security and access control issues
7. Road traffic management
8. Finishing trades

Also note that these do not include specific risk that may arise out off methods of works and tools and machinery. The Principal Contractor must conduct those baseline risk assessments for approval prior the construction phase.

2.5.2 Unforeseeable Hazards

The Principal Contractor must immediately notify Contractors as well as the Client, in writing, of any hazardous or potentially hazardous situations that may arise during the performance of construction activities so that the necessary precautions may be taken before such work begins.

2.6 Site Operational Requirements

2.6.1 Health and Safety Representative(s)

The Principal Contractor and all Contractors must ensure that Health and Safety Representative(s) are appointed under consultation with the employees. The H&S representatives must be competent to carry out their functions. The appointments must be in writing. The Health and Safety Representatives should carry out monthly inspections, keep records of the inspections and report all findings to the Responsible Person or safety officer forthwith and at monthly health & safety committee meetings. At least one Health & safety representatives is required by all Employers on site.

2.6.2 Health and Safety Committees

The Principal Contractor must ensure that project health and safety committee meetings are held monthly with minutes kept. Meetings must be chaired by the Principal Contractor's Responsible Person [CR 7(1) person]. All Contractors' Responsible Persons and Health & Safety Representatives must attend the Principal Contractor's monthly health & safety meetings. The Principal Contractor's appointed supervisors must also attend health & safety meetings. The following topics must be tabled at meetings: management appointments and risk management portfolios; sub-contractor

legal compliance issues; injuries and incidents; hazards and risk assessments (present and foreseen); safety procedures; method statements for upcoming activities; planned inspections and registers/record keeping, etc. The committee chairperson must sign off and date the minutes.

2.6.3 Health and Safety Training

2.6.3.1 Induction

The Principal Contractor must ensure that all site personnel including all sub-contractors undergo the agreed health & safety induction training session held and managed by the P/Contractor before any worker starts work on the project. A record of attendance must be kept in the health & safety file. Workers must carry proof of inductions on their person while on site i.e. identification passport cards or similar to be agreed.

2.6.3.2 Awareness

The Principal Contractor must ensure that, on site, periodic toolbox health & safety talks take place at least once every two weeks. All site personnel including all sub-contractors must attend safety talks at such intervals and keep proof thereof. These talks should deal with risks relevant to the construction work at hand i.e. they should be based on the job-specific risk assessments and safe work procedures. Records of attendance must be kept in the P/contractor's health & safety file. All contractors' employees must attend safety awareness toolbox talks carried out by their supervisors, the attendance registers must be copied to the Principal Contractor together with information on the information discussed at the session.

2.6.3.3 Competence

All competent persons must have the knowledge, experience, training, and qualifications specific to the work they have been appointed to supervise, control and/or carry out. This must be assessed on a regular basis e.g. training, evaluation, and periodic audits by the Client, progress meetings, etc. The Principal Contractor is responsible to ensure that Competent Contractors are appointed to carry out construction work on site.

2.6.4 Health & Safety Audits, Monitoring and Reporting

The Principal Contractor is obligated to conduct monthly audits on all Contractors appointed by it and keep audit reports in its health & safety file. Contractors have to audit their sub-contractors and keep records of these audits in *their* health & safety files, made available on request. The

Client/Agent will conduct monthly audits on the Principal Contractors' safety management plan.

2.6.5 Emergency Procedures

The procedure must detail the response procedures including the following key elements:

List of key competent personnel;
Details of emergency services;
Actions or steps to be taken in the event of the specific types of emergencies; Evacuation procedures: including routes and exits to be available on a drawing. Emergency procedure(s) must include, but shall not be limited to: fire; spills; injury to employees; damage to material / equipment / plant; use of hazardous substances; bomb threats; major incidents/injuries; evacuation; etc. The Principal Contractor must advise the Client in writing forthwith, of any emergency situations, together with a record of action taken/action to be taken. A contact list of all service providers (Fire Department, Ambulance, Police, Medical and Hospital, etc.) must be maintained and made available to site personnel. The emergency plan will need to be reviewed from time to time as conditions/environment changes i.e. as building work increases in extent.

2.6.6 First Aid Boxes and First Aid Equipment

The Principal Contractor and all Contractors must appoint First Aider(s) in writing. The Principal Contractor must appoint at least one First Aider to start with, which first aider must be certificated. Copies of valid certificates are to be kept on site. The Principal Contractor must provide at least 1 (one) first aid box, adequately stocked at all times. Due to the nature of this project i.e. satellite work stations/areas, further first aid boxes must be provided close to the various work stations to allow for quick, effective treatment of injured persons. As the work progresses and the structure increases in height, extra first aid

2.6.7 Personal Protective Equipment (PPE) and Clothing

The Contractor must ensure that all site workers are issued with and wear the appropriate PPE as indicated in their risk assessments. The Contractors must make provision and keep adequate quantities of SANS approved PPE on site at all times according to their risk assessments. Safety harnesses are mandatory wherever work takes place in an elevated area where safe working platforms or ladders are not possible. Overalls clearly indicating the Contractor's logo must be worn and all sub-contractors must conform to this requirement. Eye protection must be worn by those working grinders, skill saws, high pressure water cleaners.. Even those workers in close proximity to these operations will also be required to wear such eye protection.

Safe footwear will be required by all workers. A high visibility vest is mandatory on a Polokwane Municipality site.
Hard hats will be required by all workers, including those involved with internal work.

2.6.8 Occupational Health and Safety (OHS) Signage

The Principal Contractor must provide adequate on-site OHS signage. Including but not limited to: 'construction work - no unauthorised entry', 'beware of overhead work', 'hard hat area', first aid – to be posted up at all work areas/zones.
Signage must also be posted up at strategic locations to warn the public of diversions, alternative through ways and other irregularities caused by construction work (pedestrians and motorists).

Signs are also required as per law e.g. scaffolding and other potential risk areas/operations such as exposed edges and openings and trenches/excavations where persons are at work. Safety signs and awareness posters will also be required in strategic locations on site such as frequently used access routes, stairways and entrances to structures and buildings where the workers will continuously be made aware of health & safety. Health & safety signage must be well maintained including weekly inspections, cleaning, replacement and repair.

2.6.9 Public and Site Visitor Health & Safety

Public walkways and roadways must be kept clean and free of construction materials so as to prevent any negative impact on the public. Public roadways and walkways will have to be cleaned on a regular basis – daily inspections to be conducted by the Principal Contractor with action to be taken without delay (daily).
Site visitors must be briefed on the hazards they may be exposed to as well as what measures are in place or should be taken to control these hazards. The Construction Regulations require that a record of these 'inductions' be kept on site. It is advised that a visitor book with site rules leaflet be kept at the reception/site office and all visitors to be directed to such point where they must read through the site safety information and sign the visitor book. It will be the Principal Contractor's prerogative to decide whether site visitors require supervision while on site. Visitor hard hats must be kept in the site office.

Where hoarding structures are required, such hoarding must be at least 1.8m high ready fence panels covered with shade cloth, secured in place and erected at a safe distance from the actual work. The public will also have to be diverted away from any demolition zones by means of signs and other suitable diversion methods. Glazed windows facing onto public walkways and roadways must be secured so as to prevent any risk of windows shattering and falling onto persons below. This may require boarding windows closed where the risk prevails. Where loading/offloading

of equipment/plant/rubble/other materials takes place adjacent to public roadways or walkways, flagmen will be required to direct vehicles and pedestrians away from the loading area. Traffic cones or delineators will also be required demarcating the loading zone.
It is envisaged that mobile aluminium scaffolds and the like will be used extensively on site. These scaffolds will have to conform to the minimum requirements as set out in SANS 10085-2004 (A sketch. The maximum height of these scaffolds is not expected to be more than 6m and height to base width ration are not seen to a problem (2,5m x 2m frames will be adequate) It has also been identified that some work, especially on the will be directly over exits, shop entrances and public walkways. It is of utmost importance that all work takes place behind an appropriate set of hoarding, thus keeping the public well away from overhead work. Scaffolds will also need to be enclosed by means of readymade fence at all times, isolating any potentially hazardous activities to within the scaffold platform and structure. An opening will be permitted to allow workers to enter/exit the scaffold in order to access the working platform (by means of an access ladder fastened to the internal face of the frames). The Safety Agent reserves the right to impose such scaffold safety measures.

Walkways must be kept free of materials and must remain slip free. Due to the fact that water, detergents, wet cement, etc. will be used; slippery wet floors will be a risk and must be controlled as far as reasonable. Members of the public will probably have to be re-routed at times to allow for public walkway cleaning and drying. Signs will also have to be placed, warning members of the public of the risk – signs in isolation are however not an adequate safety measure deemed.

2.6.10 Access to Site

Where any permits are necessary from the local authorities, this will be the Principal Contractor's responsibility. The road surface of all public and private roadways and pavements/pedestrian walkways must remain in a reasonably clean state, free of excessive sand, stone, water or other construction related materials. The access gate(s) must be controlled and visitors must sign in and report to the site office for further instruction.

2.6.11 Night Work (After Hours)

No night work will be allowed within the hazardous zone on this project.

2.6.12 Transport of Workers

The Principal Contractor and other Contractors may not transport:
Persons together with goods or tools unless there is an appropriate area or section to store the tools or equipment;
Contractors must adhere to the National Road Traffic Act.

2.6.13 Construction Health & Safety Officer

A *full-time* construction officer (in terms of Construction Regulation 8) will be required on this project**. This employee must be registered with the SACPCMP .**The construction officer will be required to carry out at least the following duties:

a) Health & safety audits and inspections on site including administrative and Physical audits of all Contractors' health & safety plans, files and activities, and record findings in the form of audit reports to be kept in the health & safety file; b) Assess, and finally approve contractor safety plans;

2.7 Physical Requirements

2.7.1 Earthworks (including Trenching and excavations)

The contractor who will erect the canopy will not do any earth works.

No work was planned under this section, but should the scope of works change, you need to revise your risk assessments and safe work procedures.

2.7.2 Deliveries, Waste Removal, Stacking/Storage of Materials

The Principal Contractor and other relevant contractors must ensure that there is an appointed stacking supervisor and all materials, formwork and all equipment is stacked and stored safely, on level, compact ground, out of access ways and no more than three times the minimum base width in height. Pallets of bricks may not be stacked more than two above each other and must be on timber pallets. No construction materials or equipment may be stacked or stored in public areas unless authorised by the client and fenced off as per the client's requirements. Waste materials must be kept within designated construction zones. The Principal Contractor will be responsible for co-ordinating and managing this function.

2.7.4 Fire Extinguishers and Fire Fighting Equipment

The Principal Contractor and relevant Contractors shall provide adequate, regularly serviced fire fighting equipment located at strategic points on site, specific to the classes of fire likely to occur. The appropriate notices and signs must be posted up as required. A minimum of four 9kg dry chemical powder fire extinguishers must be available in and around the site office establishment and stores. Fire extinguishers must also be placed at all work zones/areas, in strategic locations. Wherever *'hot work' is taking place, additional fire extinguishers must be on hand. Contractors are responsible for ensuring compliance with hot work procedures and must be in possession of method statements detailing the safe working procedures. *'Hot work' includes all work that generates a spark or flame and may therefore result in a fire.

Further, during the finishing stages of the construction phase when the finishing trades are on site, fire extinguishers will be required at strategic locations within the work areas – to be supplied and managed by the Principal Contractor.

2.7.5 Edge Protection and Penetrations

The Principal Contractor must ensure that all exposed edges and openings are guarded and demarcated at all times until permanent protection has been erected.
The Contractor has the following options when contemplating the protection of openings, slabs and edges:

No work was planned under this section, but should the scope of works change, you need to revise your risk assessments and safe work procedures.

2.8 Plant, Machinery and Equipment

2.8.1 Construction Vehicles & Mobile Plant

“Construction Plant” includes all types of plant including but not limited to, cranes, piling rigs, excavators, construction vehicles, compaction plant, batch plants and lifting equipment.

The Principal Contractor must ensure that such plant complies with the requirements of the OHS Act, Construction Regulations (Feb 2014) and any manufacturers specifications. The Principal Contractor and all relevant contractors must inspect and keep records of inspections on construction vehicles and mobile plant used on site. Only authorised/competent persons in the possession of the necessary training certificates and in possession of a certificate of medical fitness may operate construction vehicles and mobile plant.

Appropriate PPE and clothing must be provided and maintained in good condition at all times.
Reverse alarms must be installed on construction vehicles i.e. trucks, digger loaders, etc.

Vehicles and pedestrian traffic must be safely separated, preventing any unnecessary interfacing.

Any vehicle or mobile plant using any public road must be roadworthy and carry a certificate proving this. Likewise any operator of such construction vehicle or mobile plant will have to carry the necessary driver’s license.

2.8.2 Vessels under Pressure (VuP) and Gas Bottles

The Principal Contractor and all relevant Contractors must comply with the Vessels under Pressure Regulations, including:
Providing competency and awareness training to the operators/users;
Providing the relevant PPE and clothing;
Inspecting equipment regularly (every 3 months) and keeping records of these inspections;
Providing appropriate fire fighting equipment (Fire Extinguishers) on hand;
Ensuring that oxygen and acetylene bottles are secured in an upright position, do not show signs of corrosion or damage and have flash back arrestors fitted on both torch & bottle ends of hoses.

2.8.3 Hired Plant and Machinery

The Principal Contractor must ensure that any hired plant and machinery used on site is safe for use and complies with the minimum legislated requirements. The necessary requirements as stipulated by the OHS Act and Construction Regulations (July 2003) shall apply. The Principal Contractor shall ensure that operators hired with machinery are competent and that competency and medical certificates are kept on site in the health & safety file. Any load test requirements and inspections in terms of legislation must be complied with and copies of load test certificates and inspections must be kept in the health & safety file. All relevant contractors

2.8.4 Fall Protection / Scaffolding or cherry picker / Working in elevated positions

Working at heights includes any work that takes place in an elevated position. The Principal Contractor must submit a risk-specific fall protection plan in accordance with the Construction Regulations (2014) before this work is undertaken.

All scaffolding must comply with the requirements of SANS 10085-2004. Scaffolding must be declared safe for use by a competent scaffold inspector who must complete the scaffold register. Inspections must then be carried out weekly, after bad weather, after any alterations, after an incident, and before dismantling. These scaffold inspections must be conducted by a trained certificated scaffold inspector. The Principal Contractor must keep all scaffold inspection registers on site. Full time scaffold erectors must be available on site to carry out any scaffold erections, alterations and dismantling. No such work may be carried out by untrained personnel.
Should a scaffold contractor be appointed, the agreement between the two parties must be clearly set out in writing in terms of Section 37(2) of the OHS Act.
The Principal Contractor must also appoint one or more of its own supervisory members to supervise/co-ordinate scaffolding on site.

Working in elevated positions requires the preparation of a fall protection plan. The plan must include all relevant fall related risk assessments and safe work procedures. All persons working in elevated positions must be evaluated for physical and psychological fitness. The Principal Contractor and Contractors must explain their methodology in this regard. The Fall Protection Plan developer must be competent with a minimum qualification of NQF Level 4. These courses can be done through NOSA or any other accredited institution. All persons working in elevated positions must be informed of the risks and safety measures (in other words all workers must be trained on the fall protection plan, in the form of a toolbox safety talk) and records of this training/information session must be kept on site. See Regulation 8(2) of the Construction Regulations for further information to be included in the fall protection plan.

Work from elevated positions may only be conducted as if it were being conducted from a safe ladder or safe scaffold. All openings, edges, and the like must be adequately guarded (see 'edge protection and penetrations' above).

Where fall prevention or fall arrest devices are being used, the correct devices must be used for the intended purpose and they must be properly inspected and maintained. Workers must be trained in the use and maintenance of the fall prevention and arrest equipment/devices. Safety belts for fall arrest are prohibited. Full body harnesses must be worn. Where lifelines or other devices are required, such devices must be detailed in the fall protection plan of the Contractor concerned. Workers must have the opportunity to be secured from falling at all times – this is the responsibility of the Contractor concerned, but must be enforced by the P/Contractor. It is advised that a fall protection permit system be initiated on site with the aim of keeping control of contractors working in elevated locations.

Mobile scaffolds may not exceed 3 X their minimum base width in height and must be adequately boarded as per their loading requirement. Mobile scaffolds frame towers must be erected as per the manufacturers' requirements (copies of these erection specifications/data sheets must be available to the scaffold erectors and scaffold supervisor on site). A copy of the scaffold code of practise must available on site (SANS 10085-2004) Temporary gangways/elevated access walkways must comprise of at least three scaffold boards (675mm wide) with guardrails on either side when such walkways are above 2m from the ground. Such gangways and other platforms must be supported from below, preventing excessive loading and platform collapse.

2.8.5 Formwork and Support Work (Temporary works)

The Principal Contractor must ensure that the provisions of regulation 12 of the Construction Regulations (2014) are adhered to. These provisions must include but not be limited to ensuring that all design drawings are available

on site, that all formwork and support work equipment used is examined for suitability before use (by the supplier(s)) with proof of these inspections forwarded to the hirer/user. All formwork and support work must be inspected by a competent person appointed in writing, immediately before, during and after placement of concrete or any other imposed load and thereafter on a daily basis until the formwork and support work has been removed. Records of all inspections must be kept in a register on site held by the Principal Contractor. The inspection records must suitably sequenced and filed for easy reference by the Safety Agent and other interested party.

2.8.6 Ladders and Ladder Work

The Principal Contractor must ensure that all ladders are: inspected daily with monthly records kept; in good safe working order; the correct height for the task; extend at least 1m above the landing; fastened and secured; and at a safe angle. Stepladders must be safe for use, must be the correct height for the task and the top two rungs may not be used. Records of inspections must be kept in a register on site. Contractors using their own ladders must ensure the same.

2.8.7 General Machinery

The Principal Contractor and relevant contractors must ensure compliance with the Driven Machinery Regulations, which includes carrying out risk assessments on the machines, inspecting machinery regularly, appointing a competent person to inspect and ensure maintenance, issuing PPE and relevant clothing, and training those who use machinery.

2.8.8 Electrical Installations and Portable Electrical Tools

The Client will ensure as far as possible that the Principal Contractor is made aware of the positions of all electrical power lines. The Principal Contractor must notify the Client should it not be sure of the location of any electrical power lines.

The Principal Contractor must comply with the Electrical Installation Regulations, the Electrical Machinery Regulations and the Construction Regulations (CR 24).

The Principal Contractor must keep a copy of the Certificate of Compliance (CoC) for its temporary electrical power supply. A revised CoC is required whenever the installation is altered or changed in any way. All temporary electrical installations must be inspected at least weekly by a competent person appointed in writing with records kept. Portable electrical tools and equipment must be visually inspected daily with records kept. It is advised that the P/Contractor appoints the electrical contractor to inspect the temporary electrical installation on a weekly basis with feedback given in a report so that any maintenance and repairs can be undertaken. Such

appointed inspector must ‘stop’ or isolate any distribution board that is unsafe for use.

2.9 Occupational Health

2.9.1 Industrial Hygiene (exposure to physical and chemical stress factors)

Exposure of workers to occupational health hazards and risks is very common in any work environment, especially in construction. Occupational exposure is a major problem and all Contractors must ensure that proper health and hygiene measures are put in place to prevent exposure to these hazards. Prevent inhalation, ingestion, and adsorption through the skin of hazardous chemical substances.

2.9.1.1 Noise induced hearing loss is a highly underrated occupational condition. Occupational noise emitted by construction machinery and power tools must be controlled as far as possible by implementing engineering solutions such as noise dampening, regular maintenance, servicing and inspection, screening off the noise, and reducing the number of persons exposed. Personal protective equipment such as earmuffs and earplugs must also be used in conjunction with engineering controls so as to reduce noise exposure to below the acceptable levels.

2.9.1.2 Ergonomics is the study of how workers relate to their workstations. We advise the Principal Contractor and Contractors to take this into consideration when conducting risk assessments, thereby improving the worker-task relationship, which will in turn improve productivity and reduce chronic conditions such as back strains, joint problems and mental fatigue, amongst others.

2.9.2 Hazardous Chemical Substances (HCS)

The Principal Contractor and other relevant contractors must provide the necessary training and information as far as the use, transport, and storage of HCS. The Principal Contractor must ensure that the use, transport, and storage of HCS are carried out as prescribed in the HCS Regulations. The Principal Contractor and contractors must ensure that all hazardous chemicals on site have Material Safety Data Sheets (MSDS) on site and the users are made aware of the hazards and precautions that need to be taken when using the chemicals. The First Aiders must be made aware of the MSDS’s and how to treat HCS incidents appropriately. Copies of the MSDS’s must be kept in the first aid box and in the store. All containers must be clearly labelled.
Flammable substances must be stored separately, away from other materials, and in a well-ventilated area (appropriate cross ventilation). A competent person should be appointed to be in control of this portfolio.

Stores must be well ventilated, preventing the build up of flammable and toxic gases/vapours. Should fuel storage containers be used, they must conform to the general environmental legislation and Environmental Management Plan (if a requirement on this site). The necessary safety signage must to be posted up – 'no naked flames', 'no smoking'. Two 9kg DCP fire extinguishers must be placed near to the fuel containers, but not within 5m of the containers. These extinguishers are over and above the minimum four required for the offices and stores.

2.9.3 Welfare Facilities

The Principal Contractor must supply sufficient toilets (1 toilet per 30 workers), clean, lockable changing facilities, hand washing facilities, soap, toilet paper, and hand drying material. Waste bins must be strategically placed around site and emptied regularly. Workers must not be exposed to hazardous materials/substances while eating and must be provided with adequate, sheltered eating areas complete with benches and tables. Stores may not double up a change rooms or mess areas**.**

2.9.4 Alcohol and other Drugs

No alcohol and/or other drugs will be allowed on site. No person may be under the influence of alcohol or any other drugs while on the construction site. Any person on prescription medication must inform his/her superior, who shall in turn report this to the Principal Contractor forthwith. Any person suffering from any illness/condition that may have a negative effect on his/her /anyone else's health or safety performance must report this to his/her superior, who shall in turn report this to the Principal Contractor forthwith. Any person suspected of being under the influence of alcohol or other drugs must be sent home immediately, to report back the next day for a preliminary inquiry. The Contractor concerned must follow a full disciplinary procedure and a copy of the disciplinary action must be forwarded to the Principal Contractor for its records.

2.9.5 Duties of Designers

A designer must ensure that he/she complies with the requirements of the Construction Regulation 6**.** Designers have a duty both to assist in health and safety during construction as well as post construction to ensure safe occupation of the structures concerned. This will include informing the Principal Contractor in writing of any known or anticipated dangers or hazards relating to the construction work, and making available all relevant information required for the safe execution of the work upon being designed or when the design is subsequently altered. Designers must ensure that the following information is included in a report and made available to the Principal Contractor:

PRIMARY HEALTH AND SAFETY COMPLIANCE
Project: Polokwane Municipality

ANNEXURE A

The Principal Contractor and Contractors must submit compliance with Annexure 'A' before commencing on work on site. **Compliance with Annexure 'A' must be maintained and proven to the Safety Agent at audits.**

HSS Item no.	Requirement	Legal Reference	Compliance required:
A1	Health & Safety Plan (H & S Plan)	Constructions Regs.	Withing one weeks of receipt of these specifications
A2	Notification of intention to commence construction / building work	Complete schedule 1 (Construction Regs.)	Before commencement on site
A3	Assignment of responsible persons to supervise construction work	OHS Act ~ Section 16(2) appointee ~ all written appointments under the construction regulations 2014	Before commencement on site
A4	Competence of responsible persons in the form of CV's related work history of appointees	OHS Act ~ Section 16(2) appointee ~ all written appointments under the construction regulations 2014	Together with H & S Plan
A5	Compensation for occupational injuries and diseases – proof of registration and in good standing	COIDA or FEMA	Together with H & S Plan
A6	Health and safety organogram showing all safety management portfolios and positions	Client requirement	Together with H & S Plan
A7	Initial hazard identification and risk assessment document	Construction regulations	Together with H & S Plan
A8	Fall protection plan (first draft) as defined in the construction regulations also, see	Construction regulations	Together with H & S Plan

HSS = health & safety specifications
OHS Act = occupational health & safety Act
CR = construction regulations
COIDA = compensation for occupational injuries and diseases Act

ASSIGNMENT OF PRINCIPAL CONTRACTOR'S AND CONTRACTORS' RESPONSIBLE PERSONS

Project: Polokwane Municipality

ANNEXURE B

The Principal Contractor must make all the management appointments as set out below. Compliance with annexure 'B' to be maintained and proven to the safety agent at audits (Further appointments could become necessary as the project progresses).

Item no.	Appointment	Legal Reference	Requirement
B1	CEO Assignee	Section 16(2)	A competent person to assist the CEO in achieving compliance with the OHS Act – P/Contractor's / Contractor's Responsible person
B2	Construction Work Manager	CR 8(1)	A full time competent person to wupervise and be responsible for health & safety related issues on site. The person is appointed by the Section 16(2)
B3	Assistant Construction Work Manager	CR 8(2)	A full time competent person(s) to assist the CR 8(1) appointee with daily supervision of construction work safety. One of the CR8(2) appointees must be designated to fulfill the role of the CR6(1) when such person is not on site. Make this clear in the appointment letter
B4	Health & Safety Representative(s)	Section 17	A competent person(S) to be appointed to represent the workforce in H & S matters. Reps may attend safety meetings, conduct monthly site audits, attend incident / injury investigations and make recommendations as far as H&S goes.
B5	Health & Safety Committee Member(s)	Sectin 19	H&S reps, site supervisors / foreman and the safety officer should make up the committee, with the CR8(1) appointee chairing the committee.
B6	Incident Investigator	GAR 9	A competent person to head up the investigation team and co-ordinate incident / injury investigation ons site.
B7	Risk assessment co-ordinator	CR9	A competent person to co-ordinate the drafting / reviewing / distribution of risk assessments on behalf of the principal contractor. The same applies to contractors. NQF Level 5
B8	Fall protection plan co-ordinator	CR10	A competent person to co-ordinate the drafting / reviewing / distribution of Fall Protection Plan. The same applies to contractors. NQF Level 4

B9	Emergency plan co-ordinator	Contractor Needs to be in line with service stationERP	A competent person to co-ordinate the drafting / reviewing / distribution of the site emergency procedures / evacuation plan. Such person must be fulltime on site so as to take charge of emergency situations.
B10	First Aider(s)	GSR 3	A certified person to address first aid situations and take charge of injuries. Level 1 certificate
B11	Lifting machine and lifting tackle supervisor	DMR 18	A competent P/Contractor employee to co-ordinate the management of lifting machines and tackle, ensuring that such equipment is safe for use at all times, inspected when necessary and repaired when required. The operators, banks men and contractors to liases with this person
B12	Scaffolding inspector	SANS 10085 – 2004	A competent person to inspect scaffolding before use and every time after bad weather, etc.
B13	Scaffold supervisor (P/Contractor	SANS 10085 – 2004	A competent P/Contractor employee to supervise all scaffolding on site, ensuring that scaffolds are safe for use, inspected, extended / altered, repaired when required and that all trades are co-ordinated and authorised to work on such scaffolds
B14	Scaffoldieng erector	SANS 10085 – 2004	A competent person(s) to erect scaffolding – leader of the scaffold team
B15	Formwork & support work supervisor (Temporary Works)	CR12	A competent person to supervise all formwork & support work erection & dismantling. This person must also ensure that the equipment is safe and that all the necessary inspections (pre, during, post & every day thereafter) are carried out & records kept by the competent inspectors. Desigh drawings must be available to this supervisor.
B16	Excavation supervisor / inspector	CR13	A competent person to supervise & inspect excavation work (daily) and ensure that excavations are safe. Records of inspections must be kept by this person.
B17	Ladder inspector	GSR13A	A competent person to inspect ladders daily and ensure they are safe for use, keeping monthly record.
B18	Stacking supervisor	CR28	A competent person to supervise all stacking and storage operations
B19	Explosive powered tools inspector / supervisor	CR21	A competent person to inspect & clean the tool daily, store the tool in a safe location, ensure that cartridges are signed out and in, and control all operations thereof.
B20	Temporary electrical installations inspector	CR24	A competent person to inspect all temporary electrical installations. Including weekly inspections and record keeping.

B21	Portable Electrical Tool Inspector	CR 24	A competent person to co-ordinate / inspect portable electrical tools, leads and plugs.
B22	Fire-fighting equipment inspector	CR29	A competent person to co-ordinate & inspect fire fighting equipment. Including ad-hoc checks and monthly inspections with records kept.
B23	Construction vehicles & mobile plant supervisor	CR23	A competent person(s) to co-ordinate the safety of all construction vehicles & mobile plant. Ensuring that daily inspections are done and records kept, that safety measures are in place, that operators are certified and authorised to operate and that maintenance and services are carried out when required.
B24	Construction safety officer	CR6(6)	A competent person to fulfill the functions as set out in these HSS

GENERAL COMPLIANCE REQUIREMENTS

Project: Polokwane Municipality

ANNEXURE C

The Principal Contractor and Contractors must comply with but not be limited to the requirements tabled below: Prove compliance with annexure 'C' at audits conducted by the safety agent.

Item no.	What	When	Output	Reviewed by Client Agent
C1	Construction – phase Health & Safety Plan	Monthly review	Principal Contractor to indicate the status of Contractors health & safety plans	
C2	Health & Safety File(s)	Open file when construction begins and maintain throughout	Have file on hand at audits. Contractors to report on their file at monthly health & safety audits by the Principal Contractor.	
C3	OHS Act and relevant Regulations	Monthly review	To be kept in the health & safety file on site.	
C4	Health & Safety Induction training, PTW Procedures & SKM Passport System	Every worker before he/she starts work	Attendance registers to be kept	
C5	Awareness Training (Tool Box Talks)	At least once a week	Attendance registers to be kept	
C6	Health & Safety Meetings	Monthly	Meeting minutes to be kept	

C7	Health & Safety Reports & PI / NM	Monthly	**Report covering:** • Incidents / injuries and investigations • Non conformances by employees & Contractors – reports • Internal H&S audit reports	
C8	Audits on contractors	Monthly	**Report covering:** • H&S File / Plan • WCA status • Appointment letters • Section 37(2) agreements • Risk assessment & safe work procedures • Physical site inspection • Any other contractor specific requirements	
C9	Emergency procedured	Monthly evaluation of procedure	Compile written procedure as well as tel. Numbers	
C10	Risk assessments & fall protection plan	Updated and signed off	Documented risk assessments to be available	
C11	Method statements	Drawn up and distributed before workers are exposed to the risks	Documented set of method statements reviewed and signed off.	
C12	General Inspections	Daily	**Report OHS Act compliance:** • Excavations • Portable electrical tools • Formwork & support work • Explosive powered tools	
C13	General Inspections	Daily	• Scaffolding • Temporary Electrical Installations	
C14	General Inspections	Monthly	• Fire fighting equipment • Ladders	
C15	General Inspections	Monthly	• Lifting tackle • Oxy-acetylene cutting & welding sets • Fall prevention and arrest equipment	
C16	General Inspections	6-Monthly	• Lifting machines	
C17	Load tests / performance tests	Annually / once erected, before use	• Lifting machines	

C18	List of Contractors	List to be updated weekly	Compile a list of contractors: Name, supervisor, company tel. Numbers and trade.	
C19	Workman's Compensation	Ongoing	Compile a list of Contractors workman's Compensation proof of good standing.	
C20	Construction site rules & Section 37(2) Mandatary Agreements	Ongoing	Compile a list of all signed up Mandataries. Proof of agreement documents to be kept in H&S file.	

OCCUPATIONAL HEALTH & SAFETY – HEALTH & SAFETY COSTS TO BE INCLUDED IN THE PRINCIPAL CONTRACTOR'S / CONTRACTORS' PRICE

Project: Polokwane Municipality

ANNEXURE D

In terms of the Construction Regulations (2014), it is the Client's duty to ensure that the cost for health & safety has been provided for by the Principal Contractor, before appointment.
Acting on behalf of our Client, we require the following health & safety costs to be included by the Principal Contractor. It must be made very clear that these are just some of the health & safety costs to be included in your tender price. It is the duty of the Principal Contractor and Contractors to ensure that all aspects of the Occupational Health & safety Act 85/1993 and Construction Regulations are catered for.
Pricing for Occupational Health and Safety measures should include the following if applicable:

ITEM	DESCRIPTION
1	**Supply of all items of Personal Protective Clothing/Equipment & ensure use thereof for full compliance**
1.1	Steel toe capped safety boots
1.2	Overalls
1.3	Reflective vests(high visibility)
1.4	Hard hats
1.5	Dust masks
1.6	Hearing protection
1.7	Hand gloves
1.8	Any other :Principal Contractor to specify
2	**Supply and provision of Equipment for working at Heights & ensure use thereof for full compliance**
2.1	Fall protection equipment (Safety Harness)
2.2	Double lanyard harness
2.3	Fall protection plan
2.4	Scaffolding access ladders/toe boards/hand rails
2.5	Portable Ladders
2.6	Any other: Principal Contractor to specify :

3	**Barricading: Supply & install, including removal upon completion to ensure full compliance to legislation**
3.1	Rigid type barricading
3.2	Temporary fence barricading along perimeter of excavated area
3.3	Danger tape pre-warning tape
3.4	Any other: Principal Contractor to specify :
4	**Related Training**
4.1	First Aid Training
4.2	Health and Safety Representative training
4.3	Emergency Rescue training(Height)
4.4	Hazard Identification Training
4.5	Training of Personnel working at heights
4.6	Construction Plant Training
4.7	Legal Liability(OHSACT) Training
4.8	COID ACT Training
4.9	Scaffold Erector and Inspector Training
4.10	Any other: Contractor to specify : Working at elevated
5	Occupational Health and Safety Administration
5.1	Develop of a Site Specific Health and Safety Plan and Hazard and Risk Assessment by Competent person.
5.2	Develop of Fall Protection and Rescue Plan by a Competent Fall Protection Plan Developer.
5.3	Competent Occupational Health and Safety Officer/Consultant.
6	Medical Surveillance
6.1	Medical Certificates of fitness for all Employees by an Occupational Health Practitioner.
6.2	Medical Certificates of fitness for all EPWP Employees by an Occupational Practitioner during the duration of the Construction Project.
7	Facilities and Equipment
7.1	Sanitary facility for each sex and for every 30 workers.
7.2	Changing facilities for each sex.
7.3	Sheltered eating areas
7.4	First aid boxes
7.5	Fire extinguishers
7.6	Waste bins
8	Safety Signage
8.1	Sufficient and adequate safety signage on constructions site and at all flammable stores.

ANNEXURE E

The Occupational health and Safety File must consist out of the following documentation:

INDEX

1	Appointment Letter from Polokwane Municipality.
2	Notification of Construction work.
3	Letter of Good standing - COID
4	Copy of Public Liability Insurance Policy and UIF Registration
5	Health and Safety Specifications
6	Scope of Work
7	Tool and Machinery list
8	Method Statement of all work that will be conducted.

9	Risk Assessment Guide / Procedure
10	Baseline Risk Assessments
11	Safe Work Procedures for all Risks
12	Health and Safety Information from Designer
13	Medical Certificates
14	All Health and Safety Related Policies
15	Section 37.2 Agreements
16	Induction Training Information
17	Site Specific Emergency numbers and Emergency Plan
18	Site Specific Fall Protection and Rescue Plan
19	Site Specific Health and Safety Plan
20	Incident / Accident Management Control
21	Traffic Management Plan
22	Contractor Control Procedures
23	Environmental Management
24	Hazardous Chemical Substance Register and MSDS
25	Example of Monthly Health and Safety Report
26	Health and Safety Organogram
27	Occupational Health and Safety (Construction) Appointments – With Competencies
28	Certificates for all lifting equipment
29	Sample of all registers that will be used on site.
30	Copy of Construction Building Plans (A4)
31	Copy of the Occupational Health and Safety Act and Construction Regulations 2014

ANNEXURE F

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (Regulation 4 of the Construction Regulations. 2014)

NOTIFICATION OF CONSTRUCTION WORK

1. (a) Name and postal address of principal contractor:

_____

(b) Name and tel. No of principal contractor's contact person:

_____

2. Principal contractor's compensation registration number:

_____

3. (a) Name and postal address of client:

_____

(b) Name and tel. No of client's contact person or agent:

_____

4. (a) Name and postal address of designer(s) for the project:

_____

(b) Name and tel. No of designer(s) contact person:

_____

5. Name and telephone number of principal contractor's construction supervisor on site appointed in terms of regulation 8(1).

_____

6. Name/s of principal contractor's sub-ordinate supervisors on site appointed in terms of regulation 8(2).

_____

7. Exact physical address of the construction site or site office:

_____

8. Nature of the construction work:

_____

_____

_____

9. Expected commencement date: _____

10. Expected completion date: _____

11. Estimated maximum number of persons on the construction site.

Total: _____ Male: _____ Female: _____

12. Planned number of contractors on the construction site accountable to principal

Contractor: _____

13. Name(s) of contractors already selected.

_____

_____

_____

_____ _____

Principal Contractor Date

_____ _____
Client's Agent (where applicable) Date

_____ _____
Client Date

- THIS DOCUMENT IS TO BE FORWARDED TO THE OFFICE OF THE DEPARTMENT OF LABOUR **PRIOR TO COMMENCEMENT** OF WORK ON SITE.0
-

Copies:

1. Original to **Department of Labour**

POLOKWANE MUNICIPALITY

CONSTRUCTION, OPERATIONS AND MAINTENANCE OF THE POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS (PRWWTW): PHASE 2B

C5.4 ENVIRONMENTAL AUTHORISATION

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
ECONOMIC DEVELOPMENT, ENVIRONMENT & TOURISM
Enq: Ms M K Ramalepe **Tel:** 015 290 7156 **Fax:** 015 295 5015 **Email:** RamalepeMK2@ledet.gov.za **Ref:** 16/1/8-6

The Municipal Manager: Polokwane Local Municipality
Office 106 Civic Centre
Corner Landros Mare and Bodenstein Streets
POLOKWANE
0699

For attention: Mr Sikhauli N **Email:** NditsheniS@polokwane.gov.za / ParadiseS@polokwane.gov.za

AMENDMENT OF THE ENVIRONMENTAL AUTHORISATION FOR POLOKWANE REGIONAL WASTEWATER TREATMENT WORKS AND ASSOCIATED OUTFALL SEWERS ON PORTIONS 2, 93 AND 95 OF THE FARM DOORNBULT 624 LS WITHIN POLOKWANE LOCAL MUNICIPALITY

With reference to the above-mentioned application, please be advised that the Department has decided to grant the amendment to the authorisation issued on 06 June 2001. The reasons for the decision are attached herewith.

In terms of regulation 4(2) of the Environmental Impact Assessment Regulations of 2014, you are instructed to notify all registered interested and affected parties, in writing and within 14 (fourteen) calendar days, of the date of the Department's decision in respect of your application as well as the provisions regarding the lodgement of appeals as provided in the National Appeals Regulations of 2014.

Should you wish to appeal any aspect of the decision, you must, inter alia, submit an appeal to the MEC for Economic Development, Environment and Tourism, within 20 days from the date of this notification, by means of one of the following methods:

By facsimile : 015 295 5015
By post : P O Box 55464, **POLOKWANE**, 0700
By hand : Environmental Affairs Offices, Corner Suid and Dorp Streets, **POLOKWANE,** 0699

Should you decide to appeal, you must serve a copy of your appeal on all registered interested and affected parties as well as a notice indicating where, and for what period, the appeal submission will be available for inspection.

Yours faithfully

DIRECTOR
ENVIRONMENTAL IMPACT MANAGEMENT
DATE: 17/11/2017

Cc: TEKPLAN Environmental **For attention:** Mr Kotze T **Tel:** 015 291 4177 **Fax:** 086 218 3267

DEPARTMENT OF
ECONOMIC DEVELOPMENT, ENVIRONMENT & TOURISM

AMENDED ENVIRONMENTAL AUTHORISATION

Authorisation reference number:	16/1/8-6
Last amended:	First issue 06 June 2001 (1st amendment)
Holder of authorisation:	Polokwane Local Municipality
Location of activity:	The Polokwane Regional Wastewater Treatment Works and related Outfall Sewers (RWWTW) is proposed to be located on Portions 2, 3 and 95 of the farm Doornbult 624 LS within the Polokwane Local Municipality.

DECISION

ACRONYMS

1. **NEMA:** The National Environmental Management Act, 1998 (Act 107 of 1998), as amended.
2. **EIA:** Environmental Impact Assessment.
3. **Regulations:** EIA Regulations of 2014, as amended, in terms of Chapter 5 of NEMA.
4. **Department:** Department of Economic Development, Environment and Tourism.
5. **EA:** Environmental Authorisation.
6. **EMPr:** Environmental Management Programme.

The Department is satisfied, on the basis of information available to it and subject to compliance with the conditions of this EA, that the applicant should be authorised to undertake the activity specified below.

Details regarding the basis on which the Department reached this decision are set out in Annexure 1.

ACTIVITIES AUTHORISED

By virtue of the powers conferred on it by the NEMA and the EIA Regulations the Department hereby authorises the Polokwane Local Municipality with the following contact details –

Director - Engineering Services: Mr N Sikhauli
Office 106 Civic Centre
Corner Landros Mare and Bodenstein Streets
POLOKWANE
0699

P O Box 111
POLOKWANE
0700

Tel: 015 290 2214 **Email:** NditsheniS@polokwane.gov.za / ParadiseS@polokwane.gov.za

to undertake the following activities (hereafter referred to as "the activity"):

Listed in Listing Notice 1 of the EIA Regulations, as:

Activity 10 – "The development and related operation of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes (i) with an internal diameter of 0.36 metres or more; (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve or railway line reserve; or (b) where such development will occur within an urban area."

Activity 12 – "The development of – (i) dams or weirs, where the dam or weir, including infrastructure and water surface areas, exceeds 100 square metres; or (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse;(b) in front of a development setback; or (c) if no development exists, within 32 metres of a watercourse, measured from the edge of a watercourse."

Activity 13 – "The development of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50 000 cubic metres."

Activity 28 – "Residential, mixed, retail, commercial, industrial or institutional developments where such land was used for agriculture, game farming, equestrian purposes or afforestation on or after 01 April 1998 and where such development: (i) will occur inside an urban area, where the total land to be developed is bigger than 5 hectares; or (ii) will occur outside an urban area, where the total land to be developed is bigger than 1 hectare; excluding where such land has already been developed for residential, mixed, retail, commercial, industrial or institutional purposes."

Listed in Listing Notice 2 of the EIA Regulations, as:-

Activity 4 – "The development and related operation of facilities or infrastructure, for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres."

Activity 15 – "The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan."

Activity 25 – "The development and related operation of facilities or infrastructure for the treatment of effluent, wastewater or sewage with a daily throughput capacity of 15 000 cubic metres or more."

Listed in Listing Notice 3 of the EIA Regulations, as:-

Activity 2 – "The development of reservoirs excluding dams, with a capacity of more than 250 cubic metres. **e. Limpopo** ii. Outside urban areas: (dd) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans."

Activity 4 – "The development of a road wider than 4 metres with a reserve less than 13, 5 metres. **e. Limpopo** i. Outside urban areas: (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans."

as described in the final Environmental Impact Assessment Report (EIAR) received by the Department on 04 August 2017, and is located at:

Alternative S1	Latitude	Longitude
Portions 2, 93 and 95 of the farm Doornbult 624 LS.	23° 47' 38.6" South	29° 27' 05.4" East

The activity entails the clearance of vegetation on an area measuring approximately 120 hectares (ha) in extent for the construction of the Polokwane RWWTW site that is situated approximately 7.5km North of the existing Polokwane Waste Water Treatment Works (WWTW), downstream along the Sand River on Portions 2, 93 and 95 of the farm Doornbult 624 LS within the Polokwane Local Municipality, hereafter referred to as "the property".

The amendment of the EA makes provision for a treatment capacity of 100 Ml/d instead of the 80 Ml/d treatment capacity initially authorised, to be developed in phases. The treatment process is also changed from the "U.C.T. activated sludge process" to the "Membrane Treatment process" and some realignments to the Outfall Sewer from the existing Polokwane WWTW in order to avoid productive agricultural lands.

The proposed development of the Polokwane RWWTW shall be implemented in phases, Phase 1 – 40Ml/d; Phase 2 - 40Ml/d and Phase 3 - 20Ml/d by the year 2044.

It entails the construction of the following -

<u>The Polokwane RWWTW is designed to meet the Department of Water and Sanitation's (DWS) General Standards in terms of outflow quality, consisting of:</u>

- Preliminary treatment facility with course screens and rotary fine screen with the plant influent split between two inlet works with hydraulic capacity of 120 Ml/d for first phase and 280 Ml/d for the ultimate phase, the inlet works will each have three parallel sets of mechanical front raked screens with 6mm openings followed by two Vortex grit removal tanks and finally two sets of parallel rotating drum fine screens;
- Primary sedimentation and Acid fermentation consisting of 4 tanks;
- Biological reactor with a total volume of 15 650m^3 which consisting of 2150m^3 anaerobic (13.7%), 4500m^3 anoxic (28.8%) and 9000m^3 aerobic (57.5%);
- Secondary sedimentation tanks with a diameter of 35m and a sidewall depth of 3m sloped towards the centre and equipped with rotating bridges to scrape sludge towards centre;
- Disinfection area consisting of chlorine contact tanks and a maturation tank (5 day retention) and
- Sludge management facility including Sedimentation Tanks for primary sludge fermentation, scum concentrator, sludge thickening facility, Anaerobic Digesters, Solar Drying Beds and sludge draw off point from existing Polokwane WWTW.

Outfall sewers as follow:

- Seshego Outfall Sewer – with pipelines sized as 1350mmø will carry effluent from Seshego adjacent to the existing constructed pipeline to the proposed Polokwane RWWTW;
- Polokwane West Outfall Sewer – with pipelines sized as 1500mmø will carry sewage generated from the western suburbs of Polokwane;
- Polokwane East Outfall Sewer – with pipelines sized as 1200mmø will carry effluent from the existing Polokwane WWTW to the Polokwane RWWTW;
- Seshego and Polokwane West confluence – with a pipeline sized as 1200mmø that is a section of convergence of the Seshego and Polokwane West Outfall Sewer pipelines; and
- Main Outfall Sewer - which is a convergence of all pipelines.

The granting of this EA is subject to the conditions set out below and in Annexure 2 (Departmental standard conditions).

The EMPr attached as part of reports for the above development submitted as part of the application for an EA is hereby approved and must be adhered to throughout the life cycle of the activity.

The applicant must appoint a suitably experienced Environmental Control Officer (ECO) for the construction phase of the development that will have the responsibility to ensure that the mitigation/rehabilitation measures and recommendations referred to in this EA are implemented and to ensure compliance with the provisions of the approved EMPr.

The ECO must keep record of all activities on site, problems identified, transgressions noted and a task schedule of tasks undertaken by the ECO.

EA CONDITIONS

1. The treated sewage must meet the standards for effluent discharge prescribed by the DWS in terms provisions of the National Water Act, 1998 (Act No. 36 of 1998).
2. The final disposal of sludge must be done in accordance to requirements by the DWS.
3. A groundwater management and monitoring plan that includes monitoring of water levels and water quality must be developed and adhered to in accordance with the requirements of the DWS.
4. EA must be obtained for the decommissioning existing Seshego WWTW in time for it to be commenced with, in due course of the operation of the Polokwane RWWTW.

CHIEF DIRECTOR
ENVIRONMENTAL TRADE AND PROTECTION
DATE: 17/11/2017

ANNEXURE 1: REASONS FOR THE DECISION

1. Background

The proposed establishment of the Polokwane RWWTW and associated Outfall Sewers application by Polokwane Local Municipality represented by Mr N Sikhauli is for activities listed in the EIA Regulations, namely:

Listed in Listing Notice 1 of the EIA Regulations, as:

Activity 10 – "The development and related operation of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes (i) with an internal diameter of 0.36 metres or more; (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve or railway line reserve; or (b) where such development will occur within an urban area."

Activity 12 – "The development of – (i) dams or weirs, where the dam or weir, including infrastructure and water surface areas, exceeds 100 square metres; or (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse;(b) in front of a development setback; or (c) if no development exists, within 32 metres of a watercourse, measured from the edge of a watercourse."

Activity 13 – "The development of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50 000 cubic metres."

Activity 28 – "Residential, mixed, retail, commercial, industrial or institutional developments where such land was used for agriculture, game farming, equestrian purposes or afforestation on or after 01 April 1998 and where such development: (i) will occur inside an urban area, where the total land to be developed is bigger than 5 hectares; or (ii) will occur outside an urban area, where the total land to be developed is bigger than 1 hectare; excluding where such land has already been developed for residential, mixed, retail, commercial, industrial or institutional purposes."

Listed in Listing Notice 2 of the EIA Regulations, as:-

Activity 4 - "The development and related operation of facilities or infrastructure, for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres."

Activity 15 - "The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan."

Activity 25 - "The development and related operation of facilities or infrastructure for the treatment of effluent, wastewater or sewage with a daily throughput capacity of 15 000 cubic metres or more."

Listed in Listing Notice 3 of the EIA Regulations, as:-

Activity 2 - "The development of reservoirs excluding dams, with a capacity of more than 250 cubic metres."

Activity 4 - "The development of a road wider than 4 metres with a reserve less than 13, 5 metres."

Polokwane Local Municipality (represented by Mr N Sikhauli) appointed Mr. T Kotze of TEKPLAN Environmental Consultants in terms of regulation 12 of the EIA Regulations (GNR. 326 of 07 April 2017), to undertake the process required for an amendment to change the scope of a valid EA.

2. Information considered in making the decision

In reaching its decision, the Department took, *inter alia*, the following into consideration -

a) The application for amendment of the EA submitted to the Department on 26 May 2017;

b) The information contained in the EIAR submitted to the Department on 04 August 2017;

c) The Preliminary Integrated Wastewater Treatment Works Report for Polokwane Local Municipality compiled by Mafumu Consulting and SMEC attached to the EIAR as Annexure N;

d) The Ecological report compiled by Dr GCO de Beer of Ysterberg Enviro Veld and Game Management Services attached to the EIAR as Annexure O;

e) The Biological Assessment report compiled by Dr W Vlok of Bioassets attached to the EIAR as Annexure P;

f) The Heritage Impact Assessment report compiled by Stephan Gaigher of G & A Heritage Management Consultants attached to the EIAR as Annexure Q;

g) The Palaeontological desktop study compiled by Professor B Rubidge of the University of the Witwatersrand, Johannesburg attached to the EIAR as Annexure R;

h) The Permissible Utilisation and Disposal of Sewage Sludge published by the Water Research Commission attached to the EIAR as Annexure T;

i) The Air Quality and Odour assessment report compiled by H Liebenberg-Enslin of Airshed Planning Professionals attached to the EIAR as Annexure Y;

j) The process design report compiled by Mafumu Consulting and SMEC attached to the EIAR as Annexure Z;

k) The Water Use Licence issued to the Polokwane Local Municipality on 1 December 2016 attached to the EIAR as Annexure AA; and

l) The Groundwater Impact and Geohydrological Modelling reporting compiled by R Crosby and C Viviers of AGES.

m) The objectives and requirements of relevant legislation, policies and guidelines, including section 2 of the NEMA and regulation 41 of the EIA Regulations; and

n) The findings of the site visit attended by Ms M K Ramalepe, Ms M C Rodgers, Mr M P Seshoka and T R Ngoasheng of this Department on 16 November 2016.

3. Key factors considered in making the decision

All information presented to the Department was taken into account in the Department's consideration of the application. A summary of the issues which, in the Department's view, were of the most significance is set out below:

a) A sufficient Public Participation Process (PPP) was undertaken and the applicant has satisfied the minimum requirements as prescribed in the EIA Regulations for public involvement.

b) The environmental impacts associated with the proposed activity will be addressed by the implementation of proposed mitigation measures outlined in the EIAR compiled by TEKPLAN Environmental Consultants.

c) Details provided in the EIAR have adequately addressed the safety issues pertaining to the proposed construction activities.

4. Findings

After consideration of the information and factors listed above, the Department made the following findings –

a) All environmental issues identified and commitments to sound environmental management which are incorporated in the EIAR compiled by TEKPLAN Environmental Consultants and the specialist reports compiled by various specialists can be used to avoid potential negative impacts.

b) The potential impacts on the proposed site were clearly investigated and mitigation measures outlined;

c) Findings of the site inspection are as follows:

- The pipeline and associated infrastructure to the proposed site has been constructed in line with the previously issued EA; and
- There is access to the site.

d) The PPP undertaken confirms that the applicant has satisfied the minimum requirements as prescribed in the Chapter 6 of the EIA Regulations of 2014, as amended for the involvement of interested and affected parties for the proposed development and it included the following:

- A newspaper advertisement which was placed in the Polokwane Observer newspaper on 14 June 2016 and in the Capricorn Voice on 13-19 July 2017; and
- Notices (Background Information Document) were sent to key stakeholders and the registered interested and affected parties via email, hand delivery and post.

In view of the above, the Department is satisfied that, subject to compliance with the conditions contained in the EA, the proposed activities will not conflict with the general objectives of integrated environmental management laid down in Chapter 5 of the NEMA and that any potentially detrimental environmental impacts resulting from the proposed activity can be mitigated to acceptable levels. The authorisation is accordingly granted.

RECOMMENDATIONS FOR THE AUTHORISATION

The following serve as recommendations for the EA in terms of NEMA that has been drafted for the proposed development of a wastewater treatment plant and related outfall sewers on the farm Doornbult 624 LS within Polokwane Local Municipality.

Listed in Listing Notice 1 of EIA Regulations as:

Activity 10 – "The development and related operation of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes (i) with an internal diameter of 0.36 metres or more; (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve or railway line reserve, or (b) where such development will occur within an urban area ."

Activity 12 – " The development of – (i) dams or weirs, where the dam or weir, including infrastructure and water surface areas, exceeds 100 square metres; or (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse;(b) in front of a development setback; or (c) if no development exists, within 32 metres of a watercourse, measured from the edge of a watercourse'."

Activity 13 – " The development of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50 000 cubic metres."

Activity 28 - "Residential, mixed, retail, commercial, industrial or institutional developments where such land was used for agriculture, game farming, equestrian purposes or afforestation on or after 01 April 1998 and where such development: (i) will occur inside an urban area, where the total land to be developed is bigger than 5 hectares; or (ii) will occur outside an urban area, where the total land to be developed is bigger than 1 hectare; excluding where such land has already been developed for residential, mixed, retail, commercial, industrial or institutional purposes."

Listed in Listing Notice 2 of the EIA Regulations 2014, as amended as:-

Activity 4 - "The development and related operation of facilities or infrastructure, for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres."

Activity 15 - "The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan."

Activity 25 - "The development and related operation of facilities or infrastructure for the treatment of effluent, wastewater or sewage with a daily throughput capacity of 15 000 cubic metres or more."

Listed in Listing Notice 3 of the EIA Regulations 2014, as amended as:-

Activity 2 - "The development of reservoirs excluding dams, with a capacity of more than 250 cubic metres."

Activity 4 - "The development of a road wider than 4 metres with a reserve less than 13, 5 metres."

ANNEXURE 2

DEPARTMENTAL STANDARD CONDITIONS

1. SCOPE OF AUTHORISATION

1.1 The holder of the EA shall be responsible for ensuring compliance with the conditions contained in this EA. This includes any person acting on the holder's behalf, including but not limited to, an agent, servant, contractor, sub-contractor, employee, consultant or person rendering a service to the holder of the EA.

1.2 Any changes to, or deviations from, the project description set out in this EA must be approved, in writing, by the Department before such changes or deviations may be effected. In assessing whether to grant such approval or not, the Department may further request additional information as it deems necessary to evaluate the significance and impacts of such changes or deviations and it may be necessary for the holder of the EA to apply for further authorisation in terms of the Regulations.

1.3 The activity, which is authorised, may only be carried out at the property indicated in the EA.

1.4 The holder of the EA will be held liable for any damages to the environment and associated costs, which results from any activity related to the construction and/or operation of the proposed project.

1.5 Where any of the holder of the EA's contact details change, including the name of the responsible person, the physical or postal address and/or telephonic details, the holder of the EA must in writing notify the Department as soon as the new details become known to the holder of the EA.

1.6 The Department reserves the right to monitor and audit the development throughout its full life cycle.

1.7 This EA does not negate the holder of the EA's responsibility to comply with any other statutory requirements that may be applicable to the undertaking of the activity.

2. APPEAL OF AUTHORISATION

2.1. The holder of the EA must notify all registered interested and affected party, in writing and within 14 (fourteen) calendar days, of receiving notice of the Department's decision.

2.2. The notification referred must –

2.2.1 specify the date on which the EA was issued;

2.2.2 inform all the interested and affected party of the appeal procedure provided for in the National Appeals Regulations, 2014;

2.2.3 advise all the interested and affected party that a copy of the EA will be furnished on request; and

2.2.4 give the reasons for the decision.

3. COMMENCEMENT OF THE DEVELOPMENT

3.1 In order to ensure their safety, all employees must be given the necessary personal protective equipment.

3.2 This EA must be provided to the site operator and the requirements thereof must be made fully known to him/her.

3.3 Appropriate notification signs must be erected at the construction site, warning the public (residents, visitors etc) about the hazards around the construction site and presence of heavy vehicles and machinery.

3.4 Hauling routes for construction vehicles and machinery must be clearly marked and appropriate signalling must be posted to that effect. Further, movement of construction vehicles and machinery must be restricted to areas outside of the drainage line/wet area.

3.5 Construction must include appropriate design measures that allow surface and subsurface movement of water along drainage lines so as not to impede natural surface and subsurface flows. Drainage measures must promote the dissipation of stormwater run-off.

3.6 Vegetation clearing must be kept to an absolute minimum. Mitigation measures must be implemented to reduce the risk of erosion and the invasion of alien species.

3.7 The holder of the EA must note that in terms of the National Forests Act (Act No. 84 of 1998); protected plant species (also listed in Limpopo Environmental Management Act, 2003 (Act No. 7 of 2003) must not be cut, disturbed, damaged, destroyed, and their product must not be possessed, collected, removed, transported, exported, donated, purchased or sold unless permission is granted by the Department of Agriculture, Forestry and Fisheries.

3.8 All construction areas (e. g. material lay down area), topsoil and sub-soils must be protected from contamination or pollution and stockpiling must not take place in drainage lines or where it would impede surface water runoff.

3.9 If any soil contamination is noted during the construction and operational phase of the proposed activities, the contaminated soil must be removed to a suitable waste disposal facility and the site must be rehabilitated to the satisfaction of this Department and Department of Water and Sanitation (DWS). The opportunity for the on-site remediation and re-use of contaminated soil must be investigated prior to disposal and this Department must be informed in this regard.

3.10 Should infill material be required for any purpose, the use of borrow pits must comply with the provisions of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) administered by the Department of Mineral Resources (DMR).

3.11 An integrated waste management approach must be implemented that is based on waste minimisation and must incorporate avoidance, reduction, recycling, re-use and disposal where appropriate. Uncontaminated builders' rubble generated during the construction can be re-used as back filling material on site. Ensure that no refuse or builders rubble generated on the premises is placed, dumped or deposited on adjacent properties or public places and open spaces during or after construction.

3.12 Section 28 of the NEMA places a duty of care on the holder of the EA to ensure that reasonable measures are taken to prevent pollution or degradation of the environment from occurring, continuing or recurring. Should any environmental damage result from this development or the operation thereof, the holder of the EA , must within 14 days of the damage being caused, rectify the situation at his/her own expense.

3.13 Movement of construction vehicles and machinery must be restricted to areas outside of the drainage lines/wet area.

3.14 Construction vehicles must be serviced and maintained in a manner whereby excessive smoke and noise production is reduced to acceptable levels, and to prevent oil leaks. Contaminated soil must be remediated on site or removed to an appropriately authorised landfill site.

3.15 Dust and nuisance must be minimised through damping down of unsurfaced areas.

3.16 Residents (if any) on the property and surrounding area must be informed if any unusually noisy activities are planned. Noise impacts must be reduced over distance at a rate of 1db (decibel) per 13 metres.

3.17 Chemical sanitation facilities or systems such as "toilets" that do not rely on seepage of liquids must be provided with a ratio of one for every 15 workers. These must be placed such that they prevent spills or leaks to the environment and must be maintained according to operating instructions and the contents thereof must be disposed of at an authorised waste water treatment works.

3.18 Mixing of cement, concrete, paints, solvents, sealants and adhesive must be done in specified areas on concrete aprons or on protected plastic linings to contain spillage or overflows onto soil to avoid contamination to underground water and environmental damage.

3.19 Construction activities must be suspended and a representative of the South African Heritage Resources Agency (SAHRA) and/ or Limpopo Heritage Resources Agency (LIHRA) be contacted immediately in the event of finding or uncovering any subterranean (middens, graves, etc.).

3.20 Care must be taken to ensure that the material and excavated soil required for backfilling are free of contamination from hydrocarbons.

3.21 The hydraulic fluids or chemicals required during construction must be stored in a concrete lined surface with bund walls and shall be designed in such a manner that any spillage can be contained and reclaimed without any impact on the surrounding environment. Should any spills occur it should be cleaned immediately by removing the spillage together with the polluted solid and dispose it in an authorised disposal site permitted to dispose of such waste. The Regional

Office of the DWS must be notified within 24 hours of an incident that may pollute surface and ground water.

4. MANAGEMENT OF THE ACTIVITY

4.1 A copy of this EA must be kept at the property / on-site office where the activity (ies) will be undertaken. The EA must be produced to any authorised official of the Department who requests to see it and must be made available for inspection by any employee or agent of the holder of the EA who works or undertakes work at the property.

4.2 The contents of the EMPr and its objectives must be made known to all contractors, subcontractors, agents and other people working on the site, and any updates or amendments to the EMPr must be submitted to the Department for approval.

4.3 Regular monitoring and maintenance of storm water drainage facilities must be conducted at all times and repaired, if damaged, as directed by this Department or any other relevant authority.

4.4 The holder of the EA shall note that in terms of Section 19(1) of the National Water Act, 1998 (Act No. 36 of 1998), "An owner of the land, a person in control of land or a person who occupies or uses the land on which- (a) any activity or process is or was performed or undertaken; or (b) any other situation exists, which caused or is likely to cause pollution of a water source must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring". Therefore any pollution incident(s) associated with the proposed project shall be reported to the relevant Regional Office of the DWS within 24 hours.

5. REPORTING TO THE DEPARTMENT

5.1 The holder of the EA must notify the Department, in writing and within 48 (forty eight) hours, if any condition of this EA cannot be or is not adhered to. Any notification in terms of this condition must be accompanied by reasons for the non-compliance. Non-compliance with a condition of this EA may result in criminal prosecution or other actions provided for in NEMA and the Regulations.

5.2 Fourteen (14) days written notice must be given to the Director: Environmental Compliance and Enforcement that the activity's operational phase will commence. Commencement for the purposes of this condition includes site preparation.

5.3 Any complaints received from the registered interested and affected parties (I&APs) during the construction and operational phase of the activity must be attended to as soon as possible and addressed to the satisfaction of all concerned I&APs.

5.4 The holder of the authorisation must ensure that an up to date emergency register is kept during the construction and operation of the project. This register must be made available upon request by the Department.

5.5 The holder of the EA must notify the Director: Environmental Compliance and Enforcement within thirty (30) days after the completion of the construction activities.

6. SITE CLOSURE AND DECOMMISSIONING

6.1 Should the activity ever cease or become redundant, the holder of EA shall undertake the required actions as prescribed by legislation at the time and comply with all relevant legal requirements administered by any relevant and competent authority at that time.