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Impala No.16 Shaft

Design Report - Impala No.16 Shaft Waste Rock Dump

SLR Project No.: 710.09003.0091

Report No.: 01

January 2013

Impala Platinum Limited

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DESIGN REPORT - IMPALA NO.16 SHAFT WASTE ROCK DUMP

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

Below a list of acronyms and abbreviations used in this report.

Acronyms / Abbreviations	**Definition**
WRD	Waste rock dump
RSV	Read, Swatman & Voigt (Pty) Ltd
SLR	SLR Consulting (Africa) (Pty) Ltd
ktpm	Kilo tonnes per month (a thousand tonnes per month)
USCS	Unified Soil Classification System
MAP	Mean annual precipitation
H	Horizontal distance (slope definition)
V	Vertical distance (slope definition)
FOS	Factor of Safety
OMC	Optimum moisture content
HDPE	High density polyethylene
BOQ	Bill of quantities
kg/m^3	Kilograms per cubic metre
km	Kilometres
kN/m^3	Kilonewtons per cubic metre
kPa	Kilopascals
litres/h	Litres per hour
m/s	Metres per second
m^3/h	Cubic metres per hour
$m^3/sec/m$	Cubic metres per second per metre width
mamsl	Metres above mean sea level
kg/t	Kilograms per tonne
mg/l	Milligrams per litre
mm	Millimetres
Mtpa	Mega tonnes per annum (million tonnes per annum)
NPR	Neutralising potential ratio
ppm	Parts per million
SANS	South African National Standards
t/m^3	Tonnes per cubic metre
TDS	Total dissolved solids

DESIGN REPORT - IMPALA NO.16 SHAFT WASTE ROCK DUMP

1 INTRODUCTION

This report documents the design of the new Impala No.16 Shaft Waste Rock Dump (WRD) which has been designed by SLR Consulting for Impala Platinum Limited. The mine is located approximately 16 km north-east of the town of Rustenburg in the North West Province.

The new 40m high facility has been planned to provide storage for 7.08 million tonnes of waste rock which is expected to be produced over a life of 20 years.

A layout of the new TSF (TSF4) is presented in Drawing No. 710.09003.00091-002 & -010 (Appendix A)

2 TERMS OF REFERENCE AND SCOPE OF WORK

The scope of work as provided by Read, Swatman & Voigt (Pty) Ltd (RSV) on behalf of Impala Platinum, is for a detailed design of the WRD, and covers activities associated with the development, operations and closure of the WRD.

As per the scope of work, the following was undertaken:

- Waste rock characterisation,
- Soil characterisation,
- Low permeability liner characterisation,
- Preparation of design objectives and assumptions,
- Detailed drawings,
- Quantification and cost estimates, and
- Detailed design report and specifications.

The scope excludes all electrical and mechanical design.

3 DESIGN CRITERIA AND ASSUMPTIONS

The following design parameters were initially provided:

- The WRD capacity should cater for a minimum of 20years life of mine.
- The waste rock is generated at a rate of 29,5 ktpm
- The density of deposited rock is 1 830kg/m^3.
- The waste rock will be deposited onto the WRD by means of 900mm conveyer belt at a feed rate of 300 tons/hour.

The WRD has been designed to comply with the following:

- National Water Act No. 36 of 1998 (NWA), in particular Government Notice 704, which specifies a number of design requirements concerning clean and dirty water management;
- The National Environment Management Act;

- Mineral and Petroleum Resources Development Act No 28 of 2002 (MPRDA), in particular Regulation R527; and
- Impala Environmental Standards.
- In respect of the minimum and maximum slope angles, maximum height, crown width, liner and capping thickness; the design was to adhere to the design recommendations as set out in the Impala's document titled "Environmental Design Recommendations for Waste Rock Dumps", (Report: 301 00195/01 (Part 1) Rev 5 July 2009). After a review of the above document, certain aspects of the design were treated differently to the way in which they are treated in the above document in order to achieve an improved performance.

4 AVAILABLE INFORMATION

The following documents were available for the purpose of the design:

- Invitation to tender document, "Waste Rock Dump", Enquiry No.: 002/059/P105 issued by RSV, 07 March 2012.
- "Environmental Design Recommendations for Waste Rock Dumps", (Report: 301 00195/01 (Part 1) Rev 5 July 2009.
- Metago Environmental Engineers (Pty) Ltd January 2005: Amendment to the Environmental Management Programme Report for Impala Platinum Limited, Rustenburg Operations.

Furthermore, additional information and data regarding the development, operation procedures and closure objectives of the proposed WRD was received through meetings and/or correspondence with the Impala and RSV environmental and project teams.

5 SUMMARY OF INVESTIGATIONS FOR THE WRD DESIGN

5.1 SOIL CHARACTERISATION

5.1.1 GEOTECHNICAL INVESTIGATION

A geotechnical investigation of the WRD site was undertaken by SLR in August 2012 to:

- Carry out a site investigation of the area and determine the geotechnical characteristics of the materials to be found on the site with specific reference to:
  - the definition of the near surface soil profiles,
  - the suitability and availability of material for construction,
  - the retrieval of disturbed samples for laboratory testing.
- Conduct a series of geotechnical laboratory tests on the samples obtained from the site investigation to determine soil parameters required for the design of the facility.
- Interpret the test results and provide recommendations for construction of the facility.

A total of 17 test pits in the vicinity of the proposed WRD were excavated using a Sumitomo SH240 hydraulic excavator. Test pit locations are shown in Drawing No. 710.09003.00091-009 (Appendix A). The test pit profiles are included in Appendix B.

The average depth of the excavated pits was 2.3 m, and all test pits were excavated to refusal depth. All the test pits were dry, and no ground water was encountered. The profiles and soil sampling information is summarised in Table 1 below. Geotechnical laboratory tests were carried out on a representative selection of these samples in order to determine:

- Particle size distribution;
- Atterberg limits;
- In-situ moisture content;
- Moisture-density determination; and
- Permeability characteristics.

TABLE 1: SUMMARY OF SOIL PROFILES AND SOIL SAMPLING INFORMATION

Test Pit	Top Soil	Clay Material	Soft Rock Norite	Lab Sample no.	Sample Depth (m)
TP6	0 - 0.4	0.4 - 1.3	1.3 - 1.9R	K856	0.7
TP10	0 - 0.5	0.5 - 1.6	1.6 - 2.8R	K857	2.5
TP11	0 - 0.3	0.3 - 1.3	1.3 - 3.1R		
TP12	0 - 0.4	0.4 - 1.0	1.0 - 2.3R	K858	0.6
TP13	0 - 0.4	0.4 - 1.1	1.0 - 3.2R		
TP14	0 - 0.4	0.4 - 1.0	1.0 - 4.3R	K859	0.2
TP15	0 - 0.3	0.3 - 0.9	0.9 - 1.9R		
TP16	0 - 0.3	0.3 - 1.1	1.1 - 2.6R		
TP17	0 - 0.3	0.3 - 1.4	1.4 - 2.3R		
TP18	0 - 0.4	0.4 - 1.3	1.3 - 1.8R	K861	1.8
TP20	0 - 0.4	0.4 - 1.5	1.5 - 1.9R		
TP21	0 - 0.3	0.3 - 0.7	0.7 - 1.4R		
TP22	0 - 0.3	0.3 - 1.0	1.0 - 1.3R		
TP23	0 - 0.3	0.3 - 1.2	1.2 - 1.8R	K862	1.6
TP24	0 - 0.4	0.4 - 1.2	1.2 - 2.8R		
TP25	0 - 0.4	0.4 - 1.1	1.1 - 1.6R		
TP26	0 - 0.4	0.4 - 1.0	1.0 - 2.3R		
Waste rock				K863	
Clay material mixed with soft rock norite (50:50 by volume)				K864	
Waste rock mixed with soft rock norite (50:50 by volume)				K865	

The generalised soil profile of the site is:

- 0 to 0.4 m: dry, black, loose, soft to stiff, topsoil with roots present, clay (CH material).
- 0.4 to 1.2 m: slightly moist, black, firm and slickensided, clay (CH material).
- 1.2 to 2.3 m: dry, light brown, highly weathered norite rock (GC/SM materials)

- > 2.3 m: hard rock norite.

5.1.2 GEOTECHNICAL INVESTIGATION RESULTS, INTERPRETATION AND CONCLUSIONS

The laboratory results are included in Appendix C and are summarised in Table 2 below.

Table 2: Laboratory Results Summary

Lab Sample no.	Test Pit	USCS Classification	Maximum Dry Density (kg/m³)	Optimum Moisture Content (%)	Average Coefficient of Permeability (m/s)
K856	TP6	CH			
K857	TP10	SM			
K858	TP12	CH	1 650	17.6	7.70×10^{-9}
K859	TP14	CH			
K861	TP18	GC	2 196	9.1	4.00×10^{-9}
K862	TP23	CH			
K863	Waste rock	GP			
K864	Clay material + soft rock norite*	SC			1.20×10^{-9}
K865	Waste rock + soft rock norite*	GW	2 264	7.9	2.20×10^{-7}
Note:* mixed at 50:50 by volume					

Since the soil characteristics for WRD area are expected to be very similar to those of the nearby areas where SLR has conducted numerous geotechnical investigations; it was decided to use the results derived from shear box and triaxial tests carried out on CH and SM materials from these areas (Metago, 2001 & 2006). The effective strengths shown in Table 3 are compared to the published effective strengths for typical CH and SM materials (geotechnical chart based on the Unified Soil Classification System (USCS)).

TABLE 3: PEAK STRENGTH PARAMETERS DERIVED FROM PREVIOUS TRIAXIAL AND SHEAR BOX TESTING, AND PARAMETERS FROM GEOTECHNICAL CHART

	Triaxial Testing on Similar Soils		Shear Box Testing on Similar Soils		Strength Parameters from Geotechnical Chart	
Soil Description	Cohesion c' (kPa)	Friction angle ϕ' (degrees)	Cohesion c' (kPa)	Friction angle ϕ' (degrees)	Cohesion c' (kPa)	Friction angle ϕ' (degrees)
Black slickensided clay (CH)	16 – 26	14 - 17	29 - 34.5	8.2 - 9	25 ± 10	22 ± 4
Highly weathered norite (SM)	-	-	4 - 5.5	38.4 - 38.9	0	34 ± 3

The field observations and results from the laboratory tests on the materials indicate the following:

- The residual clay sourced from the test pits is suitable for the construction of the low permeable WRD basin clay liner and clay containment wall embankments.

- The high clay content of the CH materials will result in significant material cracking and desiccation under drying conditions, therefore a protection layer will be required on top of the clay liner to maintain a more constant moisture content within the clay layer.
- There is sufficient growth medium for the rehabilitation work but there is generally not a distinct topsoil layer.
- The WRD site is used as an agricultural land with no big trees present. Site clearance costs are therefore expected to be minimal.
- Excavation conditions, and particularly the depth to refusal, are slightly variable throughout the site with refusal being experienced at depths as shallow as 1.3m with an average of around 2.3m. This is envisaged not to give significant problems with trench excavations.
- Solid and fractured norite hard rock will require blasting.
- Although the small scale laboratory permeability tests indicate excellent properties as a low permeability liner, the CH materials are unlikely to achieve this permeability with a single layer due to desiccation cracking.

5.2 WASTE ROCK CHARACTERISATION

5.2.1 GEOTECHNICAL PROPERTIES

A sample of waste rock was obtained during the geotechnical site investigation described in Section 5.1 above. From the foundation indicator test, the waste rock returned a GP (Poorly graded gravels with little or no fines) USCS classification. The waste rock geotechnical properties are summarised in Table 4.

With a broken density of 1830kg/m^3 and a Specific gravity of 2.89, the void ratio of the waste rock was calculated to be approximately 0.5.

A saturated hydraulic conductivity of 8.02 x 10^{-4} m/s for the waste rock was estimated using a modified Kozeny-Carman-Pavchich model (Mbonimpa et al.; 2002).

A water retention curve shown in Figure 1 was derived for the waste rock using the using a water retention curve prediction model (Aubertin et al. 2003). The low volumetric water content achieved at relatively low suction values indicates that rainfall will essentially infiltrate the dump and then move as a wetting front to the base the dump.

TABLE 4: WASTE ROCK GEOTECHNICAL PROPERTIES

Property	Value
USCS classification	GP (Poorly graded gravels with little or no fines)
Broken density	1830kg/m^3
Particle SG	2.89
Angle of internal friction*	38 ± 6º
Cohesion*	0 kPa
Hydraulic conductivity coefficient	8.02 x 10^{-4} m/s (K_y/K_x = 1/1)
Note:*Derived from the geotechnical chart	

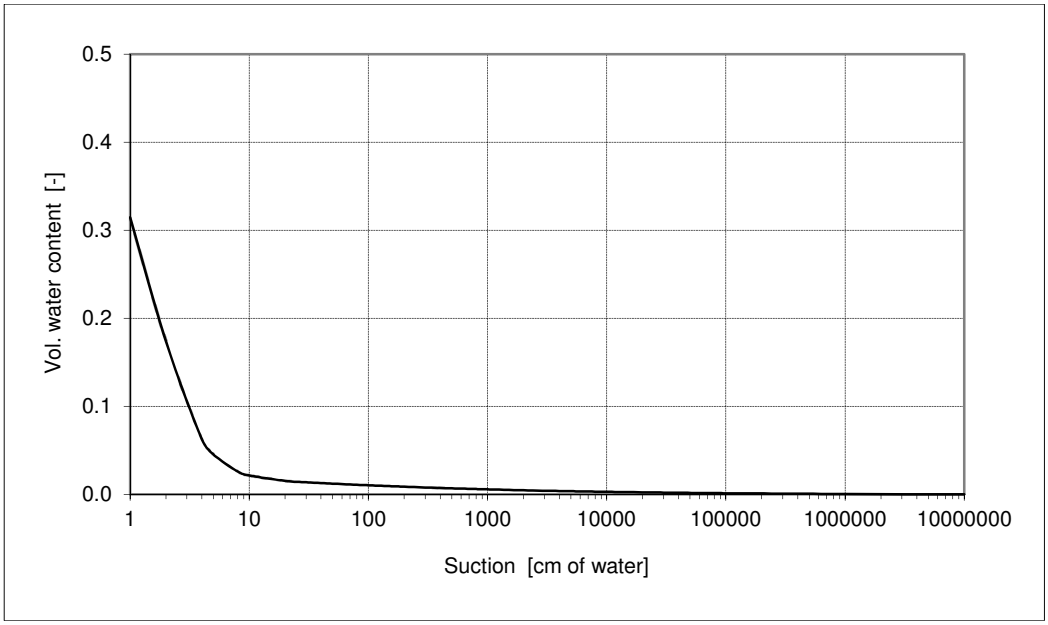

FIGURE 1: WATER RETENTION CURVE FOR WASTE ROCK

5.2.2 GEOCHEMICAL PROPERTIES

Two projects (Wade and Glass, 2008 & Metago, 2011) were previously carried out to understand the geochemistry and related potential for the pollution of water from mineralised waste stockpiles at the Impala Platinum Mine. Existing geochemical sampling and leachate analysis results from samples taken from existing waste rock stockpiles at Impala were reviewed, and in addition to this, Acid Base Accounting (ABA) was done to determine the potential for acid generation.

Geochemical tests and analysis (see Table 5 and Table 6) indicate that waste rock from both projects should be non-acid generating. There is however the potential for seepage concentrations to exceed the drinking water guideline limits for various parameters. This presents a potential pollution risk for both surface and groundwater in the both the short and long term. It follows that short and long term pollution prevention and/or treatment measures must be considered.

TABLE 5: SUMMARY OF ABA RESULTS FOR WASTE ROCK MATERIAL (WADE AND GLASS, JULY 2008)

Components	Sample 1	Sample 2	Sample 3	Sample 4
Paste pH	10.44	9.2	6.6	9.12
Total sulphur (%)	0.11	0.02	0.00	0.03
Acid potential (AP) (kg/t)	3.5	0.7	0.2	0.9
Neutralisation Potential (NP)	187.5	96.7	17.4	101.3
Net Neutralisation Potential (NNP = NP + NA)	184.0	96.1	17.3	100.4
Neutralising Potential Ration	54	147	111	116

TABLE 6: RESULTS OF THE ANALYSIS ON THE LEACHATE ON WASTE ROCK (METAGO, 2011)

All in [mg/L]	Alkalinity as CaCO3	EC (mS/m)	pH	Ag	ge As	As	B	Ba	Be	Bi	Ca	Cd	Cl
WHO Drinking Water (2008)	N/A		N/A	N/A	0.2	0.01	0.5	0.7	N/A	N/A	300	0.003	250
IFC Mining Effluents (2007)	N/A		N/A	N/A	N/A	0.1	N/A	N/A	N/A	N/A	N/A	0.05	N/A
SANS Class I		<150	5.0-9.5		<0.3	<0.01					<150	<0.005	<200
SANS Class II		150 - 370	4.0-10		0.3 - 0.5	0.01 - 0.05					150-300	0.005 - 0.01	200-600
SANS Class II (Period of Consumption)		7 years			1 year	1 year					7 years	6 months	7 years
Livestock watering	N/A	N/A	N/A	N/A	0 - 5	0 - 1	0 – 5	N/A	N/A	N/A	0 - 1000	0 -10	0 - 3000
Sample 1	20	58.5	7.90	<0.01	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	74	<0.01	73
Sample 2	8	22.5	7.90	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	22	<0.01	32

Red- Exceedance of all human health guideline limits

All in [mg/L]	Co	Cr	Cu	F	Fe	K	Li	Mg	Mn	Mo	Na	Ni	Cr^{+6}
WHO Drinking Water (2008)	N/A	0.05	2	1.5	N/A	N/A	N/A	N/A	0.400	0.07	200	0.07	0.05
IFC Mining Effluents (2007)	N/A	N/A	0.3	N/A	2	N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.1
SANS Class I	<0.5	<0.1	<1	<1.0	<0.2	<50		<70	<0.1		<200	<0.15	
SANS Class II	0.5-1	0.1 - 0.5	1-2	1.0-1.5	0.2-2	50 - 100		70-100	0.1-1		200 - 400	0.15- 0.35	
SANS Class II (Period of Consumption)	1 year	3 months	1 year	1 year	7 years	7 years		7 years	7 years		7 years	1 year	
Livestock watering	0 -1	0 -1	0 - 1	0 - 2	0 -10	N/A	N/A	0 - 500	0 - 10	0 – 0.01	0 - 2000	0 - 1	0 -1
Sample 1	<0.01	<0.01	<0.01	<0.2	0.354	5.0	<0.01	1.58	<0.01	<0.01	26	<0.01	<0.01
Sample 2	<0.01	0.062	<0.01	<0.2	0.780	2.0	<0.01	0.395	0.011	<0.01	9.9	<0.01	<0.01

Red- Exceedance of all human health guideline limits

All in [mg/L]	NO3_N	P	Pb	SO_4	Sb	Se	Si	Sn	Sr	Ti	V	Zn
WHO Drinking Water (2008)	11.3	N/A	0.01		0.02	0.01	N/A	N/A	N/A	N/A	N/A	N/A
IFC Mining Effluents (2007)	N/A	N/A	0.2		N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
SANS Class I	<10		<0.02	<400	<0.01	<0.02					<0.2	<5
SANS Class II	10 - 20		0.02 - 0.05	400-600	0.01-0.05	0.02- 0.05					0.2- 0.5	5 - 10
SANS Class II (Period of Consumption)	7 years		3 months	7 years	1 year	1 year					1 year	1 year
Livestock watering	0 - 100	N/A	0 – 0.1	0 - 1000	N/A	N/A	0 - 50	N/A	N/A	N/A	0 – 1	0 -20
Sample 1	24	0.763	<0.01	46	<0.01	<0.01	<0.01	<0.01	0.315	<0.01	<0.01	<0.01
Sample 2	9	0.778	<0.01	9	<0.01	<0.01	<0.01	<0.01	0.068	<0.01	<0.01	<0.01

(SLR, December 2011)

*SANS Class 1: Good quality water suitable for lifetime consumption.

**SANS Class II: Marginal water quality with a maximum allowance for consumption. The period of consumption is indicated in years in the above table

5.3 SLOPE STABILITY AND SEEPAGE ANALYSES

The long-term slope stability of the WRD side embankments was assessed using the slope stability assessment software package SLOPE/W 2007 from Geo-Slope International[1]. The analysis was carried out on the final reshaped profile of the WRD with the side slopes of 3H:1V (horizontal to vertical).

To account for the variability in material properties, which may affect the stability of slopes to a large extent, probabilistic analyses were conducted. The assumed material properties are shown in Table 7.

The model was run with the following settings:

- FOS Method: The Morgenstern-Price limiting equilibrium method (with Half-Sine side function).
- Failure Mode: The block failure plane option with a minimum failure plane thickness of 5m was set and 50 slices were analysed for each failure plane.
- FOS Distribution: The Monte Carlo process with 100 000 trials.

TABLE 7: MATERIAL STRENGTH PARAMETERS USED FOR SLOPE STABILITY ANALYSIS

Material	Unit Weight (kN/m^3)	Effective Friction Angle ϕ' (degrees)				Effective Cohesion C' (kPa)			
		Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
Waste rock	18	38	6	32	44	0	0	0	0
In-Situ Clay	16	12	1.3	8	16	20	3	10	30
Clay liner and walls	16	14	0.8	10	18	20	1	15	25
Weathered Norite	20	34	1.0	29	39	0	0	0	0
Bedrock	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

The input pore water pressures to the slope stability analysis were calculated using the seepage analysis software SEEP/W 2007 also from Geo-Slope International.

The seepage analysis was conducted assuming a constant infiltration rate of 5% and 80% of the mean annual precipitation (MAP) for rehabilitated and non-rehabilitated side slopes respectively. The under drainage was modelled with 2m wide drains at 20m spacing. The material properties used in the seepage analysis are shown in Table 8.

TABLE 8: MATERIAL PROPERTIES FOR SEEPAGE ANALYSIS

Material	K_{sat} (m/s)	K-Ratio (K_y/K_x)
Waste rock	8×10^{-4}	1
In-Situ Clay	1×10^{-7}	1
Clay liner and walls	1×10^{-8}	1
Weathered Norite	5×10^{-4}	1
Bedrock	n/a	n/a

The results from the stability analysis (reshaped slopes with 5% rainfall infiltration case) are summarised in Table 9, and the analysed failure mode is shown in Figure 2.

[1] More information on the SLOPE/W and SEEP/W software can be obtained online at: http://www.geo-slope.com.

TABLE 9: SLOPE STABILITY ASSESSMENT RESULTS

Mean FOS	1.69
Maximum FOS	2.02
Minimum FOS	1.37
Probability of Failure (%)	0
# of Trials	100000
Standard Dev.	0.086
Reliability Index	8.08

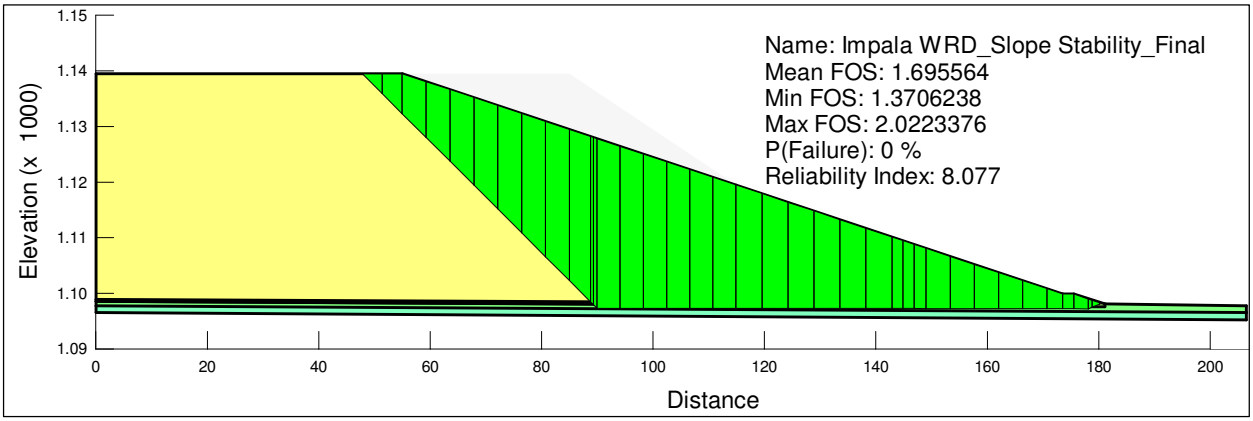

FIGURE 2: SLOPE STABILITY ASSESSMENT FOR FINAL SLOPE PROFILE

The slope stability assessment results show that the WRD will be stable as the calculated mean FOS value is above the recommended values (Table 10).

However it should be noted that during the operations, before the slopes are reshaped, the FOS will be 1.0 as the waste rock material will be standing at an angle of repose. It is recommended that the WRD side slopes be reshaped as soon as practically possible after deposition.

TABLE 10: ACCEPTABLE FACTORS OF SAFETY (CHAMBER OF MINES, 1996)

Condition	Recommended Minimum FOS
Regular monitored/ Short-term undrained	1.3
Abandoned side slopes/ Long-term drained	1.5

The seepage analysis also provided estimate flow rates to the under-drains. The seepage flux quantities intercepted by the under-drains under the rehabilitated and non-rehabilitated areas are summarised in Table 11.

TABLE 11: SEEPAGE FLUX INTERCEPTED BY DRAINS

	Under rehabilitated Areas	Under Non-rehabilitated Areas
Infiltration as % of MAP	5%	80%
Flow per m/drain (m/s/m)	1.8×10^{-8}	3.2×10^{-7}
per typical 350m drain length (litres/s)	6.4×10^{-6}	1.1×10^{-4}
per typical 350m drain length (litres/h)	23	402

The likely range of maximum seepage fluxes through the WRD foundations are summarised in Table 12 below. These rates were estimated using Darcy's flow equation (Equation 1). In the calculations, a maximum constant head[2] of 2m of water was assumed on top of the clay liner, and it was assumed that this head is lost across a 500mm thick clay liner. An average hydraulic conductivity of 1 x 10^{-8} m/s for the clay liner was used over the entire area, accounting for possible clay desiccation and cracking.

TABLE 12: MAXIMUM SEEPAGE TO THE GROUND BASED ON DARCY EQUATION

Per hectare	Phase 1	Remainder of Phases	Total Footprint	Unit
4.00 x 10^{-4}	3.26 x 10^{-3}	4.57 x 10^{-3}	7.83 x 10^{-3}	m^3/s
0.4	3.3	4.6	7.8	l/s
34.6	281	394	676	m^3/day

EQUATION 1: DARCY'S LAW

$Q = -KA\ dh/dl$

where:

Q = rate of water flow (volume per time)

K = hydraulic conductivity

A = flow area

dh/dl = hydraulic gradient.

Note that the calculation using Darcy indicates a higher average seepage flux that there is water available from rainfall. Assuming 650mm/yr and 80% infiltration prior to restoration, the influx to the waste rock per annum is limited to 5 200m^3/yr. This can be compared to 5x$10^{-4}$$m^3$/s which equates to 1.58x10^4 m^3/yr. Hence the water availability or rainfall and infiltration rate governs the seepage through the liner. After complete restoration of the waste rock dump, the seepage loss to through the liner is not expected to exceed 325m^3/yr/Ha of waste rock dump footprint, based on 5% infiltration of MAP.

6 SUMMARY OF WRD DESIGN

The WRD design is summarised in this section, and the design drawings are included as Appendix A.

6.1 LAYOUT AND SIZING

The layout of the WRD is shown in Drawing No. 710.09003.00091-002 & -010. In this report, construction and rehabilitation phases are divided as follows:

- Phase 1 - covers the work required for the first 5 years of operation;
- Remaining Phases - covers the work required for the remaining 15 years, and this work can be undertaken in multiple phases.

Key features of the sizing and layout of the WRD facility are:

[2] An average head of 0.2m above the clay liner was obtained from SEEP/W analysis of a case with infiltration of 80% of MAP with all drains working. An upper limit of 2m used in these calculation takes into account the possible clay borrow areas between the drains, which maybe up to 1m below the drain levels.

- The total footprint area is approximately 21 ha.
- The maximum height of the WRD is 40.0m.
- Phase 1 is designed to accommodate approximately 1.8 million tonnes of waste rock.
- The total volume of waste rock to be accommodated in the WRD facility is 3,868,852 m^3.
- The dump will have a single final slope after reshaping of 3H:1V.

The components of the WRD facility are described briefly in the following sections.

6.2 CLAY LINER

To prevent and minimise seepage from the waste rock dump into the groundwater during the operational phase, the WRD has been designed with a low permeability clay liner that covers the whole of the WRD basin area. Details of the clay liner are included in Drawing No. 710.09003.00091-006 (Detail 2).

A 500mm thick layer of clay (after removal of topsoil) will be compacted to 95% Proctor Density at ±2% optimum moisture content (OMC). The compaction will be carried out in two layers in order to minimise the effects of desiccation cracks.

A 500mm thick protective layer of waste rock will be placed on top of the clay layer immediately after compaction to maintain a more constant moisture content and limit desiccation cracking.

It was decided that no additional capillary break layer (e.g. cleaned and washed sand) is required over the clay liner in for this design, as the waste rock grading curve shows that the waste rock material will provide an excellent capillary break layer.

6.3 UNDER-DRAINAGE SYSTEM

The layout of the under-drainage system is shown in the general arrangement Drawing No. 710.09003.00091-002 and the details are included in Drawing No. 710.09003.00091-007. The under-drainage system consists of the following components:

Under-drains

The under-drains are design to reduce water pressure head (or driving head) on top of the clay liner, thus reducing the seepage to the ground water. They are also designed to prevent the daylighting of the phreatic surface on the slope embankments which may result in side slope stability problems.

The under-drains consist of slotted HDPE pipes covered with selected filter material. Each under-drain line is designed with a rodding station, which will be used for rodding and jetting to reduce silt build up in the pipes.

Collection Drain

The detail of the collection drain is shown in Drawing No. 710.09003.00091-007 (Detail 4). The under-drain pipes are all connected to the collection drain. The collection drain is connected to the storage tanks.

The collection drain is designed as a covered system to prevent livestock consuming seepage water, and also to enable a 'walk-away' option at WRD decommissioning.

The system consists of slotted pipe surrounded by drainage material wrapped with an HDPE liner. The drainage material will act as a flow media should the pipe be blocked. The HDPE liner prevents any seepage flowing through the collection drain from reaching groundwater.

The collection drain will be covered with vegetated backfill. Rodding stations are provided at regular intervals along the drain to assist with rodding and flushing of the drain to remove sediment that might build up, especially after covering of additional drain sections.

An electric cable conduit (to the storage tanks) is buried along a portion of the collection drain trench to prevent cable theft.

Storage Tanks

The storage tanks receive seepage water from the collection drain. The details of the storage tanks are shown in Drawing No. 710.09003.00091-011.

The three connected underground tanks have a total capacity of 18 000litres. This provides enough storage for approximately 16hours without any pumping. It is expected that on average, seepage water will flow into the tanks at a rate of 0.3 litres/s. Water from the tanks will be pumped back to the mine.

An entrance sieve has been provided for in order to minimise silt built-up inside the tanks.

6.4 CONTAINMENT WALLS

The WRD has been designed with a 1.5m and 2m high inner and outer containment walls respectively. The inner wall demarcates the waste rock dumping limits before reshaping. The outer wall forms a toe of the reshaped side slope, and also acts as a seepage barrier.

Before the reshaping of the side slopes, the area between the two containment walls will act as catchment paddocks that will temporary store any dirty runoff from non-rehabilitated slopes. To prevent breach in the walls during large storm events that occur prior to or soon after initial waste rock placement, temporary spill pipe outlets through the walls are provided for.

6.5 CAPPING LAYER AND VEGETATION

A capping layer has been designed to be placed over the reshaped top surface and side slopes of the WRD. The function of this layer will be to:

- Limit the net infiltration of water to a relatively low percentage of mean annual precipitation (MAP), but sufficient to maintain the vegetation. This significantly reduces seepage flux to the ground water.
- Improve the surface runoff water quality discharged from the WRD.
- Provide a substrate for the establishment of a sustainable vegetation cover to the entire surface of the WRD.
- In combination with the vegetation and slope profile provide a surface that will only erode very slowly to ensure an on-going replenishment of nutrients necessary for maintenance of the vegetation cover and long term formation of soils.

The design details of the capping layer are shown in Drawing No. 710.09003.00091-008. The cover design comprises of a mixed layer of topsoil and non-acid generating waste rock 0.5 m thick. The material mixing will be done in two layers and lightly compacted.

The grading curves show that the waste rock will act as a good capillary break layer and there is no need of an extra capillary break layer under the capping layer.

This design provides for randomly located plant boxes on the top and side slopes of the WRD to mimic natural landscape. The plant boxes will be spread at a density of 1 plant box per 120m^2 area, with minimum and maximum distances between these of 6m and 10m respectively.

Each box will be planted with a combination of local shrubs and grasses to promote biodiversity. The plant boxes are designed with downslope berms that will intercept some of the runoff water that can be later utilised by plants. The rest of the rehabilitated surfaces outside of the plant boxes will be grassed.

6.6 STORMWATER MANAGEMENT

Stormwater runoff generated in the upper catchments will be diverted around the WRD by a clean stormwater channel running along the outer containment wall.

The stormwater runoff from the non-rehabilitated slopes is considered dirty water, and will be stored and left to evaporate in the temporary catchment paddocks between the containment walls (see Section 6.4 above). In practise, very little runoff is likely to be generated by the un rehabilitated waste rock dump surface due to the high infiltration rates.

Runoff from rehabilitated areas is considered clean, and will be released to the environment.

6.7 TOPSOIL STOCKPILES

The topsoil stockpile area has been sized considering a maximum height of 2m (stockpiled soil); this is to prevent adverse biochemical reactions such as the accumulation of ammonium and anaerobic conditions at the base of the pile that decrease the quality of the stockpiled topsoil as a growth medium material. The surface of the topsoil stockpile will be shaped in such a way that rain water will not pond on top of the stockpile (i.e. dome shaped).

Topsoil will be sourced from and stored at the topsoil stockpile during the life of the WRD for the ongoing operations, i.e. concurrent rehabilitation and successive construction phases. A berm on the downstream of the stockpile area is included to minimise silt wash off into the surrounding area.

7 WRD DEVELOPMENT AND OPERATION

7.1 PREPARATORY CONSTRUCTION WORKS

Prior to placement of waste rock material, the WRD area needs to be prepared. The scope of construction works and the estimated costs are given below.

7.1.1 SCOPE OF CONSTRUCTION WORK

The construction of the preparatory works is planned to be executed in multiple phases. The works for the construction covered in this design include:

- Clear and grub site;
- Topsoil removal and stockpiling;
- A compacted clay liner with a maximum thickness of 0.5m;
- A 0.5m protective layer of waste rock on top of the clay liner;
- A compacted residual clay containment inner wall with a maximum height of 1.5 m;
- A compacted residual clay containment inner wall with a maximum height of 2.0 m;
- The installation of under-drains (approx.2.5 m wide) located at 20 m spacings (including drainage materials and piping);
- A collection drain, with rodding eye stations and electric cable conduit;
- Installation of 3 x 6000 litres underground drainage collection tanks (including all connections and sieves); and
- Provision of temporary stormwater control and dewatering system for use during the construction periods.

The following items required at the WRD are not included or covered in this design; they are dealt with by others:

- All electrical and mechanical installations, including lighting, security systems;
- A return water pump and its associated mountings, connections, motor control, return water pipeline, flow meters and level control;

- Conveyor systems and associated infrastructure (e.g. concrete wing-wall); and
- Fencing.

7.1.2 CONSTRUCTION COSTS ESTIMATE

The estimate has been based on a preliminary schedule of quantities, and the rates used were taken from the recently priced bill of quantities for similar works. A detailed bill of quantities (BOQ) is included as Appendix D, and the costs are summarised in Table 13. The costs amounts are in December 2012 Rands.

The construction costs are divided into 2 parts:

- Phase 1 - covers the work required for the first 5 years of operation;
- Remaining Phases - covers the work required for the remaining 15 years, and this work will be undertaken in multiple phases.

TABLE 13: CAPITAL EXPENDITURE FOR CONSTRUCTION

Schedule	Description	Phase 1	Remaining Phases	Total
A	PRELIMINARY AND GENERAL (Estimated at 15% of total construction costs)	R 664 383	R 988 890	R 1 653 273
B	SITE PREPARATION AND CLAY LINER	R 3 049 857	R 4 780 325	R 7 830 182
C	UNDER DRAINAGE COLLECTION	R 1 379 362	R 1 812 274	R 3 191 636
	SUB-TOTAL 1 (Excluding VAT & Contingencies)	**R 5 093 602**	**R 7 581 489**	**R 12 675 091**
	CONTINGENCY (Estimated at 10% of total costs)	R 509 360	R 758 149	R 1 267 509
	SUB-TOTAL 2 (Excluding VAT)	**R 5 602 962**	**R 8 339 638**	**R 13 942 600**
	VAT 14%	R 784 415	R 1 167 549	R 1 951 964
	GRAND TOTAL	**R 6 387 377**	**R 9 507 187**	**R 15 894 564**

7.1.3 QUALITY ASSURANCE PROGRAM

During the construction of the WRD, it is recommended that a quality assurance program be implemented to ensure that the intent of the design is achieved. As a minimum, the following will be necessary:

- Engineering approval for clay liner compaction and thickness;
- Monitoring and testing of drainage materials;
- Engineering approval of drainage pipe connections, and the fall in the pipe;
- Monitoring placement of the HDPE liner; and
- Preparation of as-built drawings and documented approval of any design modifications.

7.2 WRD DEVELOPMENT

Waste rock will be deposited on to the WRD by means of a 900mm conveyor belt system at a feed rate of 300 tons/h. Waste rock will initially be deposited to form a ramp, at an incline slope of approximately 7H:1V until the maximum height of 40m is reached. The WRD development will then proceed in the western direction, with the waste rock dumped from the top down the side slopes and left to stand at an angle of repose of approximately 1.5H:1V. Earthmoving equipment will be used on the top surface to shape the dump as per the modelled shaped.

The limits on the dumping of the material on the top surface are shown in Drawing No. 710.09003.00091-012. These limits must be adhered to in order to enable the reshaping of the slopes to 3H:1V. In addition, the dumping will be limited by the inner containment wall; no material must be dumped outside of this wall before the reshaping of the dump.

Concurrent rehabilitation of the WRD is planned, and this is discussed further in Section 8 below.

8 REHABILITATION AND CLOSURE

Concurrent rehabilitation of side slopes as the dump progresses is planned for the WRD. The aim of concurrent closure is to have long term evidence that the closure measures are successful in terms of meeting the closure objectives, and if they are not, provide sufficient time for them to be remedied. The closure objectives are covered in the Section 2 of the environmental impact assessment (EIA) report (SLR, 2013). The rehabilitation details are shown in Drawing No. 710.09003.00091-008.

8.1 REHABILITATION ACTIVITIES

The rehabilitation process includes the following activities:

- Push down angle of repose slopes to an overall single slope of 3H:1V (cut and fill operation);
- Blending waste rock and topsoil to form a capping layer of average thickness of 0.5m in two layers;
- Forming of plant boxes/terraces (includes filling with suitable materials, and planting of trees);
- Hydro-seed and establish competent vegetation cover to re-shaped slopes;
- Reshaping of the top-surface.

As detailed in the drawings, the outer containment wall forms a toe of the final reshaped outer slopes, and no waste rock material should be dumped or moved outside of this wall.

Prior to capping, the top of the dump should be sloped towards the perimeter (minimum slope 2%) to prevent ponding.

The capping layer design is detailed in Section 6.5 above.

The design also provides for the rehabilitation of all topsoil stockpiles and borrow pit areas outside of the WRD basin area.

8.2 REHABILITATION COSTS

The rehabilitation costs for the activities listed in Section 8.1 above are summarised in Table 14. A detailed BOQ is also included in Appendix D. This BOQ is also divided into two phases, with Phase 1 estimates covering the costs of rehabilitating the WRD shape formed after the initial 5years of operations, and the remainder of costs are shown under the "Remaining Phases" column. These costs exclude all maintenance and aftercare costs.

The concurrent rehabilitation costs can be assumed to be linear over the operational life of the WRD.

TABLE 14: CONCURRENT REHABILITATION COST ESTIMATE

Schedule	Description	Phase 1	Remaining Phases	Total
A	PRELIMINARY AND GENERAL (Estimated at 15% of total construction costs)	R 211 820	R 702 515	R 914 335
B	RE-SHAPING AND REHABILITATION	R 1 412 130	R 4 683 434	R 6 095 564
	SUB-TOTAL 1 (Excluding VAT & Contingencies)	**R 1 623 950**	**R 5 385 949**	**R 7 009 899**
	CONTINGENCY (Estimated at 10% of total costs)	R 162 395	R 538 595	R 700 990
	SUB-TOTAL 2 (Excluding VAT)	**R 1 786 344**	**R 5 924 544**	**R 7 710 888**
	VAT 14%	R 250 088	R 829 436	R 1 079 524
	GRAND TOTAL	**R 2 036 433**	**R 6 753 980**	**R 8 790 413**

8.3 CLOSURE AND DECOMMISSIONING

It is assumed that if the reshaping and rehabilitation work described above is carried out correctly during the operation of the dump, the work required on decommissioning will be minimal. The work will possibly be limited to:

- The removal of all electrical and mechanical installations;
- Repairing of damage to side slopes; and
- Identification of any additional work needed to leave the WRD in a sustainable condition.

Maintenance and aftercare will be undertaken to ensure that rehabilitation is successful, and the WRD will be a functional biodiversity landscape.

9 RECOMMENDATIONS

The following recommendations are made with regards to the WRD:

- During the construction of the WRD, it is recommended that a quality assurance program be implemented to ensure that the intent of the design is achieved.

- During the operation phase, an Operations Manual must be developed for the WRD, and it must cover the following aspects:
  - Dumping procedures (e.g. dumping limits)
  - Water management
  - Jet-rodding requirements
  - Concurrent rehabilitation and monitoring of progress towards the closure objectives.
- It is recommended that the concurrent rehabilitation process be started as soon as possible, and the progress be closely monitored, and where necessary changes be made.

10 REFERENCES

- **Metago Report 152/003 No.1, 2001,** "The Design of the New UG2 Tailings Dam (No.2), the New Return Water Dam (No.1) and the Stream Diversion at Karee Mine". (Unpublished Report)
- **Metago Report 152/029 No.1, 2006,** "Karee Mine Tailings Dam No.4 – Preliminary Design Report", January 2006 (Unpublished Report)
- **Mbonimpa, M., Aubertin, M., Chapuis, R.P., Bussiere, B., 2002,** "Practical pedotransfer functions for estimating the saturated hydraulic conductivity", Geotechnical and Geological Engineering, Volume 20, pp 235-259.
- **Aubertin, M., Mbonimpa, M., Bussiere, B., Chapuis, R.P., 2003,** "A model to predict the water retention curve from basic geotechnical properties", Canadian Geotechnical Journal, 2003, Volume 40(6): pp 1104-1122
- **Wade, P., and Glass, J., July 2008,** "Characterisation of Mine Residue, Council for Geoscience", Report No. IMPL-08-7512, July 2008
- **Metago Report EI001/059 No.1, 2011,** "Impala- Geochemistry and Acid Base Accounting", December 2011 (Unpublished Report)
- **Chamber of Mines of South Africa, March 1996**, "Guidelines for Environmental Protection, the Engineering Design, Operation and Closure of Metalliferous, Diamond and Coal Residue Deposits"
- **SLR Report 710.09003.00092 No.1, 2013,** " Environmental Impact Assessment for the Proposed Shaft 16 Waste Rock Dump Expansion and Opencast Activities at Pit 8c", January 2013 (Unpublished Report)

S.D Dladla **A James Pr Eng**

(Project Manager) **(Project Reviewer)**

APPENDIX A: DRAWINGS

Drawing Register

CLIENT NAME	**IMPALA MINE**
PROJECT NAME	SHAFT 16 WASTE ROCK DUMP EXTENSION
SLR Project No.:	**710.09003.00091**
SLR Issuing Office:	**JOHANNESBURG**
Register As At:	**09-Jan-13**

#	DRAWING NO.	DRAWING TITLE	LATEST REV ISSUED	DATE ISSUED					
				T0					
1	710.09003.00091-001	Drawing Register	**T0**	09-Jan-13					
2	710.09003.00091-002	General Arrangement	**T0**	09-Jan-13					
3	710.09003.00091-003	Overall Setting Out	**T0**	09-Jan-13					
4	710.09003.00091-004	Phase 1 Construction Layout	**T0**	09-Jan-13					
5	710.09003.00091-005	Phase 1 Construction Setting Out	**T0**	09-Jan-13					
6	710.09003.00091-006	Typical Sections	**T0**	09-Jan-13					
7	710.09003.00091-007	Underdrainage Details	**T0**	09-Jan-13					
8	710.09003.00091-008	Rehabilitation Details	**T0**	09-Jan-13					
9	710.09003.00091-009	Test Pits Setting Out	**T0**	09-Jan-13					
10	710.09003.00091-010	Overall Layout	**T0**	09-Jan-13					
11	710.09003.00091-011	Details of Underground Tanks	**T0**	09-Jan-13					
12	710.09003.00091-012	Operation Dump Limits	**T0**	09-Jan-13					

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DESIGN ENGINEER	JAN13	SD	
PROJECT DIRECTOR	JAN13	ARJ	
PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

DRAWING REGISTER

SCALE: NTS
CO-ORD SYSTEM: Lo 27
SHEET: 1 OF 1
A1

DRAWING NUMBER : 710.09003.00091-001
REV : T0

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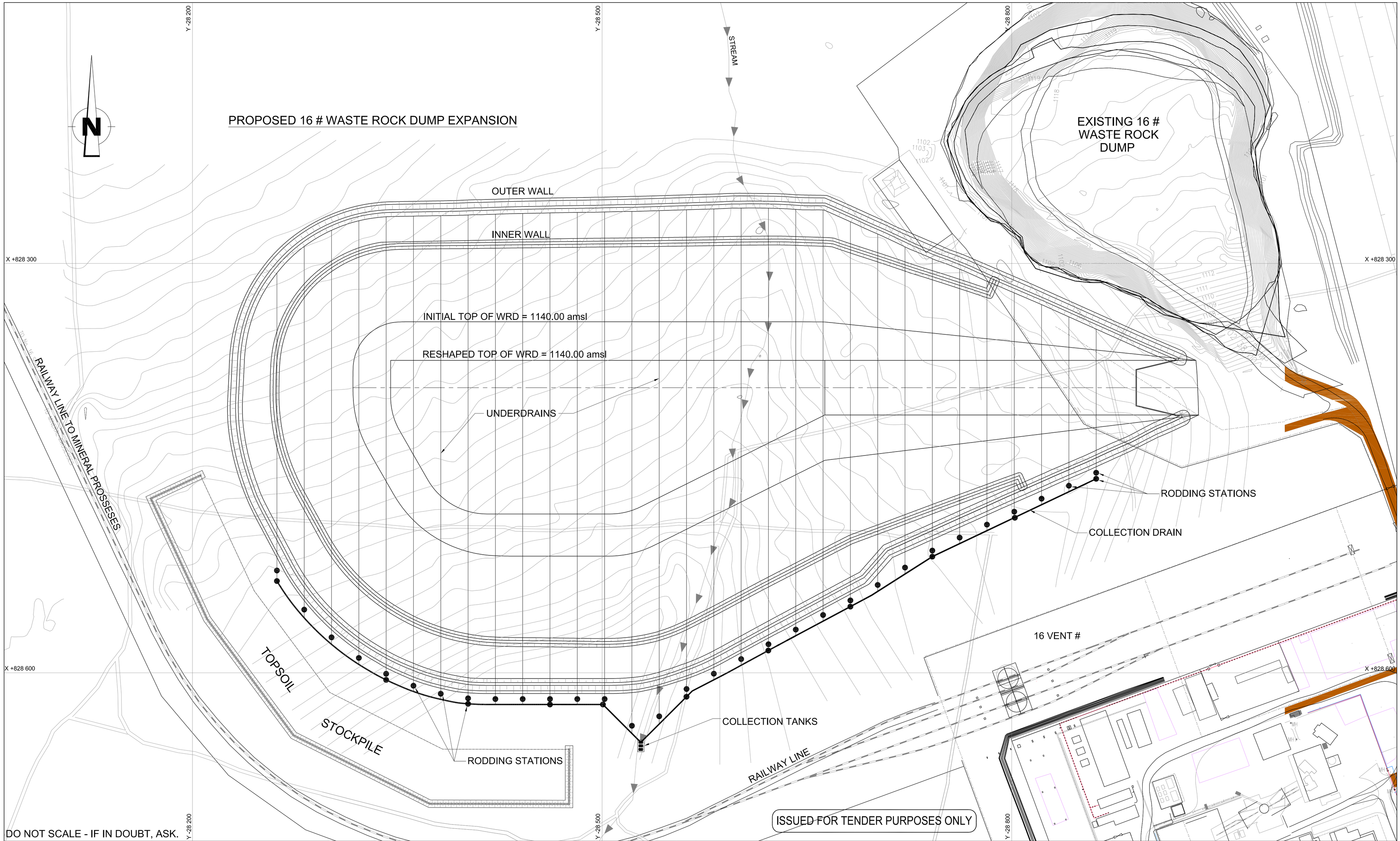

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IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

GENERAL ARRANGEMENT

SCALE 1:1250
CO-ORD SYSTEM Lo 27
SHEET 1 OF 1
A1

DRAWING NUMBER : 710.09003.00091-002 REV : T0

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COORDINATE LIST
Lo27

TOPSOIL STOCKPILE SETTING OUT

POINT	Y-COORD	X-COORD
CONST:		
TSS1	-28475.798	828696.126
TSS2	-28373.701	828695.925
TSS3	-28274.054	828645.835
TSS4	-28210.743	828560.611
TSS5	-28169.523	828472.255
TSS6	-28205.773	828455.344
TSS7	-28245.275	828540.019
TSS8	-28300.502	828614.360
TSS9	-28383.226	828655.943
TSS10	-28475.877	828656.126

COORDINATE LIST
Lo27

INITIAL WALL SETTING OUT

POINT	Y-COORD	X-COORD	ELEVATION
CONST:			
IW1	-28808.115	828463.843	FGL + 1.5m
IW2	-28804.998	828456.787	FGL + 1.5m
IW3	-28682.182	828502.297	FGL + 1.5m
IW4	-28565.284	828563.240	FGL + 1.5m
IW5	-28505.590	828450.011	FGL + 1.5m
IW6	-28504.253	828578.005	FGL + 1.5m
IW7	-28426.855	828577.196	FGL + 1.5m
IW8	-28428.442	828425.205	FGL + 1.5m
IW9	-28295.088	828498.148	FGL + 1.5m
IW10	-28277.850	828466.634	FGL + 1.5m
IW11	-28405.062	828397.049	FGL + 1.5m
IW12	-28260.085	828394.478	FGL + 1.5m
IW13	-28260.383	828377.672	FGL + 1.5m
IW14	-28353.369	828379.321	FGL + 1.5m
IW15	-28352.330	828286.327	FGL + 1.5m
IW16	-28584.660	828283.618	FGL + 1.5m
IW17	-28669.281	828284.638	FGL + 1.5m
IW18	-28783.430	828322.142	FGL + 1.5m
IW19	-28787.680	828312.226	FGL + 1.5m

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COORDINATE LIST
Lo27

FINAL WALL SETTING OUT

POINT	Y-COORD	X-COORD	ELEVATION
CONST:			
FW1	-28924.487	828411.947	FGL + 2.0m
FW2	-28886.834	828430.253	FGL + 2.0m
FW3	-28708.451	828509.766	FGL + 2.0m
FW4	-28691.248	828529.409	FGL + 2.0m
FW5	-28585.062	828586.464	FGL + 2.0m
FW6	-28499.740	828428.766	FGL + 2.0m
FW7	-28558.004	828598.335	FGL + 2.0m
FW8	-28549.125	828601.386	FGL + 2.0m
FW9	-28508.409	828482.886	FGL + 2.0m
FW10	-28508.397	828608.186	FGL + 2.0m
FW11	-28413.710	828608.178	FGL + 2.0m
FW12	-28413.719	828508.178	FGL + 2.0m
FW13	-28397.084	828606.784	FGL + 2.0m
FW14	-28394.045	828606.272	FGL + 2.0m
FW15	-28422.157	828439.626	FGL + 2.0m
FW16	-28315.834	828570.990	FGL + 2.0m
FW17	-28313.794	828569.339	FGL + 2.0m
FW18	-28421.376	828436.421	FGL + 2.0m
FW19	-28270.385	828516.688	FGL + 2.0m
FW20	-28252.565	828483.166	FGL + 2.0m
FW21	-28402.673	828403.369	FGL + 2.0m
FW22	-28232.872	828395.139	FGL + 2.0m
FW23	-28234.087	828370.062	FGL + 2.0m
FW24	-28347.954	828375.580	FGL + 2.0m
FW25	-28345.445	828261.608	FGL + 2.0m
FW26	-28593.417	828255.514	FGL + 2.0m
FW27	-28663.241	828256.760	FGL + 2.0m
FW28	-28922.082	828370.126	FGL + 2.0m

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IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION OVERALL SETTING OUT

SCALE	1:1250
CO-ORD SYSTEM	Lo 27
SHEET	1 OF 1
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DRAWING NUMBER :	710.09003.00091-003
REV :	T0

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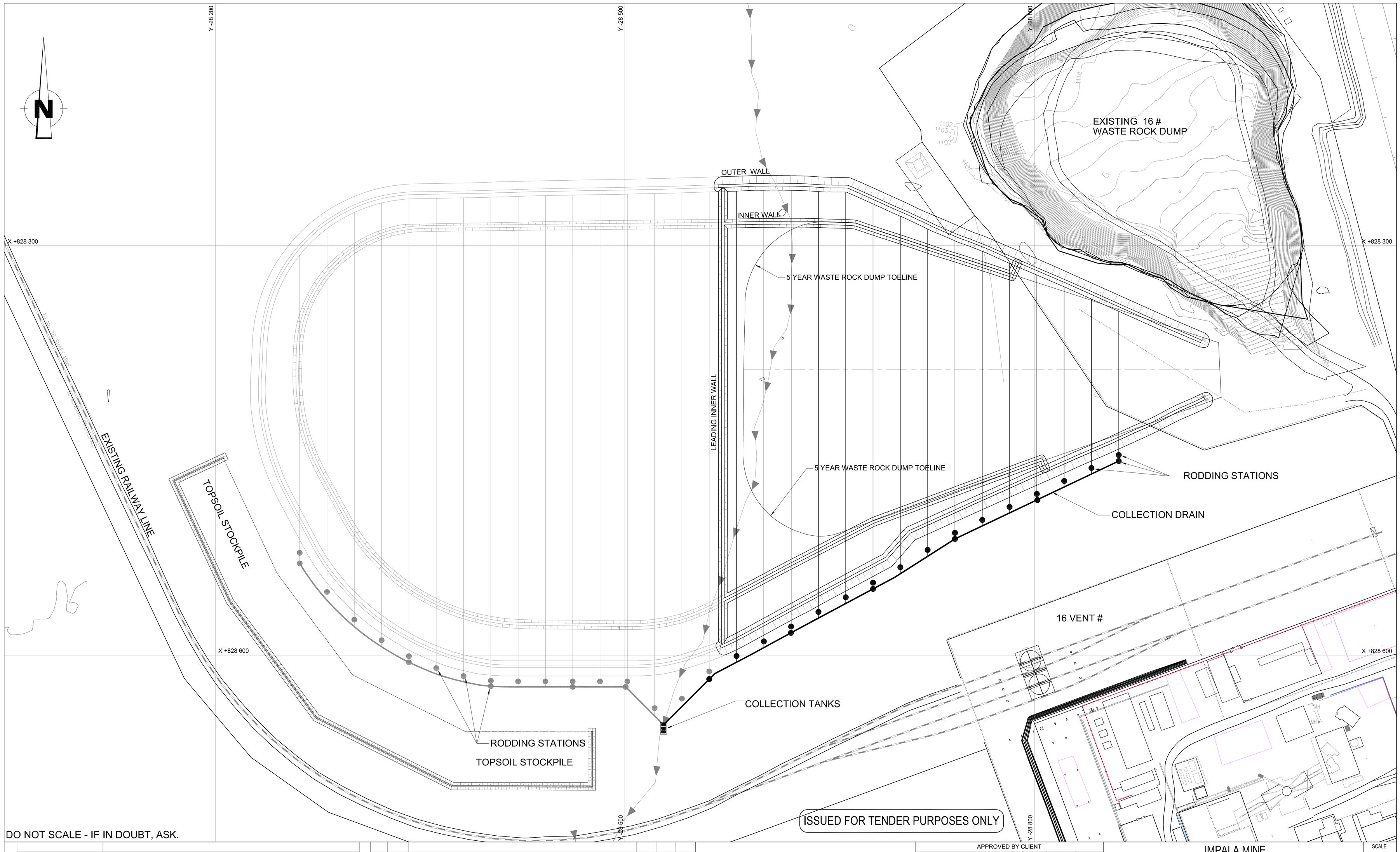

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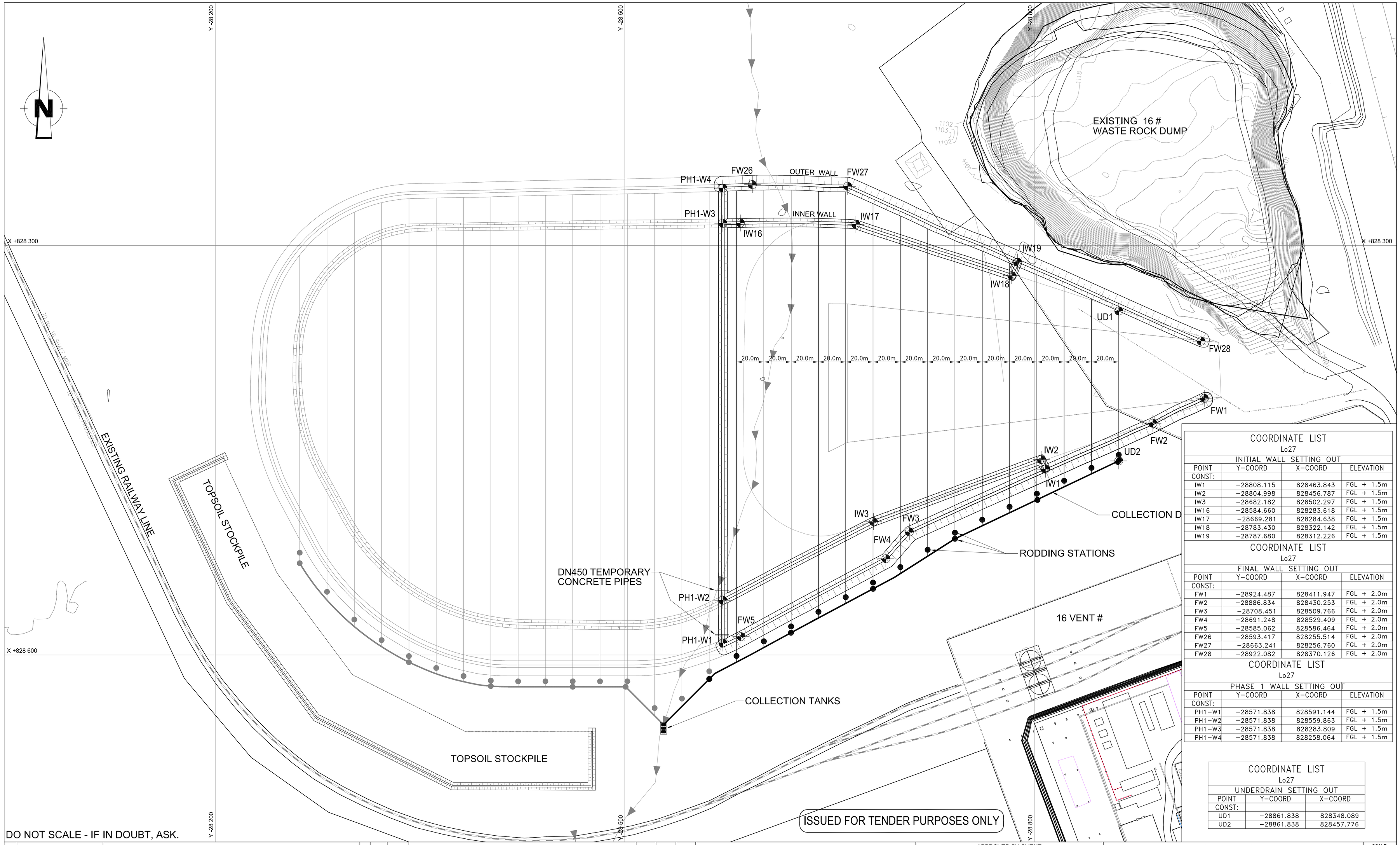
DESIGNATION	DATE	INITIALS	SIGN
DRAUGHTSMAN	JAN13	AL	
DESIGN ENGINEER	JAN13	SD	
PROJECT DIRECTOR	JAN13	ARJ	
PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION PHASE 1 CONSTRUCTION LAYOUT

SCALE	1:1250
CO-ORD SYSTEM	Lo 27
SHEET	1 OF 1
	A1
DRAWING NUMBER :	710.09003.00091-004
REV :	T0

M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-004_RevT0_Phase 1 Construction Layout.dwg Jan 09, 2013 - 2:00pm



COORDINATE LIST
Lo27
INITIAL WALL SETTING OUT

POINT	Y-COORD	X-COORD	ELEVATION
CONST:			
IW1	-28808.115	828463.843	FGL + 1.5m
IW2	-28804.998	828456.787	FGL + 1.5m
IW3	-28682.182	828502.297	FGL + 1.5m
IW16	-28584.660	828283.618	FGL + 1.5m
IW17	-28669.281	828284.638	FGL + 1.5m
IW18	-28783.430	828322.142	FGL + 1.5m
IW19	-28787.680	828312.226	FGL + 1.5m

COORDINATE LIST
Lo27
FINAL WALL SETTING OUT

POINT	Y-COORD	X-COORD	ELEVATION
CONST:			
FW1	-28924.487	828411.947	FGL + 2.0m
FW2	-28886.834	828430.253	FGL + 2.0m
FW3	-28708.451	828509.766	FGL + 2.0m
FW4	-28691.248	828529.409	FGL + 2.0m
FW5	-28585.062	828586.464	FGL + 2.0m
FW26	-28593.417	828255.514	FGL + 2.0m
FW27	-28663.241	828256.760	FGL + 2.0m
FW28	-28922.082	828370.126	FGL + 2.0m

COORDINATE LIST
Lo27
PHASE 1 WALL SETTING OUT

POINT	Y-COORD	X-COORD	ELEVATION
CONST:			
PH1-W1	-28571.838	828591.144	FGL + 1.5m
PH1-W2	-28571.838	828559.863	FGL + 1.5m
PH1-W3	-28571.838	828283.809	FGL + 1.5m
PH1-W4	-28571.838	828258.064	FGL + 1.5m

COORDINATE LIST
Lo27
UNDERDRAIN SETTING OUT

POINT	Y-COORD	X-COORD
CONST:		
UD1	-28861.838	828348.089
UD2	-28861.838	828457.776

REFERENCE

DRAWING NUMBER	TITLE

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No.	DATE	DESCRIPTION	BY	CHKD	DATE
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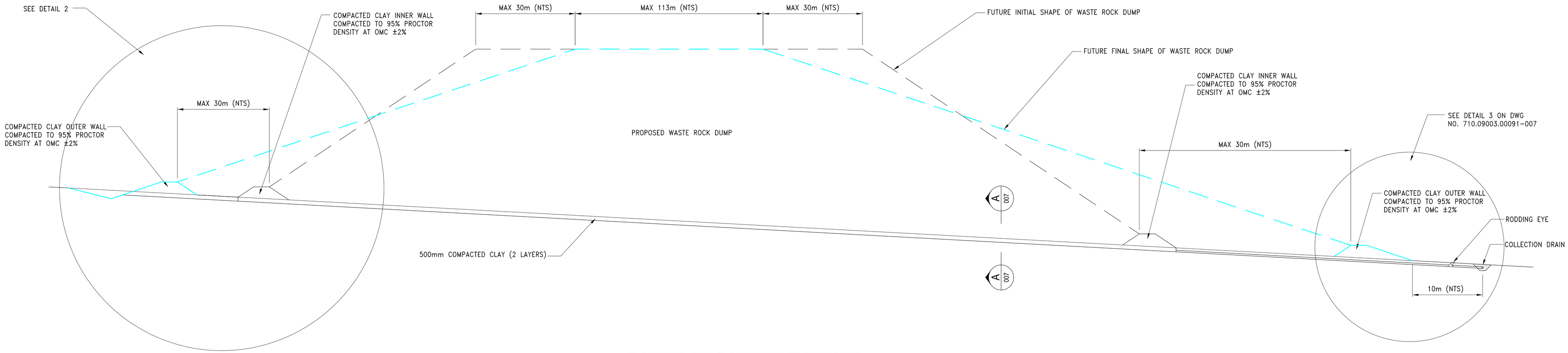
IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION PHASE 1 CONSTRUCTION SETTING OUT

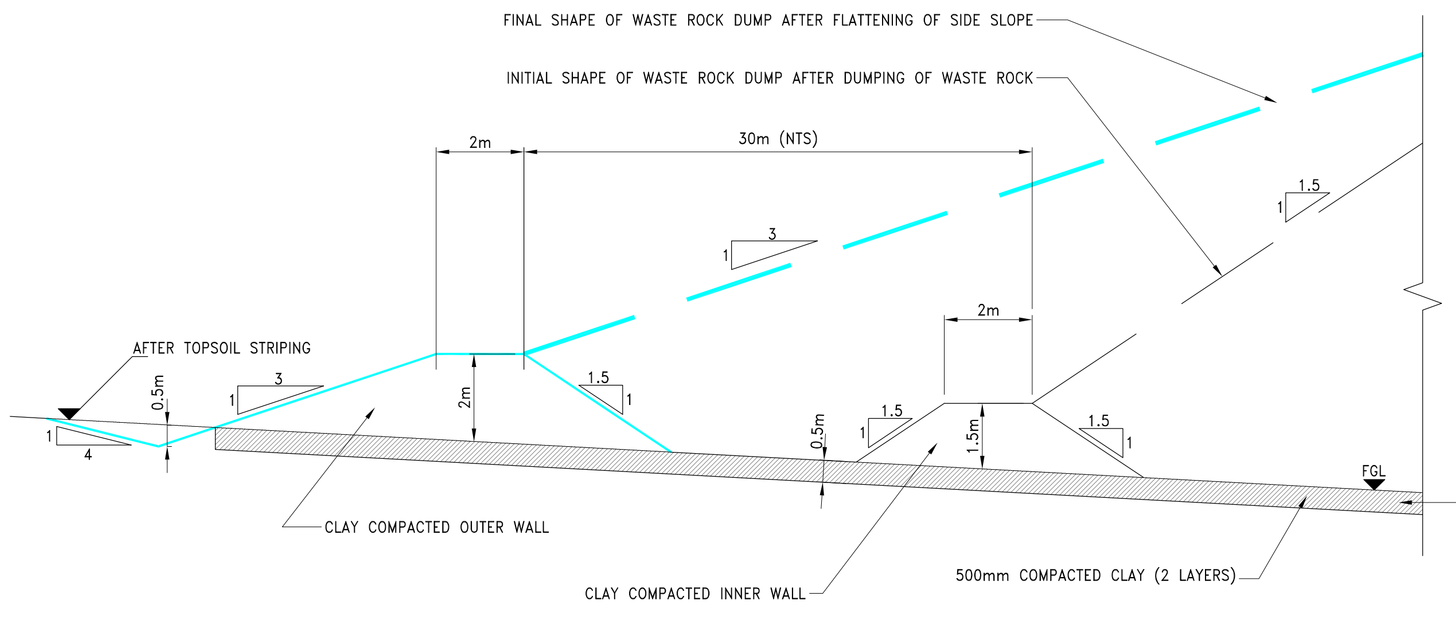
SCALE: 1:1250
CO-ORD SYSTEM: Lo 27
SHEET: 1 OF 1
A1

DRAWING NUMBER : 710.09003.00091-005
REV : T0

M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-005_RevT0_Phase 1 Construction Setting Out.dwg Jan 09, 2013 - 2:02pm



TYPICAL SECTION THROUGH WASTE ROCK DUMP
SCALE 1:250



TOPSOIL TO BE STRIPPED TO A MAXIMUM DEPTH OF 400 mm AND STOCKPILED ON THE DESIGNATED TOPSOIL STOCKPILE.
UNDERLYING BLACK TURF TO BE STRIPPED TO A FURTHER 300 mm AND TEMPORARY STOCKPILED.
UNDERLYING SURFACE TO BE RIPPED AND RECOMPACTED TO 95% PROCTOR DENSITY AT OMC ± 2%.
SOIL FROM TEMPORARY STOCKPILE TO BE USED TO FORM A FURTHER 300 mm COMPACTED LAYER.

DETAIL 2
1:100 --

ISSUED FOR TENDER PURPOSES ONLY

DO NOT SCALE - IF IN DOUBT, ASK.

REFERENCE

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PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

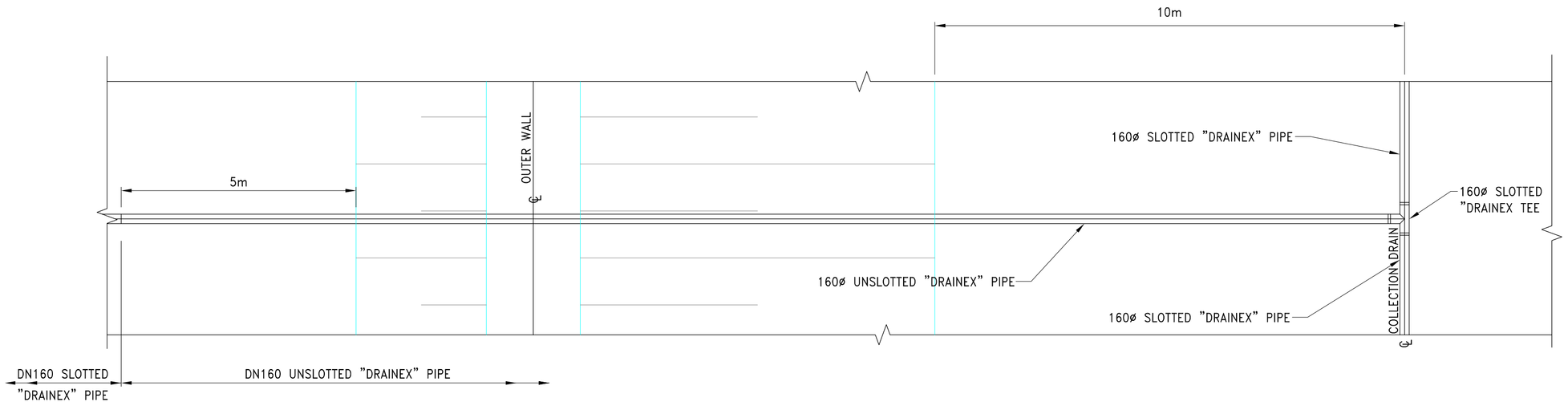
IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION
TYPICAL SECTIONS

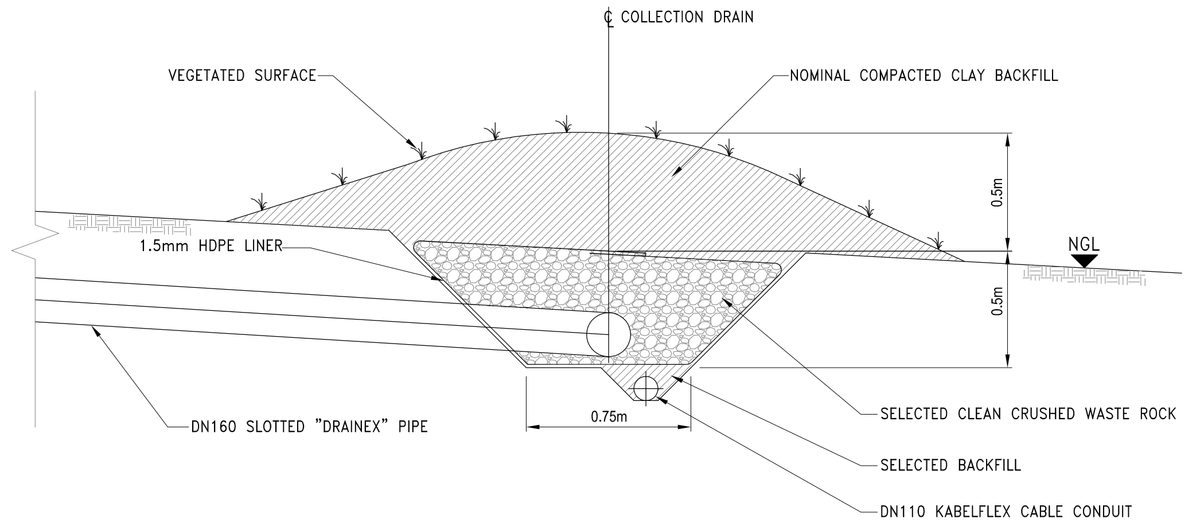
SCALE: AS SHOWN
CO-ORD SYSTEM: Lo 27
SHEET: 1 OF 1
A1

DRAWING NUMBER : 710.09003.00091-006
REV : T0

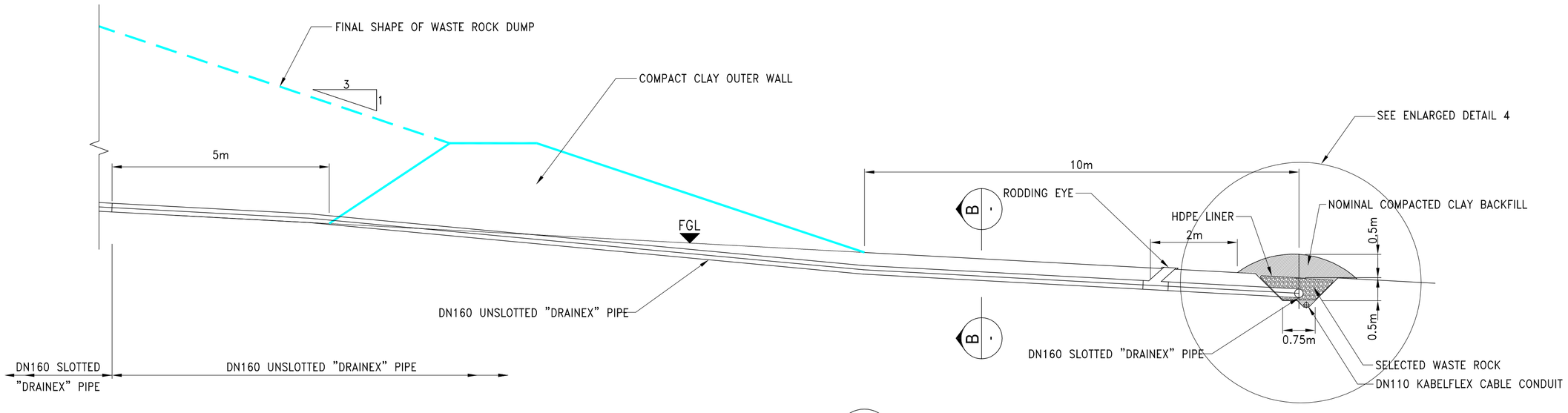
M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-006_RevT0_Typical Sections.dwg Jan 09, 2013 - 2:03pm



PLAN
1:75

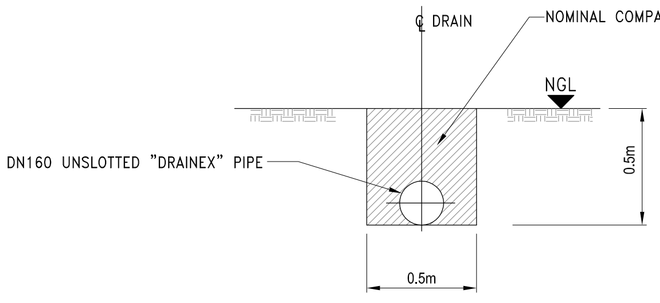


DETAIL 4
1:20

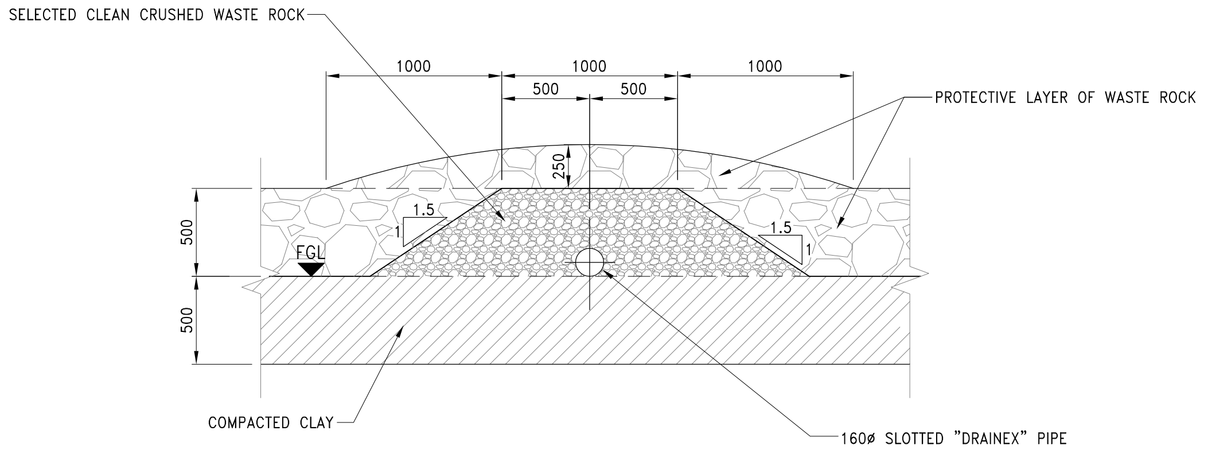


DETAIL 3
1:75

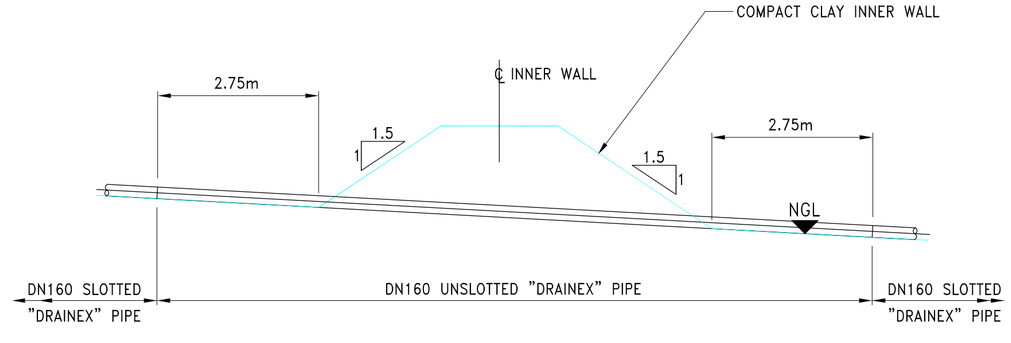
TYPICAL DETAIL OF UNDERDRAIN



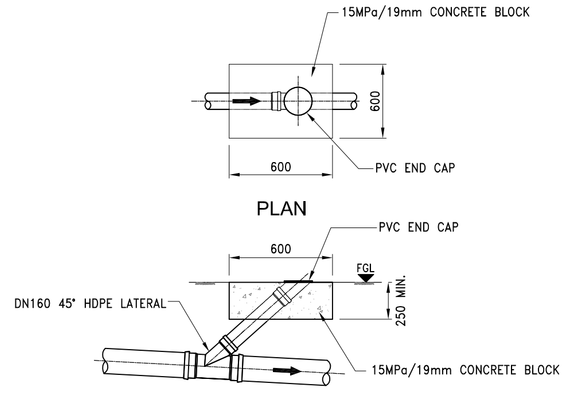
SECTION B
1:20



SECTION A
1:25



TYPICAL DETAIL OF UNDERDRAIN THROUGH INNER WALL
1:75



RODDING EYE DETAIL

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PROJECT DIRECTOR	JAN13	ARJ	
PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

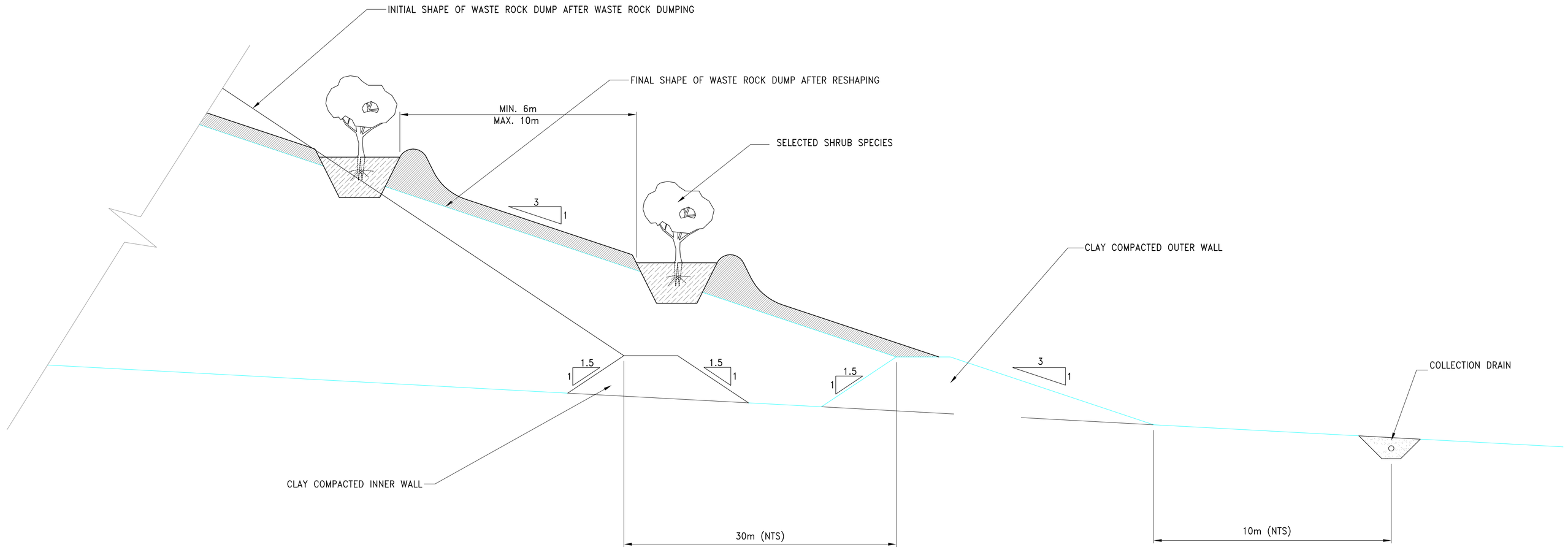
IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION
UNDERDRAINAGE DETAILS

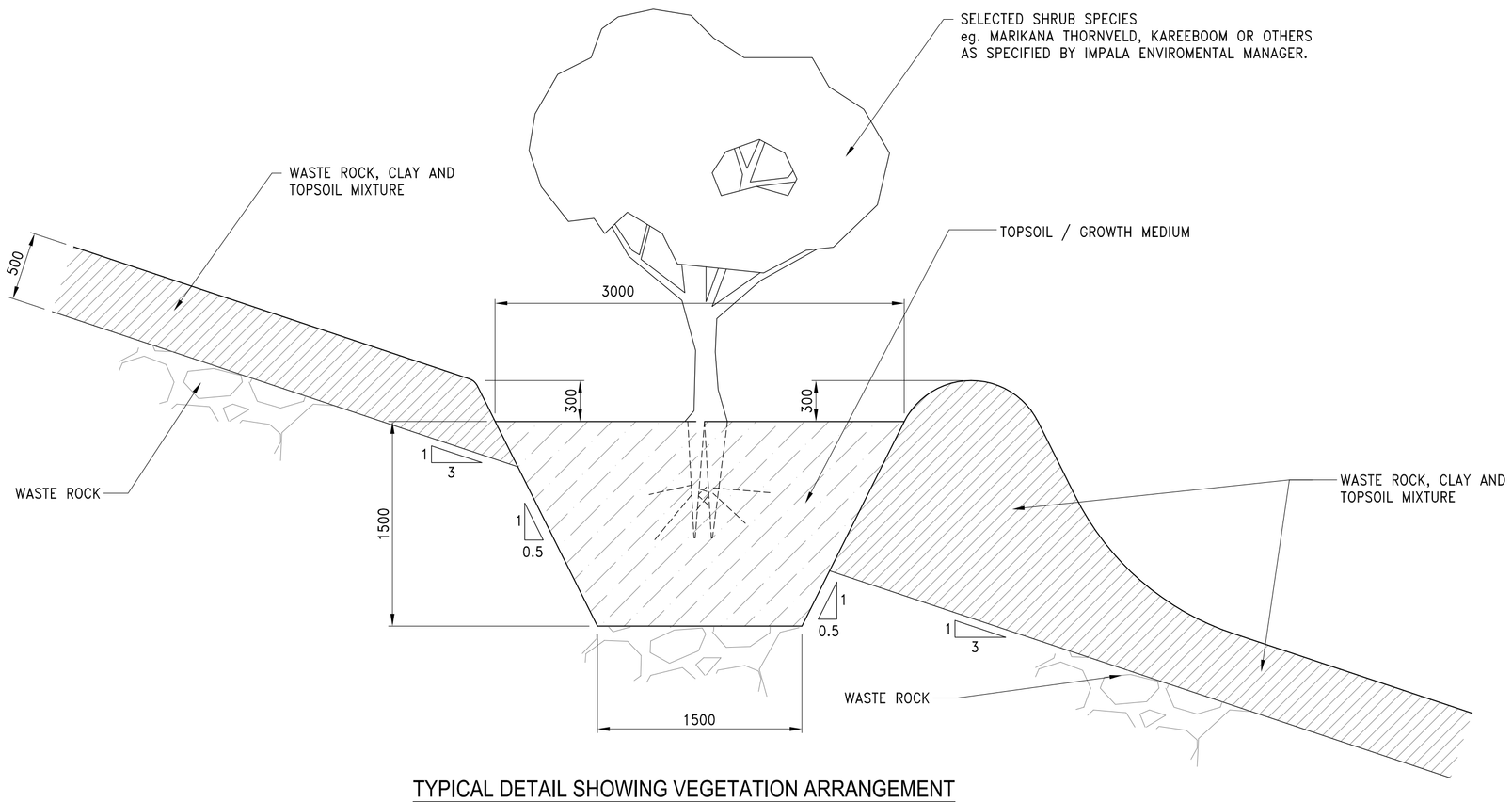
SCALE	CO-ORD SYSTEM	SHEET	
AS SHOWN	Lo 27	1 OF 1	A1

DRAWING NUMBER : 710.09003.00091-007 REV : T0

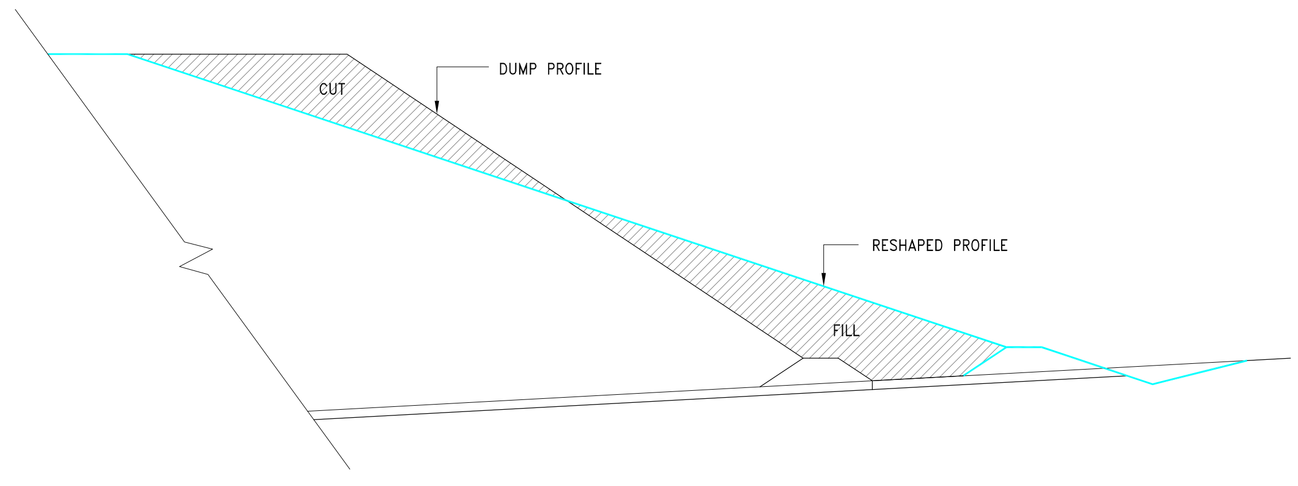
M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-007_RevT0_Underdrainage Typical Sections.dwg Jan 09, 2013 - 2:04pm



TYPICAL SECTION THROUGH INNER AND OUTER WALLS SHOWING VEGETATION ARRANGEMENT
SCALE 1:100



TYPICAL DETAIL SHOWING VEGETATION ARRANGEMENT
SCALE 1:250



TYPICAL RE-SHAPING DETAIL
SCALE 1:250

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REFERENCE

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DESIGNATION	DATE	INITIALS	SIGN
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DESIGNATION	DATE	INITIALS	SIGN
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DESIGN ENGINEER	JAN13	SD	
PROJECT DIRECTOR	JAN13	ARJ	
PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION
REHABILITATION DETAILS

SCALE	AS SHOWN
CO-ORD SYSTEM	Lo 27
SHEET	1 OF 1
	A1
DRAWING NUMBER :	710.09003.00091-008
REV :	T0

M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-008_RevT0_Rehabilitation Details.dwg Jan 09, 2013 - 2:05pm

COORDINATE LIST Lo 27		
TEST PITS SETTING OUT		
POINT	Y-COORD	X-COORD
CONST:		
TP6	-28686.284	2828362.675
TP10	-28521.256	2828516.189
TP11	-28420.986	2828414.394
TP12	-28429.564	2828349.830
TP13	-28398.461	2828515.927
TP14	-28328.881	2828441.892
TP15	-28334.610	2828346.526
TP16	-28272.853	2828515.660
TP17	-28203.252	2828450.820
TP18	-28220.148	2828349.385
TP20	-28555.438	2828227.026
TP21	-28571.928	2828316.236
TP22	-28569.030	2828402.414
TP23	-28705.615	2828485.789
TP24	-28850.631	2828526.092
TP25	-28761.418	2828470.511
TP26	-28750.072	2828559.772

NO.16 SHAFT MINE

PROPOSED 16 # WASTE ROCK DUMP EXPANSION

EXISTING 16 # WASTE ROCK DUMP

16 VENT #

Y -28 200 | Y -28 500 | Y -28 800 | Y -29 100

X +2 828 300 | X +2 828 600

TP18 TP15 TP12 TP20 TP21 TP6 TP22 TP11 TP17 TP14 TP25 TP23 TP16 TP13 TP10 TP24 TP26

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PROJECT DIRECTOR	JAN13	ARJ	
PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

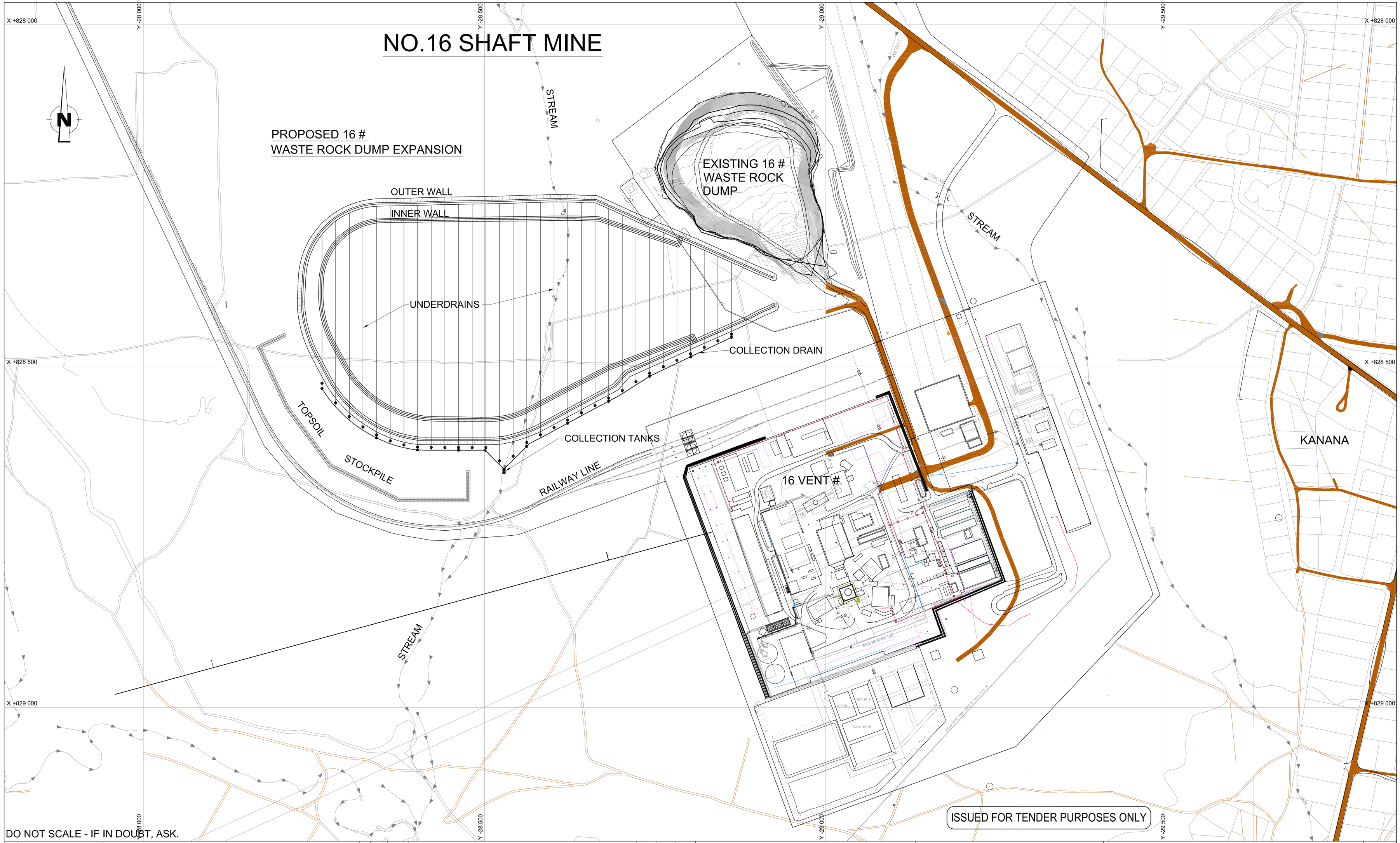
IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION TEST PITS SETTING OUT

SCALE	1:1500
CO-ORD SYSTEM	Lo 27
SHEET	1 OF 1
	A1
DRAWING NUMBER :	710.09003.00091-009
REV :	T0

M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-009_RevT0_Test Pits Setting Out.dwg Jan 09, 2013 - 2:12pm

NO.16 SHAFT MINE



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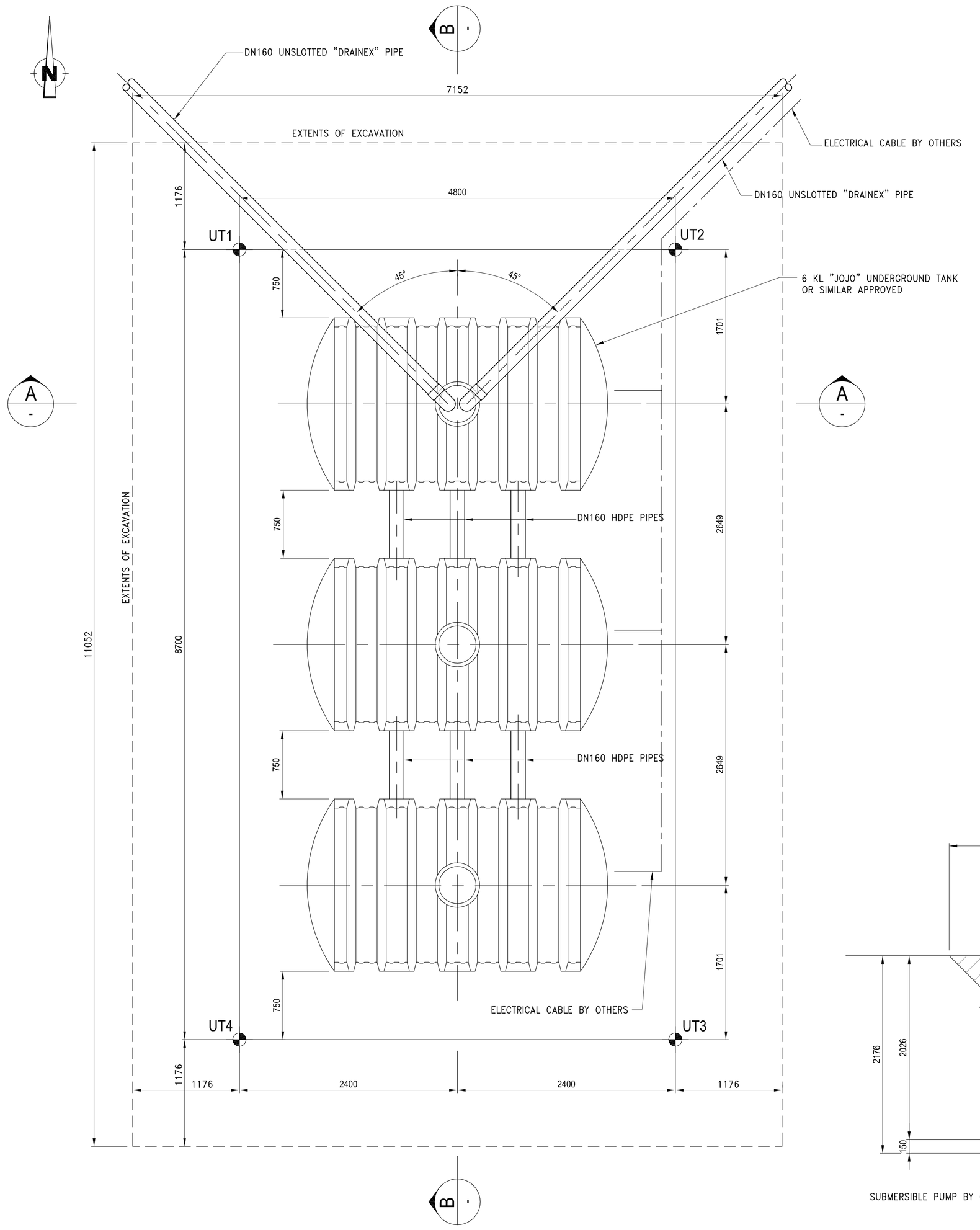
IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

OVERALL LAYOUT

SCALE	1:2500
CO-ORD SYSTEM	Lo 27
SHEET	1 OF 1
	A1

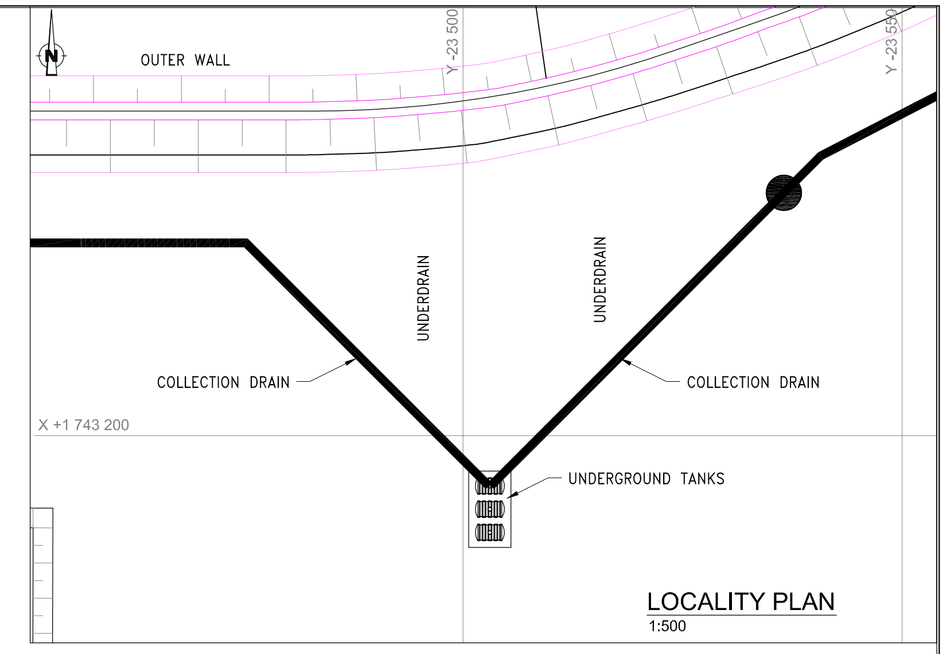
DRAWING NUMBER : 710.09003.00091-010 REV : T0

M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-010_RevT0_Overall Layout.dwg Jan 09, 2013 - 2:16pm

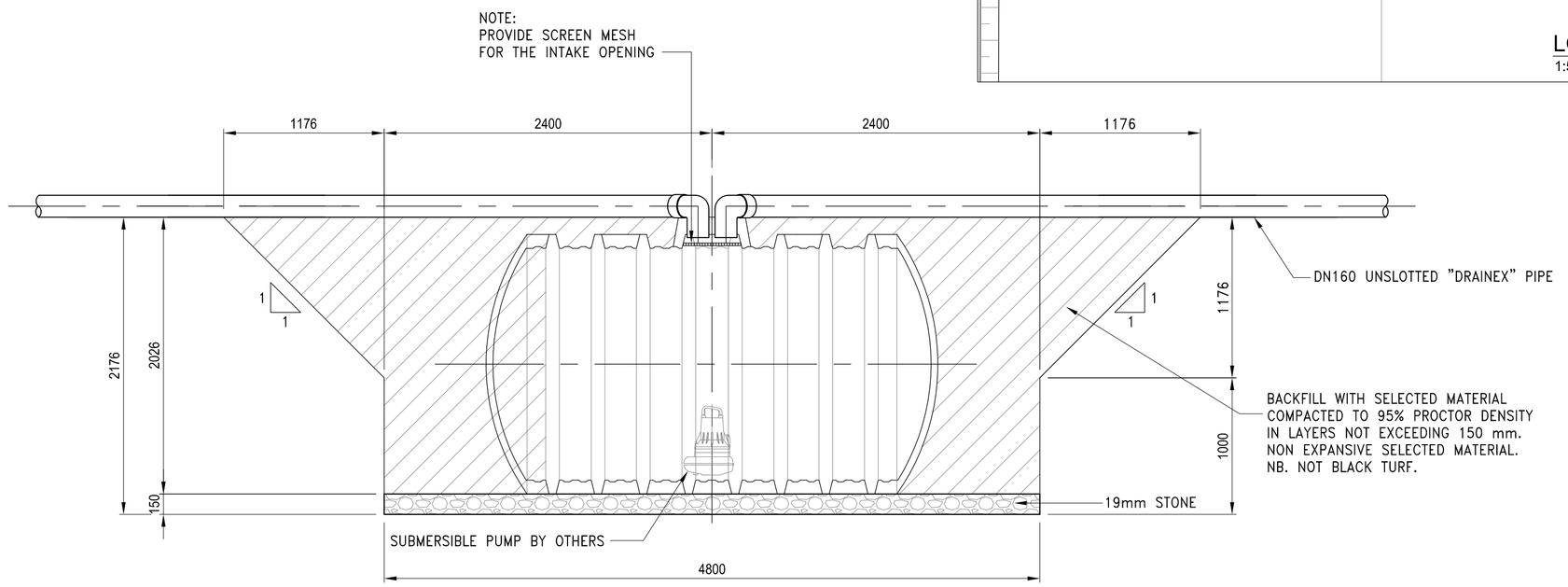


PLAN
SCALE 1:30

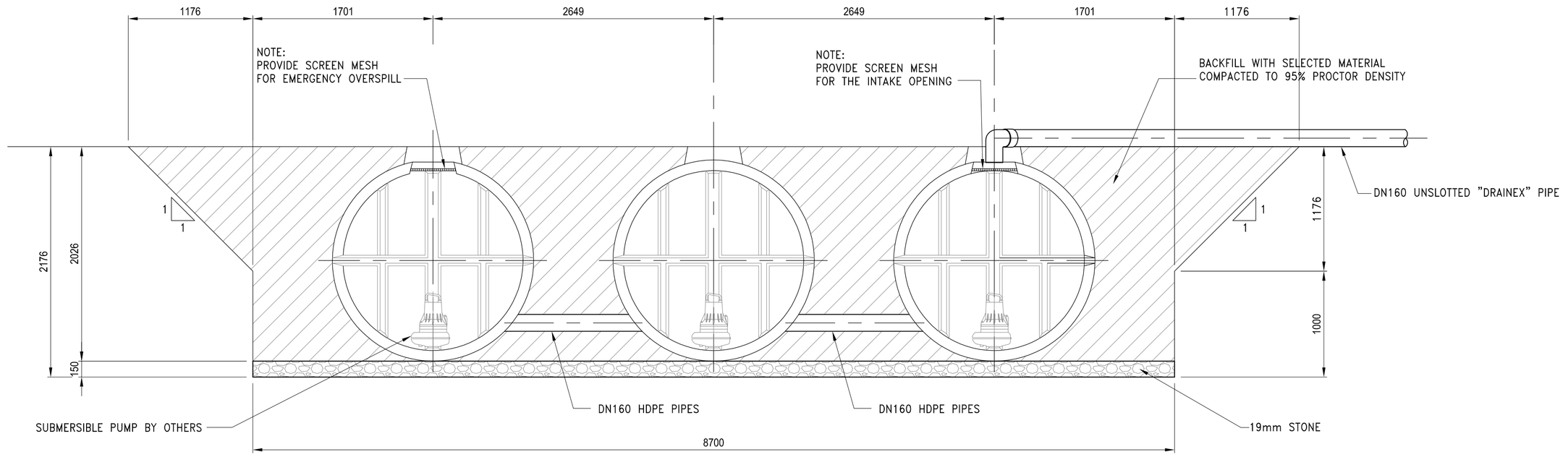
COORDINATE LIST		
Lo27		
UNDERGROUND TANKS SETTING OUT		
POINT	Y-COORD	X-COORD
CONST:		
UT1	-23500.665	1743204.022
UT2	-23505.465	1743204.022
UT3	-23505.465	1743212.721
UT4	-23500.665	1743212.721



LOCALITY PLAN
1:500



SECTION A
1:30



SECTION B
1:30

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PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

SHAFT 16 WASTE ROCK DUMP EXTENSION
DETAILS OF UNDERGROUND COLLECTION TANKS

SCALE	AS SHOWN
CO-ORD SYSTEM	Lo 27
SHEET	1 OF 1
	A1
DRAWING NUMBER :	710.09003.00091-011
REV :	T0

M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-011_RevT0_Details of Underground Collection Tanks.dwg Jan 09, 2013 - 2:17pm

COORDINATE LIST Lo 27		
DUMP LIMITS SETTING OUT		
POINT	Y-COORD	X-COORD
CONST:		
DL1	-28934.933	828371.043
DL2	-28663.119	828342.882
DL3	-28495.660	828342.720
DL4	-28328.144	828352.618
DL5	-28317.934	828401.291
DL6	-28345.787	828466.515
DL7	-28388.311	828506.375
DL8	-28526.160	828511.295
DL9	-28663.119	828444.250
DL10	-28936.838	828411.042

PROPOSED 16 # WASTE ROCK DUMP EXPANSION

Y -28 200 | Y -28 500 | Y -28 800

X +828 300 | X +828 600

STREAM

OUTER WALL

INNER WALL

DUMP LIMITS

DL1 DL2 DL3 DL4 DL5 DL6 DL7 DL8 DL9 DL10

EXISTING 16 # WASTE ROCK DUMP

16 VENT #

RAILWAY LINE TO MINERAL PROSSESES

TOPSOIL

STOCKPILE

RAILWAY LINE

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PROJECT DIRECTOR	JAN13	ARJ	
PROFESSIONAL ENGINEER (REG No. 890393)	JAN13	ARJ	

IMPALA MINE
SHAFT 16 WASTE ROCK DUMP EXTENSION

OPERATION DUMP LIMITS

SCALE	1:1250
CO-ORD SYSTEM	Lo 27
SHEET	1 OF 1
	A1
DRAWING NUMBER :	710.09003.00091-012
REV :	T0

M:\Projects 3\710.09003.00091 Impala Shaft 16 Waste Rock Dump\Drawings\710.09003.00091-012_RevT0_Operation Dump Limits.dwg Jan 10, 2013 - 8:47am

APPENDIX B: SOIL PROFILES

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 6

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 362.675
CONTRACTOR	: JJG		: Y: -28 686.284
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 6

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil
			0.4m
			Moist, Black, firm, Slickensided, Clay with Calcrete nodules present
1			1.3m
			Slightly Moist, Light Brown, Slightly weathered Norite, Silty Gravel
			1.9m
2			Bulk sample at 0.7m No water encountered Machine refusal at 1.9m
3			
4			
5			

10-31-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP11.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 10

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 516.189
CONTRACTOR	: JJG		: Y: -28 512.256
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 10

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil with some roots
			0.5m
			Slightly Moist, Black, Firm, Slickensided, Clay
1			
			1.6m
			Dry, Light Grey, Slightly weathered Norite, Fine grain size with small boulders
2			
			2.8m
			Sample at 2.5m No water encountered Machine refusal at 2.8m
3			
4			
5			

10-31-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP6.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 11

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 414.394
CONTRACTOR	: JJG		: Y: -28 420.986
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 11

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil 0.3m
			Moist, Black, Firm, Slickensided, Clay
1			1.3m
			Dry, Light Brown, Slightly weathered Norite, Fine grain size with small boulders up to 30cm
2			
			3.1m
3			No Sample No water encountered Machine refusal at 3.1m
4			
5			

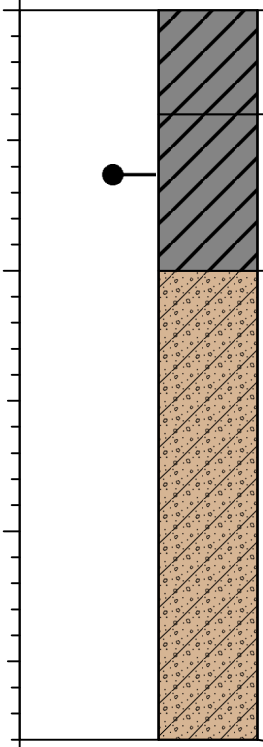
10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP11.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 12

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 349.830
CONTRACTOR	: JJG		: Y: -28 429.564
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 12



Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil
			0.4m
			Slightly Moist, Black, Firm, Slickensided, Clay
1			1.0m
			Dry, Light Brown, Highly weathered Norite, Medium grain size with rocks smaller than 20cm in size
2			2.3m
			Sample at 0.6m No water encountered Machine refusal at 2.3m
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP12.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 13

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 515.927
CONTRACTOR	: JJG		: Y: -28 398.461
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 13

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil with some roots
			0.4m
			Moist, Black, Firm, Slickensided, Clay
1			1.1m
			Slightly Moist, Light Brown, Highly weathered Norite, Medium grain sized with rocks up to 15cm
2			
3			3.2m
			No Sample No water encountered Machine refusal
4			
5			

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IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 14

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 441.892
CONTRACTOR	: JJG		: Y: -28 328.881
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 14

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil
			0.4m
			Slightly Moist, Black, Firm, Slickensided, Clay
			1.0m
1			Slightly Moist, Light Brown, Highly weathered Norite, Fine grain sized
2			
3			
4			4.3m
			Topsoil Sample at 0.2m No water encountered No Machine refusal
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP14.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 15

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 346.526
CONTRACTOR	: JJG		: Y: -28 334.610
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 15

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil 0.3m
			Slightly Moist, Black, Firm, Slickensided, Clay 0.9m
1			Slightly Moist, Light Grey, Highly weathered Norite, Coarse grain sized with boulders up to 0.4m 1.9m
2			No Sample No water encountered Machine refusal at 1.9m
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP15.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 16

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 515.660
CONTRACTOR	: JJG		: Y: -28 272.853
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 16

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil with few roots 0.3m
			Moist, Black, Firm, Slickensided, Clay 1.1m
1			Dry, Light Grey, Highly weathered Norite, Coarse grain sized with boulders up to 1.0m 2.6m
2			No Sample No water encountered Machine refusal at 2.6m
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP16.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 17

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 450.820
CONTRACTOR	: JJG		: Y: -28 203.252
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 17

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil with few roots 0.3m
			Slightly Moist, Black, Firm, Slickensided, Clay
1			1.4m
			Dry, Light Brown, Highly weathered Norite, Coarse grain size with soft rock up to 0.4m in size
2			2.3m
			Small Sample taken at 0.7m No water encountered Machine refusal
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP17.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 18

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 349.385
CONTRACTOR	: JJG		: Y: -28 220.148
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 18

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil
			0.4m
			Slightly Moist, Black, Firm, Slickensided, Clay
1			1.3m
			Dry, Light Grey, Highly weathered Norite, Medium grain size with soft rock up to 0.2m in size
			1.8m
	●		Small Sample taken at 1.8m No water encountered Machine refusal
2			
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP18.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 20

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 227.026
CONTRACTOR	: JJG		: Y: -28 555.438
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 20

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil 0.4m
			Moist, Black, Firm, Slickensided, Clay 1.5m
			Dry, Light Brown, Highly weathered Norite, Medium grain size 1.9m
2			No Sample No water encountered Machine refusal
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP20.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 21

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 316.236
CONTRACTOR	: JJG		: Y: -28 571.982
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 21

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Slightly Moist, Black, Soft, Fissured, Clay, Topsoil with few roots 0.3m
			Slightly Moist, Dark Brown, Firm, Slickensided, Clay 0.7m
1			Dry, Light Brown, Highly weathered Norite, Silty 1.4m
			On drainage channel No Sample No water encountered Machine refusal
2			
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP21.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 22

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 402.414
CONTRACTOR	: JJG		: Y: -28 569.030
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 22

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil 0.3m
			Slightly Moist, Brown, Firm, Slickensided, Clay 1.0m
1			Dry, Light Brown, Highly weathered Norite, Fine grain size 1.3m
			No Sample No water encountered Machine refusal
2			
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP22.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 23

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 485.789
CONTRACTOR	: JJG		: Y: -28 705.615
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 23

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil 0.3m
			Slightly Moist, Black, Firm, Slickensided, Clay
1			1.2m
			Dry, Light Brown, Highly weathered Norite, Medium grain size
			1.8m
2			Small Sample at 1.6m No water encountered Machine refusal
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP23.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 24

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 526.092
CONTRACTOR	: JJG		: Y: -28 850.631
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 24

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil with some roots
			0.4m
			Slightly Moist, Black, Firm, Slickensided, Clay
1			1.2m
			Dry, Light Brown, Highly weathered Norite, fine grain size
2			2.8m
			No Sample No water encountered Machine refusal
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP24.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 25

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 470.511
CONTRACTOR	: JJG		: Y: -28 761.418
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 25

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			
			Dry, Black, Soft, Fissured, Clay, Topsoil with some roots
			0.4m
			Slightly Moist, Black, Firm, Slickensided, Clay
1			1.1m
			Dry, Light Gray, Highly weathered Norite, fine grained
			1.6m
			No Sample No water encountered Machine refusal at 1.6m
2			
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP25.bor

IMPALA PLATINUM
GEOTECHNICAL INVESTIGATION

PROJECT No. 710.09003.00091

TP 26

EXCAVATOR	: Sumitomo JH240	DATE	: 24/08/1012
OPERATOR	: Pitrous Dludlu	POSITION	: X: 2 828 559.772
CONTRACTOR	: JJG		: Y: -28 750.072
PROFILED BY	: S.D DLADLA	WEATHER	: Hot, no wind
HOLE TYPE	:	HOLE NO	: TP 26

Depth in Meters	SAMPLE	GRAPHIC	DESCRIPTION
0			Dry, Black, Soft, Fissured, Clay, Topsoil
			0.4m
			Slightly Moist, Brown, Firm, Slickensided, Clay
1			1.0m
			Dry, Light Brown, Highly weathered Norite, Medium grain size
2			2.3m
			No Sample No water encountered Machine refusal at 2.3m
3			
4			
5			

10-30-2012 C:\Documents and Settings\bnorman\Desktop\Impala Soil profiles\TP26.bor

APPENDIX C: MATERIALS LABORATORY TEST RESULTS

FOUNDATION INDICATOR TEST RESULTS

A SANAS accredited testing laboratory No T0062
36/38 Fourth Street, Booysens Reserve, Johannesburg 2091
P O Box 82223, Southdale 2135
Tel: +27 (0)11 835-3117 • Fax: +27 (0)11 835-2503
Tel: +27 (0)11 835-3117 • Fax: +27 (0)11 835-2503

Civilab
Civil Engineering Testing Laboratories

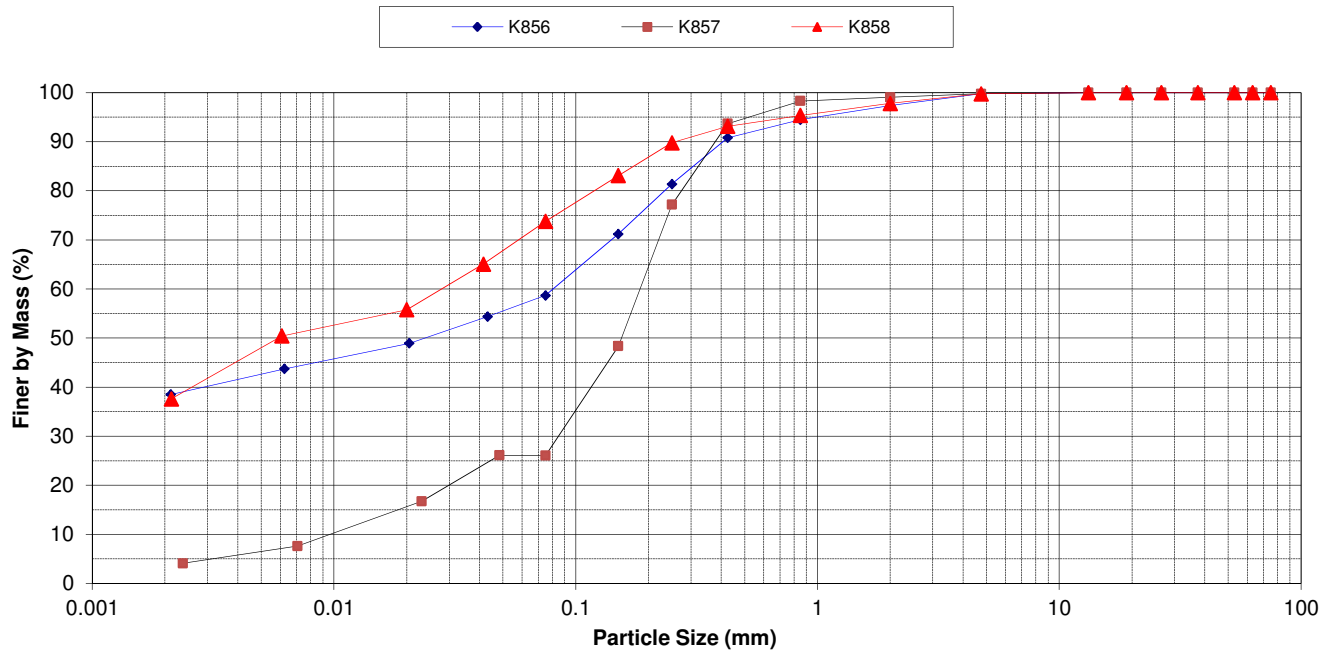
Foundation Indicator Test Data

Project	IMPALA WRD		
Project No.	1039/F95/08/2012	Date	6 September 2012

Sample No.	K856	K857	K858
Field Ref. No.	TP 6	TP 10	TP 12
Depth	0.70	2.50	0.60
Sieve size	%Passing	% Passing	% Passing
75	100	100	100
63	100	100	100
53	100	100	100
37.5	100	100	100
26.5	100	100	100
19.0	100	100	100
13.2	100	100	100
4.75	100	100	100
2.00	97	99	98
0.85	94	98	95
0.425	91	94	93
0.250	81	77	90
0.150	71	48	83
0.075	59	26	74
0.04	54	24	65
0.02	49	16	56
0.006	44	7	50
0.002	38	4	37

Sample No.	K856	K857	K858
%Gravel	3	1	2
%Sand	40	73	27
%Silt	19	23	34
%Clay	38	4	37
NMC %	28.2	10.8	31.6
Liquid Limit	56	NP	63
Plasticity Index	37	NP	41
Linear Shrink.	17.	0.	15.
Overall P.I.	34	NP	38
Grading Modulus	0.53	0.81	0.35
H.R.B.	A-7-6 (15)	A-2-4 (0)	A-7-6 (20)
Unified	CH	SM	CH
Weston swell (%) at 1 kPa	2.2		3.2

Analysis as per method D422 of ASTM of 1985
The results reported relate only to the samples tested.



Remarks:

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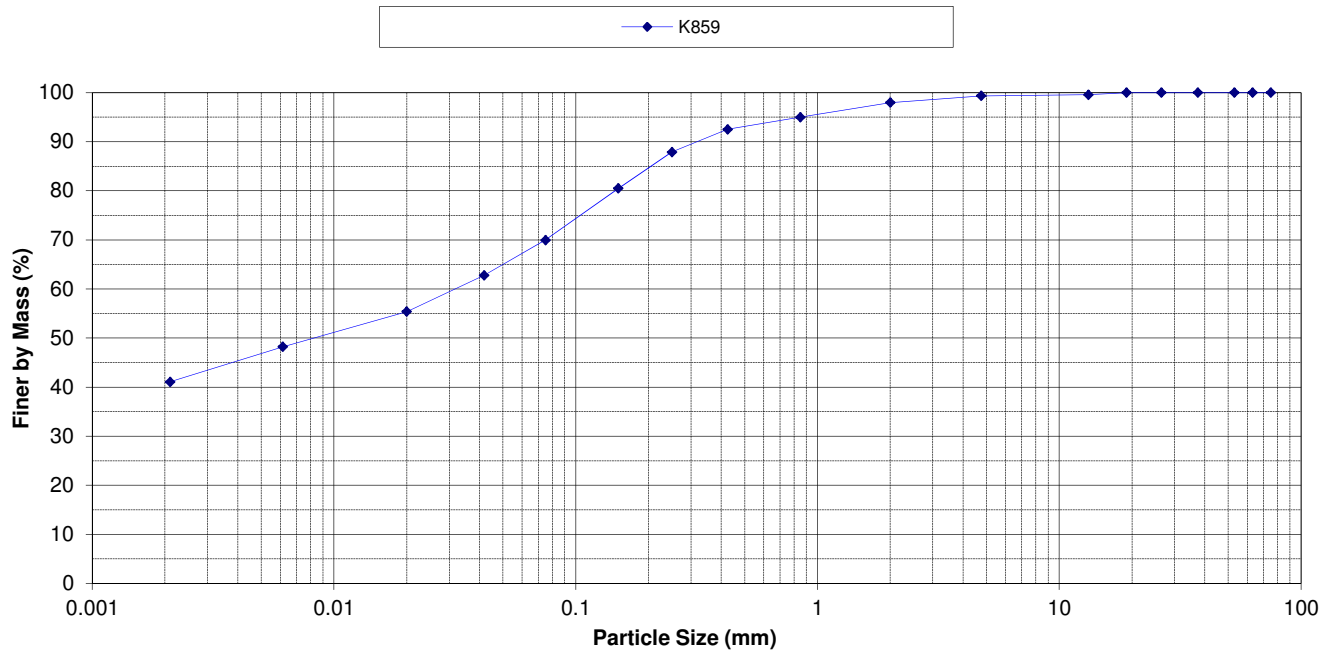
Foundation Indicator Test Data

Project	IMPALA WRD		
Project No.	1039/F95/08/2012	Date	11 September 2012

Sample No.	K859		
Field Ref. No.	TP 14		
Depth	Topsoil		
Sieve size	%Passing	% Passing	% Passing
75	100		
63	100		
53	100		
37.5	100		
26.5	100		
19.0	100		
13.2	100		
4.75	99		
2.00	98		
0.85	95		
0.425	93		
0.250	88		
0.150	80		
0.075	70		
0.04	62		
0.02	55		
0.006	48		
0.002	41		

Sample No.	K859		
%Gravel	2		
%Sand	31		
%Silt	26		
%Clay	41		
NMC %	28.0		
Liquid Limit	59		
Plasticity Index	38		
Linear Shrink.	18.5		
Overall P.I.	35		
Grading Modulus	0.40		
H.R.B.	A-7-6 (18)		
Unified	CH		
Weston swell (%) at 1 kPa	3.1		

Analysis as per method D422 of ASTM of 1985
The results reported relate only to the samples tested.



Remarks:

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Civil Engineering Testing Laboratories

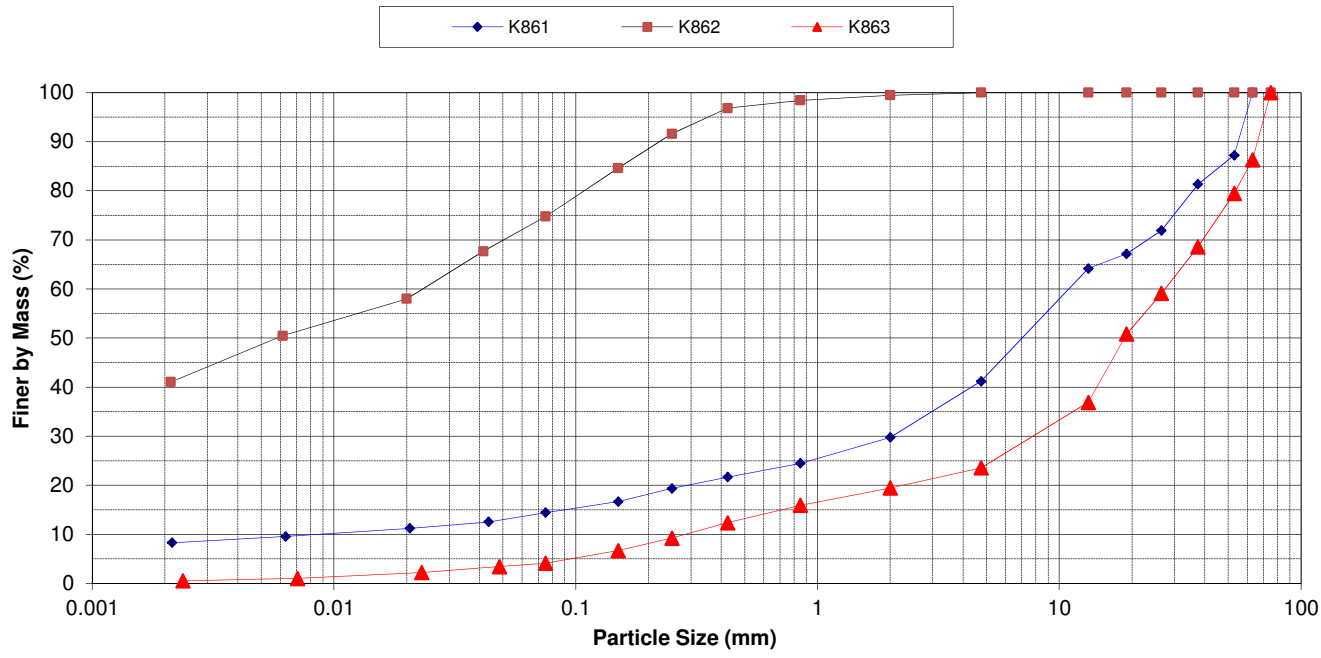
Foundation Indicator Test Data

Project	IMPALA WRD		
Project No.	1039/F95/08/2012	Date	6 September 2012

Sample No.	K861	K862	K863
Field Ref. No.	TP 18	TP 23	WRD
Depth	1.80	1.60	Wasterock
Sieve size	%Passing	% Passing	% Passing
75	100	100	100
63	100	100	86
53	87	100	79
37.5	81	100	69
26.5	72	100	59
19.0	67	100	51
13.2	64	100	37
4.75	41	100	24
2.00	30	99	19
0.85	24	98	16
0.425	22	97	12
0.250	19	92	9
0.150	17	85	7
0.075	14	75	4
0.04	12	67	3
0.02	11	58	2
0.006	9	50	1
0.002	8	41	0

Sample No.	K861	K862	K863
%Gravel	70	1	81
%Sand	16	27	16
%Silt	5	32	3
%Clay	8	41	0
NMC %	13.6	32.3	Not Tested
Liquid Limit	61	62	NP
Plasticity Index	38	42	NP
Linear Shrink.	17.	19.	0.
Overall P.I.	8	41	NP
Grading Modulus	2.34	0.29	2.64
H.R.B.	A-2-7 (0)	A-7-6 (20)	A-1-a (0)
Unified	GC	CH	GP
Weston swell (%) at 1 kPa	0.0	3.4	

Analysis as per method D422 of ASTM of 1985
The results reported relate only to the samples tested.



Remarks:

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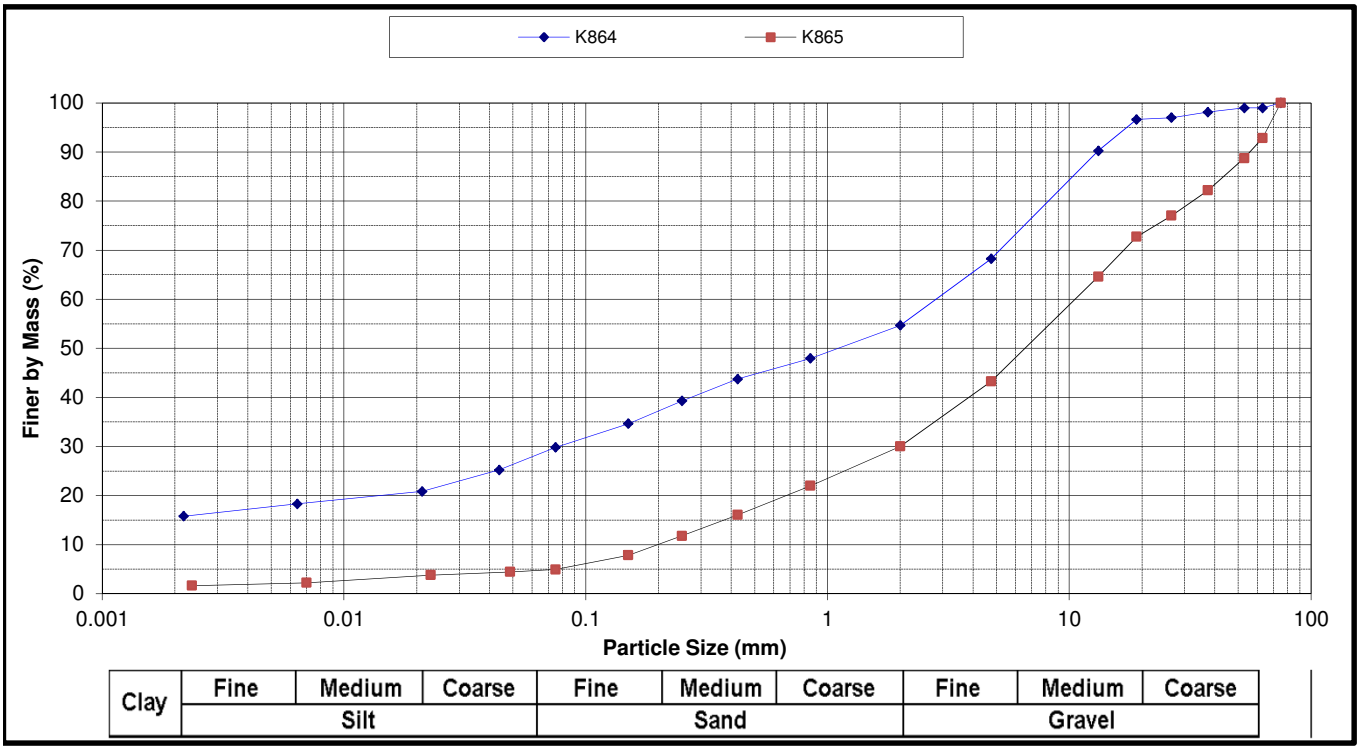
36/38 Fourth Street, Booysens Reserve, Johannesburg 2091
P O Box 82223, Southdale 2135
Tel: +27 (0)11 835-3117 • Fax: +27 (0)11 835-2503
Email: jhb@civilab.co.za • Website: www.civilab.co.za

Civilab
Civil Engineering Testing Laboratories

Foundation Indicator Test Data

Project	IMPALA WRD		
Project No.	1039/F95/08/2012	Date	11 September 2012

Sample No.	K864	K865		Sample No.	K864	K865	
Field Ref. No.	Clay + Soft rock norite (50:50)	Wasterock + Soft norite (50:50)		%Gravel	45	70	
Depth	-	-		%Sand	27	25	
Sieve size	%Passing	% Passing	% Passing	%Silt	12	3	
75	100	100		%Clay	16	2	
63	99	93		NMC %	Not Tested	Not Tested	
53	99	89		Liquid Limit	51	24	
37.5	98	82		Plasticity Index	28	5	
26.5	97	77					
19.0	97	73		Linear Shrink.	15.	2.5	
13.2	90	65		Overall P.I.	12	1	
4.75	68	43		Grading Modulus	1.72	2.49	
2.00	55	30					
0.85	48	22		H.R.B.	A-2-7 (3)	A-1-a (0)	
0.425	44	16		Unified	SC	GW	
0.250	39	12		Weston swell (%) at 1 kPa			
0.150	35	8					
0.075	30	5		Analysis as per method D422 of ASTM of 1985			
0.04	25	4		The results reported relate only to the samples tested.			
0.02	21	4		Documents may only be reproduced or published in their full context.			
0.006	18	2					
0.002	16	2					



Remarks:

PERMEABILITY TEST RESULTS

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Falling Head Permeability Test Results

Project:	IMPALA WRD		
Project No:	F95/08/2012	Date:	12/09/2012

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m^3		Coefficient of Permeability (m/s)		
			Before Test (%)	After Test (%)	As re-moulded	As tested	Range Minimum	Range Maximum	Average
K858	TP 12	0.6							
K861	TP 18	1.8	9.6	18.0	2078	2114	3.2E-09	4.7E-09	**4.0E-09**
K864	Clay material + Soft Rock Norite	-	12.3	19.1	1878	2039	1.1E-09	1.3E-09	**1.2E-09**
K865	Wasterock + Soft Rock Norite (50:50)	-	7.8	10.4	2153	2190	2.0E-07	2.4E-07	**2.2E-07**

Remarks: Samples remoulded to 95% of MDD @ OMC.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

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Falling Head Permeability Test Results

Project:	IMPALA WRD		
Project No:	F95/08/2012	Date:	12/09/2012

Lab. Sample Reference	Field Sample Reference	Depth (m)	Moisture Contents		Dry density Kg/m^3		Coefficient of Permeability (m/s)		
			Before Test (%)	After Test (%)	As re-moulded	As tested	Range Minimum	Range Maximum	Average
K858	TP 12	0.6	18.9	33.5	1550	1642	6.5E-09	8.5E-09	**7.7E-09**
K861	TP 18	1.8	9.6	18.0	2078	2114	3.2E-09	4.7E-09	**4.0E-09**
K864	Clay material + Soft Rock Norite	-	12.3	19.1	1878	2039	1.1E-09	1.3E-09	**1.2E-09**
K865	Wasterock + Soft Rock Norite (50:50)	-	7.8	10.4	2153	2190	2.0E-07	2.4E-07	**2.2E-07**

Remarks: Samples remoulded to 95% of MDD @ OMC.
Saturated and tested under a load of 100kPa.
Densities reported are under a load of 100kPa.

MOISTURE-DENSITY TEST RESULTS

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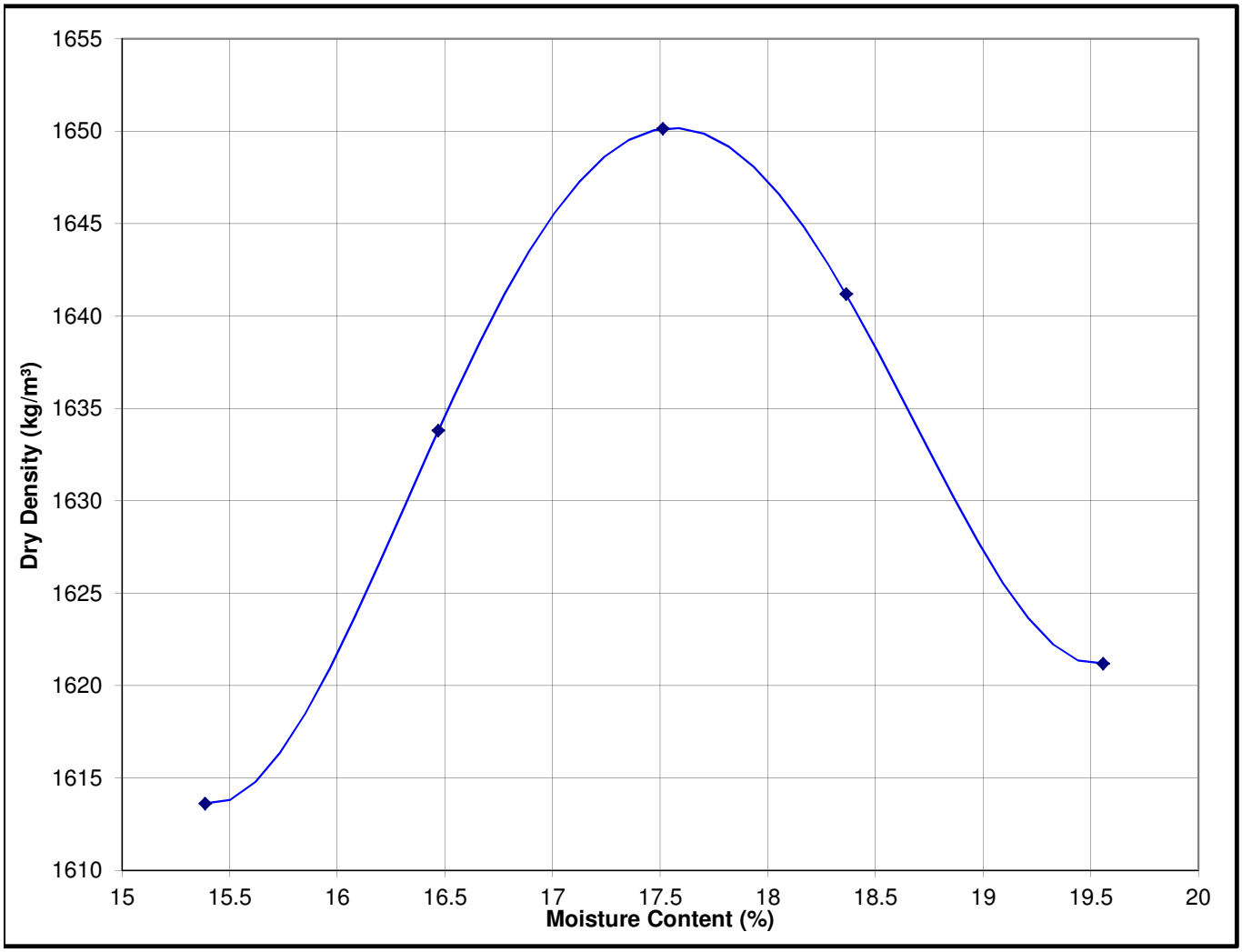
Moisture Density Relationship

Project:	IMPALA WRD		
Project No.:	1039/F95/08/2012	Date:	18 September 2012
Field Reference:	TP 12	Laboratory Ref.:	K858
Depth (m):	0.6	Remarks:	Untreated
Description:	-		

Compactive Effort: **Mod. AASHTO**

Percent Water Content (%):	17.5	18.4	16.5	19.6	15.4				
Dry Density (kg/m^3):	1650	1641	1634	1621	1614				

Maximum Dry Density: **1650 kg/m^3** **Optimum Moisture Content:** **17.6 %**



Analysis according to Method A7 of TMH1 of 1986.
The results relate only to the samples tested.
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Remarks:

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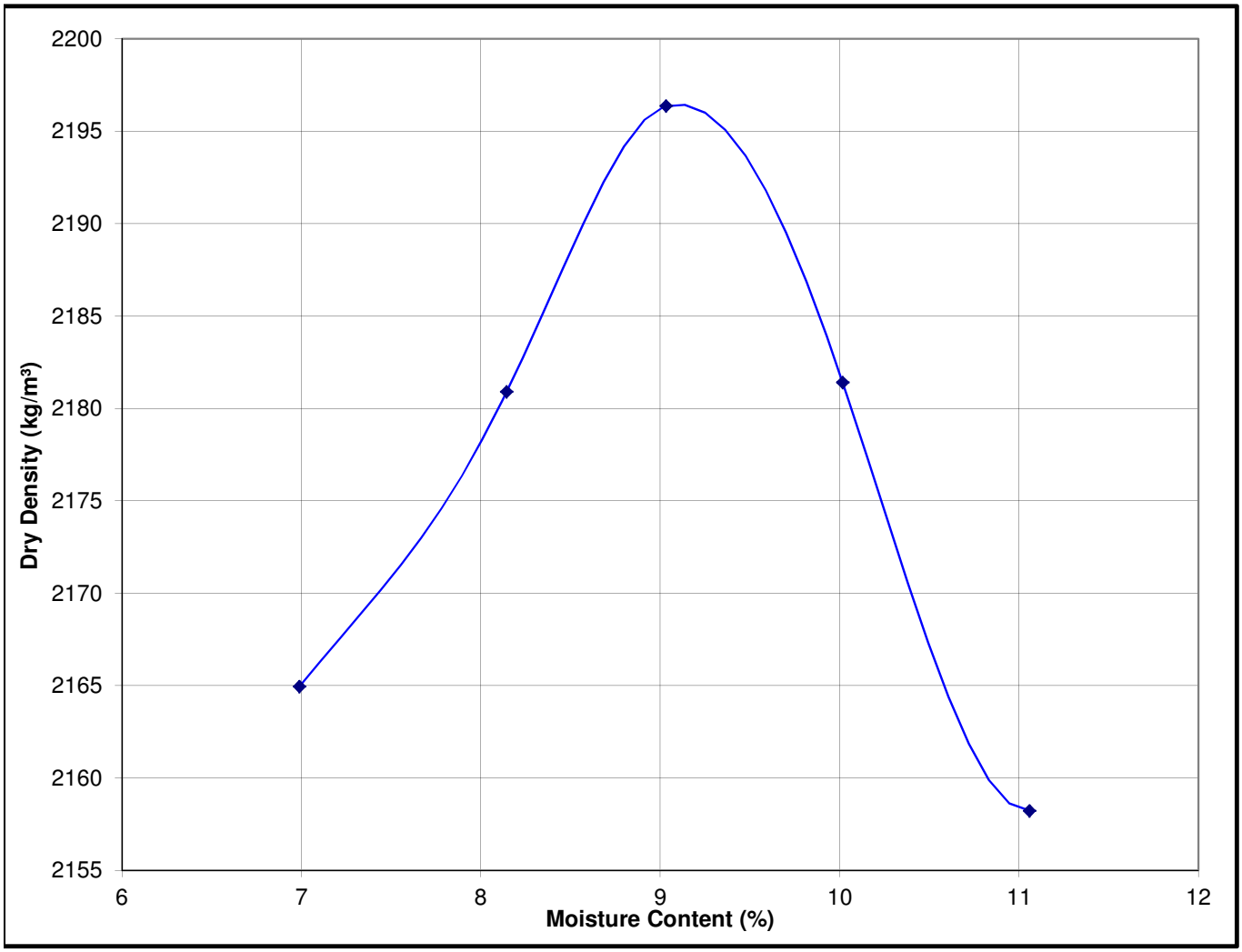
Moisture Density Relationship

Project:	IMPALA WRD		
Project No.:	1039/F95/08/2012	Date:	13 September 2012
Field Reference:	TP 18	Laboratory Ref.:	K861
Depth (m):	1.8	Remarks:	Untreated
Description:	-		

Compactive Effort: **Mod. AASHTO**

Percent Water Content (%):	7.0	8.1	9.0	10.0	11.1				
Dry Density (kg/m^3):	2165	2181	2196	2181	2158				

Maximum Dry Density:	**2196 kg/m^3**	**Optimum Moisture Content:**	**9.1 %**



Analysis according to Method A7 of TMH1 of 1986.
The results relate only to the samples tested.
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Remarks:

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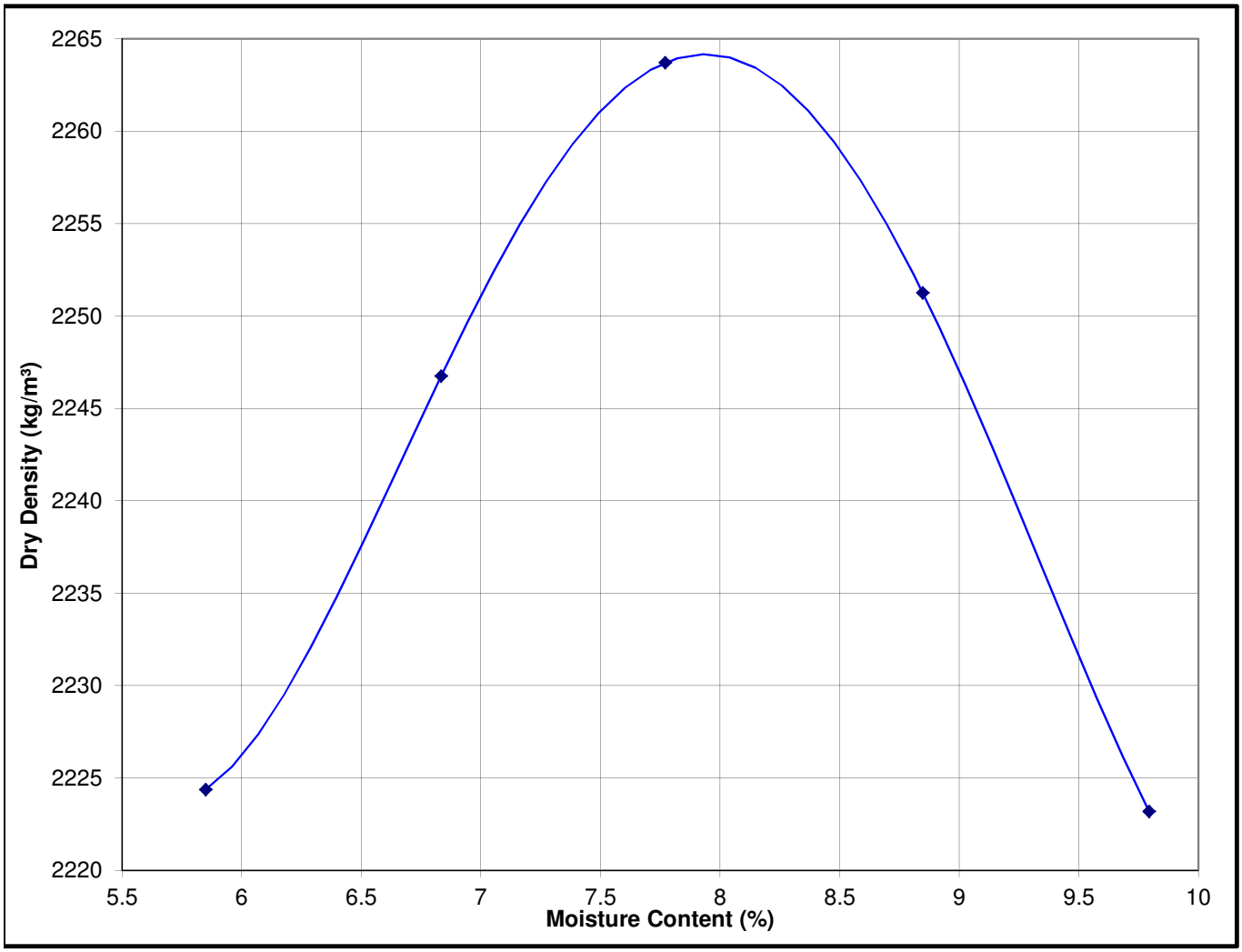
Moisture Density Relationship

Project:	IMPALA WRD		
Project No.:	1039/F95/08/2012	Date:	5 September 2012
Field Reference:	-	Laboratory Ref.:	K865
Depth (m):	-	Remarks:	Untreated
Description:	WASTEROCK + SOFT ROCK NORITE (50:50)		

Compactive Effort: **Mod. AASHTO**

Percent Water Content (%):	6.8	7.8	8.8	5.9	9.8				
Dry Density (kg/m^3):	2247	2264	2251	2224	2223				

Maximum Dry Density:	**2264 kg/m^3**	**Optimum Moisture Content:**	**7.9 %**



Analysis according to Method A7 of TMH1 of 1986.
The results relate only to the samples tested.
This report may only be reproduced or published in its full context.
Remarks:

DISPERSIVE TEST RESULTS

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Analyses on Potentially Dispersive Soils

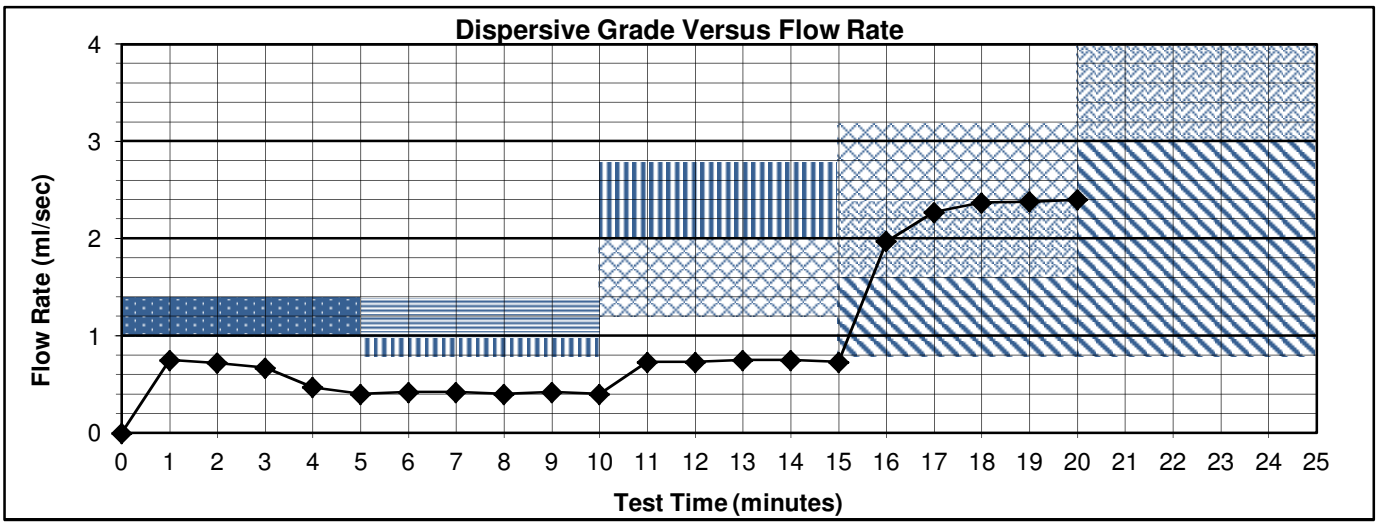
Project Name	IMPALA WRD	Lab. No.	K856
Job Number	1039/F95/08/2012	Client/Field No.	TP 6
Date Received	25/09/2012	Depth (m)	0.7

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested		< 2.0 mm	Compacted Density	kg/m^3	Bulk	1838
Liquid Limit	%	56			Dry	1530
Plastic Limit	%	19	Natural Moisture Content (%)			20.1
Plasticity Index	%	37	Hole size after test (mm)			1

Head (mm)	50										180					360					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flow Rate (ml/sec)	0.8	0.7	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.7	0.7	0.8	0.8	0.7	2.0	2.3	2.4	2.4	2.4					
Effluent Water	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C					
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
D1	D2	ND4	ND3	ND2	ND1

Classification of test sample

ND 3 (Intermediate)

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	0.001 M Sodium Hydroxide solution

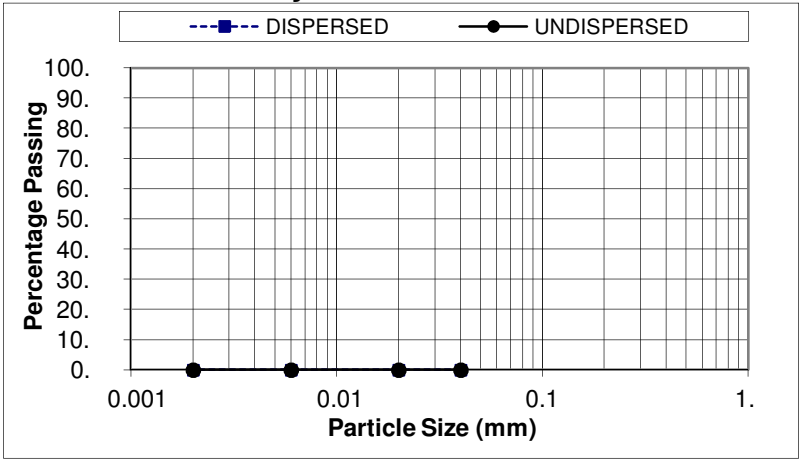
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

1 (Non-Dispersive)

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

Not tested

Remarks:

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Analyses on Potentially Dispersive Soils

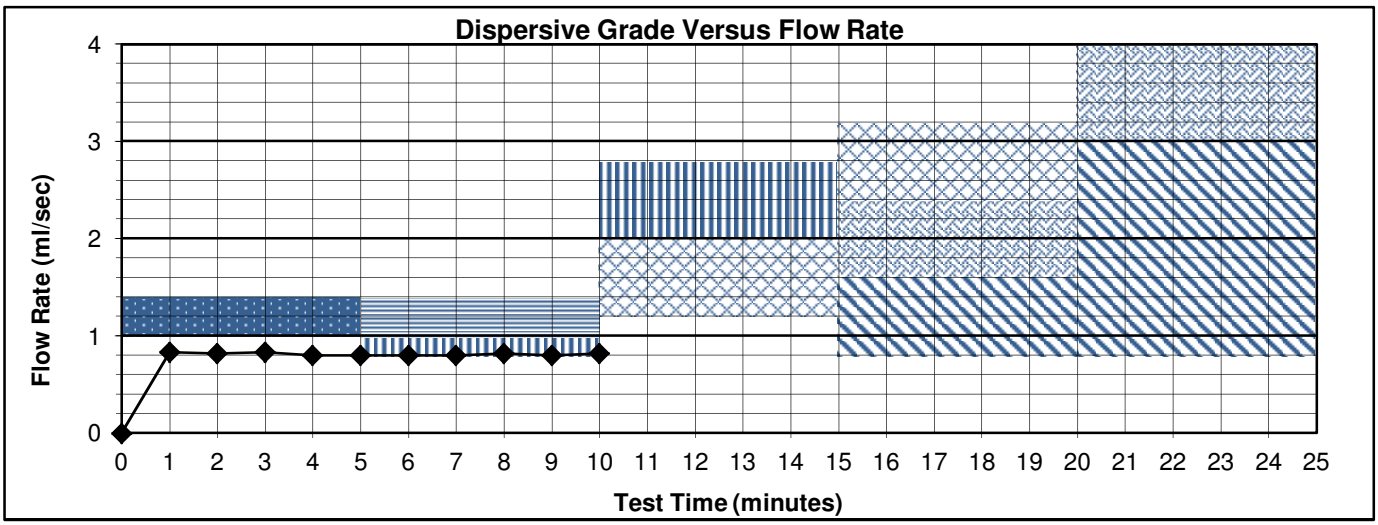
Project Name	IMPALA WRD	Lab. No.	K857
Job Number	1039/F95/08/2012	Client/Field No.	TP 10
Date Received	25/09/2012	Depth (m)	2.5

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested		< 2.0 mm	Compacted Density	kg/m^3	Bulk	1956
Liquid Limit	%	NP			Dry	1743
Plastic Limit	%	NP	Natural Moisture Content (%)			12.2
Plasticity Index	%	NP	Hole size after test (mm)			0

Head (mm)	50										180					360					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flow Rate (ml/sec)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8															
Effluent Water	C	C	C	C	C	C	C	C	C	C															
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
D1	D2	ND4	ND3	ND2	ND1

Classification of test sample

ND 4 (Intermediate)

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	0.001 M Sodium Hydroxide solution

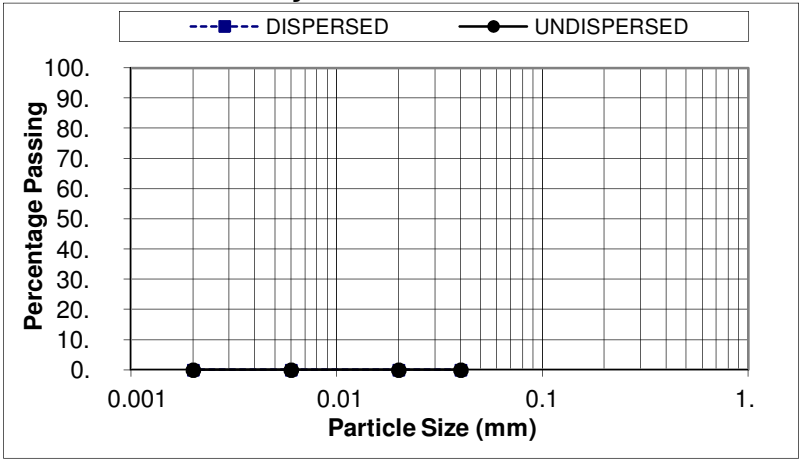
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

2 (Non-Dispersive)

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

Not tested

Remarks:

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Analyses on Potentially Dispersive Soils

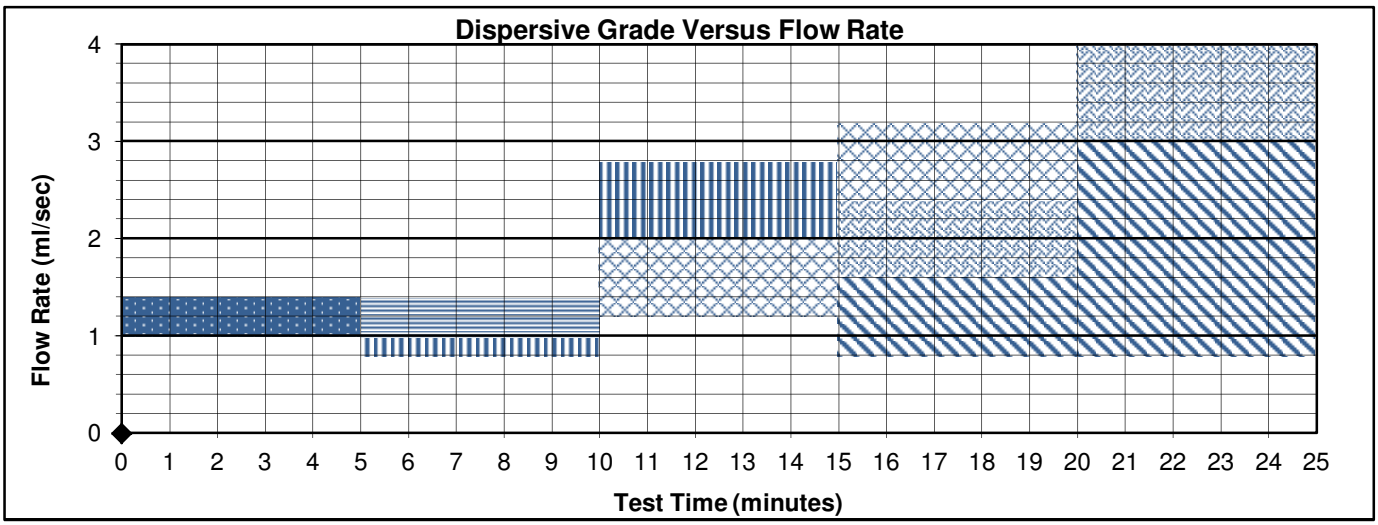
Project Name	IMPALA WRD	Lab. No.	K858
Job Number	1039/F95/08/2012	Client/Field No.	TP 12
Date Received	25/09/2012	Depth (m)	0.6

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Natural Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					360					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
D1	D2	ND4	ND3	ND2	ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	0.001 M Sodium Hydroxide solution

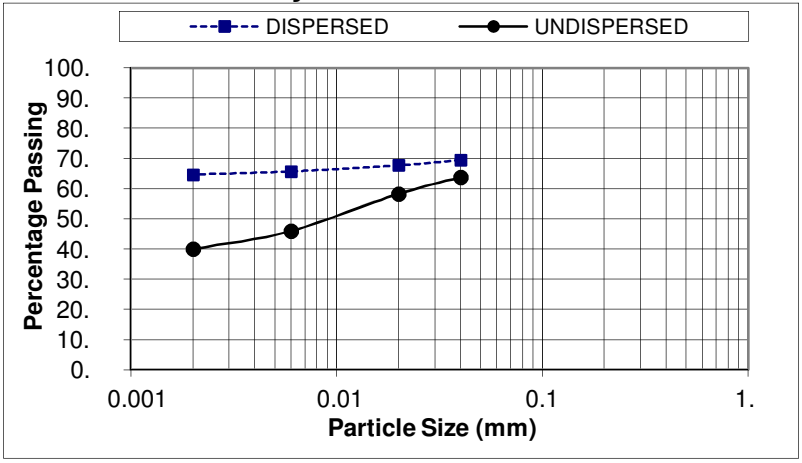
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

1 (Non-Dispersive)

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

62 (Dispersive)

Remarks:

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Analyses on Potentially Dispersive Soils

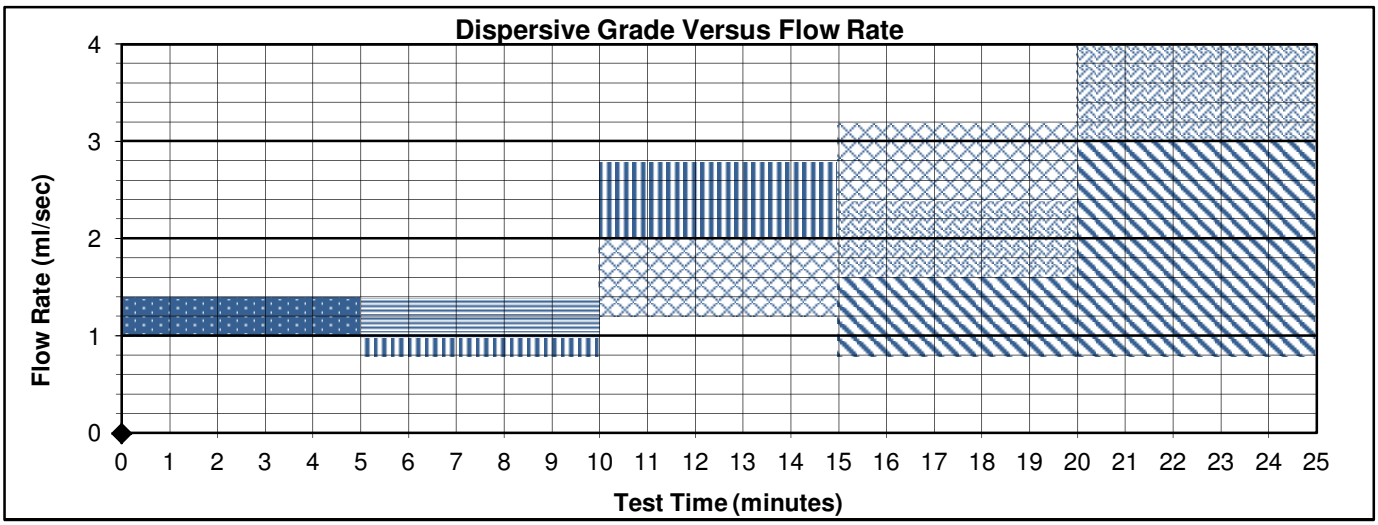
Project Name	IMPALA WRD	Lab. No.	K861
Job Number	1039/F95/08/2012	Client/Field No.	TP 18
Date Received	25/09/2012	Depth (m)	1.8

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Natural Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					360					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
D1	D2	ND4	ND3	ND2	ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	0.001 M Sodium Hydroxide solution

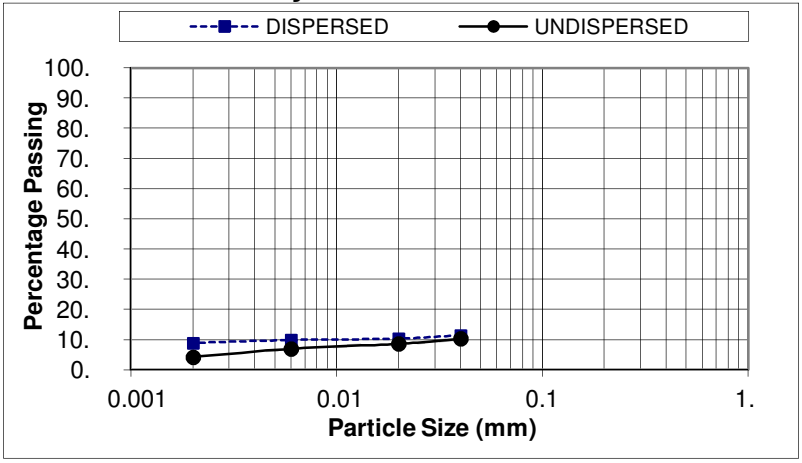
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

1 (Non-Dispersive)

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

47 (Intermediate)

Remarks:

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Analyses on Potentially Dispersive Soils

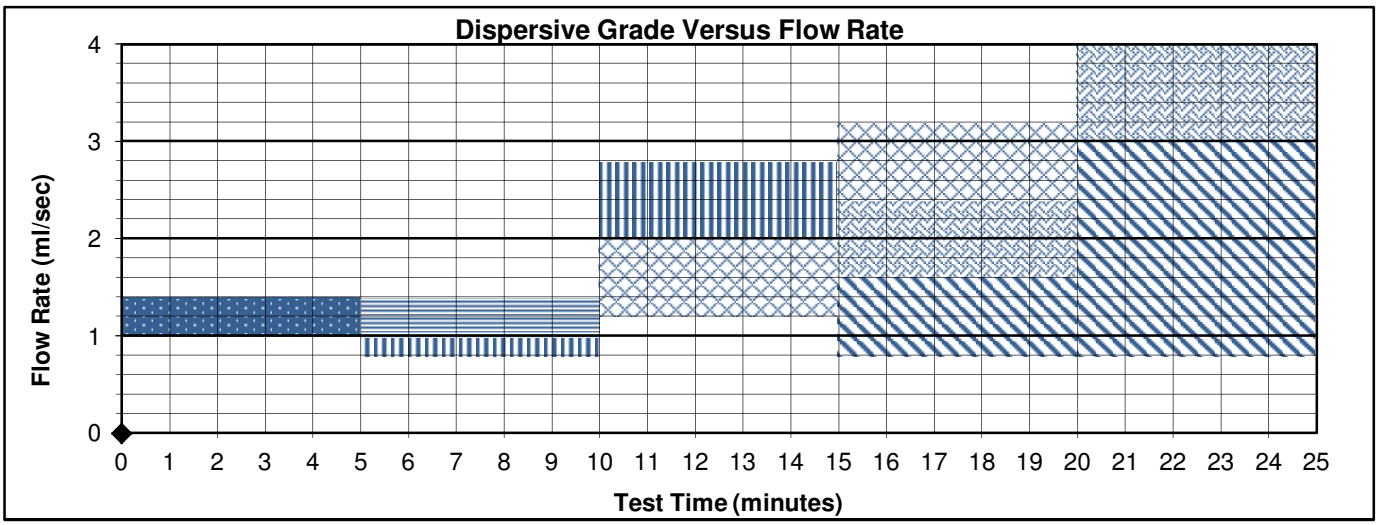
Project Name	IMPALA WRD	Lab. No.	K862
Job Number	1039/F95/08/2012	Client/Field No.	TP 23
Date Received	25/09/2012	Depth (m)	1.6

Pinhole Test in accordance with 6.2 of BS 1377:Part 5:1990

Parameters of Test Sample

Fraction tested			Compacted Density	kg/m^3	Bulk	
Liquid Limit	%				Dry	
Plastic Limit	%		Natural Moisture Content (%)			
Plasticity Index	%		Hole size after test (mm)			

Head (mm)	50										180					360					1020				
Time (min)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flow Rate (ml/sec)																									
Effluent Water																									
	Symbol:	PC-Perfectly Clear						C-Clear		SD-Slightly Dark				MD-Moderately Dark					D-Dark		VD-Very Dark				



Dispersive Grade Index

Dispersive		Intermediate		Non-dispersive	
D1	D2	ND4	ND3	ND2	ND1

Classification of test sample

Not tested

Crumb Test in accordance with 6.3 of BS 1377:Part 5:1990

Reagent used	0.001 M Sodium Hydroxide solution

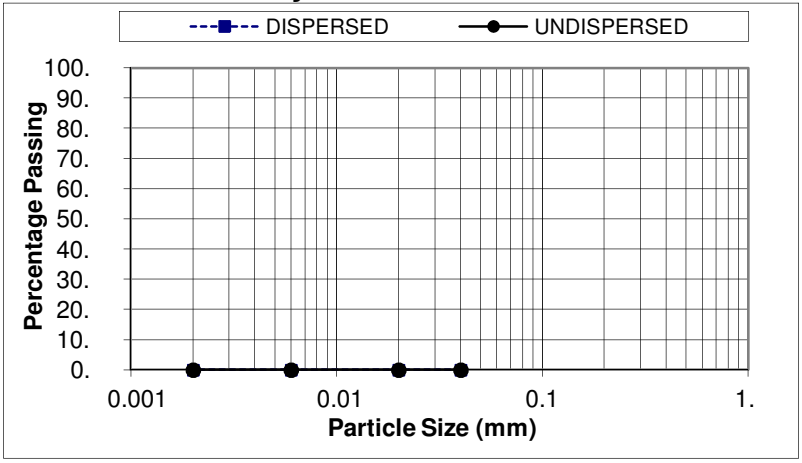
Dispersive Grade Index

Non-dispersive		Dispersive	
1	2	3	4

Classification of test sample

1 (Non-Dispersive)

Double Hydrometer Test in accordance with 6.4 of BS 1377:Part 5:1990



Dispersive Grade Index

Extract from the U.S. Department of Agricultur: Soil Conservation service: Soil Mechanics Note No. 13 (1991)

Dispersion %	Class
<30	Non-Dispersive
30-60	Intermediate (additional tests recommended)
>60	Dispersive

Classification of test sample

Not tested

Remarks:

APPENDIX D: BILL OF QUANTITIES

Main Summary

CLIENT: **IMPALA PLATINUM LIMITED**
PROJECT: **NO. 16 SHAFT: NEW WASTE ROCK DUMP CONSTRUCTION** **BASE DATE:** **Dec-2012**

Schedule	Description	Phase 1	Remaining Phases	Total
A	**PRELIMINARY AND GENERAL (Estimated at 15% of total construction costs)**	R 664 383	R 988 890	R 1 653 273
B	**SITE PREPARATION AND CLAY LINER**	R 3 049 857	R 4 780 325	R 7 830 182
C	**UNDER DRAINAGE COLLECTION**	R 1 379 362	R 1 812 274	R 3 191 636
	SUB-TOTAL 1 (Excluding VAT & Contingencies)	**R 5 093 602**	**R 7 581 489**	**R 12 675 091**
	CONTINGENCY (Estimated at 10% of total costs)	R 509 360	R 758 149	R 1 267 509
	SUB-TOTAL 2 (Excluding VAT)	**R 5 602 962**	**R 8 339 638**	**R 13 942 600**
	VAT 14%	R 784 415	R 1 167 549	R 1 951 964
	GRAND TOTAL	**R 6 387 377**	**R 9 507 187**	**R 15 894 564**

Schedule B: Site Preparation and Earthworks

CLIENT: IMPALA PLATINUM LIMITED
PROJECT: NO. 16 SHAFT: NEW WASTE ROCK DUMP CONSTRUCTION

Item	Description	Unit	QUANTITIES			RATE	AMOUNTS		
			Phase 1	Remaining Phases	Total		Phase 1	Remaining Phases	Total
1	**SITE PREPARATION**								
1.1	**Clear and grub site, including removal of trees up to 1.5 m girth (spoil to be spread neatly within 1 km as directed by Engineer):**								
1.1.1	Waste rock dump area and collection trench	m²	81 381	114 267	195 647.49	R 1.45	R 118 166	R 165 916	**R 284 082**
1.1.2	Topsoil stockpile area	m²	15 771	0	15 771.49	R 1.45	R 22 901	R 0	**R 22 901**
1.2	**Remove topsoil and subsoil to a maximum depth of 400mm and stockpile as directed at topsoil stockpile areas. Stockpiles to have a maximum side slope of 1:3 and height not exceeding 2 m (freehaul distance of 1 km)**								
1.2.1	Waste rock dump area and collection trench	m³	32 552	45 707	78 258.99	R 19.72	R 642 031	R 901 472	**R 1 543 503**
2	**EARTHWORKS AND EXCAVATIONS**								
2.1	**Bulk excavation in Class A material. Material to be used for backfill, stockpile, fill, construction of embankments or disposed as directed by the Engineer within 1 km. (Rate to allow for cutting back, dewatering etc.):**								
2.1.1	Waste rock dump basin - Top ± 300mm layer (excl. topsoil strip) to temporary stockpile (Paid for as fill, see item 3.1.4)	m³	24 414	34 280	58 694.25	R 0.00	R 0	R 0	**R 0**
2.2	**Base preparation of insitu material (Rip and Re-compact or Compact only as specified by Engineer) to:**								
2.2.1	Waste rock dump basin, minimum of 250mm thick clay layer compacted to 95% Proctor Density (±2% OMC) (NB: for areas where the minimum thickness of the insitu clay is less than 250mm see Item 3.1.6)	m²	81 381	114 267	195 647.49	R 3.50	R 284 834	R 399 933	**R 684 767**
	TOTAL CARRIED FORWARD						**R 1 067 932**	**R 1 467 321**	**R 2 535 253**

Item	Description	Unit	QUANTITIES			RATE	AMOUNTS		
			Phase 1	Remaining Phases	Total		Phase 1	Remaining Phases	Total
	TOTAL BROUGHT FORWARD						R 1 067 932	R 1 467 321	**R 2 535 253**
3	**FORM EMBANKMENTS AND FILLS**								
3.1	**Construct compacted embankment walls and fills with selected material from waste rock dump basin or approved borrow pits, excavations or stockpiles and compact to required specification or Engineers approval (rate to include for opening of borrow areas, load, haul [free haul 1 km], spread, level, trim, compact, tie-in, form side slopes etc.):**								
3.1.1	Inner wall in 150mm layers compacted to 95% Proctor Density (±2% OMC)	m³	4 751	7 632	12 382	R 30.78	R 146 222	R 234 885	**R 381 106**
3.1.2	Outer wall in 150mm layers compacted to 95% Proctor Density (±2% OMC)	m³	11 144	19 461	30 604	R 30.78	R 342 986	R 598 960	**R 941 945**
3.1.3	Silt control berm at the topsoil stockpile area (norminally compacted)	m³	1 020	2 256	3 277	R 30.78	R 31 408	R 69 449	**R 100 856**
3.1.5	Leading inner wall in 150mm layers compacted to 95% Proctor Density (±2% OMC)	m³	3 234	16 169	19 402	R 30.78	R 99 529	R 497 641	**R 597 169**
3.1.4	Waste rock dump basin clay liner (Top Layer ±300mm) compacted to 95% Proctor Density (±2% OMC)	m³	24 414	34 280	58 694.25	R 30.78	R 751 423	R 1 055 069	**R 1 806 492**
3.1.6	Extra over item 2.2.1 for clay fill in areas where the minimum thickness of the insitu clay is less than 250mm	m³	Supply rate only						
3.2	**Form protective layer, using selected waste rock material :**								
3.2.1	On top of the clay liner (rate to include for opening of borrow areas, load, haul [free haul 1 km], spread, level, trim, compact, etc.)	m³	40 690	57 133	97 823.74	R 15.00	R 610 357	R 857 000	**R 1 467 357**
3.2.2	Over haulage, extra over Item 3.2.1 for waste rock from mine waste rock dump	m³.km	Supply rate only				R 0	R 0	**R 0**
	Sub-Total (Excluding VAT)						**R 3 049 857**	**R 4 780 325**	**R 7 830 178**

Schedule C: Under Drainage Collection

CLIENT: IMPALA PLATINUM LIMITED
PROJECT: NO. 16 SHAFT: NEW WASTE ROCK DUMP CONSTRUCTION

Item	Description	Unit	QUANTITIES			RATE	AMOUNTS		
			Phase 1	Remaining Phases	Total		Phase 1	Remaining Phases	Total
1	**EARTHWORKS AND EXCAVATIONS**								
1.1	**Bulk excavation in Class A material. Material to be used for backfill, stockpile, fill, construction of embankments or disposed as directed by the Engineer within 1 km. (Rate to allow for cutting back, dewatering etc.):**								
1.1.1	Storage tanks excavation	m^3	263	0	263	R 24.12	R 6 342	R 0	**R 6 342**
1.2	**Restricted excavation in Class A material. Material to be used for backfill, stockpile, fill, construction of embankments or disposed as directed by the Engineer within 1 km. (Rate to allow for shoring, max vertical excavation 2.0 m, cutting back, dewatering, marking of open trenches etc.):**								
1.2.1	Under drainage pipe trenches (between outer wall and collection trench)	m^3	40	49	88	R 36.09	R 1 428	R 1 764	**R 3 192**
1.2.2	Collection trench	m^3	308	246	554	R 36.09	R 11 132	R 8 866	**R 19 998**
1.2.3	Electricity cable conduit pipe trench	m^3	30	0	30	R 36.09	R 1 078	R 0	**R 1 078**
1.3	**Excavate in Class B material and use for backfill, fill or stockpile within freehaul distance of 1 km**								
1.3.1	Storage tanks excavation (extra over Item 1.1.1)	m^3	13	0	13	R 216.88	R 2 851	R 0	**R 2 851**
1.3.2	Collection trench (extra over Item 1.2.2)	m^3	Supply rate only						
1.4	**Base preparation of insitu material (Rip and Recompact or Compact only as specified by Engineer) to:**								
1.4.1	Collection trench and storage sump area (95% Proctor density or as specified on the drawing)	m^2	122	0	122	R 27.71	R 3 370	R 0	**R 3 370**
2	**FORM EMBANKMENTS AND FILLS**								
2.1	**Backfill with selected and approved material from approved borrow pit or excavations and compact as detailed or as directed by Engineer (Free Haul Distance 1 km):**								
2.1.1	Storage tanks - Compacted fill (non-expansive material to 97% Mod. AASHTO in 150mm layers)	m^3	235	0	235	R 64.00	R 15 023	R 0	**R 15 023**
2.1.2	Trenches between the outer wall and the collection trench - Norminally compacted non-expansive material	m^3	66	82	148	R 64.00	R 4 226	R 5 221	**R 9 447**
2.1.3	Collection trench bund - Norminally compacted clay material	m^3	363	289	652	R 20.59	R 7 474	R 5 953	**R 13 427**
	TOTAL CARRIED FORWARD						**R 52 924**	**R 21 804**	**R 74 728**

Item	Description	Unit	QUANTITIES			RATE	AMOUNTS		
			Phase 1	Remaining Phases	Total		Phase 1	Remaining Phases	Total
	TOTAL BROUGHT FORWARD						R 52 924	R 21 804	**R 74 728**
3	**DRAINAGE**								
3.1	**Supply and place selected drainage material to form:**								
3.1.1	Under drains (selected crushed waste rock)	m^3	2 500	4 400	6 900	R 175.00	R 437 500	R 770 000	**R 1 207 500**
3.1.2	Collection drain (selected crushed waste rock)	m^3	296	233	529	R 175.00	R 51 844	R 40 688	**R 92 532**
3.1.3	Storage tanks bedding (19mm stone)	m^3	6	0	6	R 175.00	R 1 097	R 0	**R 1 097**
3.2	**Supply and install drainage pipes and fittings:**								
3.2.1	Supply and install 160 mm diameter slotted HDPE corrugated Drainex pipes or similar with joints to SABS standard (including all jointing material, bends and fittings) to underdrains	m	2 867	5 027	7 894	R 138.19	R 396 207	R 694 668	**R 1 090 875**
3.2.2	Supply and install 160 mm diameter closed HDPE corrugated Drainex pipes or similar with joints to SABS standard (including all jointing material, bends and fittings) to underdrains	m	341	389	730	R 141.77	R 48 304	R 55 158	**R 103 462**
3.2.3	Supply and install joints between the DN160 underdrain pipes and DN160 collector drain pipe	No.	15	16	31	R 183.19	R 2 748	R 2 932	**R 5 680**
3.2.4	Supply and install jet rodding stations to underdrain pipes (rate to include pipes and all jointing material, fittings, end-caps and concrete blocks)	No.	15	16	31	R 750.00	R 11 250	R 12 000	**R 23 250**
3.2.5	Supply and install jet rodding stations to collector drain pipes (rate to include pipes and all jointing material, fittings, end-caps and concrete blocks)	No.	6	5	11	R 800.00	R 4 800	R 4 000	**R 8 800**
4	**HDPE LINING**								
4.1	**Supply and install 1500 micron HDPE liner system as detailed (rate to include for cutting, wastage, welding and quality control testing) to:**								
4.1.1	HDPE lining for the Collection Trench	m^2	1 570	1 251	2 821	R 162.46	R 255 096	R 203 169	**R 458 265**
5	**STORAGE SYSTEM**								
5.1	Supply and install 3 X 6,000L JoJo underground tanks or equivalent	No.	3	0	3	R 14 000.00	R 42 000	R 0	**R 42 000**
5.2	Supply and install connectors between the underground tanks (rate to include pipes,drilling and welding/sealing)	No.	12	0	12	500.00	R 6 000	R 0	**R 6 000**
6	**MISCELLANEOUS**								
6.1	Supply and install DN110 Kabelflex Cable Conduit or similar	m	485	0	485	R 125.00	R 60 625	R 0	**R 60 625**
6.2	Supply and install 450ND class 50D spigot and socket joint reinforced concrete pipes in 2.44m standard lengths to the leading inner wall for temporary stormwater control	No.	4	4	8	R 950.00	R 3 800	R 3 800	**R 7 600**
6.3	Hydroseed and establish competent vegetation cover to collector trench bund	m^2	1 185	930	2 115	R 4.36	R 5 167	R 4 055	**R 9 222**
	Sub-Total (Excluding VAT)						**R 1 379 362**	**R 1 812 274**	**R 3 191 636**

Main Summary

CLIENT: **IMPALA PLATINUM LIMITED**
PROJECT: **NO. 16 SHAFT: NEW WASTE ROCK DUMP RE-SHAPING AND REHABILITATION** **BASE DATE:** **Dec-2012**

Schedule	Description	Phase 1	Remaining Phases	Total
A	**PRELIMINARY AND GENERAL (Estimated at 15% of total construction costs)**	R 211 820	R 702 515	R 914 335
B	**RE-SHAPING AND REHABILITATION**	R 1 412 130	R 4 683 434	R 6 095 564
	SUB-TOTAL 1 (Excluding VAT & Contingencies)	**R 1 623 950**	**R 5 385 949**	**R 7 009 899**
	CONTINGENCY (Estimated at 10% of total costs)	R 162 395	R 538 595	R 700 990
	SUB-TOTAL 2 (Excluding VAT)	**R 1 786 344**	**R 5 924 544**	**R 7 710 888**
	VAT 14%	R 250 088	R 829 436	R 1 079 524
	GRAND TOTAL	**R 2 036 433**	**R 6 753 980**	**R 8 790 413**

Schedule B: Re-Shaping and Rehabilitation of the WRD Walls

CLIENT: IMPALA PLATINUM LIMITED
PROJECT: NO. 16 SHAFT: NEW WASTE ROCK DUMP RE-SHAPING AND

Item	Description	Unit	QUANTITIES			RATE	AMOUNTS		
			Phase 1	Remaining Phases	Total		Phase 1	Remaining Phases	Total
1	**FORM EMBANKMENTS AND FILLS**								
1.1	**Re-Shape of slopes. (rate to include for push down, spread, level, trim, form side slopes etc.): Rate to be measured as per meter length of crest**								
1.1.1	Push down average 20m high angle of repose slopes to an overall slope of 3H:1V	m	549	0	549	R 642.72	R 352 840	R 0	**R 352 840**
1.1.2	Push down average 40m high angle of repose slopes to an overall slope of 3H:1V	m	44	768	812	R 1 004.79	R 44 384	R 771 309	**R 815 693**
1.2	**Excavate, load, haul from topsoil stockpiles, place, spread and mix**								
1.2.1	300mm Thick topsoil to outside face of WRD wall, and mix with waste rock to an average thickness of 500mm	m^3	11 400	45 815	57 215	R 31.62	R 360 464	R 1 448 654	**R 1 809 117**
2	**PLANT BOXES**								
2.1	Restricted excavation on the WRD re-shaped side slopes to form "plant boxes"/terraces. Material to be used for construction of the downstream berms (Rate to allow for shoring, max vertical excavation 2.0 m, cutting back, dewatering, marking of open trenches etc.):	m^3	3 816	15 335	19 151	R 41.79	R 159 459	R 640 845	**R 800 303**
2.2	Supply and place topsoil mixed with a growth medium suitable for the planting of trees inside the "plant boxes"	m^3	3 816	15 335	19 151	R 57.75	R 220 357	R 885 586	**R 1 105 942**
2.3	Supply and plant suitable plants inside the 'plant boxes' (NB: rate per box)	No.	314	1 262	1 576	R 210.00	R 65 951	R 265 047	**R 330 997**
3	**Hydroseed and vegetation cover**								
3.1	Hydroseed and establish competent vegetation cover to re-shaped slope	m^2	35 174	141 358	176 531	R 4.36	R 153 474	R 616 792	**R 770 266**
3.2	Hydroseed and establish competent vegetation cover to top soil stockpiles footprint areas	m^2	0	15 771	15 771	R 3.50	R 55 201	R 55 201	**R 55 201**
Sub-Total (Excluding VAT)							**R 1 412 130**	**R 4 683 434**	**R 6 040 359**

RECORD OF REPORT DISTRIBUTION

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Report Number:	01
Proponent:	Impala Platinum Limited

Name	Entity	Copy No.	Date issued	Issuer
S Kaalsen	RSV	1	23/01/2013	S Dladla

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