Transnet Capital Projects

Geotechnical Engineering Survey of the Existing Manganese Rail Corridor between Hotazel and the Port of Ngqura on the Ngqura 16Mtpa Manganese Project

Report on Postmasburg Housing Development

Contract No H339473-S018

Reference : 12-186 – Rev 0A

Dated : 20 March 2013

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1. POSTMASBURG HOUSING DEVELOPMENT

1.1 Introduction

Moore Spence Jones (Pty) Ltd were requested by Hatch Africa (Pty) Ltd to provide a cost estimate for a preliminary geotechnical investigation for the proposed Postmasburg Housing Development in Postmasburg. The scope of work (SOW) for this investigation was provided by Hatch. Moore Spence Jones were subsequently appointed by Mr. F Van Biljon through Compensation Event, CE005, in an email dated 11th February 2013 to proceed with the investigation as proposed.

The purpose of this geotechnical investigation is to provide the following information:

- Establish the nature and engineering properties of the general ground conditions underlying the proposed residential development.
- Provide an assessment of the appropriate NHBRC Site Classifications, with particular reference to development over dolomitic terrain and any further investigations that may be required to identify potential stability problems related to development on dolomitic terrain, such as sinkhole and doline development.
- Make preliminary recommendations in respect of the design and construction of foundations and earthworks for the proposed development. All comments referring to foundation recommendations should be augmented and/or pre-empted by the results and recommendations of the outstanding dolomite stability survey.

1.2 Site Description

The salient features of the Postmasburg Housing Development are summarised below:

- General Locality - The site is accessed from a turnoff on the R385 approximately 800m north west of the town of Postmasburg. At the turnoff continue along a gravel road in a northerly direction for approximately 200m to the site.
- Site Description – The site is bounded on the north and west by the existing railway line and on the east and south by existing roads, namely, 1st Avenue and 4th Avenue respectively.
- Topography - The site is generally flat.
- Vegetation - The site is generally covered by scattered grasses and small trees.
- Climatology - The site falls within an arid semi-desert zone generally associated with very hot summers with not more than 100-200mm annual rainfall and very dry mild winters that are cold at night.
- Services – Abundant underground services are noted at the Postmasburg housing development site.
- Land usage - There are existing houses interspersed with concrete foundations of demolished houses and open land contained within the proposed housing development.

1.3 Fieldwork

In terms of the SOW provided by Hatch the field work for this preliminary geotechnical investigation comprised the following:

- Trial pits, and
- CBR Dynamic Cone Penetrometer tests

1.3.1 Trial Pits

Twenty nine trial pits, designated TP1 through to TP29, were scheduled for investigation. However, due to access and excessive underground services only TP1 through to TP12 were dug by TLB excavator at the approximate positions shown in Figure H339473-3-137-C-AR-0004-01. The pits were advanced to refusal depths between 0.45 and 1.45 metres below existing ground level. The trial pits were profiled[1] and sampled by an engineering geologist.

The detailed logs and photographs of the trial pits are provided in Appendix A. Representative disturbed samples of material were taken from selected horizons for later testing in a commercial soils laboratory.

1.3.2 CBR Dynamic Cone Penetrometer tests

Twenty nine CBR Dynamic Cone Penetrometer (DCP) tests, designated DCP1 through to DCP29, were scheduled for investigation. However due to access and excessive underground services only DCP1 through to DCP12 were carried out adjacent to the trial pit positions at the approximate positions shown in Figure H339473-3-137-C-AR-0004-01. The DCP tests were advanced to refusal depths between 0.18m and 1.00 metre below existing ground level. The results of the tests, giving inferred shear strength parameters and insitu CBR values associated with the insitu soils, are provided in Appendix B.

1.4 Site Geology

The geological map (Figure H339473-3-137-C-AR-0004-02) of the general area within which the site occurs indicates that the site is underlain by a mantle of colluvium overlying residual calcrete soils and residual dolomite which in turn is overlying hardpan calcrete and dolomite of the Campbell Rand Formation, Ghaap Group. In some of the trial pits the upper colluvial layer is absent and the residual soil extends from surface. Fill was only found in TP8 from 0.0 to 0.35 metres below ground level.

In summary the following generalised ground conditions can be expected (depth to base of layer):

0.0-0.15m:	Loose silty SAND with gravel. Colluvium.
0.15-1.45m:	Loose to very dense silty SAND with gravel or silty sandy GRAVEL. Residual Calcrete/Residual Dolomite.
+1.45m:	Hardpan CALCRETE/Soft rock DOLOMITE.

1.5 Groundwater

No groundwater was encountered in any of the trial pits put down.

1.6 Laboratory Testing

In order to classify the subgrade materials, and to assess their suitability for use in general construction, the following laboratory testing was carried out on soil samples taken during the fieldwork.

- Indicator testing to determine Atterberg Limits and Particle Size Distribution,
- Modified AASHTO maximum dry density tests,
- California Bearing Ratio tests, and

The results of the laboratory tests are given in Appendix C and summarised separately in Table 1.

[1] Geoterminology Workshop (2002) – Guidelines for Soil and Rock Logging - SAIEG-AEG-SAICE (Geotech Div) pp47

Table 1
Summary of Results of Particle Size Distribution Analysis, Atterberg Limit Determinations and CBR tests

TP No.	DEPTH (m)	Lab No.	DESCRIPTION	63.0	53.0	37.5	26.5	19.0	13.2	4.75	2.00	0.425	0.075	Silt <0.05 >0.005	Clay <0.005	SOIL MORTAR ANALYSIS CS <2.00 >0.475	FS <0.425 >0.075	<0.075	ATTERBERG CONSTANTS LL	PI	LS	GM	MODIFIED AASHTO OMC	MOD	CBR (ITS / UCS) * 100%	98%	95%	93%	90%	CBR COMP MOIST	SWELL	IN SITU MOISTURE %	SAR INDEX	CLASSIFICATION: TRH14; Transnet S410; TRH20; USCS
TP2	0.00-1.20	013/0299	Slightly moist dark orangey to reddish brown silty sandy GRAVEL. Residual Dolomite.		100	98	95	90	84	57	45	38	6	5	3	26	61	13	-	S.P.	2.0	2.1	6.5	2148	98.0	61.0	29.0	18.0	9.0	6.6	0	2.0	51	G7; Layer A; Type B Gravel Wearing Course; SP-SM
TP4	0.15-0.90	013/0298	Dry orangey to dark reddish brown silty sandy GRAVEL. Residual Dolomite.			100	98	95	88	53	44	38	5	6	2	24	66	10	-	N.P.	0.0	2.1	6.5	2212	102.0	78.0	52.0	40.0	26.0	6.5	0	0.9	50	G5; Layer A; Type B Gravel Wearing Course; SP-SM
TP5	0.18-0.90	013/0301	Dry orange to dark reddish brown silty sandy GRAVEL. Residual Dolomite.		100	98	93	88	83	54	45	38	4	5	3	28	63	9	-	S.P.	0.3	2.1	5.0	2266	104.0	68.0	36.0	24.0	12	5.0	0	1.5	49	G7; Layer A; Type B Gravel Wearing Course; SP
TP6	0.00-0.45	013/0302	Dry orange to reddish brown silty gravelly SAND. Colluvium and Residual Calcrete mix.		100	99	98	96	88	77	70	58	8	5	2	28	61	12	-	N.P.	0.0	1.6	5.0	2032	40.0	61.0	21.0	16.0	11.0	5.0	0	1.5	53	G7; Layer A; Type B Gravel Wearing Course; SP-SM
TP7	0.00-1.00	013/0303	Dry dark orangey brown silty SAND with gravel. Residual Dolomite.					100	99	95	85	67	7	6	2	29	63	8	-	N.P.	0.0	1.4	5.5	2042	92.0	45.0	15.0	7.0	2.0	5.4	0	1.9	52	<G10; <BE ;Type B Gravel Wearing Course; SP-SM
	1.00-1.35	013/0304	Dry orangey brown to orangey grey silty SAND with gravel. Residual Dolomite.		100	99	98	96	95	79	66	51	6	6	3	32	59	9	-	S.P.	0.5	1.8	5.5	2144	87.0	55.0	27.0	17.0	8.0	5.4	0	2.0	51	G7; Layer A; Type B Gravel Wearing Course; SP-SM
TP9	0.20-0.80	013/0306	Slightly moist orangey brown silty sandy GRAVEL. Residual Calcrete.		100	99	97	93	90	59	45	35	6	5	3	33	54	14	-	S.P.	1.4	2.1	7.0	2189	34.0	24.0	15.0	11.0	7.0	7.0	0	1.6	51	G9; Layer B; Type B Gravel Wearing Course; SP-SM
TP12	0.00-1.25	013/0309	Slightly moist orangey to dark reddish brown silty sandy GRAVEL. Residual Dolomite.		100	98	94	88	83	51	36	30	5	6	4	30	57	14	-	S.P.	1.9	2.3	6.5	2189	57.0	42.0	24.0	17.0	10.0	6.5	0	1.7	50	G7; Layer A; Type B Gravel Wearing Course; SP-SM

LL - Liquid Limit
PI - Plasticity Index
LS - Linear Shrinkage
GM - Grading Modulus
MDD - Maximum Dry Density
OMC - Optimum Moisture Content

Classification in Terms of: USPRA
Unified Soil Classification System
TRH14 (1985)
Spoornet Classification
TRH20: A – Erodible materials
B – Ravels and Corrugates
C – Ravels
D – Slippery
E – Good

In order to assess the quality of the groundwater and the soil encountered in some of the trial pit positions, soil chemistry analysis was undertaken by ALS Inspection South Africa (Pty) Ltd in Durban. The results of these tests are given in Table 2 below.

Table 2
Summary of Results of Groundwater Analysis of Soil Samples

Test Description	TP1 (Depth: 0.15-0.90m)	TP7 (Depth: 0.00-1.20m)	TP14 (Depth: 1.00-1.35m)	TP28 (Depth: 0.00-1.25m)	South African Water Quality Target Range[2]		Standard Limits for Drinking Water (SANS241)[3]
					Industrial (Category 1 processes)	Domestic	
pH, at 25 °C	8.3	7.4	8.6	8.1	7.0-8.0	6.0-9.0	5.0-9.7
Electrical Conductivity, mS/m	5.3	2.2	4.2	2.4	0-15	0-70[4]	<170
Chlorides, as Cl, mg/l			<10	<10	0-20	0-100	<300
Dissolved Sulphates, as SO4, mg/l			<10	<10	0-30	0-200	<250
Calcium, as Ca, mg/l			166.3	5.5	-	0-32	-
Ammonia, as NH_4 mg/l			<1	<1	-	0-1	<1.5
Magnesium, as Mg, mg/l			3.4	1.8	-	0-30	-
Total Dissolved Solids, mg/l			148	152	0-100	0-450	<1200
Alkalinity, as $CaCO_3$, mg/l			30	19	0-50	-	
Calcium Carbonate Saturated pH			9.1	9.2	-	-	-
Temperature, °C			25	25	-	-	-
Langelier Index [Calculation]			-0.63	-1.39	-	-	-
Aggressiveness Index [Calculation]			7.94 (Mildly to highly aggressive)	12.50 (Moderately to non-aggressive)	-	-	-

1.7 Existing Subgrade Conditions

From the results of the fieldwork it is evident that the proposed housing development is underlain by either a mantle of fill or colluvial material to about 0.15metres depth. The fill and colluvial material is overlying residual calcrete and residual dolomite soils. The upper layers are in turn underlain by hardpan calrete and dolomite bedrock.

The results of the CBR Dynamic Cone Penetrometer (DCP) tests are summarised in Table 3 below.

Table 3
Summary of CBR DCP Test Results

Depth	CBR Values					
	DCP1	DCP2	DCP3	DCP4	DCP5	DCP6
150mm	19	5	25	16	3	31
300mm	50	55	59	63	11	Refusal
450mm	Refusal	109	43	Refusal	48	
600mm		Refusal	Refusal		Refusal	
750mm						
900mm						
Depth	**CBR Values**					
	DCP7	**DCP8**	**DCP9**	**DCP10**	**DCP11**	**DCP12**
150mm	11	13	20	48	23	17
300mm	46	78	131	103	Refusal	59
450mm	47	76	Refusal	Refusal		Refusal
600mm	32	Refusal				
750mm	30					
900mm	41					

[2] Department of Water Affairs and Forestry (1996) South African Water Quality Guidelines Volume 1 (Domestic Use) and Volume 3 (Industrial Use). Second Edition.
[3] Standard Limits for Drinking Water - SANS241-1:2011
[4] Department of Water Affairs and Forestry (1998) Quality of Domestic Water Supplies, Volume 1, Third Edition.

In general it can be seen that at the locations of the DCP tests the insitu CBR strengths are generally fair to very good, with values between 20 and 109. This could be attributed to the relatively medium dense to very dense residual material. Some variability is noted in the upper 300mm with poor insitu CBR values in the range 3 to 19 (very loose to loose unconsolidated and uncompacted colluvial and fill material). Shallow refusals are attributed to hardpan calcrete or shallow dolomite rock.

1.8 Dolomite Stability

The site is underlain by dolomitic terrain and although it was an historical housing development, it is unlikely that the site has been properly zoned in terms of the land use risk classification guidelines[5] for developments of this nature.

The dolomite area designation, identifying the likely development risk of development over dolomitic terrain for Postmasburg Housing Development is given in Table 4 below.

Table 4
Dolomite Area Designations

Dolomite Area Designation	Description	Single Story Masonry House Construction Type
D1	No precautionary measures are required to permit the construction of housing units due to an adequate overburden thickness.	• As for site class R, H-H3, C-C2 and S-S2
D2	The risk of sinkhole and doline formation is adjudged to be such that only general precautionary measures, which are intended to prevent the concentrated ingress of water into the ground, are required to permit the construction of housing units.	• As for site class R, H-H3, C-C2 and S-S2
D3	The risk of sinkhole and doline formation is adjudged to be such that precautionary measures in addition to those pertaining to the prevention of concentrated ingress of water into the ground, are required to permit the construction of housing units.	• Special foundations e.g. Fill mattresses, rafts, spanning near surface pinnacles.
D4	The risk of sinkhole and doline formation is such that precautionary measures cannot adequately reduce such risks to acceptable limits so as to permit the construction of housing units or the precautionary measures which are required are impracticable to implement.	• -

The results of the shallow investigation should always be subject and, where necessary, over-ridden or pre-empted by the recommendations contained in a further percussion drilling investigation (NHBRC Phase 1 investigation).

From the NHBRC guidelines, it is strongly recommended that the following is carried out:

- Geophysics Gravity Survey, and
- Follow up percussion drilling

1.9 Development Recommendations

It is understood that the proposed development will comprise up to 185 residential units generally consisting of single story houses and one community facility comprising a crèche, tuck shop and playground area.

[5] National Department of Housing, RSA. Geotechnical Site Investigations for Housing Developments : Project Linked Greenfield Subsidy Project Developments. Generic Specifications

1.9.1 Excavation Requirements and Trenchability

A general indication of soft excavation depths could be obtained from the refusal depths of the trial pits, between 0.45 to 1.45 metres below existing ground level. Below these depths further excavation may require Intermediate, grading into Hard Excavation with depth.

1.9.2 Earthworks

Once the site has been classified in terms of Table 4 above, the required earthworks and drainage measures to investigate the development of sinkholes/doline features are specifically defined and will require adherence in addition to the general recommendations given below.

From the generally flat nature of the site it is anticipated that cuts and fills will be low, i.e. of the order less than 1.0 metre.

It is recommended that all earthworks be carried out in accordance with SABS1200DM (current version).

In general, it is recommended that cut slopes in soil and fill embankments have a slope not steeper than 1 vertical to 1.5 horizontal to promote stability. Cuts in bedrock may be constructed at 1 vertical to 0.5 horizontal provided there are no unfavourably dipping joints in the cutting face which may combine with the cut angle to produce potentially unstable slopes. However should any cuts exceed 1.5 metres in height it is recommended that Moore Spence Jones assess the stability of these slopes and give specific recommendations where necessary.

The need for subsoil drainage both beneath and in fills will have to be assessed during the earthworks, taking into account the height and locality of individual fills.

The fills should be placed in layers not exceeding 200mm loose thickness, and compacted to a minimum of 95% Modified AASHTO maximum dry density at 2 % wet of optimum moisture content. The odd boulders that may occur on site which are larger than $^{2}/_{3}$ of the layer thickness should not be included in the fill material. Materials consisting of very clayey residual soils should preferably be spoiled as they will be moisture sensitive and difficult to compact when wet.

Both during and after construction, the site should be well graded to permit water to drain readily away and to prevent ponding of water anywhere on the ground surface. All terraces and earthworks in general should be sloped to a gradient of not less than 1 vertical in 50 horizontal to prevent ponding and ingress of water into the subsoils. Surface drainage should be directed away from the crests of fill embankments to prevent over-topping and erosion of fill slopes.

Cut and fill slopes should be topsoiled and planted with grass. This will limit erosion of these slopes and the problems associated with wash-aways of fill embankments. Ideally grass sodding should be carried out to provide immediate protection to the embankments.

A most important factor in the promotion of a stable site is the control and removal of both surface and ground water from the site. It is important that the design of the stormwater management system allow for the drainage of accumulated surface water. Such water should be directed towards the natural drainage lines on the site. Disposal of stormwater should in any case conform to the local authority's requirements.

1.9.3 Assessment of InSitu Moisture Contents

Insitu moisture content values in Table 1 are significantly lower than the optimum moisture content (OMC) values of the materials tested. This is an indication that during onsite compaction significant volumes of additional water will be required to achieve optimum moisture content.

1.9.4 Materials Evaluation

The materials making up the existing layers and underlying insitu materials within the housing development area have been classified in terms of their suitability for use in construction on the basis

of field observations and laboratory testing. The classification and recommended usage is summarised in Table 5 below.

Table 5
Materials Classification and Usage

Material Type	Description	Classification Details	Recommended Use and Subgrade Treatment
Residual Dolomite	Silty SAND with gravel or silty sandy GRAVEL	PI = NP to SP Silt & clay = 7 to 10 GM = 1.4 to 2.3 SAR Index = 49 to 53 CBR = 2 to 26 @ 90% MDD CBR = 7 to 40 @ 93% MDD CBR = 15 to 52 @ 95% MDD Materials quality generally classify as SP/SM, <G10 to G5; generally Layer A quality. However, Layer B and less than BE quality material is noted in minor quantities.	Recommended general usage as Layer A, minimum compaction 95% MDD. Substandard materials to be selectively removed during construction. Gravel wearing course is generally Type B (ravels and corrugates). Material generally suitable for selected layer construction of roads.

1.9.5 Foundations

While the adoption of specific founding solutions for this site will depend on the site dolomitic designation, the following general recommendations apply.

The site has been evaluated in terms of the foundation class system and dolomitic area designation guidelines laid down by the NHBRC[6]. From the walkover mapping exercise, trial pit profiling, insitu-CBR values from DCP tests and laboratory tests, it is considered reasonable to assign the NHBRC foundation categories P (dolomite D2/D3) and C1 to C2 and dolomitic area designation D1 and D2. The sandy foundation soils in the area are anticipated to have a collapse settlement in the range 5 to 10mm.

The recommended foundation design for dwellings and structures is discussed in detail in Table 6 below.

Table 6
Foundation design, building procedures and precautionary measures for single storey residential structures founded on soil horizons subject to collapse settlement

Site Class	Estimated Total Settlement (mm)	Construction Type	Foundation Design And Building Procedures (Expected Damage Limited To Category 1)
C1/C2	5 – 10	Modified normal	• Reinforced strip footings. • Articulation joints at some internal and all external doors. • Light reinforcement in masonry. • Site drainage and service/plumbing precautions. • Foundation pressure not to exceed 50kPa.
		Compaction of insitu soils below individual footings	• Remove insitu material below foundations to a depth and width of 1,5 times the foundation width or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at –1% to +2% of optimum moisture content. • Normal construction with lightly reinforced strip foundation and light reinforcement in masonry.
		Deep strip foundations	• Normal construction with drainage precautions. • Founding on a competent horizon below the

[6] NHBRC House Building Manual Parts 1&2: Revision No. 1, September 2002.

			problem horizon.
		Soil raft	• Remove insitu material to 1,0m beyond perimeter of the building to a depth of 1,5 times the widest foundation or to a competent horizon and replace with material compacted to 93% MOD AASHTO density at –1% to +2% of optimum moisture content. • Normal construction with lightly reinforced strip footings and light reinforcement in masonry.
P	5 - 10	Variable (e.g. fill mattresses, rafts, piers, piles etc.	• Dependent on foundation construction type

NOTE:
1. Differential settlement equals 75% of total settlement.
2. The relaxation of some of these requirements, e.g. the reduction or omission of reinforcement or articulation joints, may result in a Category 2 level of expected damage.

It is recommended that the foundations for all dwellings and structures are designed by a competent structural engineer. In addition, it is further recommended that the precautions are taken in the construction of the block/brickwork, drainage and plumbing as outlined in Table 5 above.

It is recommended that the buildings be founded in soils of at least medium dense consistency where a maximum allowable bearing pressure of 60 kPa is considered applicable. No foundations should be founded in fill unless the fill is specifically engineered for this purpose. If a building is located over the fill part of a platform then the footings will need to be taken down through the fill and into the insitu material where the above bearing pressure recommendation applies. To optimise shallow founding it is recommended that the buildings are positioned in areas of cut of building platforms as far as possible.

Provided that this can be adhered to it is anticipated that most foundations will consist of the normal type.

It is recommended that Moore Spence Jones (Pty) Ltd inspect and approve all foundations excavations to confirm depth of founding and bearing pressure.

1.9.6 Recommended Subgrade Treatment

The summary of subgrade conditions encountered within the housing development area, together with recommended subgrade treatment and materials usage, is given in Table 7.

Table 7
Recommended Subgrade Treatment and Materials Usage

Test	Summary of Subgrade Conditions (average depth to base of layer)	Recommended Subgrade Treatment
TP1 to TP12 DCP1 to DCP12	Residual Dolomite: Loose to very dense silty SAND with gravel or silty sandy GRAVEL.	Comprises silty sandy gravelly material. This material is suitable for Layer A construction with recommended minimum compaction 95% MDD.

1.10 Conclusions

This report contains the results of a preliminary geotechnical investigation carried out for the proposed Postmasburg Housing Development which will comprise residential structures and a community facility.

The subsoil conditions encountered beneath the site generally comprise a mantle of fill and colluvial material to about 0.15 metres. The fill and colluvial material is overlying residual calcrete and residual dolomite soils. The upper layers are in turn underlain by hardpan calcrete and dolomite bedrock.

Recommendations for earthworks and drainage to promote the stable development, materials usage, subgrade preparation and foundations are provided.

The following can be concluded:

- The area must be zoned, in accordance with the NHBRC Dolomite Area designation as given in Table 4. In terms of NDOH requirements, additional investigative work to define the Dolomitic site designation is required:

  - Gravity Survey, and
  - Percussion boreholes.

- In terms of foundations, the majority of the site that could be accessed can be designated as NHBRC Site Class P (dolomite D2/D3) and C1-C2. These designations are subject to the finalisation of the Dolomitic risk designation.

Finally, the ground conditions described in this report refer specifically to those encountered in the inspection pits on site during this investigation. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important that Moore Spence Jones Pty Ltd carry out further site investigations during the construction phase. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary design and expense. In this regard it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.

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Appendix A
Test Pit Logs and Photographs

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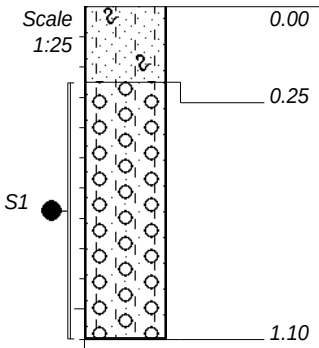
GEOTECHNICAL, CIVIL & ENVIRONMENTAL ENGINEERS

HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP1**
Sheet 1 of 1

JOB NUMBER: 12-186



Slightly moist greyish brown loose intact silty fine grained SAND with grass roots. Colluvium.

Slightly moist orangey to reddish brown dense to very dense with depth intact silty sandy fine to coarse GRAVEL. Residual Dolomite. Gravel consists of fine to coarse (2-60mm diameter) subangular dolomite fragments.

NOTES

1) Final depth at 1.10m Refusal on at least soft rock dolomite.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.25--1.10m (1 x Small) and (3 x Bulk)

5) Test pit relocated due to access issues.

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866702
Y-COORD : 0701781

HOLE No: **TP1**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP1
DEPTH (m)	1.10	**CHAINAGE POSITION**	

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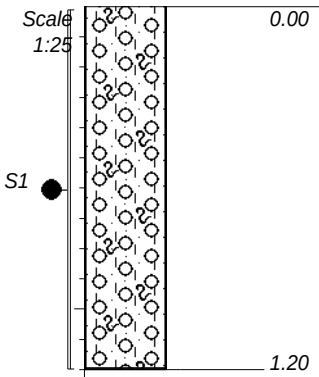
GEOTECHNICAL, CIVIL & ENVIRONMENTAL ENGINEERS

HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP2**
Sheet 1 of 1

JOB NUMBER: 12-186



Slightly moist dark orangey to reddish brown loose becoming very dense with depth intact silty sandy fine to coarse GRAVEL with grass roots. Residual Dolomite. Gravel consists of fine to coarse (2-60mm diameter) subrounded to rounded dolomite fragments.

NOTES

1) Final depth at 1.20m. Refusal on at least soft rock dolomite.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.01--1.20m (1 x Small) and (3 x Bulk)

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

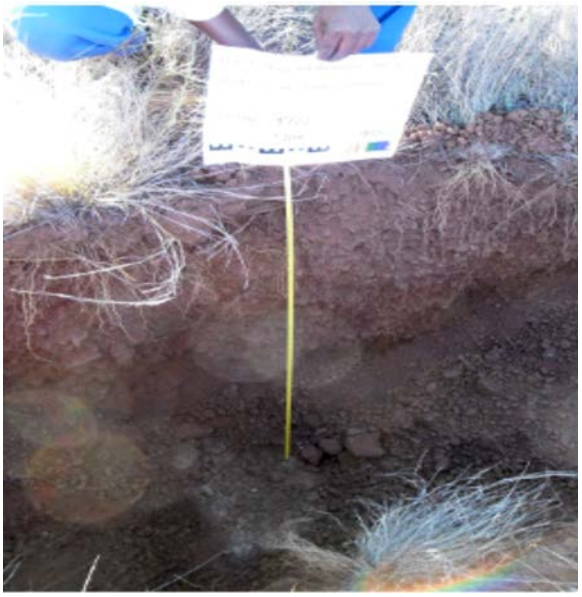
DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866650
Y-COORD : 0701723

HOLE No: **TP2**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP2
DEPTH (m)	1.20	**CHAINAGE POSITION**	



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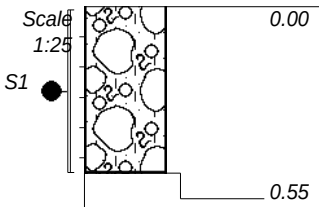
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP3**
Sheet 1 of 1

JOB NUMBER: 12-186



Slightly moist dark orangey brown mottled grey loose becoming very dense with depth intact silty fine to medium grained sandy GRAVEL with abundant cobbles, boulders and some grass roots. Residual Dolomite. Gravel consists of fine to coarse subrounded (2-60mm diameter) dolomite fragments.

NOTES

1) Final depth at 0.55m. Refusal on at least soft rock dolomite.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.01--0.55m (1 x Small)

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866563
Y-COORD : 0701722

HOLE No: **TP3**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP3
DEPTH (m)	0.55	**CHAINAGE POSITION**	

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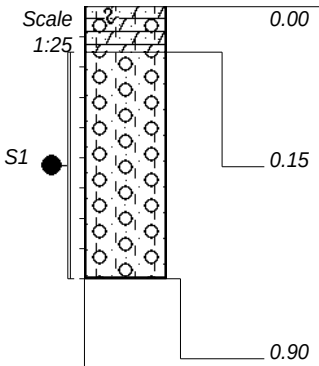
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP4**
Sheet 1 of 1

JOB NUMBER: 12-186



Dry light greyish brown loose intact silty gravelly fine to medium grained SAND with roots. Colluvium. Gravel consists of fine to medium (5-20mm diameter) subrounded matrix supported dolomite fragments.

Dry orangey to dark reddish brown medium dense to very dense with depth intact silty sandy fine to coarse GRAVEL with cobbles. Residual Dolomite. Gravel consists of fine to coarse (2-60mm diameter) subangular to subrounded dolomite fragments.

NOTES

1) Final depth at 0.90m. Refusal on at least soft rock dolomite bedrock.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.15--0.90m (1 x Small) and (3 x Bulk)

5) Test pit relocated due to excessive services.

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : NM
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 08/02/2013
DATE : 08/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866548
Y-COORD : 0701935

HOLE No: **TP4**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	8-Feb-13	**TEST PIT NO.**	TP4
DEPTH (m)	0.90	**CHAINAGE POSITION**	

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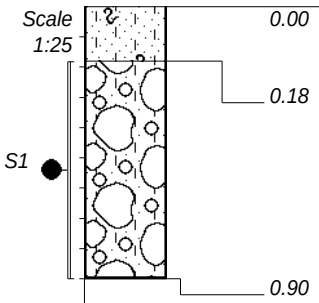
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP5**
Sheet 1 of 1

JOB NUMBER: 12-186



Dry greyish brown loose intact silty fine grained SAND with roots. Colluvium.

Dry orange to dark reddish brown mottled white and grey medium dense to very dense with depth intact silty sandy fine to coarse GRAVEL with abundant cobbles and boulders. Residual Dolomite. Gravel consists of fine to coarse (2-60mm diameter) subangular to subrounded dolomite fragments.

NOTES

1) Final depth at 0.90m. Refusal on at least soft rock dolomite bedrock.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.18--0.90m (1 x Small) and (3 x Bulk)

5) Test pit relocated due to excessive services.

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : NM
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 08/02/2013
DATE : 08/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866407
Y-COORD : 0701998

HOLE No: **TP5**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	8-Feb-13	**TEST PIT NO.**	TP5
DEPTH (m)	0.90	**CHAINAGE POSITION**	

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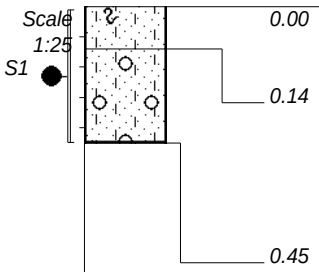
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP6**
Sheet 1 of 1

JOB NUMBER: 12-186



Dry light greyish brown loose intact silty fine to medium grained SAND with roots. Colluvium.

Dry orange to reddish brown mottled white loose becoming very dense with depth intact silty gravelly fine to medium grained SAND. Residual Calcrete. Gravel consists of abundant fine to coarse calcrete fragments.

NOTES

1) Final depth at 0.45m. Refusal on at least hardpan calcrete.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.01--0.45m (1 x Small) and (3 x Bulk)

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : NM
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 08/02/2013
DATE : 08/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866377
Y-COORD : 0702059

HOLE No: **TP6**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	8-Feb-13	**TEST PIT NO.**	TP6
DEPTH (m)	0.45	**CHAINAGE POSITION**	

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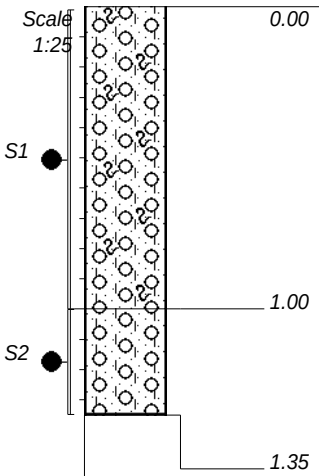
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP7**
Sheet 1 of 1

JOB NUMBER: 12-186



Dry dark orangey brown loose intact silty fine to medium grained SAND with abundant gravel and some grass roots. Residual Dolomite. Gravel consists of fine to medium subangular to subrounded (5-20mm diameter) dolomite fragments.

Dry orangey brown to orangey grey medium dense to very dense with depth intact silty fine grained SAND with abundant gravel and cobbles. Residual Dolomite. Gravel consists of fine to coarse (5-80mm diameter) subrounded dolomite fragments.

NOTES

1) Final depth at 1.35m. Refusal on at least soft rock dolomite.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.01--1.00m (1 x Small) and (3 x Bulk)
S2 1.00--1.35m (1 x Small) and (3 x Bulk)

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866325
Y-COORD : 0702158

HOLE No: **TP7**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP7
DEPTH (m)	1.35	**CHAINAGE POSITION**	

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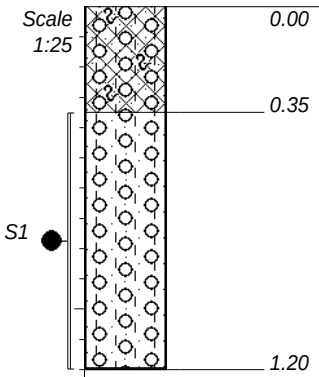
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP8**
Sheet 1 of 1

JOB NUMBER: 12-186



Dry orangey brown loose intact silty fine grained SAND with abundant gravel, grass roots and foreign objects. Fill.

Dry orangey to reddish brown loose becoming very dense with depth intact silty sandy fine to coarse GRAVEL. Residual Dolomite. Gravel consists of fine to coarse (2-60mm diameter) subangular to subrounded dolomite fragments.

NOTES

1) Final depth at 1.20m. Refusal on at least soft rock dolomite.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.35--1.20m (1 x Small) and (3 x Bulk)

5) Test pit relocated due to the reduced number of pits by Hatch.

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866388
Y-COORD : 0702237

HOLE No: **TP8**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP8
DEPTH (m)	1.20	**CHAINAGE POSITION**	

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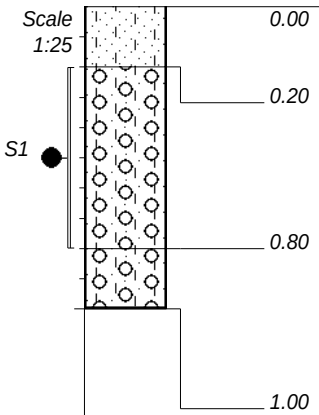
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP9**
Sheet 1 of 1

JOB NUMBER: 12-186



Slightly moist greyish brown loose intact silty fine grained SAND. Colluvium.

Slightly moist orangey brown mottled white dense to very dense intact silty sandy fine to coarse GRAVEL. Residual Calcrete.

Slightly moist light pinkish grey very dense intact silty sandy GRAVEL. Residual Calcrete. Gravel consists of fine to coarse (5-50mm diameter) subangular to subrounded matrix supported calcrete fragments.

NOTES

1) Final depth at 1.00m. Refusal on at least hardpan calcrete.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.20--0.80m (1 x Small) and (3 x Bulk)

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866276
Y-COORD : 0702242

HOLE No: **TP9**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP9
DEPTH (m)	1.00	**CHAINAGE POSITION**	

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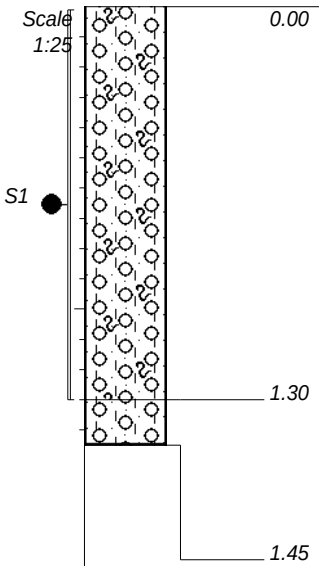
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP10**
Sheet 1 of 1

JOB NUMBER: 12-186



Slightly moist to dry orangey to reddish brown mottled white loose becoming medium dense to dense with depth intact silty sandy fine to coarse GRAVEL with grass roots. Residual Calcrete.

Slightly moist light pinkish to creamy white dense to very dense with depth intact silty sandy fine to coarse GRAVEL. Residual Calcrete. Gravel consists of fine to coarse (4-30mm diameter) subrounded calcrete fragments.

NOTES

1) Final depth at 1.45m. Refusal on at least hardpan calcrete.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.01--1.30m (1 x Small) and (3 x Bulk)

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866217
Y-COORD : 0702325

HOLE No: **TP10**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP10
DEPTH (m)	1.45	**CHAINAGE POSITION**	

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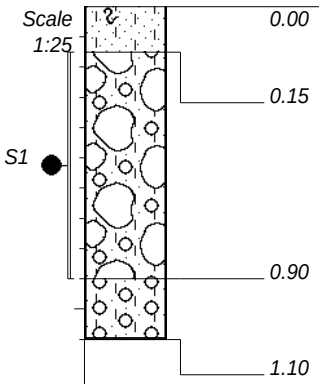
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP11**
Sheet 1 of 1

JOB NUMBER: 12-186



Slightly moist greyish brown loose to medium dense intact silty fine grained SAND with grass roots. Colluvium.

Dry orangey to dark reddish brown medium dense to dense with depth intact silty sandy fine to coarse GRAVEL with cobbles and boulders. Residual Dolomite.

Dry light pinkish to creamy white very dense intact silty sandy fine to coarse GRAVEL. Residual Calcrete.

NOTES

1) Final depth at 1.10m. Refusal on at least hardpan calcrete.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.15--0.90m (1 x Small) and (3 x Bulk)

5) Test pit position is close to a pipe.

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866077
Y-COORD : 0702361

HOLE No: **TP11**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP11
DEPTH (m)	1.10	**CHAINAGE POSITION**	

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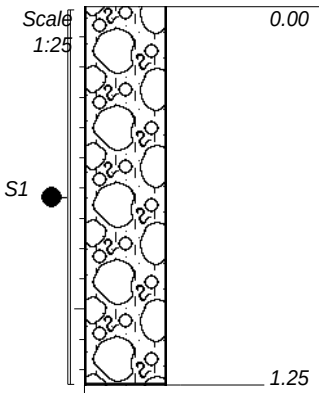
HATCH
Manganese Rail Corridor
Postmasburg Housing

HOLE No: **TP12**
Sheet 1 of 1

JOB NUMBER: 12-186



Slightly moist orangey to dark reddish brown loose becoming dense to very dense intact silty sandy fine to coarse GRAVEL with boulders and roots. Residual Dolomite. Gravel consists of fine to coarse (5-50mm diameter) subrounded dolomite fragments.

NOTES

1) Final depth at 1.25m. Refusal on at least soft rock dolomite bedrock.

2) No groundwater seepage.

3) No sidewall collapse.

4) Samples taken :
S1 0.01--1.25m (1 x Small) and (3 x Bulk)

5) Test pit relocated due to reduction in number of pits.

CONTRACTOR : Kouga Plant
MACHINE : Hidro
DRILLED BY :
PROFILED BY : WK

TYPE SET BY : MC
SETUP FILE : MSJ2004.SET

INCLINATION :
DIAM :
DATE : 07/02/2013
DATE : 07/02/2013

DATE : 07/03/2013 10:45
TEXT : G\TP1TP12.doc

ELEVATION :
X-COORD : 6866029
Y-COORD : 0702440

HOLE No: **TP12**

MOORE SPENCE JONES

PROJECT	Manganese Rail Corridor	**SECTION**	Postmasburg Housing
DATE PROFILED	7-Feb-13	**TEST PIT NO.**	TP12
DEPTH (m)	1.25	**CHAINAGE POSITION**	

Appendix B
DCP Test Results

MOORE SPENCE JONES

CONSULTING GEOTECHNICAL, CIVIL & ENVIRONMENTAL ENGINEERS
CONSULTING GEOLOGISTS & SCIENTISTS

FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

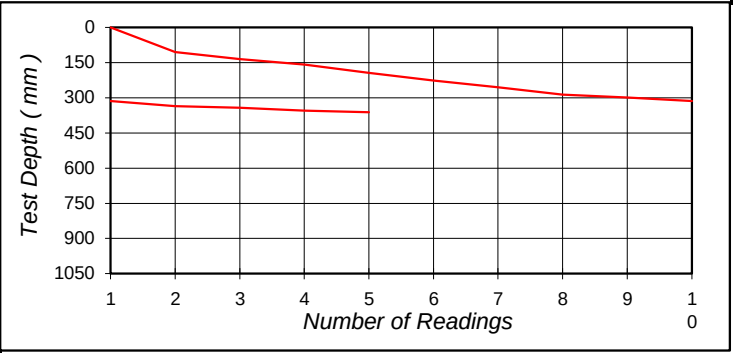
Description **Postmasburg Housing**

Test no: **DCP1**

DCP Readings

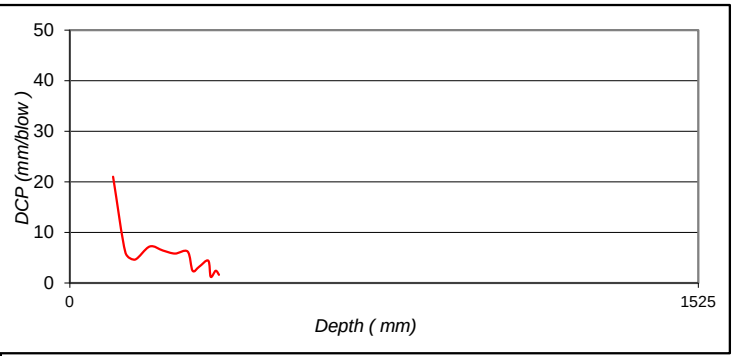
Blows per reading: **5**

no.	mm	no.	mm	no.	mm	no.	mm	no.	mm
1	**105**	11	**342**	21		31		41	
2	**135**	12	**354**	22		32		42	
3	**158**	13	**362**	23		33		43	
4	**194**	14		24		34		44	
5	**226**	15		25		35		45	
6	**255**	16		26		36		46	
7	**286**	17		27		37		47	
8	**298**	18		28		38		48	
9	**314**	19		29		39		49	
10	**336**	20		30		40		50	

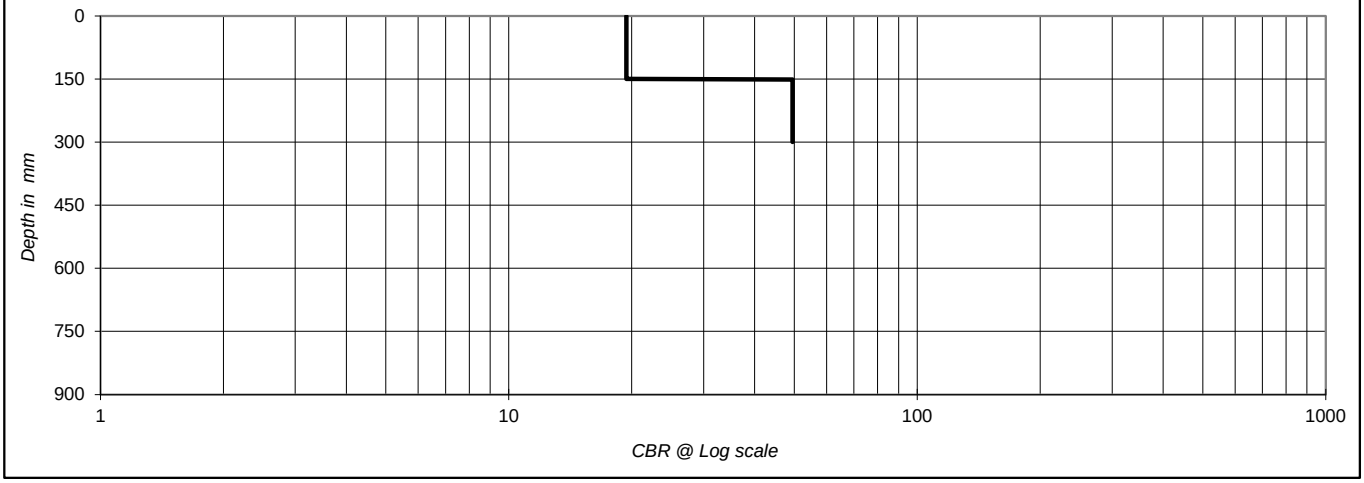


DCP number (mm / Blow) DN

DN	mm	DN	mm	DN	mm	DN	mm	DN	mm
21	105	1.2	342						
6	135	2.4	354						
4.6	158	1.6	362						
7.2	194								
6.4	226								
5.8	255								
6.2	286								
2.4	298								
3.2	314								
4.4	336								



Layer - Strength diagram



Depth (mm)					In situ	Blows/mm	
no.	From	-	To	DN	CBR	150mm	300mm
1	1	-	150	11	**19**	13	**20.3**
2	151	-	300	5.5	**50**	27	
3	301	-	450				
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 362 mm**

MOORE SPENCE JONES

CONSULTING GEOTECHNICAL, CIVIL & ENVIRONMENTAL ENGINEERS
CONSULTING GEOLOGISTS & SCIENTISTS

FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

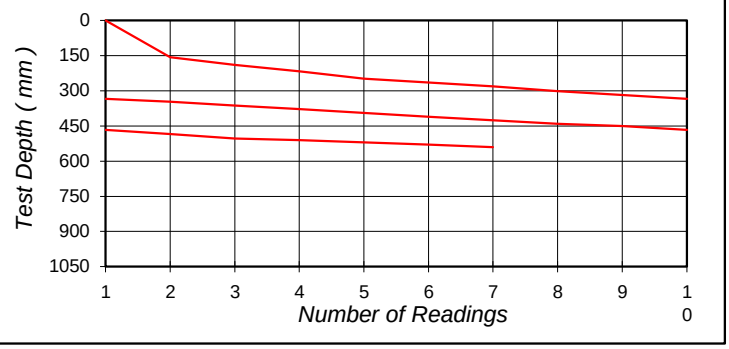
Description **Postmasburg Housing**

Test no: **DCP2**

DCP Readings

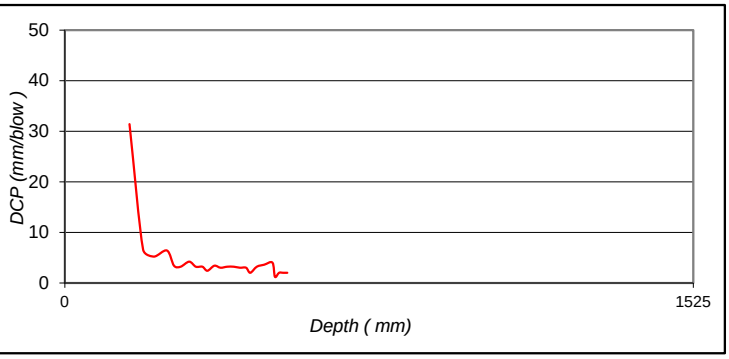
Blows per reading: **5**

no.	mm	no.	mm	no.	mm	no.	mm	no.	mm
1	**157**	11	**363**	21	**510**	31		41	
2	**190**	12	**378**	22	**520**	32		42	
3	**216**	13	**394**	23	**530**	33		43	
4	**248**	14	**410**	24	**540**	34		44	
5	**265**	15	**425**	25		35		45	
6	**281**	16	**440**	26		36		46	
7	**302**	17	**450**	27		37		47	
8	**318**	18	**466**	28		38		48	
9	**334**	19	**484**	29		39		49	
10	**346**	20	**504**	30		40		50	

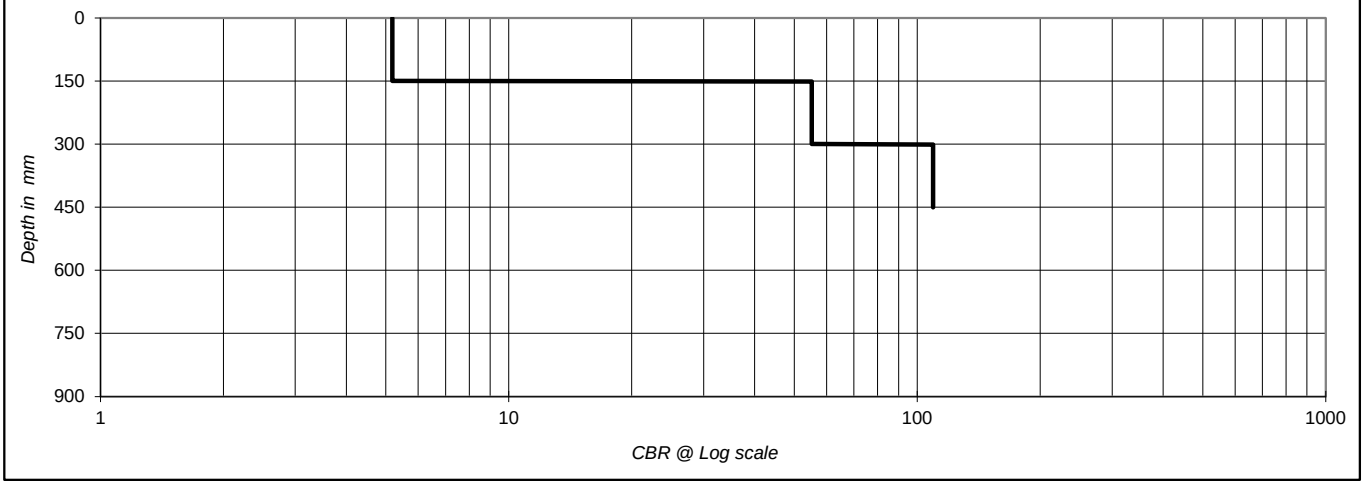


DCP number (mm / Blow) DN

DN	mm	DN	mm	DN	mm	DN	mm	DN	mm
31	157	3.4	363	1.2	510				
6.6	190	3	378	2	520				
5.2	216	3.2	394	2	530				
6.4	248	3.2	410	2	540				
3.4	265	3	425						
3.2	281	3	440						
4.2	302	2	450						
3.2	318	3.2	466						
3.2	334	3.6	484						
2.4	346	4	504						



Layer - Strength diagram



Depth (mm)					In situ	Blows/mm	
no.	From	-	To	DN	CBR	150mm	300mm
1	1	-	150	31	**5**	5	**17.3**
2	151	-	300	5	**55**	30	
3	301	-	450	3	**109**	50	**25.2**
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 540 mm**

MOORE SPENCE JONES

CONSULTING GEOTECHNICAL, CIVIL & ENVIRONMENTAL ENGINEERS
CONSULTING GEOLOGISTS & SCIENTISTS

FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

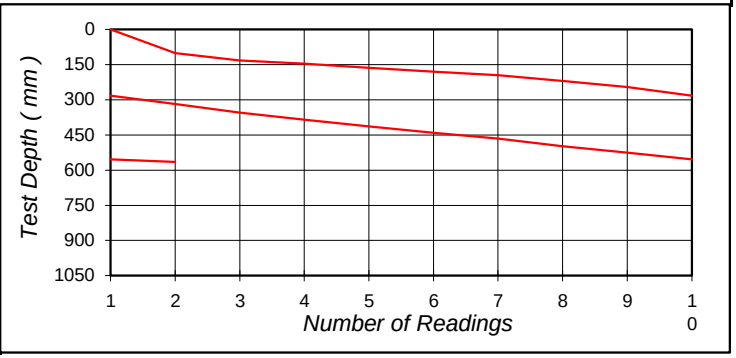
Description **Postmasburg Housing**

Test no: **DCP3**

DCP Readings

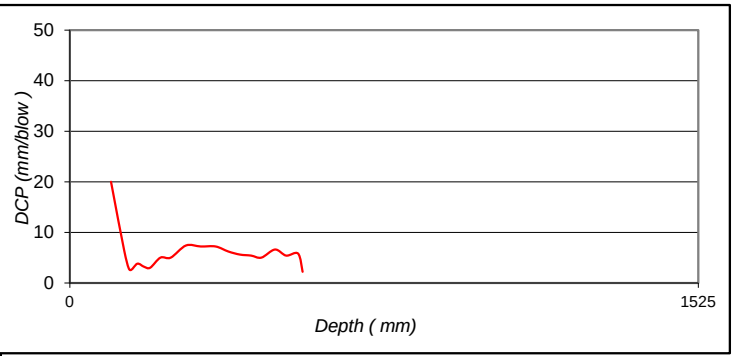
Blows per reading: **5**

no.	mm	no.	mm	no.	mm	no.	mm	no.	mm
1	**100**	11	**354**	21		31		41	
2	**132**	12	**385**	22		32		42	
3	**145**	13	**413**	23		33		43	
4	**164**	14	**440**	24		34		44	
5	**180**	15	**465**	25		35		45	
6	**195**	16	**498**	26		36		46	
7	**220**	17	**525**	27		37		47	
8	**245**	18	**554**	28		38		48	
9	**282**	19	**565**	29		39		49	
10	**318**	20		30		40		50	

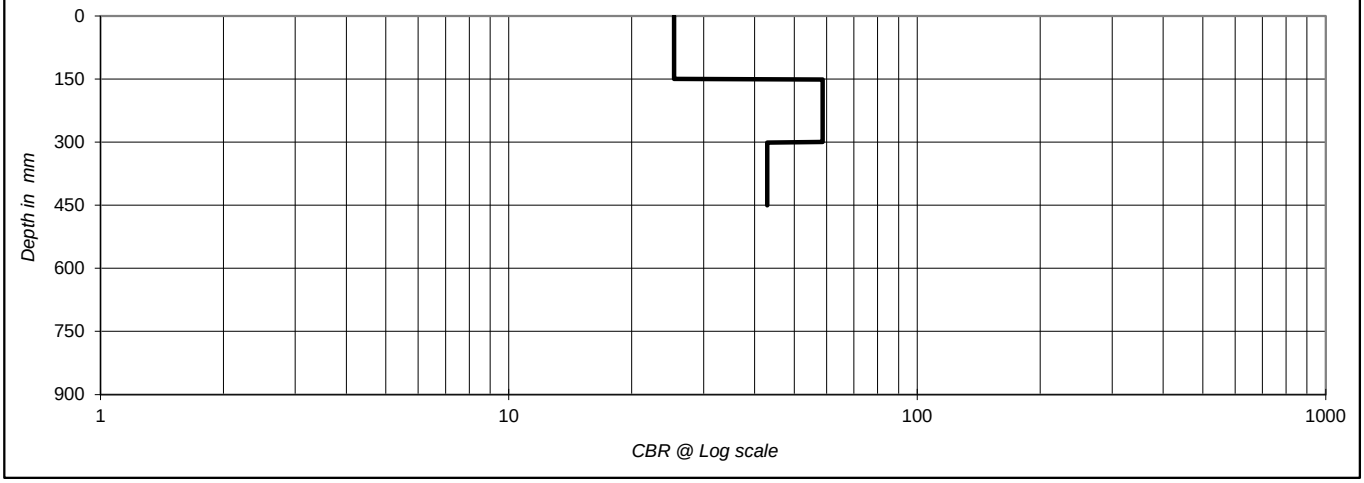


DCP number (mm / Blow) DN

DN	mm	DN	mm	DN	mm	DN	mm	DN	mm
20	100	7.2	354						
6.4	132	6.2	385						
2.6	145	5.6	413						
3.8	164	5.4	440						
3.2	180	5	465						
3	195	6.6	498						
5	220	5.4	525						
5	245	5.8	554						
7.4	282	2.2	565						
7.2	318								



Layer - Strength diagram



no.	Depth (mm) From	-	To	DN	In situ CBR	Blows/mm 150mm	300mm
1	1	-	150	9.2	**25**	16	**23.8**
2	151	-	300	4.8	**59**	31	
3	301	-	450	6.1	**43**	25	**12.3**
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 565 mm**

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FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **8-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

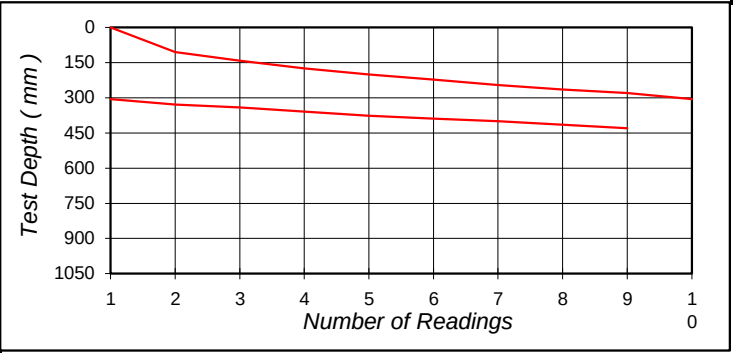
Description **Postmasburg Housing**

Test no: **DCP4**

DCP Readings

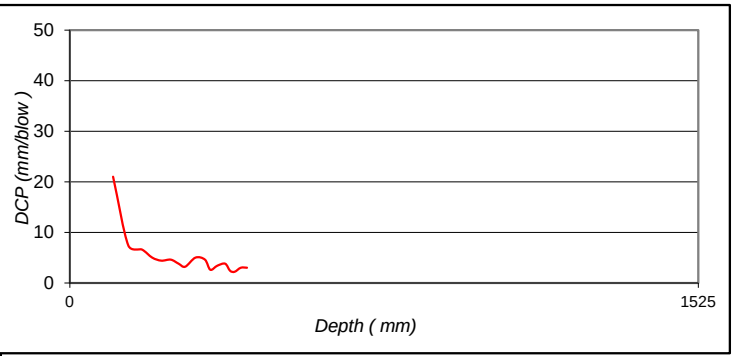
Blows per reading: **5**

no.	mm	no.	mm	no.	mm	no.	mm	no.	mm
1	**105**	11	**341**	21		31		41	
2	**142**	12	**358**	22		32		42	
3	**175**	13	**377**	23		33		43	
4	**200**	14	**389**	24		34		44	
5	**222**	15	**400**	25		35		45	
6	**245**	16	**415**	26		36		46	
7	**264**	17	**430**	27		37		47	
8	**280**	18		28		38		48	
9	**305**	19		29		39		49	
10	**328**	20		30		40		50	

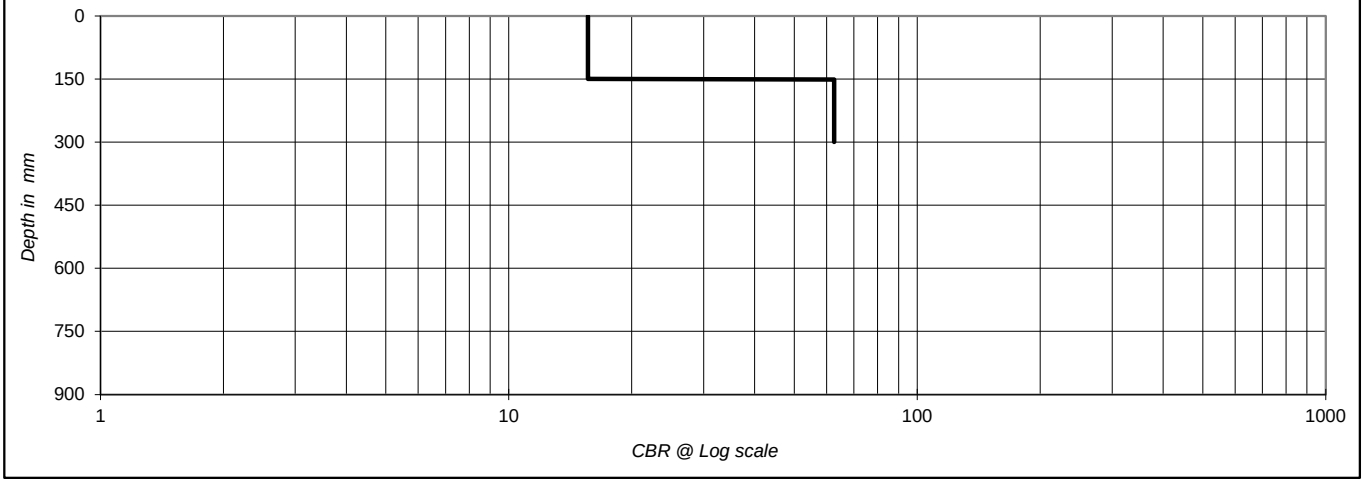


DCP number (mm / Blow) DN

DN	mm	DN	mm	DN	mm	DN	mm	DN	mm
21	105	2.6	341						
7.4	142	3.4	358						
6.6	175	3.8	377						
5	200	2.4	389						
4.4	222	2.2	400						
4.6	245	3	415						
3.8	264	3	430						
3.2	280								
5	305								
4.6	328								



Layer - Strength diagram



Depth (mm)					In situ	Blows/mm	
no.	From	-	To	DN	CBR	150mm	300mm
1	1	-	150	13	**16**	11	**22.0**
2	151	-	300	4.6	**63**	33	
3	301	-	450				
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 430 mm**

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CONSULTING GEOLOGISTS & SCIENTISTS

FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **8-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

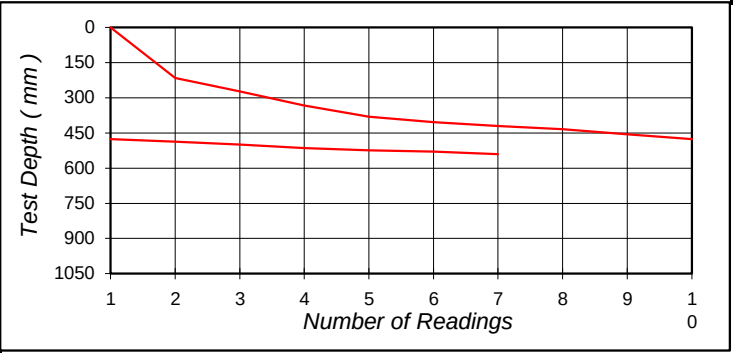
Description **Postmasburg Housing**

Test no: **DCP5**

DCP Readings

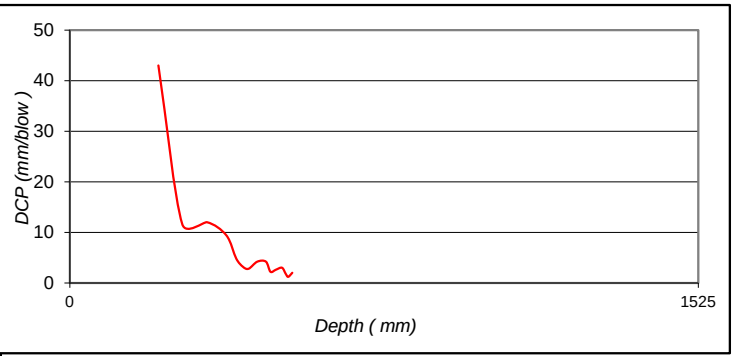
Blows per reading: **5**

no.	mm	no.	mm	no.	mm	no.	mm	no.	mm
1	**215**	11	**500**	21		31		41	
2	**273**	12	**515**	22		32		42	
3	**333**	13	**524**	23		33		43	
4	**380**	14	**530**	24		34		44	
5	**404**	15	**540**	25		35		45	
6	**420**	16		26		36		46	
7	**434**	17		27		37		47	
8	**455**	18		28		38		48	
9	**476**	19		29		39		49	
10	**487**	20		30		40		50	

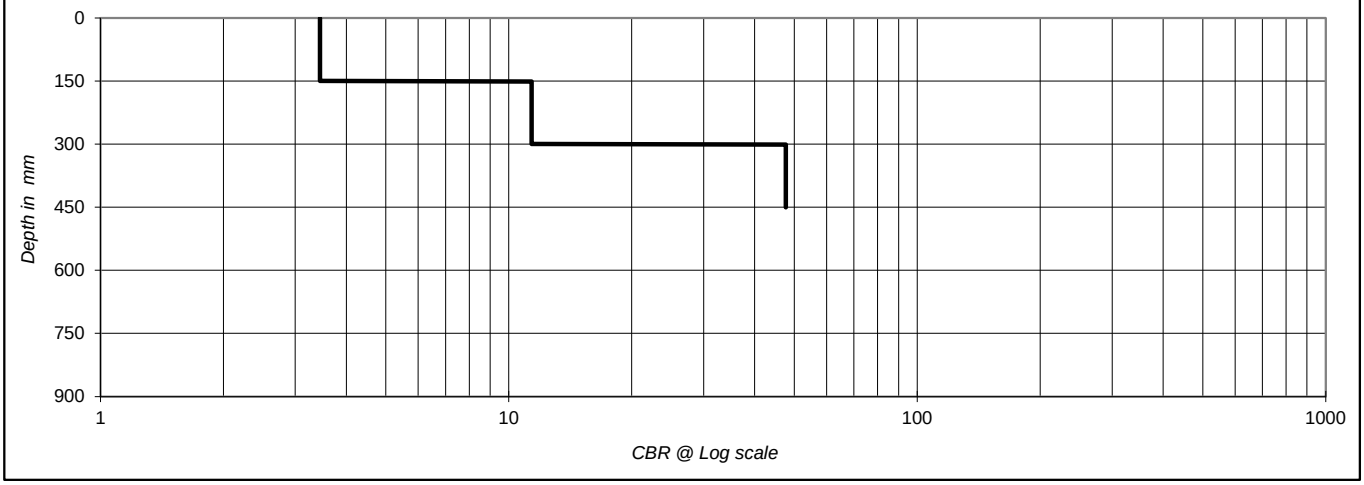


DCP number (mm / Blow) DN

DN	mm	DN	mm	DN	mm	DN	mm	DN	mm
43	215	2.6	500						
12	273	3	515						
12	333	1.8	524						
9.4	380	1.2	530						
4.8	404	2	540						
3.2	420								
2.8	434								
4.2	455								
4.2	476								
2.2	487								



Layer - Strength diagram



Depth (mm)					In situ	Blows/mm	
no.	From	-	To	DN	CBR	150mm	300mm
1	1	-	150	43	**3**	3	**6.1**
2	151	-	300	17	**11**	9	
3	301	-	450	5.6	**48**	27	**13.3**
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 540 mm**

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CONSULTING GEOLOGISTS & SCIENTISTS

FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **8-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

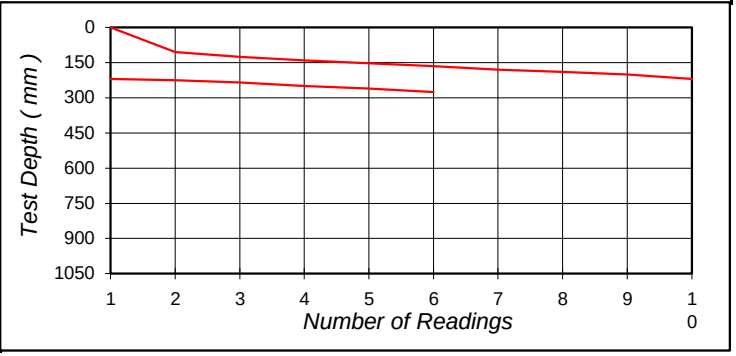
Description **Postmasburg Housing**

Test no: **DCP6**

DCP Readings

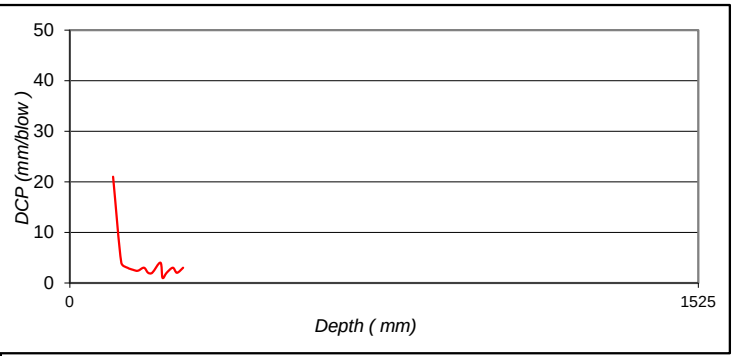
Blows per reading: **5**

no.	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*
1	**105**	11	**235**	21		31		41	
2	**125**	12	**250**	22		32		42	
3	**140**	13	**260**	23		33		43	
4	**153**	14	**275**	24		34		44	
5	**165**	15		25		35		45	
6	**180**	16		26		36		46	
7	**190**	17		27		37		47	
8	**200**	18		28		38		48	
9	**220**	19		29		39		49	
10	**225**	20		30		40		50	

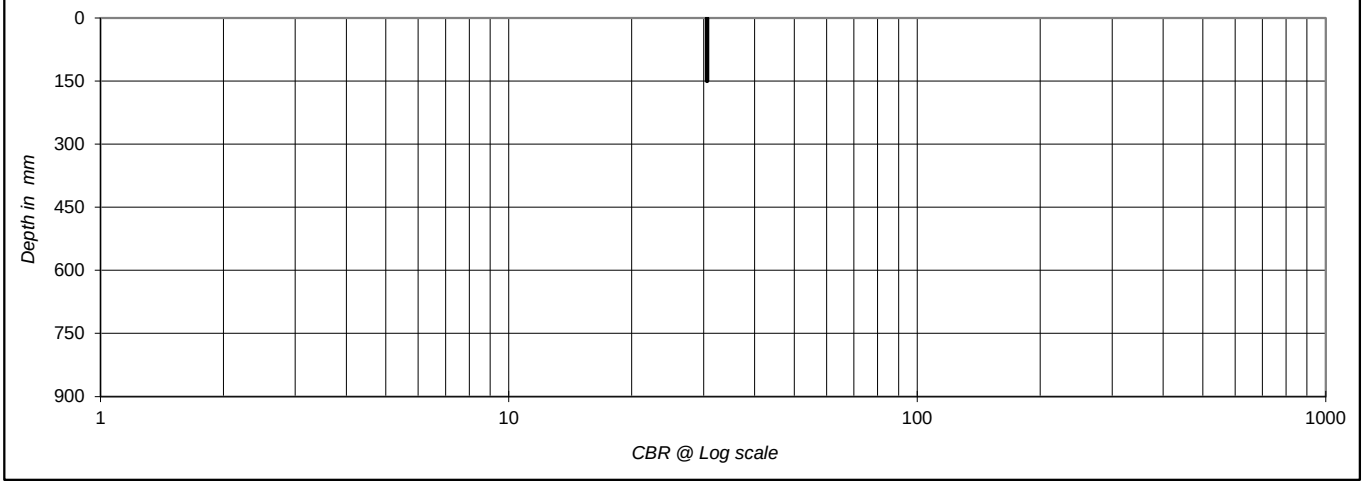


DCP number (mm / Blow) DN

DN	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*
21	105	2	235						
4	125	3	250						
3	140	2	260						
2.6	153	3	275						
2.4	165								
3	180								
2	190								
2	200								
4	220								
1	225								



Layer - Strength diagram



no.	*Depth (mm) From*	-	*To*	*DN*	*In situ CBR*	*Blows/mm* 150mm	300mm
1	1	-	150	8	**31**	19	**#DIV/0!**
2	151	-	300	###	######	#DIV/0!	
3	301	-	450				
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 275 mm**

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FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

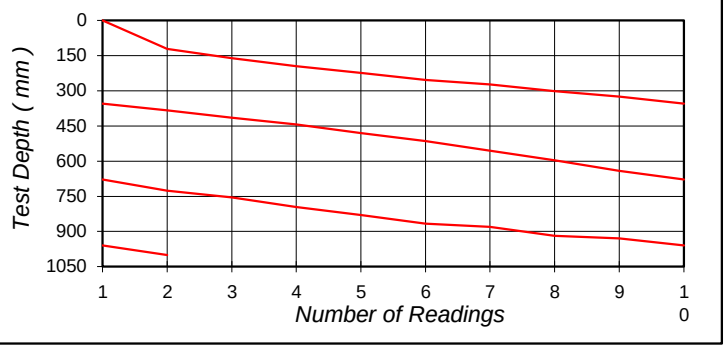
Description **Postmasburg Housing**

Test no: **DCP7**

DCP Readings

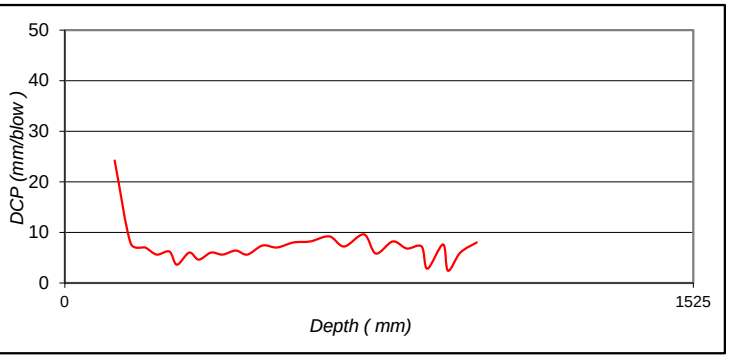
Blows per reading: **5**

no.	mm	no.	mm	no.	mm	no.	mm	no.	mm
1	**121**	11	**415**	21	**796**	31		41	
2	**160**	12	**443**	22	**830**	32		42	
3	**195**	13	**480**	23	**866**	33		43	
4	**223**	14	**515**	24	**880**	34		44	
5	**254**	15	**555**	25	**918**	35		45	
6	**272**	16	**596**	26	**930**	36		46	
7	**302**	17	**642**	27	**960**	37		47	
8	**325**	18	**678**	28	**1000**	38		48	
9	**355**	19	**726**	29		39		49	
10	**383**	20	**755**	30		40		50	

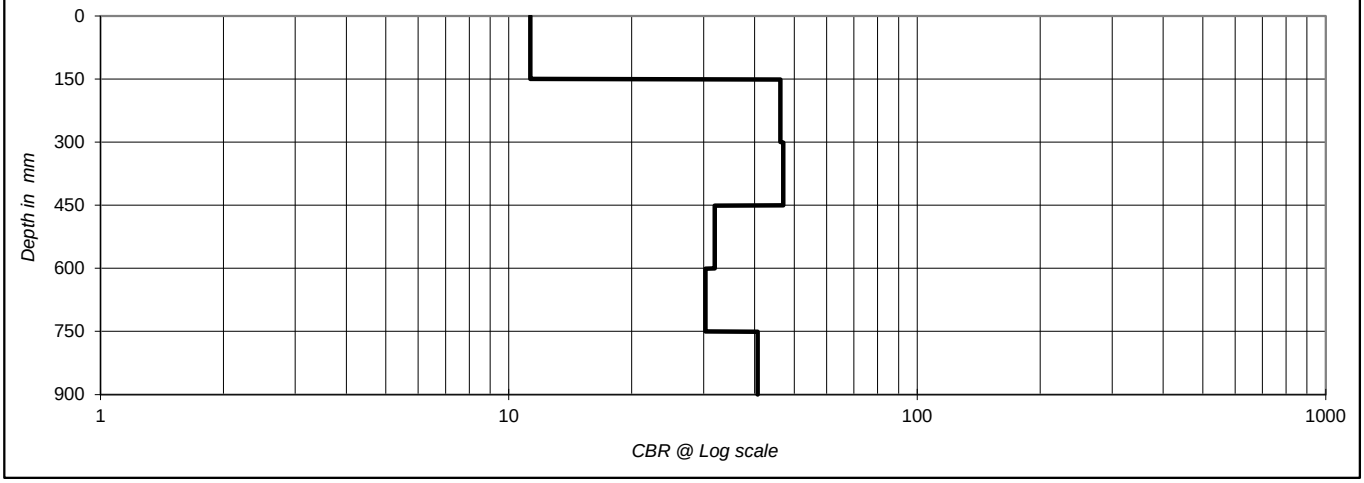


DCP number (mm / Blow) DN

DN	mm	DN	mm	DN	mm	DN	mm	DN	mm
24	121	6.4	415	8.2	796				
7.8	160	5.6	443	6.8	830				
7	195	7.4	480	7.2	866				
5.6	223	7	515	2.8	880				
6.2	254	8	555	7.6	918				
3.6	272	8.2	596	2.4	930				
6	302	9.2	642	6	960				
4.6	325	7.2	678	8	1000				
6	355	9.6	726						
5.6	383	5.8	755						



Layer - Strength diagram



Depth (mm)					In situ	Blows/mm	
no.	From	-	To	DN	CBR	150mm	300mm
1	1	-	150	17	**11**	9	**17.3**
2	151	-	300	5.8	**46**	26	
3	301	-	450	5.7	**47**	26	**22.9**
4	451	-	600	7.7	**32**	19	
5	601	-	750	8	**30**	19	**21.1**
6	751	-	900	6.4	**41**	23	

REMARKS Max. penetration depth : 1000 mm

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FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

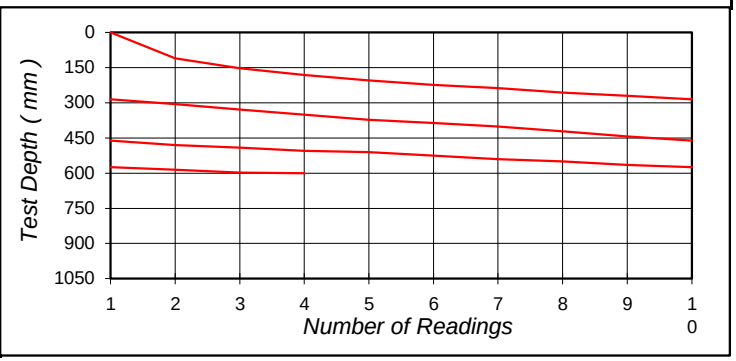
Description **Postmasburg Housing**

Test no: **DCP8**

DCP Readings

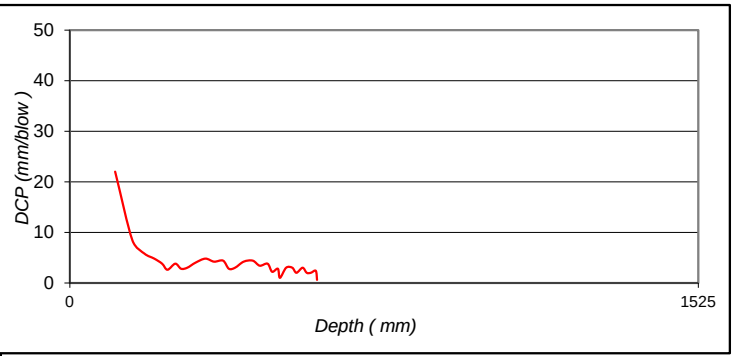
Blows per reading: **5**

no.	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*
1	**110**	11	**329**	21	**505**	31		41	
2	**152**	12	**350**	22	**510**	32		42	
3	**181**	13	**372**	23	**525**	33		43	
4	**205**	14	**386**	24	**540**	34		44	
5	**224**	15	**401**	25	**550**	35		45	
6	**237**	16	**422**	26	**565**	36		46	
7	**256**	17	**444**	27	**575**	37		47	
8	**270**	18	**461**	28	**585**	38		48	
9	**285**	19	**480**	29	**597**	39		49	
10	**305**	20	**491**	30	**600**	40		50	

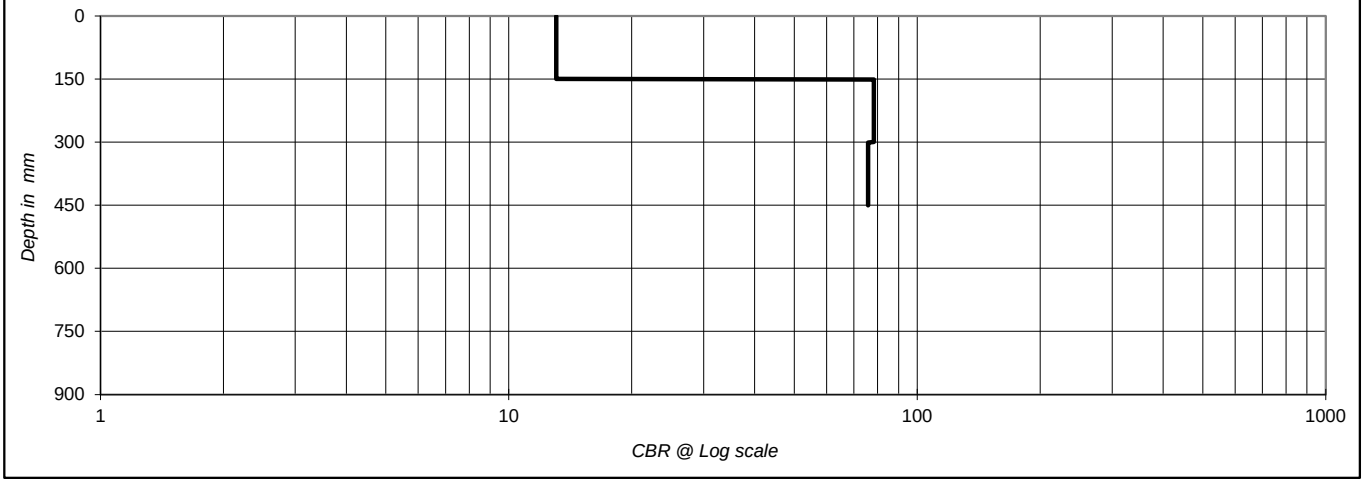


DCP number (mm / Blow) DN

DN	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*
22	110	4.8	329	2.8	505				
8.4	152	4.2	350	1	510				
5.8	181	4.4	372	3	525				
4.8	205	2.8	386	3	540				
3.8	224	3	401	2	550				
2.6	237	4.2	422	3	565				
3.8	256	4.4	444	2	575				
2.8	270	3.4	461	2	585				
3	285	3.8	480	2.4	597				
4	305	2.2	491	0.6	600				



Layer - Strength diagram



Depth (mm)					*In situ*	*Blows/mm*	
no.	*From*	-	*To*	*DN*	*CBR*	150mm	300mm
1	1	-	150	15	**13**	10	**24.4**
2	151	-	300	3.8	**78**	39	
3	301	-	450	3.9	**76**	38	**19.0**
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 600 mm**

MOORE SPENCE JONES

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FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

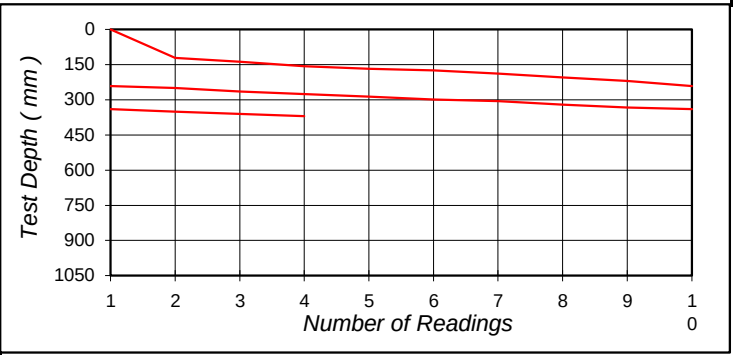
Description **Postmasburg Housing**

Test no: **DCP9**

DCP Readings

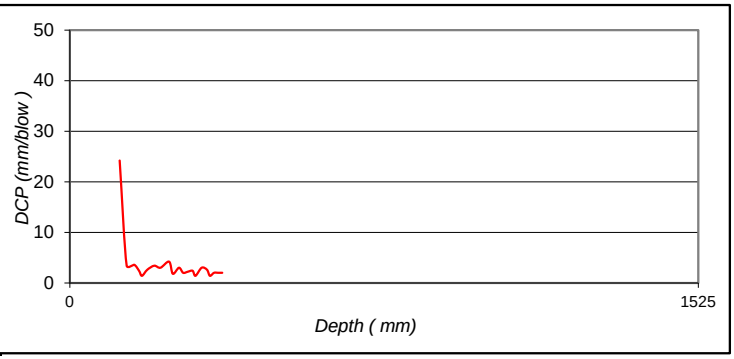
Blows per reading: **5**

no.	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*
1	**121**	11	**265**	21	**370**	31		41	
2	**138**	12	**275**	22		32		42	
3	**156**	13	**286**	23		33		43	
4	**168**	14	**298**	24		34		44	
5	**175**	15	**305**	25		35		45	
6	**188**	16	**320**	26		36		46	
7	**205**	17	**333**	27		37		47	
8	**220**	18	**340**	28		38		48	
9	**241**	19	**350**	29		39		49	
10	**250**	20	**360**	30		40		50	

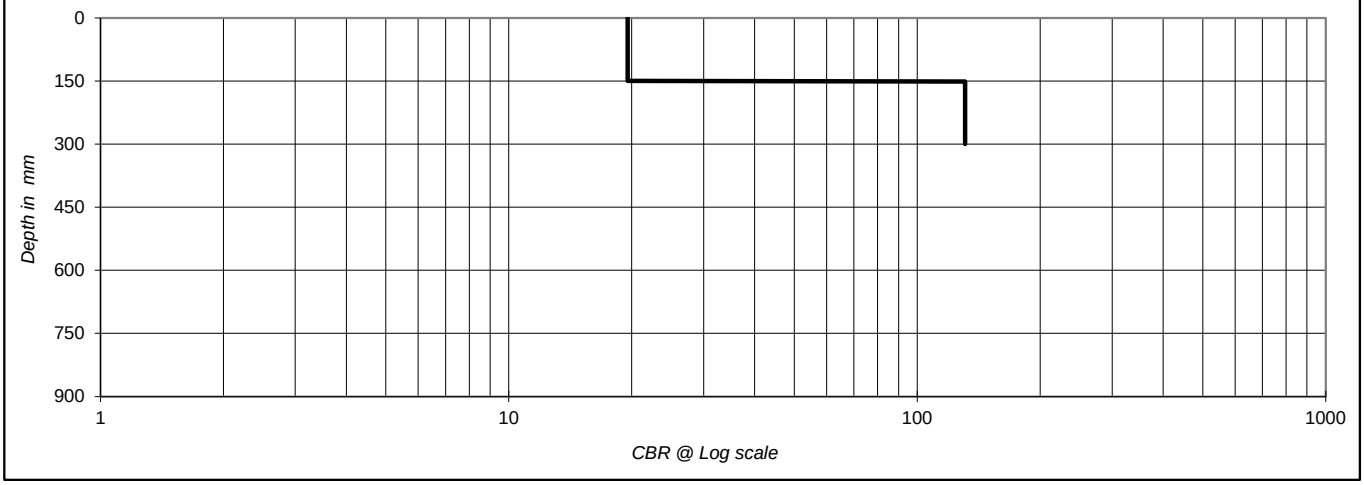


DCP number (mm / Blow) DN

DN	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*
24	121	3	265	2	370				
3.4	138	2	275						
3.6	156	2.2	286						
2.4	168	2.4	298						
1.4	175	1.4	305						
2.6	188	3	320						
3.4	205	2.6	333						
3	220	1.4	340						
4.2	241	2	350						
1.8	250	2	360						



Layer - Strength diagram



	Depth (mm)				*In situ*	*Blows/mm*	
no.	*From*	-	*To*	*DN*	*CBR*	150mm	300mm
1	1	-	150	11	**20**	13	**35.7**
2	151	-	300	2.6	**131**	58	
3	301	-	450				
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 370 mm**

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CONSULTING GEOLOGISTS & SCIENTISTS

FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

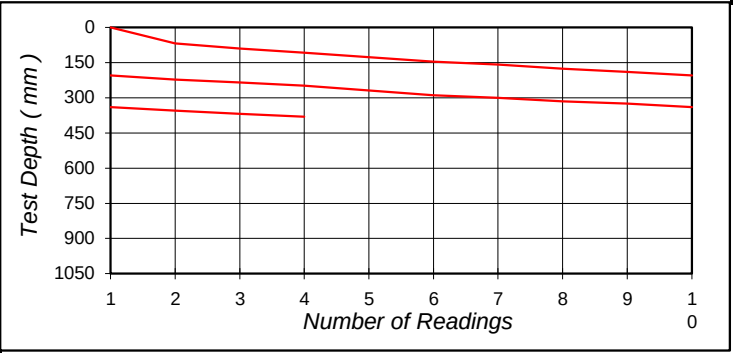
Description **Postmasburg Housing**

Test no: **DCP10**

DCP Readings

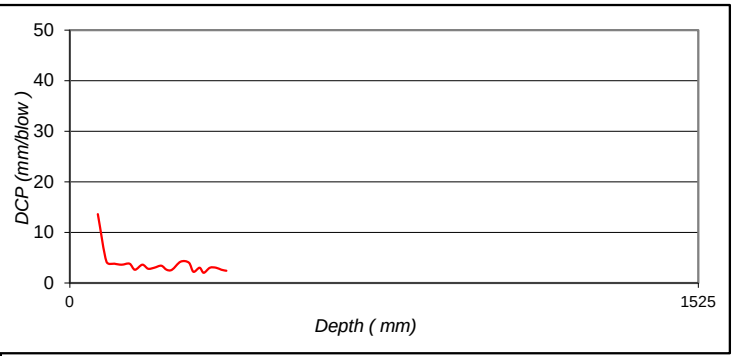
Blows per reading: **5**

no.	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*
1	**68**	11	**235**	21	**380**	31		41	
2	**89**	12	**248**	22		32		42	
3	**108**	13	**269**	23		33		43	
4	**126**	14	**289**	24		34		44	
5	**145**	15	**300**	25		35		45	
6	**158**	16	**315**	26		36		46	
7	**176**	17	**325**	27		37		47	
8	**190**	18	**340**	28		38		48	
9	**205**	19	**355**	29		39		49	
10	**222**	20	**368**	30		40		50	

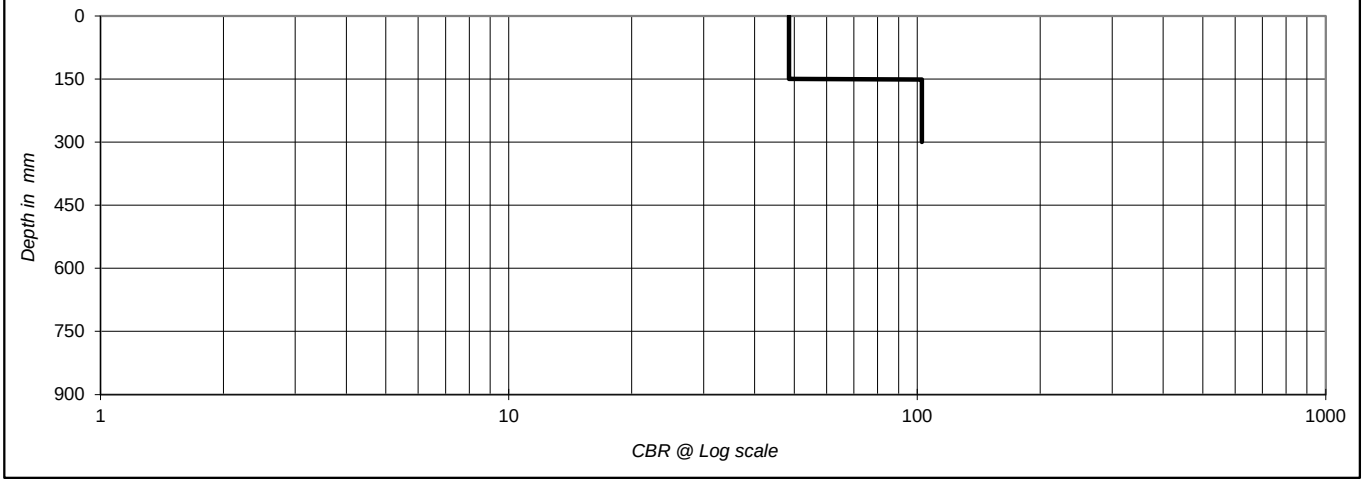


DCP number (mm / Blow) DN

DN	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*
14	68	2.6	235	2.4	380				
4.2	89	2.6	248						
3.8	108	4.2	269						
3.6	126	4	289						
3.8	145	2.2	300						
2.6	158	3	315						
3.6	176	2	325						
2.8	190	3	340						
3	205	3	355						
3.4	222	2.6	368						



Layer - Strength diagram



no.	*Depth (mm) From*	-	*To*	*DN*	*In situ CBR*	*Blows/mm* 150mm	300mm
1	1	-	150	5.6	**48**	27	**37.5**
2	151	-	300	3.1	**103**	48	
3	301	-	450				
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 380 mm**

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FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

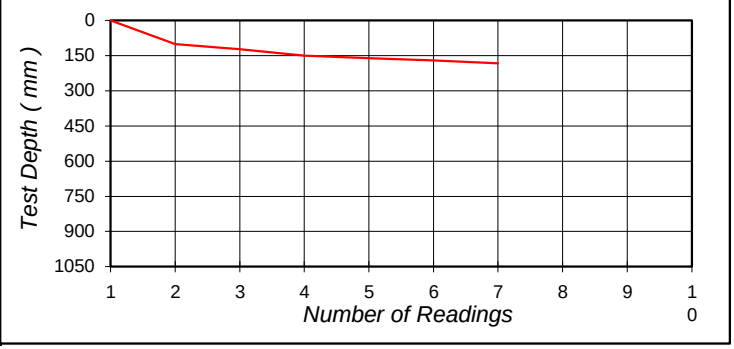
Description **Postmasburg Housing**

Test no: **DCP11**

DCP Readings

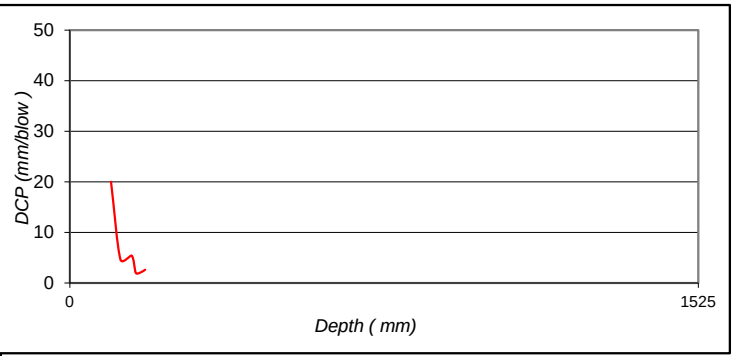
Blows per reading: **5**

no.	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*
1	**100**	11		21		31		41	
2	**123**	12		22		32		42	
3	**150**	13		23		33		43	
4	**160**	14		24		34		44	
5	**170**	15		25		35		45	
6	**183**	16		26		36		46	
7		17		27		37		47	
8		18		28		38		48	
9		19		29		39		49	
10		20		30		40		50	

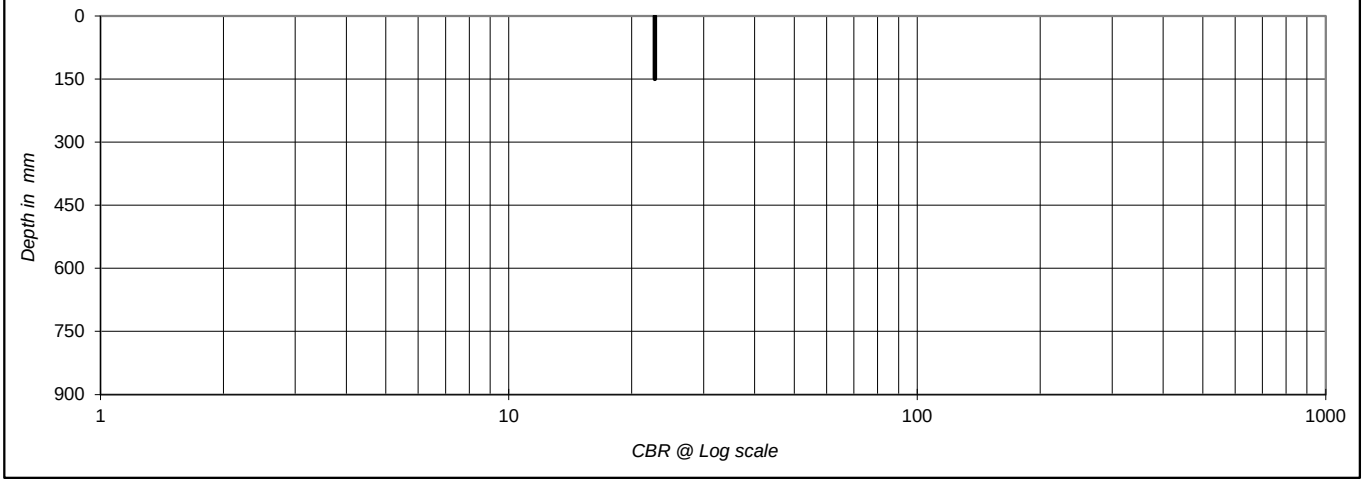


DCP number (mm / Blow) DN

DN	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*
20	100								
4.6	123								
5.4	150								
2	160								
2	170								
2.6	183								



Layer - Strength diagram



	Depth (mm)				*In situ*	*Blows/mm*	
no.	*From*	-	*To*	*DN*	*CBR*	150mm	300mm
1	1	-	150	10	**23**	15	**#DIV/0!**
2	151	-	300	###	######	#DIV/0!	
3	301	-	450				
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 183 mm**

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FOUNDATION INVESTIGATION - DCP

Client: **HATCH** | *Date:* **7-Feb-13**

Contract: **Manganese Rail Corridor (12-186)**

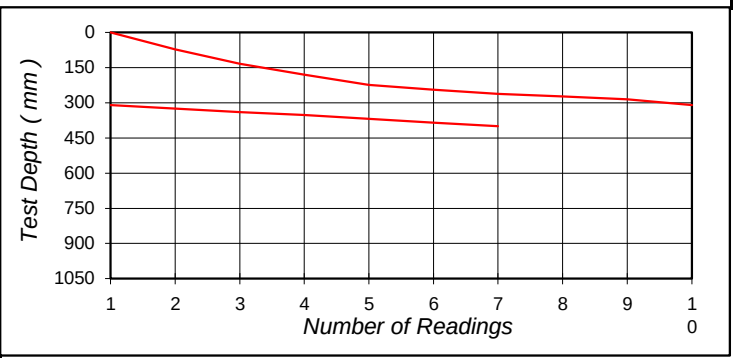
Description **Postmasburg Housing**

Test no: **DCP12**

DCP Readings

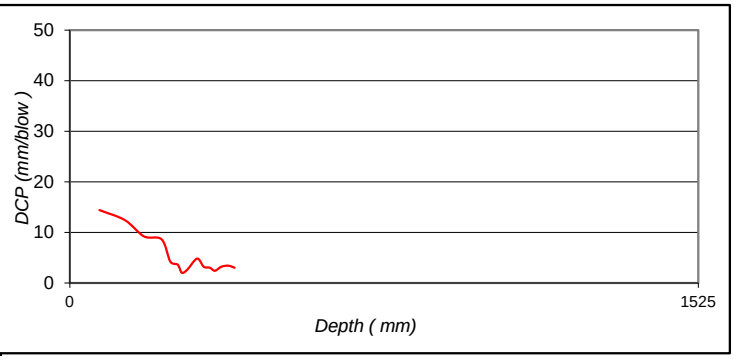
Blows per reading: **5**

no.	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*	*no.*	*mm*
1	**72**	11	**340**	21		31		41	
2	**134**	12	**352**	22		32		42	
3	**180**	13	**368**	23		33		43	
4	**223**	14	**385**	24		34		44	
5	**244**	15	**400**	25		35		45	
6	**262**	16		26		36		46	
7	**272**	17		27		37		47	
8	**285**	18		28		38		48	
9	**309**	19		29		39		49	
10	**325**	20		30		40		50	

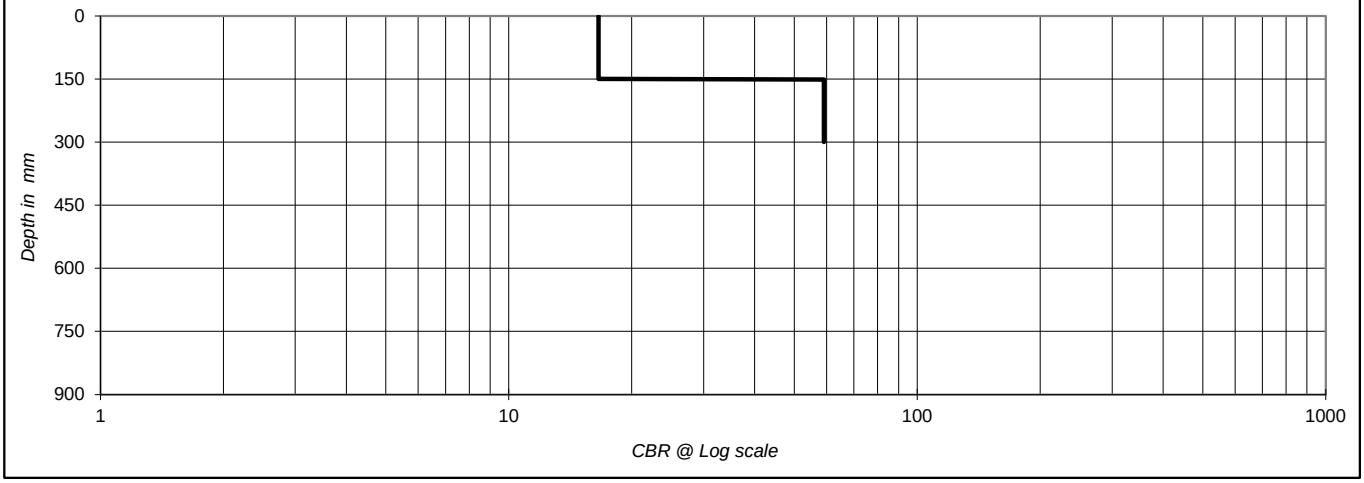


DCP number (mm / Blow) DN

DN	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*	*DN*	*mm*
14	72	3	340						
12	134	2.4	352						
9.2	180	3.2	368						
8.6	223	3.4	385						
4.2	244	3	400						
3.6	262								
2	272								
2.6	285								
4.8	309								
3.2	325								



Layer - Strength diagram



	Depth (mm)				*In situ*	*Blows/mm*	
no.	*From*	-	*To*	*DN*	*CBR*	150mm	300mm
1	1	-	150	13	**17**	12	**21.6**
2	151	-	300	4.8	**59**	31	
3	301	-	450				
4	451	-	600				
5	601	-	750				
6	751	-	900				

REMARKS **Refusal at 400 mm**

Appendix C
Laboratory Test Results

SIMLAB (PTY) LIMITED -
GEOTECHNICAL SERVICES
P.O. Box 6249
BLOEMFONTEIN
9300
Tel.: 051 - 447 0224 / 5
Fax.: 051 - 448 8329
E-mail : **simbfn@simlab.co.za**

CENTRE-LINE MATERIALS SURVEY

GROUND LEVEL AND FINAL ROAD LEVEL

km DISTANCE

SAMPLE DATA

TP No.	DEPTH (m)	Lab No.	DESCRIPTION	63.0	53.0	37.5	26.5	19.0	13.2	4.75	2.00	0.425	0.075	Silt <0.05 >0.005	Clay <0.005	SOIL MORTAR ANALYSIS CS < 2.00 >0.475	SOIL MORTAR ANALYSIS FS <0.425 >0.075	SOIL MORTAR ANALYSIS <0.075	ATTERBERG CONSTANTS LL	ATTERBERG CONSTANTS PI	ATTERBERG CONSTANTS LS	GM	MODIFIED AASHTO OMC	MODIFIED AASHTO MOD	CBR (ITS / UCS) * 100%	98%	95%	93%	90%	CBR COMP MOIST	CBR SWELL	IN SITU MOISTURE %	CLASSIFICATION: TRH14; Transnet S410; TRH20; USCS
TP2	0 - 1200	013/0299	Poorly graded sand with silt and gravel. Residual Dolomite		100	98	95	90	84	57	45	38	6	5	3	26	61	13	-	S.P.	2.0	2.1	6.5	2148	98.0	61.0	29.0	18.0	9.0	6.6	0	2.0	G7; A; B; SP-SM
TP4	150 - 900	013/0298	Poorly graded sand with silt and gravel. Residual Dolomite			100	98	95	88	53	44	38	5	6	2	24	66	10	-	N.P.	0.0	2.1	6.5	2212	102.0	78.0	52.0	40.0	26.0	6.5	0	0.9	G5; A; B; SP-SM
TP5	180 - 900	013/0301	Poorly graded sand with gravel. Residual Dolomite		100	98	93	88	83	54	45	38	4	5	3	28	63	9	-	S.P.	0.3	2.1	5.0	2266	104.0	68.0	36.0	24.0	12	5.0	0	1.5	G7; A; B; SP
TP6	0 - 450	013/0302	Poorly graded sand with silt and gravel. Colluvium & Residual Calcrete mix		100	99	98	96	88	77	70	58	8	5	2	28	61	12	-	N.P.	0.0	1.6	5.0	2032	40.0	61.0	21.0	16.0	11.0	5.0	0	1.5	G7; A; B; SP-SM
TP7	0 - 1000	013/0303	Dry dark orangey brown silty sand with gravel. Residual Dolomite					100	99	95	85	67	7	6	2	29	63	8	-	N.P.	0.0	1.4	5.5	2042	92.0	45.0	15.0	7.0	2.0	5.4	0	1.9	<G10; <BE; B; SP-SM
	1000 - 1350	013/0304	Poorly graded sand with silt and gravel. Residual Dolomite		100	99	98	96	95	79	66	51	6	6	3	32	59	9	-	S.P.	0.5	1.8	5.5	2144	87.0	55.0	27.0	17.0	8.0	5.4	0	2.0	G7; A; B; SP-SM
TP9	200 - 800	013/0306	Poorly graded sand with silt and gravel. Residual Calcrete		100	99	97	93	90	59	45	35	6	5	3	33	54	14	-	S.P.	1.4	2.1	7.0	2189	34.0	24.0	15.0	11.0	7.0	7.0	0	1.6	G9; B; B; SP-SM
TP12	0 - 1250	013/0309	Poorly graded sand with silt and gravel. Residual Dolomite		100	98	94	88	83	51	36	30	5	6	4	30	57	14	-	S.P.	1.9	2.3	6.5	2189	57.0	42.0	24.0	17.0	10.0	6.5	0	1.7	G7; A; B; SP-SM

* Average value in kPa, obtained at MOD. AASHTO compaction and OMC are shown against the amount of stabilising agent.

CS : Coarse Sand, **FS** : Fine Sand, **LL** : Liquid Limit, **PI** : Plasticity Index, **LS** : Linear Shrinkage, **GM** : Grading Modules, **OMC** : Optimum Moisture Content, **MOD** : Maximum Dry Density, **CBR** : California Bearing Ratio, **COMP MOIST** : Compaction Moisture, **UCS** : Unconfined Compressive Strength, **ITS** : Indirect Tensile Strength, **N/C** : No Classification, **N/S** : No Sample

ROUTE : **GEOTECHNICAL INVESTIGATION FOR NGQURA 16Mtpa MANGANESE PROJECT** **SECTION :** **NORTHERN AREA – POSTMASBURG HOUSING DEVELOPMENT** **PAGE :** 1 of 1

Reference №: 12692/Amended Date: 19 March 2013

CERTIFICATE OF ANALYSIS

Report On:	4 (Four)	Samples I.D.:	Soil
Date & Time Received:	13/03/13 – 13:00	Taken By:	Yourselves
Date & Time Analysis Started:	14/03/13 – 08:00	From:	Sue – Anya Khelawan
Date & Time Analysis Finished:	18/03/13 – 15:05		

MARKED:
1. **TP5 (DEPTH 0.15 – 0.90)**
2. **TP7 (DEPTH 0.00 – 1.20)**
3. **TP14 (DEPTH 1.00 – 1.35)**
4. **TP28 (DEPTH 0.00 – 1.25)**

Analysis on an as received basis:

	1.	2.	3.	4.
pH, at 25ºC [pH Meter]	8.3	7.4	8.6	8.1
Electrical Conductivity, mS/m [Conductivity Meter]	5.3	2.2	4.2	2.4
Chlorides, as Cl, mg/ ℓ [Potentiometric]	-	-	<10	<10
Dissolved Sulphates, as SO_4, mg/ℓ [Gravimetric]	-	-	<10	<10
Calcium, as Ca, mg/ ℓ [ICP]	-	-	6.3	5.5
Ammonia, as NH_4, mg/ ℓ [Colourimetric]	-	-	<1	<1
Magnesium, as Mg, mg / ℓ [ICP]	-	-	3.4	1.8
Total Dissolved Solids, mg/ℓ [Gravimetric]	-	-	148	152
Alkalinity, as $CaCO_3$, mg/ℓ [Titrimetric]	-	-	30	19
Calcium Carbonate Saturated pH [pH Meter]	-	-	9.1	9.2
Temperature, ºC [Thermometer]	-	-	25	25
Aggressiveness Index [Calculation]	-	-	749	1250
Langelier Index [Calculation]	-	-	-0.63	-1.39

Comment:
According to the above results Sample No.3 is mildly to fairly aggressive and Sample No. 4 is very highly aggressive towards set and reinforced concrete when leached in water.

Please note: This certificate number 12692/Amended replaces certificate number 12692.
It is the responsibility of the customer to ensure that certificate number 12692 is destroyed.

Technical Signatory: Chemistry _____ Microbiology_____
Mr. S. Ramdeen - Supervisor Ms. N. Kassim – Supervisor

Branch Manager: _____
Dr A. A. Khan

Worley Parsons RSA
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