NSW GOVERNMENT Public Works Advisory

White Cliffs Water Supply Scheme

Water Treatment Plant, Rising Mains and Weir

Geotechnical Investigation

Report Number: 17-GT29A

January 2018

Prepared for:

Central Darling Shire Council

CENTRAL DARLING SHIRE COUNCIL

White Cliffs Water Supply Scheme
Water Treatment Plant, Rising Mains and Weir

Geotechnical Investigation

Report Number: 17-GT29A

January 2018

Document Control

Issue / Revision	Author	Reviewer	Approved for Issue	
			Name	Date
Final	P.Anderson	C.Karwaj	P.Anderson	17.1.2018

File path: G:\Watertec\Geotech\!PROJECTS\Central Darling Shire Council\White Cliffs Water Supply (GT29A)\Reporting\GT29A-White Cliffs WS Report .docx

Contact name

Peta Anderson

Engineering Geologist

McKell Building 2-24 Rawson Place Sydney NSW 2000

T: 02 9372 7834

E: peta.anderson@finance.nsw.gov.au W: https://www.finance.nsw.gov.au/

Table of contents

Plates

Figures

Appendices

1 Introduction

1.1 General

The town of White Cliffs is located within the Central Darling Shire Local Government Area (LGA) in western NSW. The current water supply system in White Cliffs has a history of failure and interruptions to water supply, resulting from: inadequate, ageing infrastructure; drought prone water supply sources; unsuitable back-up water supplies; and the remoteness of location.

A scoping study report titled "*Ivanhoe, White Cliffs and Wilcannia Water Supply Upgrades – Scoping Study*" (Report No: WSR16047, June 2016), was prepared by NSW Water Solutions (NSW Public Works) for Central Darling Shire Council. In the scoping study, NSW Public Works recommended construction of a new water treatment plant (WTP) at the existing White Cliffs WTP site and a new reticulation main.

It is understood that the proposed WTP will comprise the following new structures:

- Two (2) concrete water tanks - each 4m in height and 6m in diameter.
- One (1) concrete water tank - 6m high and 7m in diameter.
- Two (2) concrete water tanks - each 6m in height and 3m in diameter.
- One (1) plant building – single storey and approximately 12m x 12m in plan.
- Two (2) lagoons – each 50m x 40m in plan.

The locations of the new building, tanks and lagoons are yet to be determined, and may be anywhere within the existing WTP site. The reticulation mains are approximately 6.5km in length; however, the alignments are yet to be determined.

A new weir will also be constructed at or in the immediate vicinity of the existing weir adjacent to Dam No. 3 (Wakefield). The weir will be approximately 1.5m in height and 6m in length.

In August 2016, Central Darling Shire Council commissioned the Geotechnical Engineering Section (Public Works Advisory, Infrastructure Services) to undertake a geotechnical investigation for the proposed development.

The scope of work was outlined in discussions held between Jay Ariyawanse and Glenn Fernandes (Water & Wastewater Technologies), and Conrad Karwaj and Peter Shun (Geotechnical Engineering), and confirmed in our proposal (WSP 16042) dated July 2016.

Upon commencement of the fieldwork, the WTP site operator (Tony Latham) indicated that an alternate rising main alignment was being considered. Approval was then given by Council to investigate this alternate alignment as well as the initially proposed and surveyed route. It should be noted that there is no survey available for the alternate section of the alignment.

1.2 Location

White Cliffs is a small town within the Central Darling Shire LGA in western New South Wales, approximately 1,000km west-northwest of Sydney. The existing WTP is located on the southern outskirts of the town, south of Beth Street (see **Figure 1**) at coordinates of 6584500 N and 699920 E (MGA Zone 54). Access to the WTP site is via a gravel driveway off Beth Street.

The proposed weir site is located approximately 4.5km north-northeast of White Cliffs (see **Figure 1**). There is an existing weir structure located approximately 20m east of Dam No. 3 (Wakefield) and 70m west of Wannara Creek. It is understood that the proposed weir will be located in close proximity to the existing weir. The coordinates of the existing weir are 6589560 N and 701550 E (MGA Zone 54). Access to the weir is along an unformed access road off the Kayrunnera Road.

Proposed rising mains will connect Dam No. 1 (located approximately 2km south-southwest of White Cliffs), Dam No. 2 (located on the south-western outskirts of the town of White Cliffs) and Dam No. 3, Wakefield (located approximately 4.5km north-northeast of White Cliffs), with the proposed WTP. The locations of the rising main alignments are shown on **Figure 1**.

1.3 Objectives

The objectives of the geotechnical investigation were to:

- discuss the site conditions;
- determine the subsurface conditions within the target depths range;
- assess the properties of subsurface materials;
- assess suitability of the excavated soils for re-use as a liner for the lagoons;
- recommend suitable footing systems, founding depths and allowable bearing capacities; and
- assess the excavation characteristics of the encountered strata and earthwork requirements.

1.4 Terminology

The methods used in this report to describe the soil profiles, including visual classification of material types encountered, are in accordance with Australian Standard AS1726 Geotechnical Site Investigations. For bedrock description, the methods are in-house and are based on AS1726, ISRM etc. Explanation of terminology used is given in **Appendix A**.

1.5 Limitations

The Geotechnical Engineering Section has conducted an investigation and prepared this report in response to specific instructions from the client to whom this report is addressed. This report is intended for the sole use of the client, and only for the purpose which it was prepared. Any third party who relies on the report or any representation contained in it does so at their own risk.

2 Regional Geology

The White Cliffs 1:250,000 Geological Series Sheet SH 54-12 (First Edition, 1964) indicates that the majority of the rising main alignments (including Line WCP1, Line WCP2, and the majority of Line WCP3 and the majority of the alternate alignment) and the WTP site are located within Cretaceous sediments of the Rowling Downs Group comprising sandstone, siltstone and claystone, which is porcellanous in part.

The northern end of Line WCP3 and the north-eastern end of the alternate alignment (i.e. in the vicinity of Dam No. 3), and the proposed weir are located within Quaternary sediments comprising floodplains, outwash areas and drainage flats of black and red clayey silt and sand.

Between the town of White Cliffs and Dam No. 3, the reticulation may encounter small sections of silicified conglomerate, quartzite and porcellanite of Tertiary age. If the alternate alignment is adopted, the reticulation may traverse small sections of this geological unit.

3 Fieldwork

Fieldwork was carried out on the 14th and 15th February 2017, and comprised drilling a total of thirty-four (34) boreholes. Eight (8) boreholes (B1 to B8) were drilled within the WTP site to depths varying from 4.3m to 5.0m. Sixteen (16) boreholes (RM1 to RM16) were drilled along the proposed rising main alignment to depths of 1.2m to 2.0m, and eight (8) boreholes (RM17 to RM24) were drilled along the alternate mainalignment section to depths varying from 0.5m to 1.5m. One (1) borehole (WR1) was drilled near the weir location to a depth of 2.3m. This borehole was located on the creek bank approximately 60m to the north-west of the existing weir. Vehicle access closer to the existing weir was not possible at the time of fieldwork due to very soft ground conditions.

The drilling was carried out by Fico Group Pty Ltd, using a ute-mounted FG102 drill rig. The boreholes were advanced using continuous, spiral flight augers fitted with a vee bit or a tungsten carbide (TC) bit. All boreholes were terminated upon reaching their nominal target depths or TC bit refusal, whichever occurred first.

Standard Penetration Tests (SPTs) were carried out in the majority of the boreholes. This was supplemented by taking undisturbed, thin-walled tube (U50) samples and disturbed samples off the auger flights.

The fieldwork was supervised full-time by a senior technical officer from our Section, who positioned and logged the boreholes and directed in-situ testing and sampling.

Detailed borehole logs are presented in **Appendix B**. Borehole locations are shown on **Figures 2 to 17**.

4 Laboratory Testing

Representative samples of in-situ sediments from the WTP site were subjected to the following range of tests in accordance with either, the relevant test method of Australian Standard AS1289 or a NATA approved in-house method:

- In-situ density and moisture content from undisturbed (U50) sample;
- Particle size distribution;
- Atterberg limits;
- Linear shrinkage;
- Emerson Class Number;
- Standard compaction; and
- Shrink-swell indices.

The geotechnical testing was carried out by our Section's Geotechnical Centre laboratory at Manly Vale. A summary of test data and individual test report sheets are presented in **Appendix C**.

5 Corrosion and Scaling Assessment

Eight (8) samples along the rising main alignment were selected for corrosion and scaling assessment. The samples were analysed for the following:

- pH 1:5 extract ratio;
- Electrical Conductivity (EC) 1:5 extract ratio;
- Soluble Sulphate (SO_4); and,
- Soluble Chloride (Cl).

The testing was carried out by Sydney Environmental and Soil Laboratory Pty Ltd (SESL) for the purposes of assessment of soil aggressivity towards concrete and steel, in accordance with Australian Standard AS2159-2009 (Piling Design and Installation).

Detailed test results and comments by SESL are presented in **Appendix D**. Generally, the soil ranges from very slightly acidic (pH level of 6.5) to strongly alkaline (pH level of 8.9), and from very low salinity (EC of 0.09mS/cm) to extremely saline (EC of 3.9mS/cm). The sulphate and chloride levels are low. Overall, the laboratory's assessment is that the likelihood of aggressive corrosion is low to mild.

6 Water Treatment Plant and Sludge Lagoons

6.1 Site Description

The existing WTP is located on the southern outskirts of the town and is surrounded by rural open space.

The existing WTP buildings and tanks are located in the southern part of the site (see **Figure 16** and **Plate 1**). There is a gravel access road leading from Beth Street to the metal buildings and around the existing storage ponds. There are three (3) storage ponds located in the central and northern parts of the existing WTP site (see **Plates 2 to 4**). It appears that the ponds have been constructed entirely in cut. The area is mostly bare with some patchy grass cover around the storage ponds. There are also some shrubs/ small trees around the northern pond and central western pond.

At the time of fieldwork, the proposed sludge lagoons were to be located to the west of the existing WTP site, which is a vacant parcel of land (see **Figure 16**). The ground surface is mostly bare with some minor grass cover. **Plates 5 to 7** show general views of the vacant block. There are two storage tanks within the vacant block, near the boundary with the WTP site. **Plate 8** shows a view of the existing WTP from the vacant block. There are some minor low fill mounds and a small stockpile of wood within the vacant block.

Based on a conceptual layout plan provided after the completion of the fieldwork (see **Figure 18**), it appears that the WTP building will be essentially located immediately to the west of the existing metal water treatment plant and workshop buildings. It also appears that the sludge lagoons will be located in the eastern part of the vacant parcel of land, mostly within the vacant block and partly within the existing WTP site.

6.2 Subsurface Conditions

6.2.1 Subsurface Profiles

Boreholes B1 to B4 were drilled within the existing WTP site to depths of 4.3m to 5.0m, where the proposed building and new tanks were to be located. Boreholes B5 to B8 were drilled to depths of 4.5m to 5.0m, within the vacant block of land where the proposed sludge lagoons were to be located. The subsurface profiles within the existing WTP site and the vacant block are essentially similar and comprise a sequence of silty sand with varying concentrations of gravel and clay, followed by residual sandy clayey silt/ clayey silt/ sandy silty clay, and then weathered claystone/ siltstone bedrock.

At discrete borehole locations B1 and B2, there is a thin layer of material overlying the silty sand with variable clay and gravel layer, which was encountered from the surface in the remaining six (6) boreholes. The surface layer in B1 comprises stiff sandy silty clay (CI type) to 0.3m depth. In borehole B2, loose, gravelly silty sand fill was encountered to 0.15m depth.

Generally, the upper horizon to a depth of approximately 1.3m to 2.5m comprises silty sand with varying concentrations of clay and gravel (SM, SM/SC, SC, SM/GM, GM type materials). The distribution of the clay and gravel tends to be sporadic across the site (existing WTP and vacant block). The consistency of the silty sand layer is generally medium dense; however, very loose/ loose, wet sediments were encountered in boreholes B1 (1.1m-1.7m), B2 (2.0m-2.4m) and B3 (0.8m-2.2m), which were all drilled in close proximity to the existing storage ponds.

The upper silty sand horizon is underlain by residual soil comprising sandy clayey silt / clayey silt/ sandy silty clay (CI type and CI/CH type) to depths of 3.5m to 4.1m. The consistency of the residual soil is generally stiff ranging to very stiff with SPT N values of N = 10 to N = 17 and the material is generally moist; however, in boreholes B2 and B3, located in close proximity to the existing storage ponds, the residual soil is in a moist to very moist state. It should be noted that the residual soil layer was not encountered in borehole B8.

The residual soil horizon is underlain by weathered claystone/ siltstone bedrock to the borehole termination depths of 4.3m to 5.0m. In borehole B1, the claystone/ siltstone is highly weathered to moderately weathered with a weak rock substance strength to the borehole termination depth of 4.3m, where TC bit refusal was registered. In boreholes B2 and B3, the claystone is extremely weathered but it behaves as a very stiff (N = 22) clayey silt with evident rock structure. In boreholes B4 to B8, the encountered claystone/ siltstone is extremely weathered to highly weathered and behaves as a very stiff to hard (N = 28 to N = 44) clayey silt with evident rock structure.

6.2.2 Groundwater

Groundwater, at the time of drilling, was encountered in boreholes B1, B2 and B3 at depths of 1.6m, 2.0m and 2.1m, respectively. At the completion of drilling the water in boreholes B1 and B2 had risen to depths of 0.5m and 1.5m, respectively. These boreholes are located in relatively close proximity to the existing storage ponds within the WTP site. It is likely that the groundwater encountered in the boreholes is perched water associated with seepage from the nearby ponds.

Groundwater was not encountered in boreholes B4 to B8 within the depth of investigation (5.0m maximum), at the time of fieldwork. However, the silty sand layer (0.7m to 1.3m depth) in B4 was in a very moist to wet state.

It should be noted that groundwater levels and the presence of seepage are subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole logs.

6.3 Proposed Water Treatment Plant Building

Based on the conceptual layout plan, borehole B4 was drilled within the footprint of the proposed new WTP building. In this borehole, medium dense silty gravelly sand/ silty sand was encountered to 1.3m, underlain by stiff sandy clayey silt to 3.5m depth, followed by extremely weathered to highly weathered claystone/ siltstone (behaves as a very stiff to hard clayey silt) to the borehole termination depth of 5.0m.

6.3.1 Material Properties

As part of the current investigation, one (1) sample from borehole B2, which was drilled within the initially nominated building area was tested for a range of properties. However, this borehole is located some 50m to the northeast of where the conceptual layout plan shows the building.

The selected sample from borehole B2 (0.5-0.75m) graded as clayey silty sand with trace of gravel with a breakdown of 6% gravel, 58% sand, 24% silt and 12% clay. The fines are of low plasticity with a liquid limit of 34%, plasticity index of 9% and linear shrinkage of 6.5%. The shrink and swell strains are 1.9% and 0.0%, respectively, with a shrink-swell index (Iss) of 1.1. The sample from B2 classifies as SM-SC in accordance with Australian Standard AS1726.

The above material tested from borehole B2 is considered to be similar in properties to the layer of silty sand encountered in borehole B4 from 0.7m to 1.3m.

6.3.2 Site Classification

Site classification following procedures given in Australian Standard AS2870-2011 "*Residential slabs and footings*" code is not strictly applicable for the proposed works. However, the main water treatment plant building is comparable to a residential structure and therefore, it is considered that the provisions in the above code can be applied to this building.

In the area where the proposed WTP building and tanks will be located, the subsurface profiles comprise dominantly silty sand (SC and SM type) to depths of 1.3m to 2.4m, followed by dominantly sandy clayey silt to depths of 3.5m to 4.1m and then followed by weathered claystone/ siltstone.

The soil tested from borehole B2 (0.5m to 0.75m depth), which classifies as an SM-SC type clayey silty sand, returned combined shrink-swell strains of 1.9%. Based on the test results and the fact that White Cliffs is located within a semi-arid climatic zone where the interpreted design depth of suction change is 4.0m, the characteristic ground surface movement is estimated to be between 35mm and 40mm, which is applicable to Class "M-D" site (moderately reactive clay site with deep-seated moisture changes), in accordance with the above Australian Standard.

6.3.3 Footings

For the proposed WTP building, a shallow footing system may be adopted and designed from engineering principles allowing for a characteristic ground surface movement (y_s) of say 40mm. Alternatively, standard designs of footing system may be adopted and proportioned in accordance with Section 3 of AS2870-2011 for site classification of "M-D" subject to restrictions given in the code and checking of adequacy.

The footings should be founded within medium dense silty gravelly sand /silty sand. In design, an allowable bearing pressure of 150kPa is recommended.

The footing system used in the construction of the proposed tanks should be similar to that used for the proposed WTP building, with appropriate foundation preparation.

6.3.4 Earthworks

6.3.4.1 Site Stripping and Foundation Preparation

The proposed finished floor levels of the new WTP building and tanks are not known. However, it is expected that they will be close to the existing ground surface level; therefore, only minor stripping may be required.

Any surface fill should be stripped within the foundation area and put to spoil.

After stripping, the exposed subgrade should be inspected for consistency. Where required, proof roll the subgrade with a smooth static roller of minimum of 10 tonnes operating weight by typically 4 to 6 passes. Any soft/ loose spots detected in the subgrade should be over-excavated out by at least 0.3m and re-compacted.

6.3.4.2 Excavation Characteristics

Excavations in the soil deposits to design invert levels should be readily achievable using conventional earth moving equipment such as a backhoe.

Construction difficulties associated with permanent groundwater are not envisaged.

6.4 Proposed Sludge Lagoons

Boreholes B5 to B8 were drilled within the vacant block of land where the proposed sludge lagoons were to be located. However, based on the conceptual layout, provided after the fieldwork was completed, boreholes B3 to B5 appear to be located in close proximity to the proposed sludge lagoons.

The proposed finished floor levels of the sludge lagoons were not known at the time of writing this report; however, they will be constructed with a balance of cut and fill, with the cuts expected to be in the order of 2.0m to 2.5m depth.

6.4.1 Material Properties

As part of the current investigation, two (2) samples within the initially nominated sludge lagoons area were tested for a range of properties. The samples were from boreholes B5 (0.3-0.7m) and B8 (1.5-2.3m). Based on the conceptual layout plan, provided after laboratory testing was completed, borehole B5 is located in close proximity to the proposed sludge lagoons, while borehole B8 is located approximately 55m to the west of the proposed lagoons.

The selected sample from borehole B5 graded as gravelly silty sand with trace of clay with a breakdown of 17% gravel, 49% sand, 19% silt and 15% clay. The fines are of low plasticity with a liquid limit of 45%, plasticity index of 17% and linear shrinkage of 9.0%. The sample classifies as SM in accordance with Australian Standard AS1726. The clay fraction of the tested sample is non-dispersive with an Emerson Class Number of 4. This material has a maximum dry density of 1.39t/m^3 at corresponding optimum moisture content of 29.0%.

The selected sample from borehole B8 graded as clayey gravelly silty sand with a breakdown of 17% gravel, 61% sand, 19% silt and 3% clay. The fines are of low plasticity with a liquid limit of 38%, plasticity index of 0% and linear shrinkage of 3.0%. The sample classifies as SM in accordance with Australian Standard AS1726. The clay fraction of the tested sample is dispersive with an Emerson Class Number of 2. This material has a maximum dry density of 1.52t/m^3 at corresponding optimum moisture content of 26.0%.

6.4.2 Earthworks

6.4.2.1 Site Stripping and Foundation Preparation

After stripping to the required depths within the proposed embankment footprint area, the exposed subgrade should be inspected for consistency. Where required, proof roll the subgrade with a smooth static roller of minimum of 10 tonnes operating weight by typically 4 to 6 passes. Any soft/ loose spots detected in the subgrade should be over-excavated out by at least 0.3m and re-compacted or replaced with engineered fill.

The fill mound located in the southern part of the proposed lagoons area should be stripped and put to spoil.

It is also recommended that the existing storage pond located immediately to the east of the proposed lagoons is drained (if water present) and stripped of any vegetation and loose or saturated sediments. The pond should then be backfilled with engineered fill prior to construction of the nearby sludge lagoon embankment.

6.4.2.2 Engineered Fill

It is understood that the lagoons are going to be constructed in cut and fill.

The investigation revealed that the materials from excavations within the upper horizon of the soil profile (to depths of approximately 1.3m to 2.2m) will comprise silty sand with varying concentrations of clay and gravel. These materials, due to their low clay contents, are expected to be permeable.

The lower part of the soil profile encountered in the boreholes comprised residual sandy clayey silt/ clayey silt/ sandy silty clay. Depending on the depths of the sludge lagoons, this material may be encountered in the lower parts of the cut batters and/or in the floors. This material visually is of medium plasticity and when remoulded have a low permeability due to the high fines content.

Based on the above, both soil horizon materials are considered suitable for use as engineered fill in the construction of the proposed embankments. However, it is recommended that the sludge lagoons are lined for example with a geosynthetic clay liner (GCL) to ensure the lagoons are watertight.

6.4.2.3 Compaction Requirements and Control Testing

Embankment fill should be placed in near-horizontal layers generally not exceeding 150mm loose thickness and compacted to a minimum standard dry density ratio (AS 1289.5.4.1) of 98% at a moisture content within the range of 2% dry to 1% wet of the standard optimum moisture content.

During the course of filling, “Level 1 Inspection and Testing” should be conducted in accordance with AS 3798-2007 "*Guideline on Earthworks for Commercial and Residential Development*".

6.4.2.4 Excavation Characteristics

Excavations in the soil deposits to design invert levels should be readily achievable using conventional earth moving equipment such as a backhoe or excavator.

6.4.2.5 Dewatering

The groundwater level in borehole B3 was taken at the time of fieldwork. Immediately after completion of drilling, the borehole was backfilled and therefore, no long term monitoring was carried out. Groundwater was not encountered within the depths of drilling in boreholes B4 or B5.

The observed groundwater level in borehole B3 is interpreted to be perched water associated with the existing nearby ponds. The proposed finished floor levels of the lagoons are not known; however, groundwater seepage or very moist to wet zones may be encountered in close proximity to the existing ponds. However, this is not expected to be an issue once the existing ponds are drained and the nearest pond backfilled with engineered fill.

6.4.2.6 Permeability

The sediments expected to be exposed within the sludge lagoon areas comprise mostly silty sand with varying concentrations of clay and gravel SM, SM/SC, SC, SM/GM, GM type materials) in the cut batters and sandy clayey silt/ sandy silty clay (CI type and CI/CH-type) in the floor; however, the finished floor level of the lagoons is not known. Based on limited testing, the in-situ silty sands are expected to be permeable due to their low clay contents. The sandy clayey silt/ sandy silty clay has not been tested; however, it expected that due to the high fines content they will have a low permeability once remoulded.

Therefore, due to the variation in material expected to be encountered within the footprint of the lagoons, lining is required to ensure that the lagoons are watertight.

7 Weir

7.1 Site Description and Subsurface Conditions

7.1.1 Site Description

The proposed weir is to be located approximately 4.5km north-northeast of White Cliffs. It will be located to the north-east of Dam No.3 (Wakefield), in close proximity to where the existing weir is located (see **Figure 15**). The existing weir is a currently a rock-filled gabion structure (see **Plate 9**). The gabion mesh is mostly damaged and the rocks are exposed, particularly on the northern side. The nearby dam is shown in **Plate 10**. **Plate 11** shows the location of borehole WR1, while **Plate 12** shows the general view from WR1, looking south-east towards the direction of the existing weir. Vehicle access closer to the existing weir was not possible at the time of fieldwork due to very soft ground conditions (see **Plate 13**).

7.1.2 Subsurface Profiles

Borehole WR1 was drilled on the creek bank, approximately 60m to the north-west of the existing weir (see **Figure 15**). The subsurface conditions at the weir site are expected to be similar to those encountered in WR1; however, there may be a higher sand, gravel and cobble concentration in the surficial layer near the existing weir.

The surficial layer in WR1 is a 0.4m thick deposit of sandy clayey silt (CI-type), which is red-brown, stiff and dry. This is followed by gravel and cobbles in a sandy clayey silt matrix (GC/CI). The gravel is rounded and occurs in layers. The sandy clayey silt matrix is red-brown and dry. The consistency of this layer is stiff to very stiff with the SPT at 1.0m depth only penetrating 6cm before refusing on gravel or a cobble. The borehole was terminated at 2.3m depth, where tungsten carbide (TC) bit refusal occurred on a large cobble.

7.1.3 Groundwater

Groundwater was not encountered in borehole WR1 within the depth of investigation (2.3m), at the time of fieldwork. It should be noted that the presence of seepage is subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole log.

7.2 Footings

For the proposed weir, because of the presence of cobbles, it is recommended that a concrete cut-off wall be constructed along the centreline of the weir structure across the existing creek and up the creek banks on both the right and left abutment sides of the creek. It is understood that the top of the weir structure, where it spans the creek, will be at RL 144.30m. The concrete cut-off wall should be embedded into the medium plasticity sandy clayey silt with gravel and cobbles of very stiff consistency. The weir structure itself (upstream and downstream of the cut-off wall) should be founded on gravel and cobbles in a sandy clayey silt matrix of stiff consistency. An allowable bearing pressure of 100kPa is recommended for this material.

7.3 Earthworks

7.3.1 Site Stripping and Foundation Preparation

It is understood that a minimum of 0.45m depth of in-situ material will need to be excavated to allow for construction of the proposed weir structure (ie. placement of rockfill and bedding material). The subsurface conditions at the weir site are not known; however, the stripping is expected to expose a subgrade of gravel and cobbles in a sandy clayey silt matrix.

After stripping, the exposed subgrade should be inspected for consistency. Where required, proof roll the subgrade with a smooth static roller of minimum of 10 tonnes operating weight by typically 4 to 6 passes. Any soft/ loose spots detected in the subgrade should be over-excavated out for the full depth and re-compacted or replaced with engineered fill.

7.3.2 Engineered Fill

It is understood that the proposed weir will be constructed of a 0.15m layer of gravel bedding material overlain by a 0.3m to 0.6m layer of rockfill (slush concreted). The gravel bedding will be placed on a layer of geotextile. It is expected that the gravel and rockfill will need to be imported.

7.3.3 Excavation Characteristics

Excavations in the soil deposits to design invert levels should be readily achievable using conventional earth moving equipment such as a backhoe.

8 Rising Main – Line WCP1

8.1 Site Description

Proposed rising main Line WCP1 will connect Dam No. 1, located nearly 2km to the south-west of the town of White Cliffs, with the proposed new WTP on the southern outskirts of the town (see **Figures 2 to 5**). From Ch. 0.0m at Dam No. 1, the rising main heads in a north-easterly direction. The ground slopes at a moderate angle down the dam's embankment to Ch. 8.2m and then slopes generally at very gentle gradients to Ch. 1598.3m, which is near the corner of Beth Street and Ethel Street. There is a shallow drainage channel traversed at Ch. 291.2m and an approximate 1m high embankment at Ch. 1582.2m. There are some small trees surrounding the dam (see **Plate 14**) and along the drainage channel (see **Plates 15 and 16**); however, the remainder of this section of the alignment is mostly bare ground with patchy grass and low shrubs.

At Ch. 1598.3m, the alignment takes a near right-angled bend and crosses Beth Street at Ch. 1613.2m and heads in an easterly direction along the northern road reserve of Beth Street to Ch. 1894.8m. The road reserve along this section of the alignment is generally surfaced with gravel and there are some small shrubs and rare grass (see **Plate 17**). This section of the alignment is relatively flat.

At Ch. 1894.8m, the alignment takes another right-angled bend to the south, crosses Beth Street at Ch. 1911.8m and enters the vacant block of land at Ch. 1936.6m, where the proposed sludge lagoons and new WTP will be located. **Plate 18** shows the view from the bend in the alignment across Beth Street towards the proposed WTP. The topography in this section of the alignment rises slightly to the south within the vacant block of land.

8.2 Subsurface Conditions

8.2.1 Chainage Ch. 0.0m to Ch. 1598.3m

This section of the alignment is the north-easterly trending section of pipeline between Dam No. 1 and the junction of Beth Street and Ethel Street. The subsurface conditions along this section of the

alignment may be extrapolated from data presented in the logs of boreholes RM1, RM2 and RM4 (see **Appendix B**).

Generally, the drilling revealed a variation in type and thickness of sediments at the discrete borehole locations.

Borehole RM1 the sediments are mostly sandy to the borehole termination depth of 1.5m. A 0.2m thick layer of silty gravelly sand (SM type) overlies a very stiff horizon of sandy silty clay (CI type) to 0.6m, followed by medium dense (SPT N-value = 30) silty clayey sand with fine calcrete gravel to 1.5m depth.

Sediments with a higher gravel concentration were encountered at discrete borehole location RM2. Silty sandy gravel (GM type) was encountered to 0.5m depth, followed by silty gravelly sand (SM/GM type) to the borehole termination depth of 1.5m. This material is medium dense with an SPT value of N=32.

Borehole RM4 was drilled near the northern end of this section of the alignment, in close proximity to where Line WCP2 meets Line WCP1. Predominantly fine grained sediments were encountered in the upper part of the profile in borehole RM4. Stiff sandy silty clay (CI) was encountered to 0.6m depth, followed by very stiff (N=26) silty clay with sand (CI/CH type) to 1.1m depth. The clay is underlain by extremely weathered to highly weathered sandstone with a very weak rock substance strength to the borehole termination depth of 1.3m, where TC bit refusal was encountered.

Groundwater was not encountered at the time of fieldwork, within the depths of investigation (1.5m maximum).

8.2.2 Chainage Ch. 1598.3m to Ch. 1993.9m

This section of the alignment includes the easterly trending section from the Beth Street/ Ethel Street junction to Ch. 1894.8m and then the southerly trending section ending at the proposed WTP. The subsurface conditions along this section of the alignment may be extrapolated from data presented in the logs of boreholes RM4, RM5 and B5 and B6 (see **Appendix B**).

Generally, the drilling revealed a variation in type and thickness of sediments at the discrete borehole locations along this section of the alignment.

The subsurface conditions encountered in borehole RM4 are described above in **Section 9.2.1**. The sediments at the western end of this section of the alignment (in the vicinity of RM4) are fine grained in the upper part of the profile and are underlain by weathered sandstone.

At the eastern end of this section of the alignment the sediments are courser grained i.e. sand (SM, SM/SC) and gravel (GM) to depths of 1.5m to 1.8m.

In boreholes RM5 and B5, the subsurface conditions are very similar and comprise loose, GM type sediments (gravel and cobbles in a silty sand matrix or sandy gravel with cobbles) to depths of 0.6m and 0.3m, respectively. The gravel is underlain by medium dense to dense gravelly silty sand (SM type and SM/GM type) to 1.5m depth in both boreholes. Borehole RM5 was terminated at the target depth of 1.5m.

The upper 1.8m of the profile in borehole B6 comprises gravelly silty sand (SM/SC type) with cobbles, which is medium dense in consistency.

The coarse grained sediments encountered in B5 and B6 are underlain by stiff to very stiff sandy silty clay/ clayey silt (CI/CH, CI) to depths of 3.5m and 4.0m, respectively, followed by weathered claystone/siltstone to the borehole termination depths of 4.5m and 5.0m.

Groundwater was not encountered at the time of fieldwork, within the depths of investigation (5.0m maximum).

8.3 Summary and Discussions

8.3.1 Foundation Conditions

It is understood that the proposed rising main Line WCP1 will generally be founded at depths in the order of approximately 1.0m. In localised sections, i.e. beneath the dam embankment from Ch. 0.0m to Ch. 8.2m and the embankment at Ch. 1582.2m; the depth of the rising main may be slightly deeper.

By extrapolation of data from discrete boreholes, the proposed rising main will be founded within medium dense silty clayey sand/ silty gravelly sand/ gravelly silty sand, very stiff silty clay with sand, or possibly weathered sandstone.

The bearing capacity of the founding strata is more than adequate while settlement is of no concern.

8.3.2 Excavation Characteristics

Excavations to design invert levels will be within the soil mantle and extremely weathered to highly weathered sandstone, and should be readily achievable using conventional earth moving equipment such as a hydraulic excavator. Excavation in highly weathered or better quality sandstone (ie. below the TC bit refusal levels) is likely to be more difficult and assistance from a rock breaker may be required, possibly in sections where the pipeline will be deeper (see **Section 9.3.1**).

8.3.3 Trench Supports

Generally, the majority of the trench walls should be self-supporting during the short term construction period. However, for any excavations that are in loose sediments prone to collapsing (i.e. similar to the upper horizon sediments encountered in RM5) or for excavations in excess of 1.5m depth, the trenches would need to be benched, stepped or battered back, as required for safety purposes.

Construction difficulties associated with permanent groundwater are not envisaged.

9 Rising Main – Line WCP2

9.1 Site Description

Line WCP2 is a short section of pipeline trending in a south-easterly direction that will join Dam No. 2 with Line WCP1 (see **Figure 4**). From Ch. 0.0m the alignment crosses the embankment of the dam to Ch. 27.0m. From this point onwards the alignment is relatively flat, apart from the crossing of an approximate 1m deep watercourse at Ch. 76.6m and a 1.2m high embankment at Ch. 140.9m. Line WCP2 joins Line WCP1 at Ch. 158.8m, which corresponds to the bend at Ch. 1598.3m on Line WCP1. There are some shrubs, rare small trees (mainly along the watercourse) and patchy grass along this section of the alignment. **Plate 19** shows the view towards the Dam from near the edge of the watercourse. **Plate 20** shows the watercourse in the foreground and the drill rig set up on borehole RM3.

9.2 Subsurface Conditions

Two boreholes (RM3 and RM4) were drilled along the proposed rising main Line WCP2. The boreholes were drilled to depths of 1.4m and 1.3m, respectively, where TC bit refusal was encountered.

At discrete borehole locations the upper horizon is slightly variable. In RM3, stiff sandy silty clay (CI/SC type) was encountered to 0.6m depth, followed by loose to medium dense silty sandy gravel (GM type) to 0.9m depth. In RM4, stiff sandy silty clay (CI type) was encountered to 0.6m depth, followed by very stiff silty clay (CI/CH type) to 1.1m depth.

The upper horizon sediments are underlain by extremely weathered to highly weathered sandstone with a very weak rock substance strength to the borehole termination depths of 1.4m and 1.3m, respectively, where TC bit refusal was registered.

Groundwater was not encountered in boreholes RM3 and RM4 within the depth of investigation (1.4m maximum), at the time of fieldwork. However, it should be noted that the presence of seepage is subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole logs. It should be noted that the watercourse at Ch. 76.6m was dry at the time of fieldwork.

9.3 Summary and Discussions

9.3.1 Foundation Conditions

It is understood that the proposed rising main Line WCP2 will generally be founded at depths in the order of approximately 1.0m. In localised sections, i.e. beneath the dam embankment from Ch. 0.0m to Ch. 27.0m; the watercourse at Ch. 76.6m; and the embankment at Ch. 140.9m; the depth of the rising main may be slightly deeper.

By extrapolation of data from discrete boreholes, the proposed rising main will be founded within loose to medium dense silty sandy gravel, very stiff silty clay with sand, or weathered sandstone.

The bearing capacity of the founding strata is more than adequate while settlement is of no concern.

9.3.2 Excavation Characteristics

Excavations to design invert levels will be within the soil mantle and extremely weathered to highly weathered sandstone, and should be readily achievable using conventional earth moving equipment such as a hydraulic excavator. Excavation in highly weathered or better quality sandstone (ie. below the TC bit refusal levels) is likely to be more difficult and assistance from a rock breaker may be required, possibly in sections where the pipeline will be deeper (see **Section 10.3.1**).

9.3.3 Trench Supports

Generally, trench walls should be self-supporting during the short term construction period. However, for any excavations that are in excess of 1.5m depth, the trenches would need to be benched, stepped or battered back, as required for safety purposes.

Construction difficulties associated with permanent groundwater are not envisaged. However, at the watercourse crossing there is some potential for encountering surface water or seepage, depending on prevailing weather conditions at the time of construction; therefore, dewatering may be required.

10 Rising Main – Line WCP3

10.1 Site Description

Proposed rising main Line WCP3 will connect Dam No. 3 (Wakefield), located approximately 5.5km to the north-northeast of the town of White Cliffs, with the proposed new WTP on the southern outskirts of the town (see **Figures 6 to 14**).

From Ch. 0.0m at Dam No. 3, the rising main heads in a south-westerly direction. The ground slopes at a moderate angle to the south, down the dam's embankment to the fence line at Ch. 61.5m (see **Plate 21**). There are some gullies/ rutting visible down the embankment, which have been created where water has overflowed the Dam's embankment. From the fence line the ground then slopes generally at very gentle gradients to Ch. 452.3m, which is where shallowly incised (approx. 1m) watercourse is intersected. **Plate 22** shows the view looking south from near the location of borehole RM16 towards the watercourse. **Plate 23** shows the northern bank of the watercourse. The ground surface is mostly bare along this section of the alignment, with some shrubs, low clumps of grass and rare small trees in the vicinity of the watercourse.

From Ch. 476.1m on the southern side of the watercourse, the topography rises very gently to Ch. 1002.6m. **Plate 24** shows the view looking north-northeast along this section of the alignment from near the location of borehole RM15 (Ch. 995.8m). The ground surface is mostly bare, with rare sparse shrubs. A very shallow (0.3m deep) watercourse is traversed within this section at Ch. 830.4m. At Ch. 1002.6m is a shallow (0.6m deep) watercourse. Weathered siltstone is exposed in the base of the watercourse and gravel and cobbles litter the ground surface nearby, along with small shrubs, clumps of grass and rare small trees (see **Plate 25**).

From Ch. 1024.2m, on the southern side of the watercourse near RM15, the topography continues to rise gently to Ch. 1420.5m and then descend gently to Ch. 1595.9m, where the alignment bends to the southeast, near the location of borehole RM14. A very shallow (approximately 0.4m deep) meandering watercourse is traversed within this section of the alignment at Ch. 1204.9m and Ch. 1308.6m.

From Ch. 1595.9m (borehole RM14) to Ch. 2887.8m (borehole RM12), the alignment is straight and heads in a south-easterly direction on the southern side of the fence line. The topography in this section undulates very gently and the ground surface is mostly bare, with some low grass, sparse small shrubs and rare small trees (see **Plates 26** and **27**). Three (3) very shallow (up to approximately 0.3m deep) watercourses are traversed at Ch. 1794.3m, Ch. 1864.9m and Ch. 2031.5m. The existing water pipeline is intersected at Ch. 2869.5m.

At Ch. 2887.8m the alignment bends the southwest, generally following the curve in the dirt track to Ch. 3296.7m (borehole RM11), where the alignment bends further to the west and heads generally in a west-southwesterly direction to Ch. 4145.6m. The topography is very gently undulating in this section, rising very gently from Ch. 2912.3m to Ch. 3415.7m, descending very gently to 3792.1m, where a very shallow watercourse is intersected, and then rising gently again to Ch. 4145.6m. The ground surface in this section of the alignment is mostly grassed with some bare patches, small shrubs and rare small trees (see **Plate 28**). There is an approximate 1.6m high embankment/ spoil pile traversed between Ch. 4104.5m and Ch. 4135.9m, which is shown in the background of **Plate 29**.

From Ch. 4145.6m the alignment bends back towards the south and heads in a south-southeasterly direction, generally following the dirt track (see **Plate 30**) to Kayrunnera Road at Ch. 5058.1m, which is bitumen sealed. The alignment crosses Kayrunnera Road and continues in the same direction on the eastern side of Boundary Lane to Keraro Road at Ch. 5337.4m, which is also bitumen sealed (see **Plate 31**). From the edge of Keraro Road (Ch. 5377.9m) the alignment continues south-southeast to Ch. 5605.8m, where it joins with line WCP1 at corresponding Ch. 1894.8m. The topography is generally very gently undulating between Ch. 4145.6m and Ch. 5605.8m. Some dirt tracks or gravel roads are traversed within this section at Ch. 4551.4m, Ch. 4723.0m, and Ch.

5273.7m. The gravel roads and bitumen road crossings also have a number of underground services intersecting them such as water pipelines, Telstra cables and an optic fibre cable (at Ch. 5074.9m), as well as overhead electricity lines. The road reserves are generally bare, with some clumps of grass, small shrubs and some rare small to medium sized trees nearby. At Ch. 5443.4m, to the south of borehole RM7, an approximate 1m deep watercourse is traversed and at Ch. 5478.6m an approximate 1.7m deep watercourse is traversed. Borehole RM6 was drilled at the base of the deeper watercourse. **Plate 32** shows the northern bank of the watercourse, looking north from borehole RM6. **Plate 33** shows existing water pipelines exposed in the base of the watercourse to the west of borehole RM6. **Plate 34** shows the view looking south from the northern bank of the deeper watercourse towards the existing WTP. There is generally more vegetation in the vicinity of the watercourses.

10.2 Subsurface Conditions

10.2.1 Chainage Ch. 0.0m to Ch. 1595.9m

This section of the alignment includes the straight south-southwesterly trending section from Dam No. 3 (Wakefield) to the bend in the alignment at Ch. 1595.9m. The subsurface conditions along this section may be extrapolated from data presented in the logs of boreholes RM16, RM15 and RM14 (see **Appendix B**).

Generally, the drilling revealed some variation in type and thickness of sediments at the discrete borehole locations along this section of the alignment.

The sediments encountered at discrete boreholes RM16 and RM14 are fine grained and comprise sandy clayey silt/ sandy silty clay (CI and CH type) to the borehole termination depth of 1.5m in RM16 and to 1.2m depth in RM14. The consistency of the fine grained material generally ranges from stiff to hard. In borehole RM14, The sandy silty clay is followed by extremely weathered siltstone with an extremely weak to very weak rock substance strength from 1.2m to the borehole termination depth of 1.5m.

Borehole RM15 was drilled at Ch. 995.8m in close proximity to a watercourse. The surficial layer encountered is coarser grained and comprises medium dense sandy silty gravel (GM type) to 0.5m depth. The gravel is followed by extremely weathered to highly weathered siltstone with a very weak rock substance strength to the borehole termination depth of 2.0m.

Groundwater was not encountered in the boreholes at the time of fieldwork, within the depths of investigation (2.0m maximum). However, it should be noted that the presence of seepage is subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole logs. It should be noted that the watercourses traversed within this section of the alignment were dry at the time of fieldwork.

10.2.2 Chainage Ch. 1595.9m to Ch. 3381.1m

This section of the alignment includes the straight south-easterly trending section from Ch. 1595.9m to the start of the curved section at Ch. 2887.8m, which continues to Ch. 3381.1m. The subsurface conditions along this section may be extrapolated from data presented in the logs of boreholes RM14, RM13, RM12 and RM11 (see **Appendix B**).

Generally, the drilling revealed some minor variation in type and thickness of sediments at the discrete borehole locations.

The subsurface conditions encountered in borehole RM14 are described above in **Section 11.2.1**. The sediments at the northern end of this section of the alignment (in the vicinity of RM14) are fine grained in the upper part of the profile and are underlain by weathered siltstone.

The subsurface conditions encountered in the middle and southern parts of this section can be extrapolated from the logs of boreholes RM13, RM12 and RM11. The surficial layer encountered in these boreholes is coarse grained and comprises loose ranging to medium dense, clayey sandy gravel/ silty sandy gravel (GM/GC and GM type) to depths of 0.2m to 0.5m. The gravel layer is

followed by finer grained material ranging from medium dense gravelly silty sand (SM type) to sandy silt and clayey silt (ML and CL/ML type) of firm to stiff consistency to the borehole termination depths of 1.5m.

Groundwater was not encountered in the boreholes at the time of fieldwork, within the depths of investigation (1.5m maximum). However, it should be noted that the presence of seepage is subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole logs. It should be noted that some very shallow watercourses were traversed within this section of the alignment, which were dry at the time of fieldwork.

10.2.3 Chainage Ch. 3381.1m to Ch. 5056.1m

This section of the alignment includes the straight, westerly trending section from Ch. 3381.1m through the curved section near Ch. 4230.3m and the south-southwesterly trending section to Kayrunnera Road (Ch. 5056.1m), on the northern edge of the town. The subsurface conditions along this section may be extrapolated from data presented in the logs of boreholes RM10, RM9 and RM8 (see **Appendix B**).

Generally, the drilling revealed some minor variation in type and thickness of sediments at the discrete borehole locations.

The sediments encountered at discrete borehole location RM10 are fine grained comprising stiff to hard, clayey silt and silty clay (CI and CH type) to 1.0m depth. The fine grained sediments are followed by extremely weathered to highly weathered sandstone with a very weak rock substance strength to the borehole termination depth of 1.2m, where TC bit refusal was registered.

The subsurface conditions encountered in the middle and southern parts of this section can be extrapolated from the logs of boreholes RM9 and RM8. The sediments are typically sandy in nature and comprise loose ranging to medium dense, gravelly silty sand (SM type) to depths of 0.8m to 0.9m, followed by medium dense, gravelly clayey silty sand (SC type) to the borehole termination depths of 1.5m.

Groundwater was not encountered in the boreholes at the time of fieldwork, within the depths of investigation (1.5m maximum). However, it should be noted that the presence of seepage is subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole logs.

10.2.4 Chainage Ch. 5056.1m to Ch. 5605.8m

This section of the alignment includes the relatively straight, south-southwesterly trending section of the alignment from the northern edge of the township (Ch. 5056.1m) to Ch. 5605.8m, where line WCP3 joins with Line WCP1 at corresponding Ch. 1894.8m. The subsurface conditions along this section may be extrapolated from data presented in the logs of boreholes RM7, RM6 and RM5 (see **Appendix B**).

Generally, the drilling revealed some variation in type and thickness of sediments at the discrete borehole locations.

Borehole RM7 was drilled at Ch. 5433.7m on the northern side of a shallow watercourse. The subsurface conditions encountered comprise loose, gravelly silty sand (SM type) to 0.2m, underlain by hard, sandy silty clay to 0.9m, followed by medium dense, clayey sandy gravel (GC type), and then followed by medium dense, gravelly clayey silty sand (SC type) to the borehole termination depth of 1.5m.

Borehole RM6 was drilled at the base of the watercourse at Ch. 5478.6m. These sediments were generally coarser grained, comprising medium dense, clayey silty sand (SC type) to 0.4m, followed by dense ranging to medium dense, silty sandy gravel (GM type) to the borehole termination depth of 2.0m.

Borehole RM5 was drilled at the junction of Line WCP3 and Line WCP1. The subsurface conditions comprise gravel and cobbles in a loose silty sand matrix (GM type) to 0.6m depth, underlain by medium dense, gravelly silty sand (SM) type to the borehole termination depth of 1.5m.

Groundwater was not encountered in the boreholes at the time of fieldwork, within the depths of investigation (1.5m maximum). However, it should be noted that the presence of seepage is subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole logs. It should be noted that the watercourses traversed within this section of the alignment were dry at the time of fieldwork.

10.3 Summary and Discussions

10.3.1 Foundation Conditions

It is understood that the proposed rising main Line WCP3 will generally be founded at depths in the order of approximately 1.0m. In localised sections, i.e. beneath the dam embankment from Ch. 0.0m to Ch. 61.5m; the watercourses; and the embankment/ spoil pile between Ch. 4104.5m and Ch. 4135.9m; the depth of the rising main may be slightly deeper.

By extrapolation of data from discrete boreholes, the proposed rising main will be founded mostly within medium dense granular (sand or gravel) material with variable fines content, with minor sections within stiff to very stiff clayey silt/ sandy clayey silt/ sandy silty clay, or extremely weathered to highly weathered sandstone/ siltstone.

The bearing capacity of the founding strata is more than adequate while settlement is of no concern.

10.3.2 Excavation Characteristics

Excavations to design invert levels will be within the soil mantle and extremely weathered to highly weathered sandstone, and should be readily achievable using conventional earth moving equipment such as a hydraulic excavator. Excavation in highly weathered or better quality sandstone (ie. below the TC bit refusal levels) is likely to be more difficult and assistance from a rock breaker may be required, possibly in sections where the pipeline will be deeper (see **Section 11.3.1**).

10.3.3 Trench Supports

Generally, trench walls should be self-supporting during the short term construction period. However, for any excavations that are in excess of 1.5m depth, the trenches would need to be benched, stepped or battered back, as required for safety purposes.

Construction difficulties associated with permanent groundwater are not envisaged. However, at the watercourse crossings there is some potential for encountering surface water or seepage, depending on prevailing weather conditions at the time of construction; therefore, dewatering may be required.

11 Pipeline Route – Alternate Section

11.1 Site Description

At the time of fieldwork, the WTP site operator indicated that an alternate rising main alignment was being considered. The alternate route was shown to our site supervisor by the WTP operator and a total of nine (9) boreholes (RM17 to RM24 and RM21A) were drilled between Dam No. 3 (Wakefield) and the town of White Cliffs. It should be noted that there is no survey available for the alternate section of the alignment.

The alternate alignment will head in a south-westerly direction from Dam No. 3 and follow the electricity powerline easement to Kayrunnera Road (see **Figure 17**). At the Kayrunnera Road the

alignment bends to the south and follows the eastern road reserve to the north-western outskirts of the town.

The topography along the alternate section is relatively flat to gently undulating and the ground surface is mostly bare to sparsely grass covered, with rare shrubs and small trees. Some general photos along the alignment are shown in **Plates 35** to **40.**

11.2 Subsurface Conditions

Boreholes RM17 to RM19 were drilled along the powerline easement between Dam No. 3 and Kayrunnera Road.

The subsurface conditions encountered in boreholes RM17 and RM18 were fairly similar comprising dense, gravel and cobbles in a silty sand matrix (GM type) to medium dense, gravelly clayey sandy silt (CL/GC type) to the borehole termination depths of 0.5m and 1.5m, respectively. TC bit refusal was registered at 0.5m in RM17, possibly on a large cobble or siltstone bedrock.

Borehole RM19, located at the south-western end of the powerline easement, comprised very stiff sandy clayey silt (CI/CL type) for the entire depth of 1.5m.

Borehole RM20 was drilled approximately 500m to the south of the junction of the powerline easement to Dam No. 3 and Kayrunnera Road. The sediments encountered comprise stiff sandy clayey silt (CI type) to 0.6m, followed by medium dense clayey silty sand (CI/SC type) to the borehole termination depth of 1.5m.

The subsurface conditions encountered along the remaining investigated section of Kayrunnera Road (boreholes RM21 to RM24 and RM21A) are quite similar, apart from some minor variation in the surficial horizon.

The surficial horizon encountered in RM21 and nearby RM21A, comprises loose sandy silty gravel (GM type) to depths of 0.2m and 0.1m, respectively. In RM22, the surficial sediments are finer grained comprising stiff, sandy silty clay (CI/CH type) to 0.7m.

In boreholes RM23 and RM24, located at the southern end of the alternate alignment, comprise loose, silty sand and gravelly silty sand (SM type), respectively, to 0.2m depth.

Beneath the slightly variable surficial layer in boreholes RM21 to RM24 and RM21A, weathered siltstone/ sandstone/ conglomerate was encountered to the borehole termination depths of 0.6m to 1.5m. The bedrock ranges from extremely weathered with an extremely weak rock substance strength to highly weathered with a very weak to medium strong rock substance strength. TC bit refusal was registered at 0.6m in borehole RM21 on what is inferred to be moderately weathered sandstone/ conglomerate. Consequently, RM21A was drilled approximately 6.5m from the location of RM21 to confirm the rock quality that is expected to be encountered. It should be noted that rock outcrop was observed in the vicinity of RM21.

Groundwater was not encountered in boreholes RM17 to RM24 and RM21A within the depth of investigation (1.5m maximum), at the time of fieldwork. However, it should be noted that the presence of seepage is subject to prevailing weather conditions at the time of construction and may differ from those presented on the borehole logs.

11.3 Summary and Discussions

11.3.1 Foundation Conditions

It is understood that the possible alternate route is likely to be founded at depths in the order of approximately 1.0m.

By extrapolation of data from discrete boreholes, the rising main will be founded within medium dense gravel and cobbles in a silty sand matrix, very stiff sandy clayey silt, medium dense clayey silty sand, or weathered siltstone/ sandstone/ conglomerate.

The bearing capacity of the founding strata is more than adequate while settlement is of no concern.

11.3.2 Excavation Characteristics

Excavations to design invert levels will be within the soil mantle and weathered siltstone/ sandstone/ conglomerate, and should be readily achievable using conventional earth moving equipment such as a hydraulic excavator. Excavation in highly weathered or better quality sandstone (ie. below the TC bit refusal levels) is likely to be more difficult and assistance from a rock breaker may be required.

11.3.3 Trench Supports

Generally, trench walls should be self-supporting during the short term construction period. However, for any excavations that are in excess of 1.5m depth, the trenches would need to be benched, stepped or battered back, as required for safety purposes.

Construction difficulties associated with permanent groundwater are not envisaged.

12 General Remarks

This report is based on extrapolation of data from discrete boreholes and may not represent actual conditions between them. Should different conditions be encountered at the time of construction then advice should be sought from a geotechnical consultant.

PLATES

PLATE 1: View looking south showing the existing water treatment plant buildings and tanks.

PLATE 2: View looking north-east showing the existing central eastern storage pond.

PLATE 3: View looking north-west showing the existing central western storage pond.

PLATE 4: View looking north-west showing the existing northern storage pond.

PLATE 5: View looking north-west showing the vacant block to the west of the existing WTP site.

PLATE 6: View looking north from within the vacant block of land.

PLATE 7: View looking north-east from within the vacant block of land.

PLATE 8: View looking south-east from within the vacant block of land.

PLATE 9: View looking west showing the existing weir, which is a rock-filled gabion structure. The gabion mesh is mostly damaged. The Dam No.3 (Wakefield) embankment is visible in the background of the photo.

PLATE 10: View looking south-west showing Dam No. 3 (Wakefield).

PLATE 11: View looking north-west towards the location of borehole WR1.

PLATE 12: View looking south-east from near the location of borehole WR1. The existing weir is located beyond the bank, past the large trees.

PLATE 13: View looking south-east across the bank shown in Plate 12. The ground is very soft and was inaccessible at the time of fieldwork. The existing weir is located beyond the trees.

PLATE 14: View looking south-west along Line WCP1 towards Dam No. 1. The peg is at Ch. 199.8m.

PLATE 15: View looking north-east towards the drainage channel where borehole RM1 was located.

PLATE 16: View looking north-east showing the shallow drainage channel where borehole RM1 was located.

PLATE 17: View looking west along Beth Street and Line WCP1 from the location of borehole RM5.

PLATE 18: View looking south from the location of borehole RM5 towards the WTP site along Line WCP1.

PLATE 19: Looking west towards Dam No. 2 along Line WCP2 from the location of borehole RM3.

PLATE 20: View of watercourse near borehole RM3. Drill rig is set up on RM3.

PLATE 21: View looking north-east towards Dam No. 3. Some rutting and gullies are visible where water has overflowed the dam embankment.

PLATE 22: View looking south from borehole RM16 showing the nearby watercourse.

PLATE 23: Close up view of the northern bank of the watercourse near RM16.

PLATE 24: View looking north-northeast from near RM15. Ground surface is mostly bare, with rare shrubs.

PLATE 25: View looking west showing the watercourse near RM15. Weathered siltstone is exposed in the base of the watercourse.

PLATE 26: View looking south-east from the location of RM14 (Ch. 1595.9m).

PLATE 27: View looking north-west from the location of RM12 (Ch. 2887.8m).

PLATE 28: View looking west-southwest from near RM10. The scour valve is visible in the lower right corner of the photograph.

PLATE 29: View looking east-northeast from near RM9. The 'spoil' pile/ embankment is visible in the background.

PLATE 30: View looking south from near RM8 (Ch. 4808.7m) towards White Cliffs township.

PLATE 31: View looking north towards Keraro Road. The survey peg to the right of the vehicle is at RM7 (Ch. 5433.7m).

PLATE 32: View looking north towards the northern bank of the watercourse from near RM6.

PLATE 33: Pipelines exposed in the base of the watercourse to the west of borehole RM6.

PLATE 34: View looking south-southeast from the northern bank of the deeper watercourse towards the existing WTP. The peg at the base of the watercourse marks the location of RM6.

PLATE 35: View from near RM17 looking north-east along the alternate alignment towards Dam No. 3 (Wakefield).

PLATE 36: View looking south-west along the alternate alignment from near RM18.

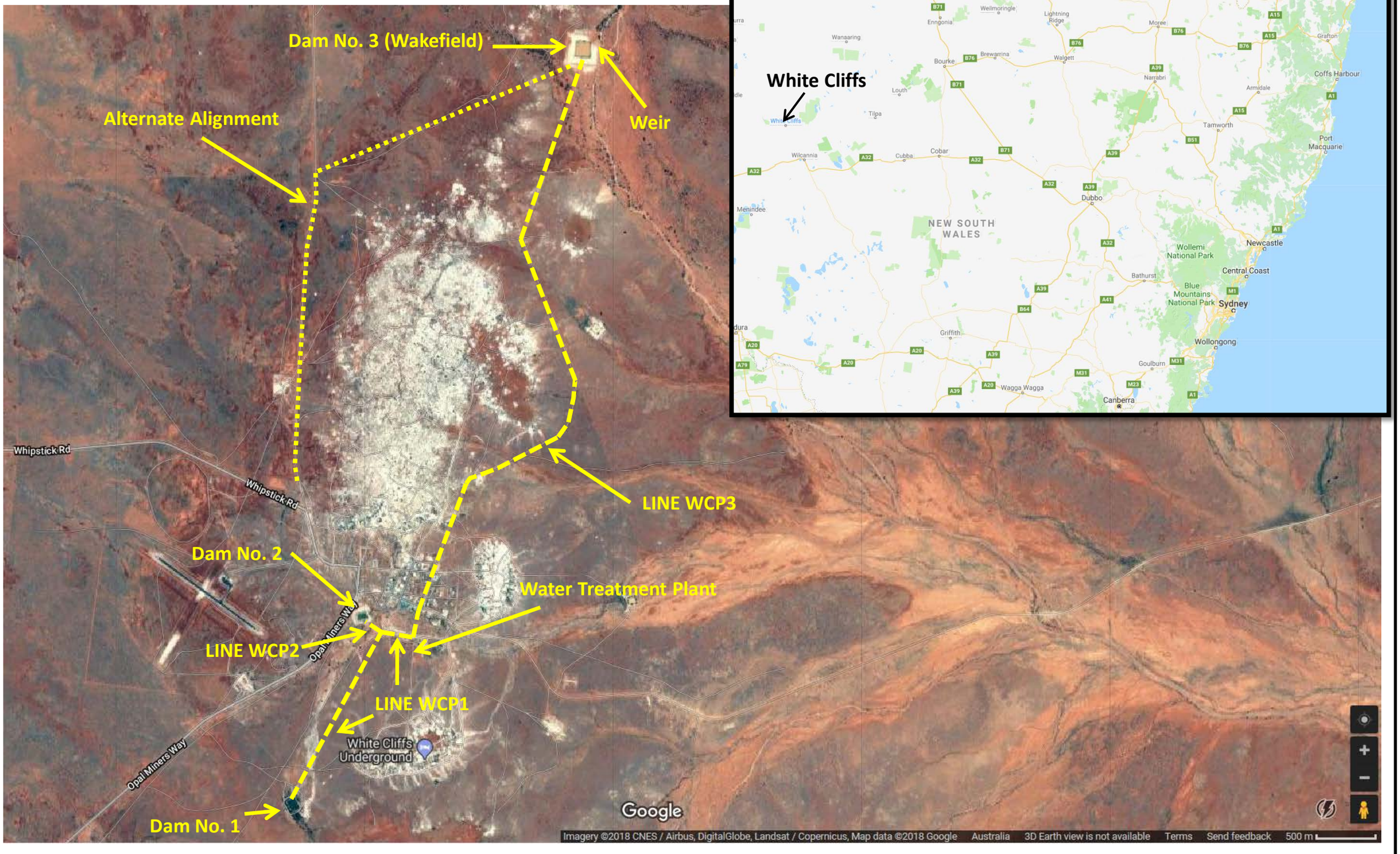
PLATE 37: View looking north-east along the alternate alignment from where the powerline easement intersects with Kayrunnera Road.

PLATE 38: View looking south along Kayrunnera Road from near the location of RM20.

PLATE 39: Rock outcrop in the vicinity of RM21.

PLATE 40: View looking south along Kayrunnera Road from near RM23 towards the township of White Cliffs.

FIGURES



NSW GOVERNMENT Public Works Advisory

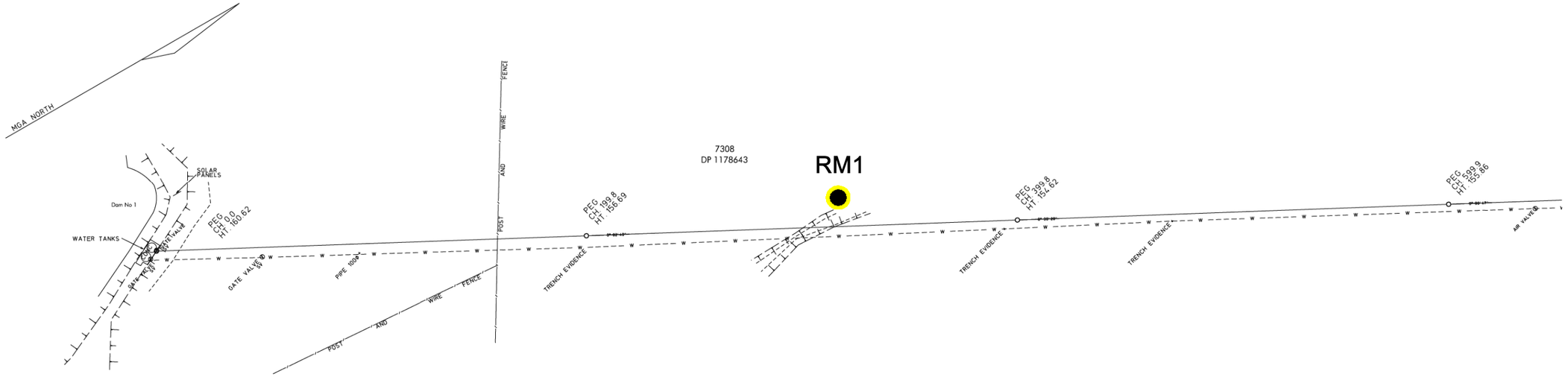
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Locality Plan

GT29A

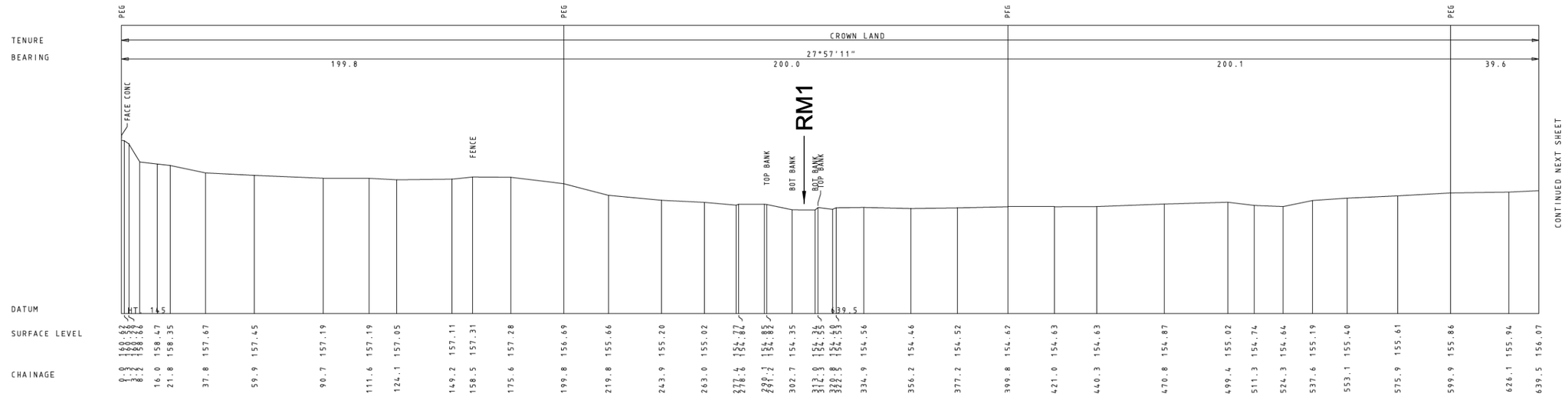
FIGURE
1



LEGEND
(all locations are approximate)
● **RM1** Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP1

NSW GOVERNMENT PublicWorks Advisory

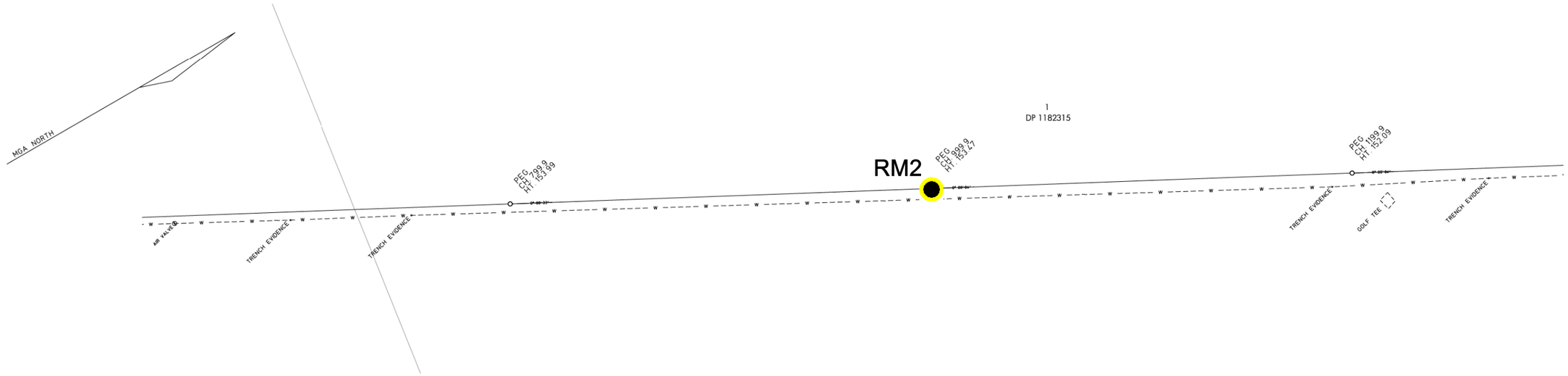
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP1 CH. 0.0 to CH. 639.5

GT29A

FIGURE 2

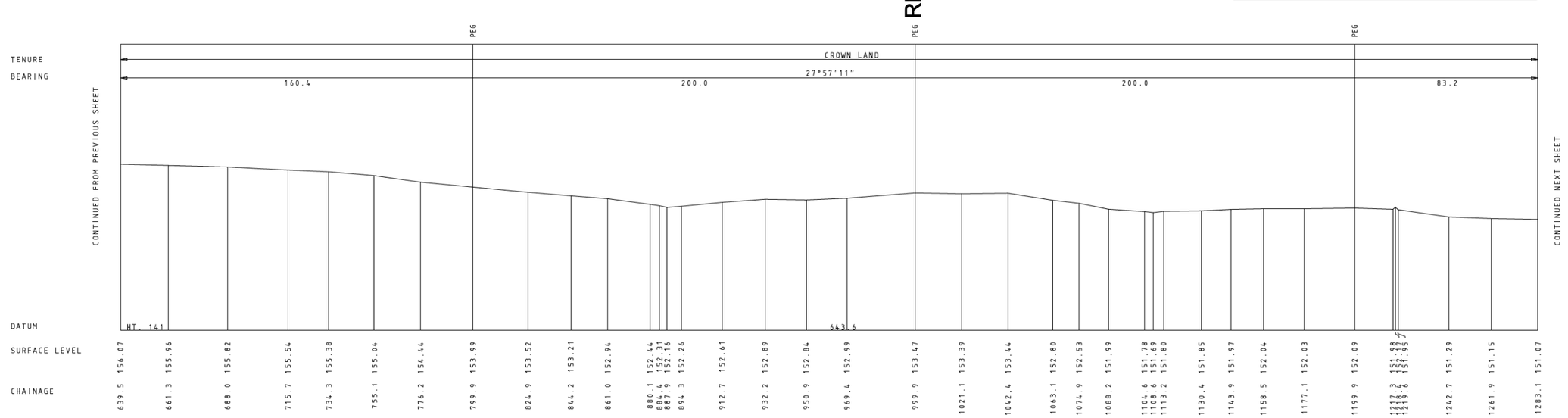


LEGEND
(all locations are approximate)

● **RM2** Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP1

PublicWorks Advisory
NSW GOVERNMENT

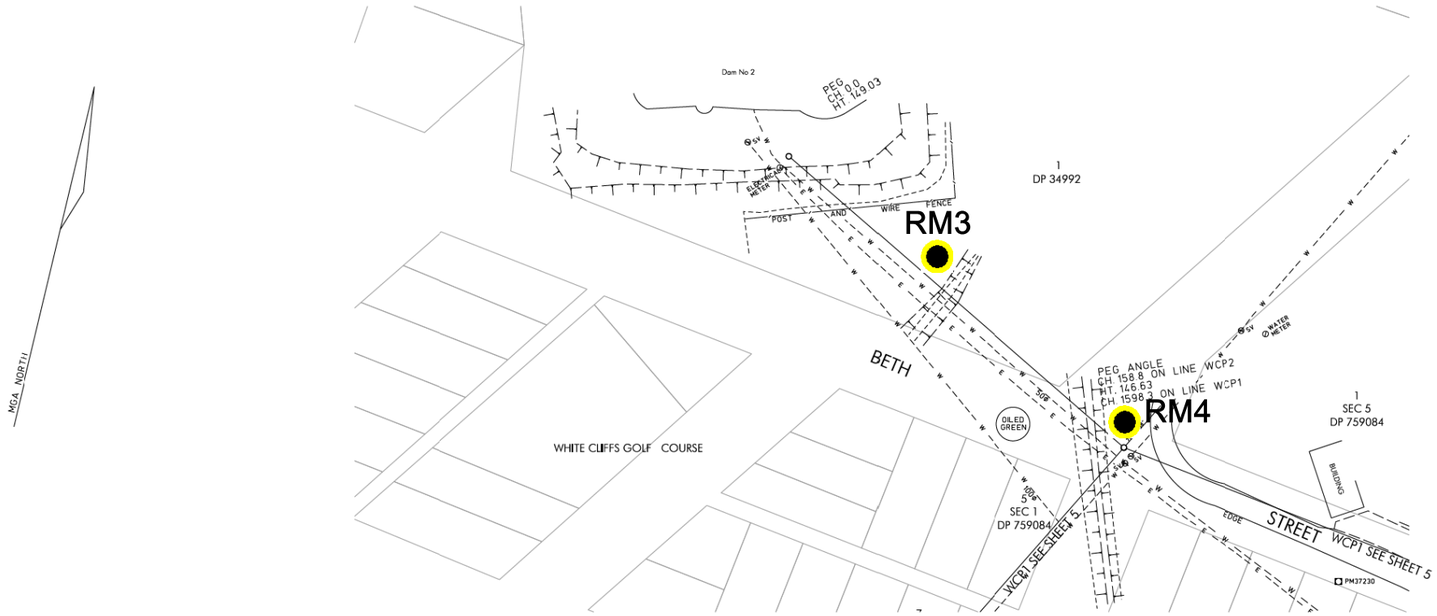
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP1 CH. 639.5 to CH. 1283.1

GT29A

FIGURE
3

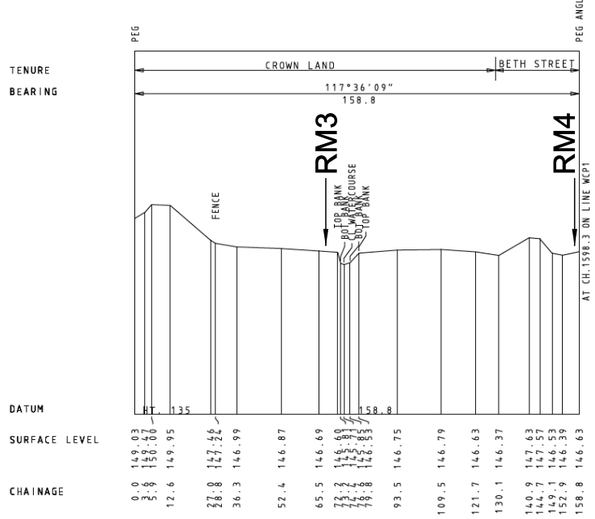


LEGEND
(all locations are approximate)

- **RM3** Borehole Location
- **RM4** Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP2

NSW GOVERNMENT PublicWorks Advisory

LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

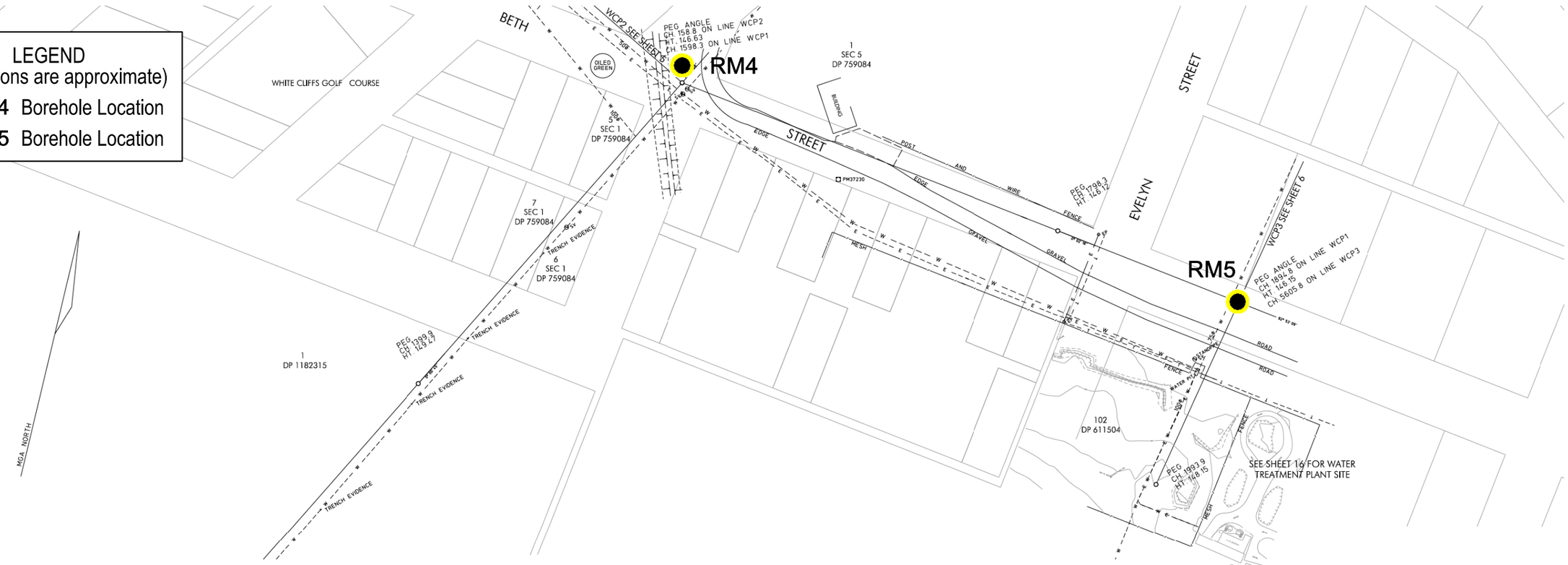
Borehole Location Plan - Line WCP2 CH. 0 to CH. 158.8

GT29A

FIGURE 4

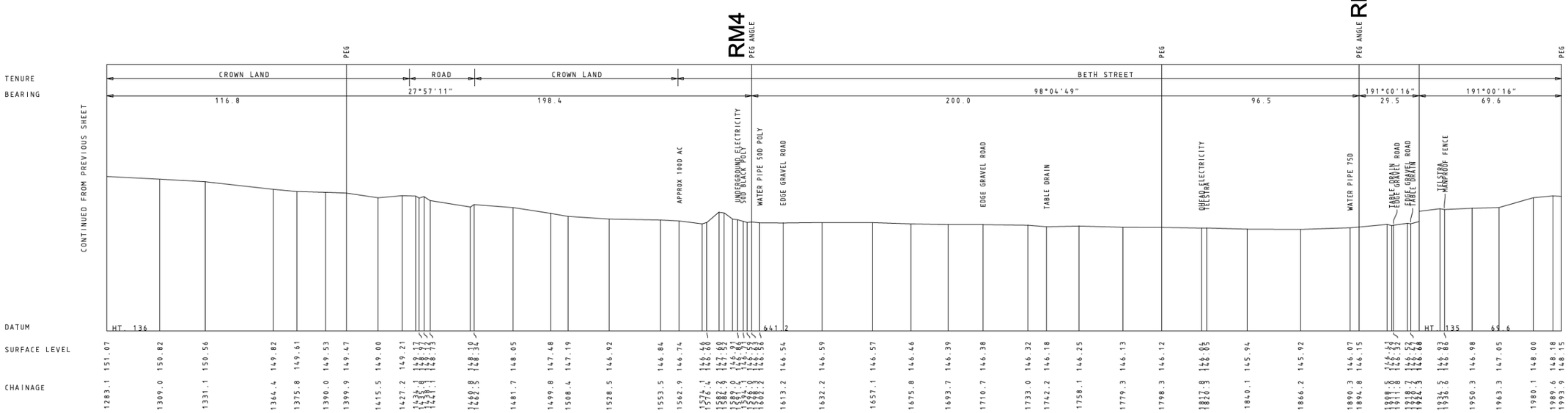
LEGEND
(all locations are approximate)

- RM4 Borehole Location
- RM5 Borehole Location



LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP1

NSW GOVERNMENT PublicWorks Advisory

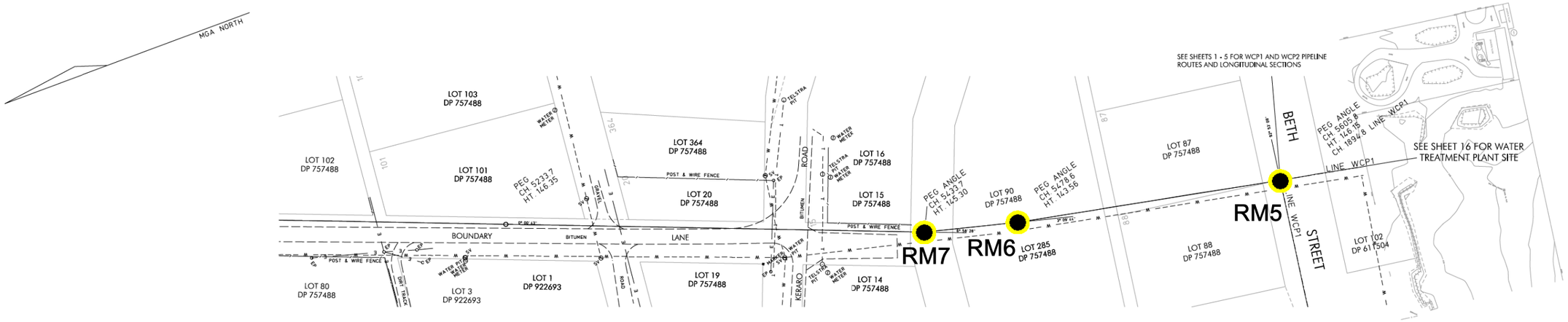
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP1 CH. 1283.1 to CH. 1993.9

GT29A

FIGURE
5

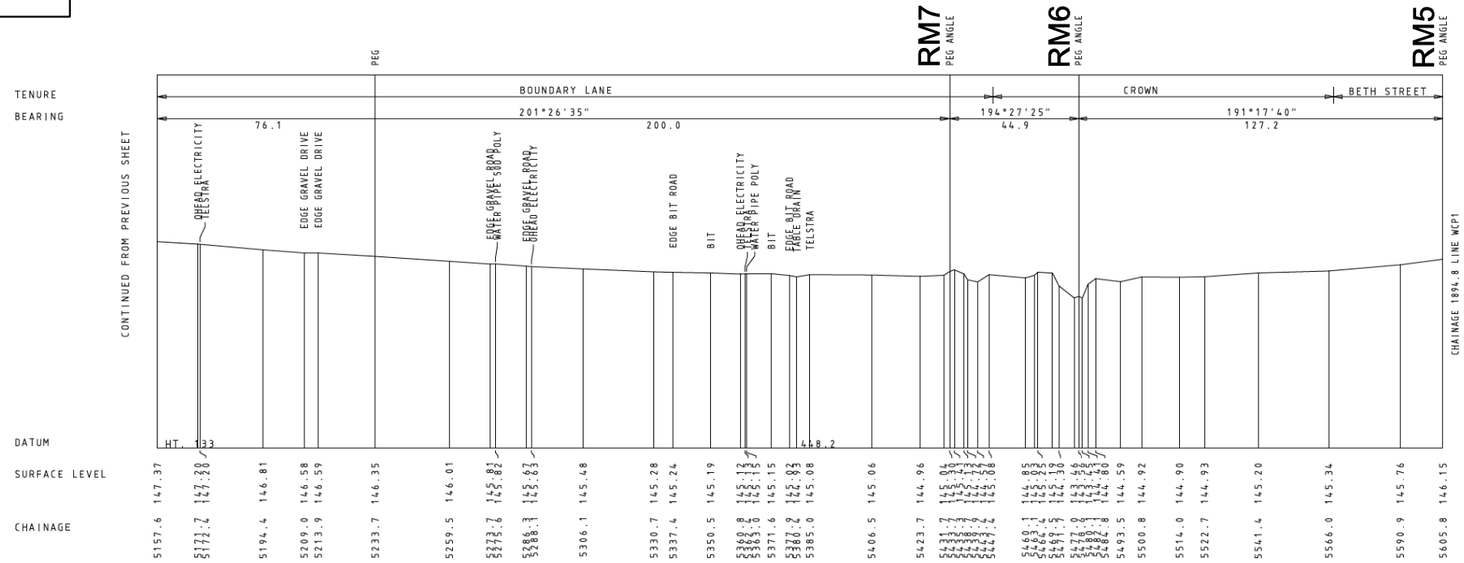


LEGEND
(all locations are approximate)

- **RM5** Borehole Location
- **RM6** Borehole Location
- **RM7** Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

PublicWorks Advisory
NSW GOVERNMENT
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

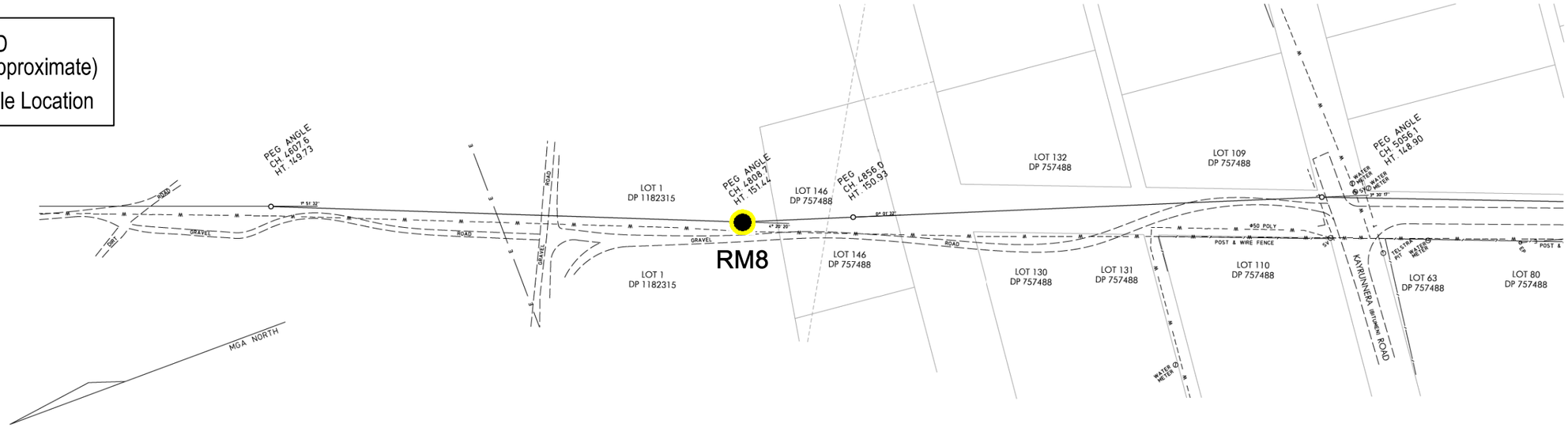
Borehole Location Plan - Line WCP3 CH. 5157.6 to CH. 5605.8

GT29A

FIGURE 6

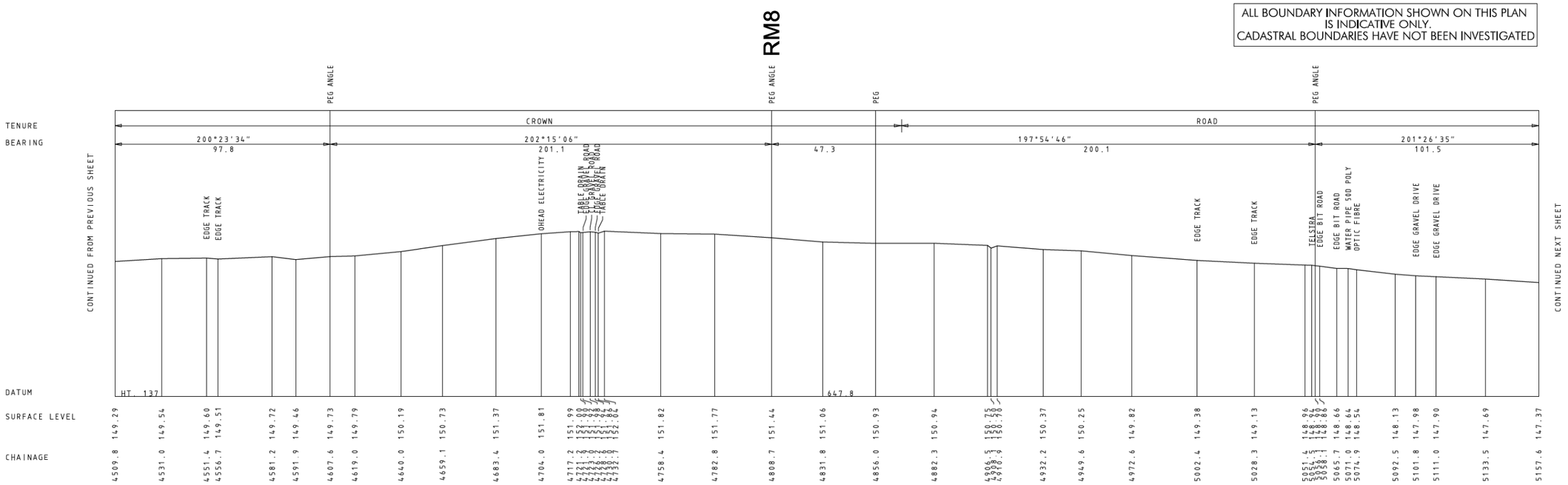
LEGEND
(all locations are approximate)

RM8 Borehole Location



LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

NSW GOVERNMENT PublicWorks Advisory

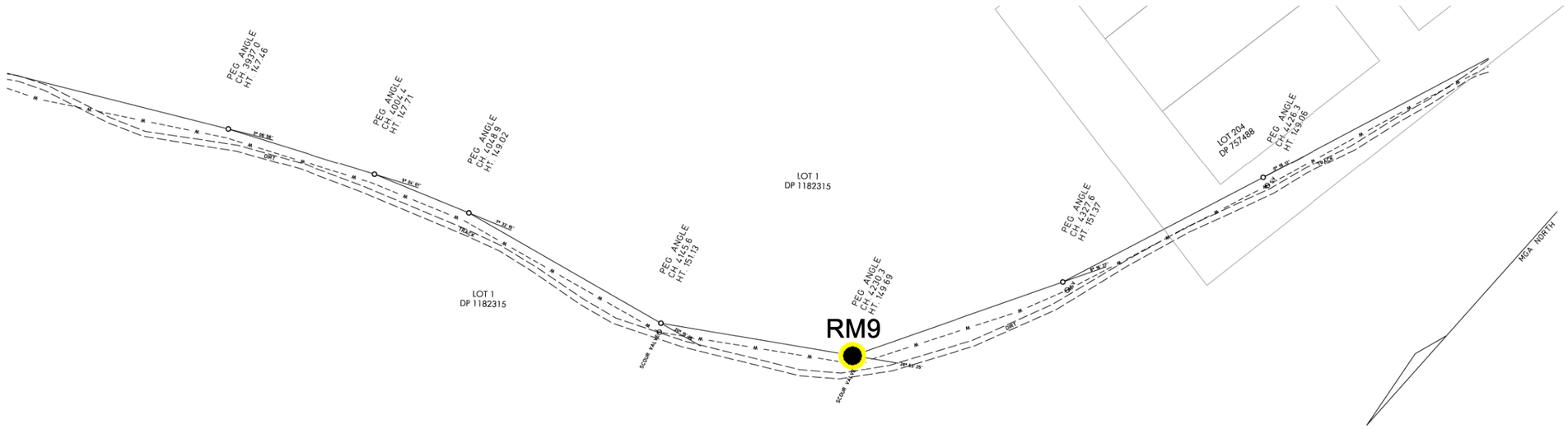
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 4509.8 to CH. 5157.6

GT29A

FIGURE
7

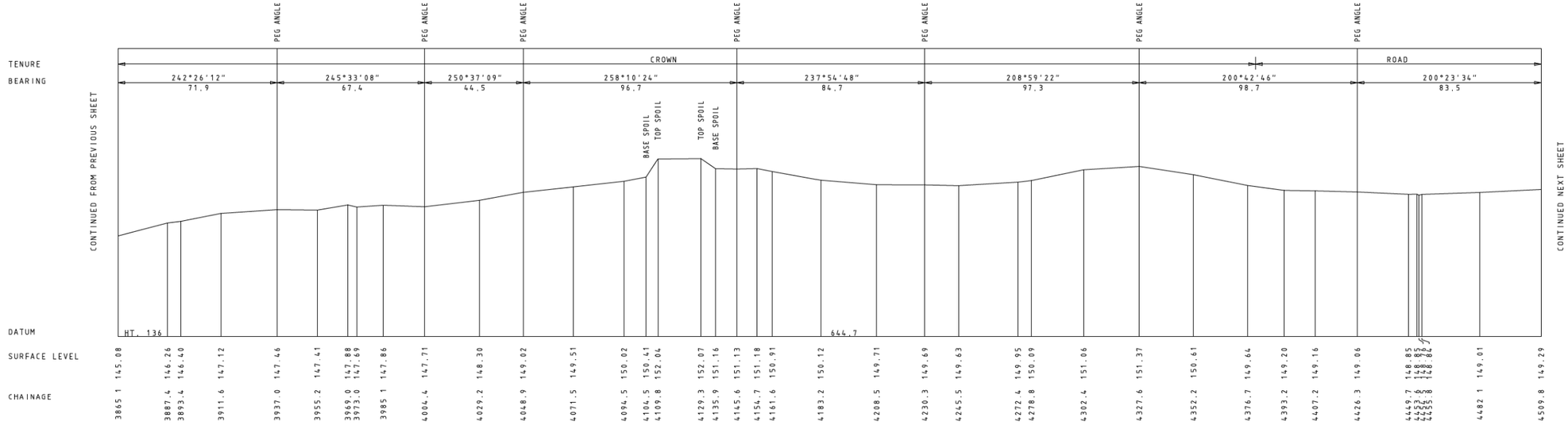


LEGEND
(all locations are approximate)

RM9 Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

PublicWorks Advisory
NSW GOVERNMENT

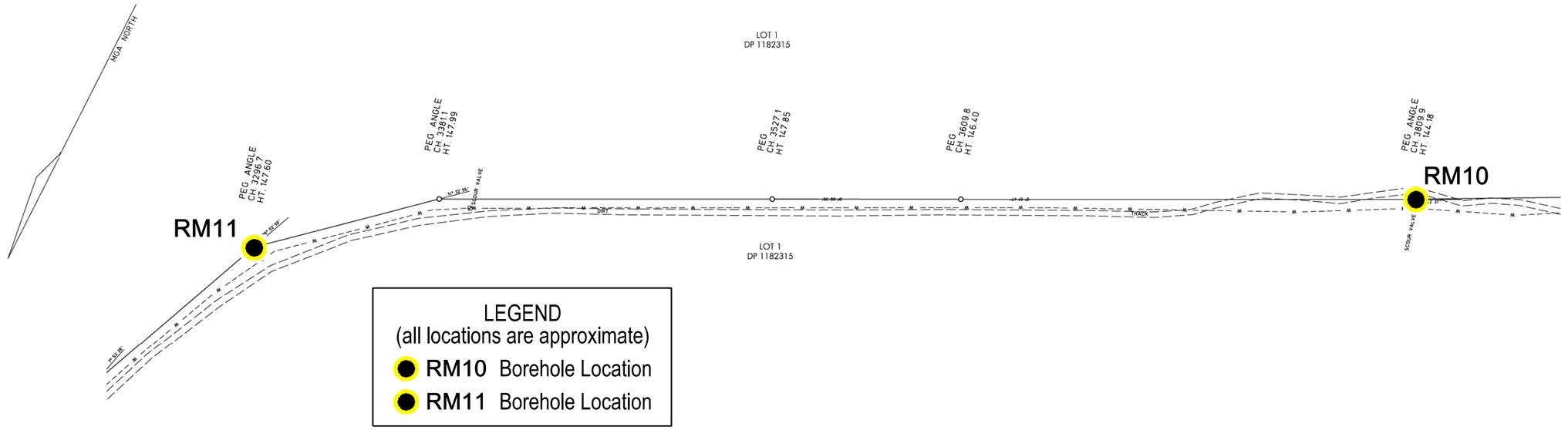
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 3865.1 to CH. 4509.8

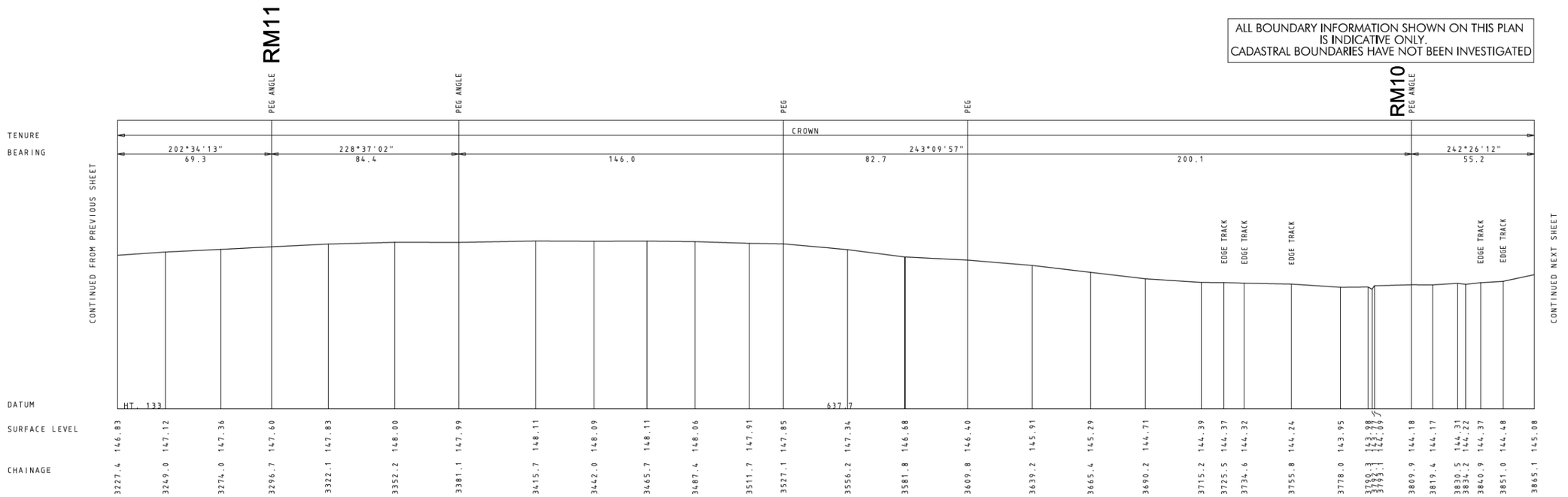
GT29A

FIGURE
8



LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

NSW GOVERNMENT PublicWorks Advisory

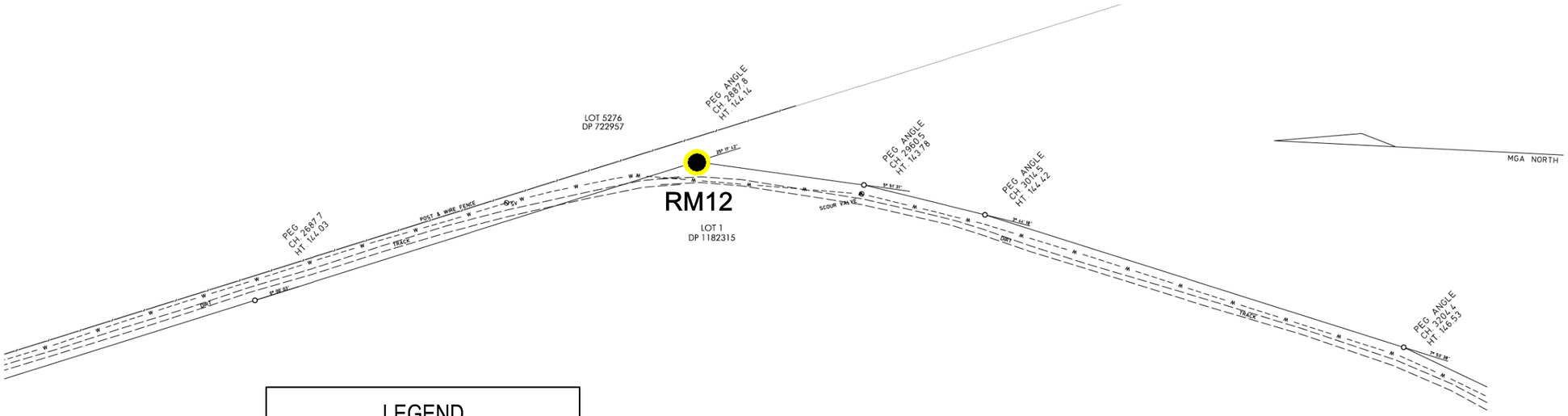
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 3227.4 to CH. 3865.1

GT29A

FIGURE
9



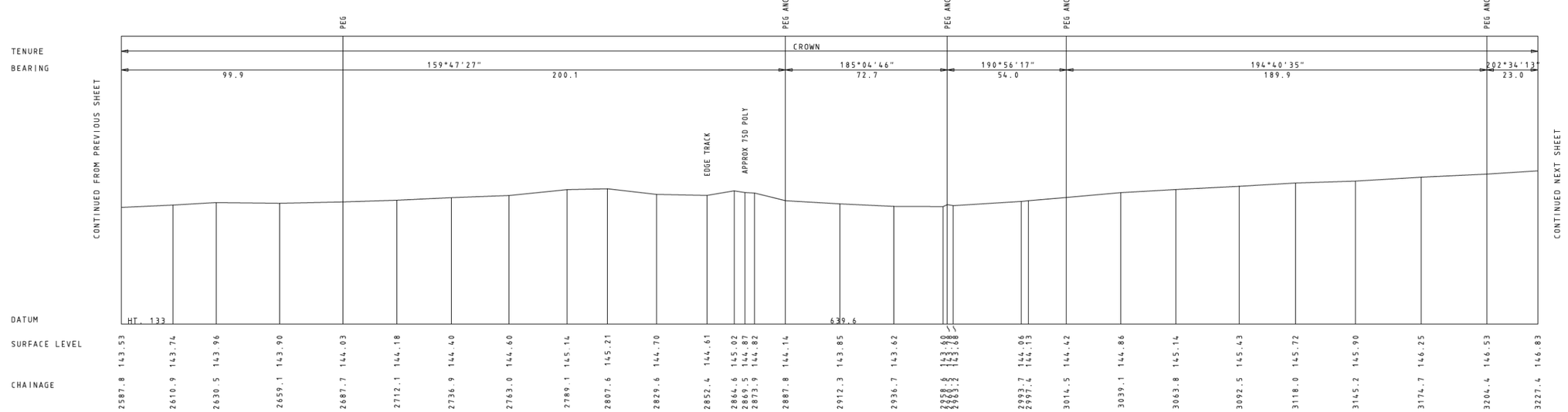
LEGEND
(all locations are approximate)

RM12 Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED

RM12



LINE WCP3

PublicWorks Advisory
NSW GOVERNMENT

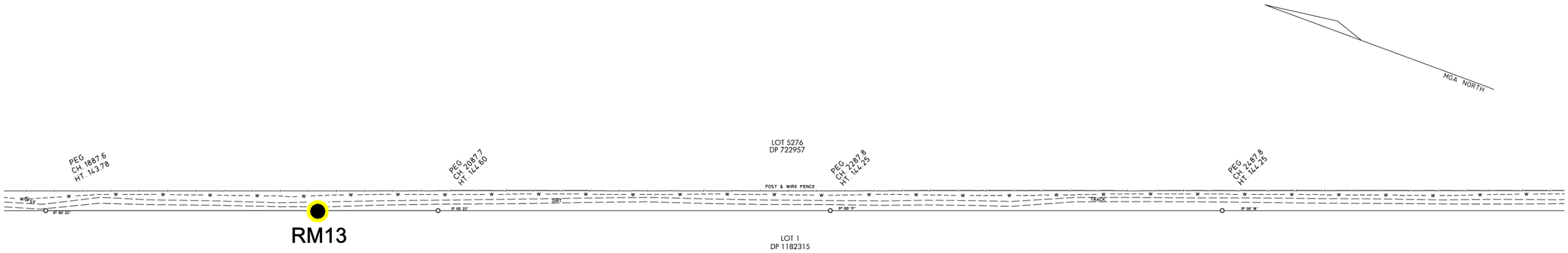
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 2587.8 to CH. 3227.4

GT29A

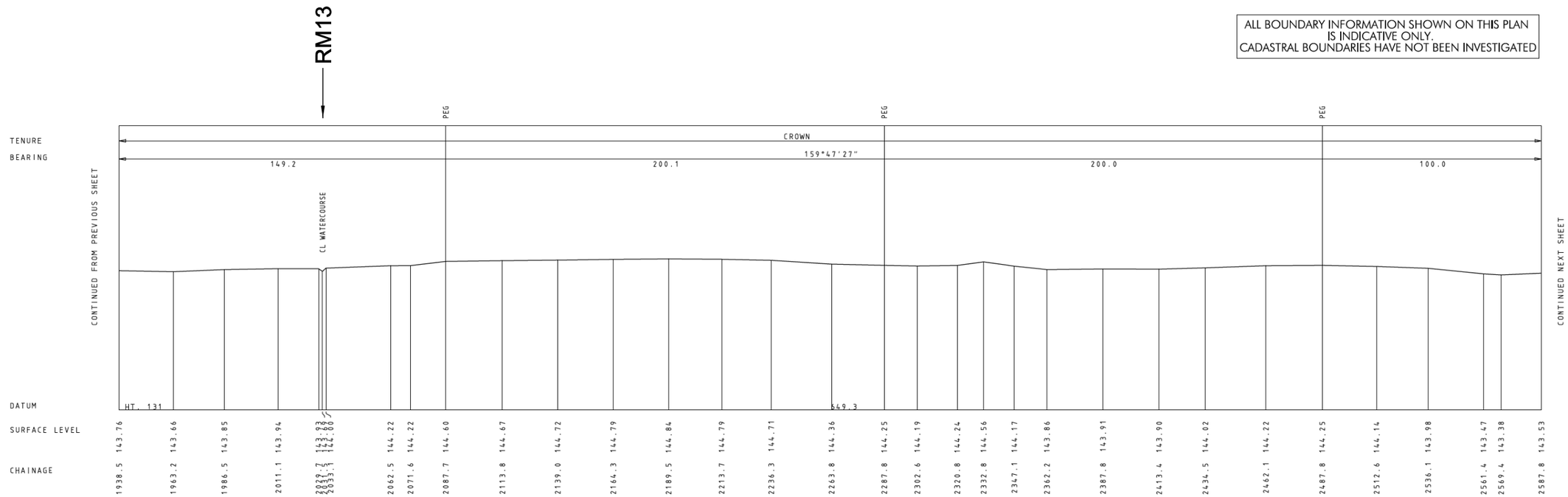
FIGURE 10



LEGEND
(all locations are approximate)
RM13 Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

PublicWorks Advisory
NSW GOVERNMENT

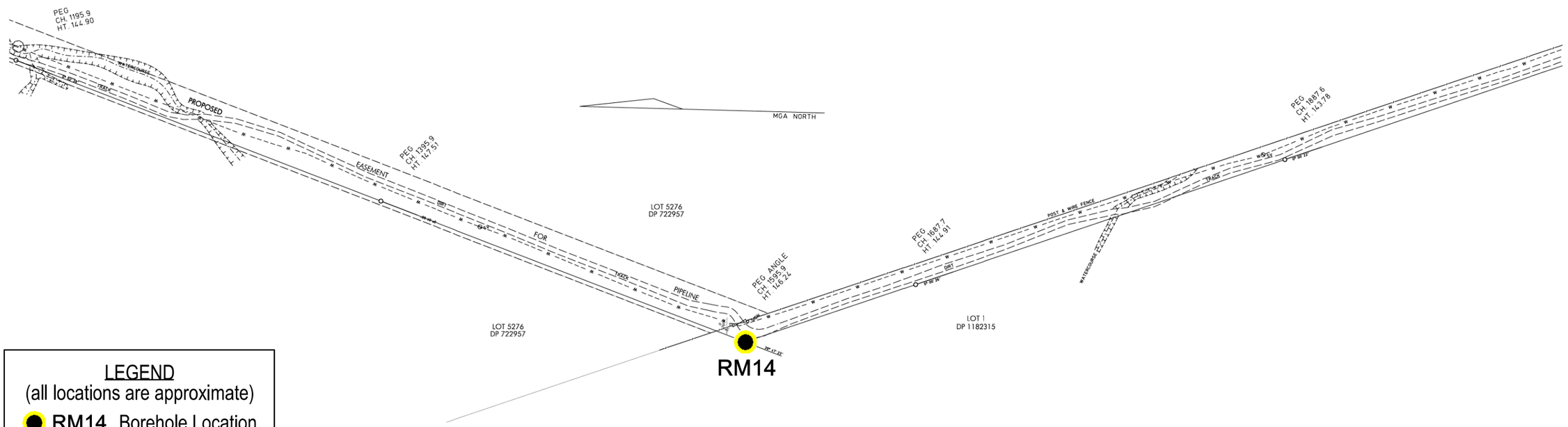
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 1938.5 to CH. 2587.8

GT29A

FIGURE 11

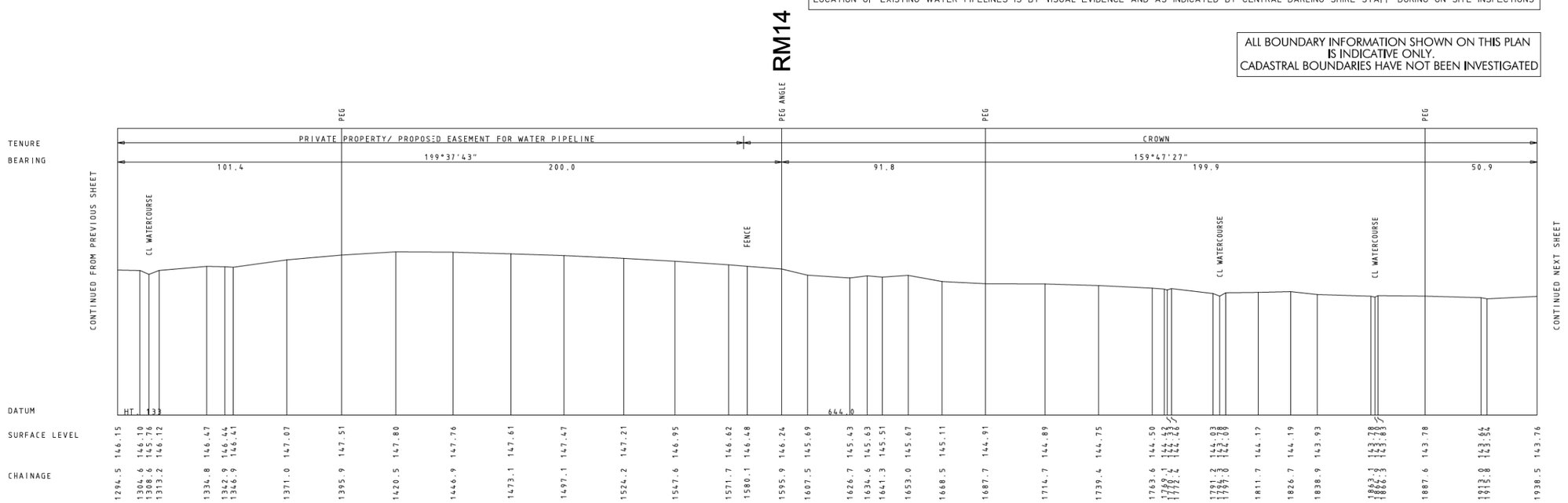


LEGEND
(all locations are approximate)

● **RM14** Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

PublicWorks Advisory
NSW GOVERNMENT

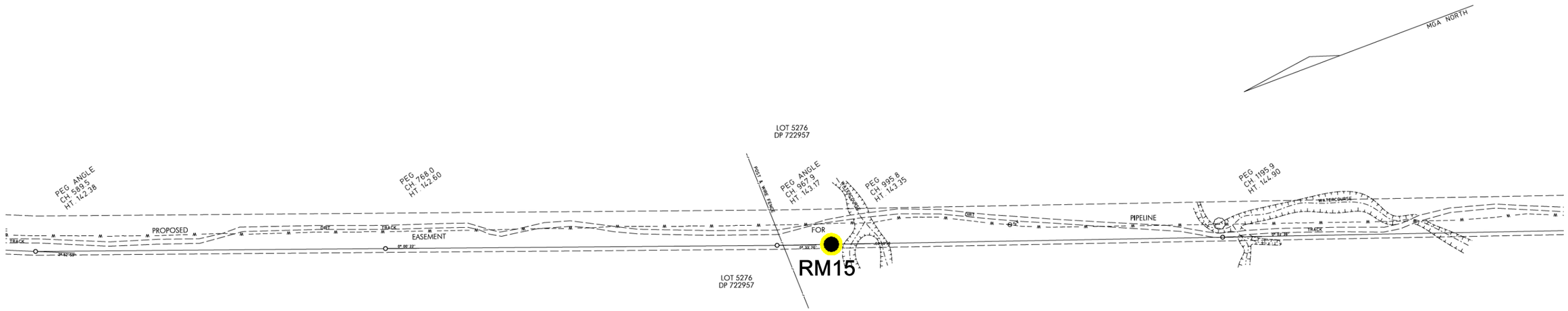
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 1294.5 to CH. 1938.5

GT29A

FIGURE 12

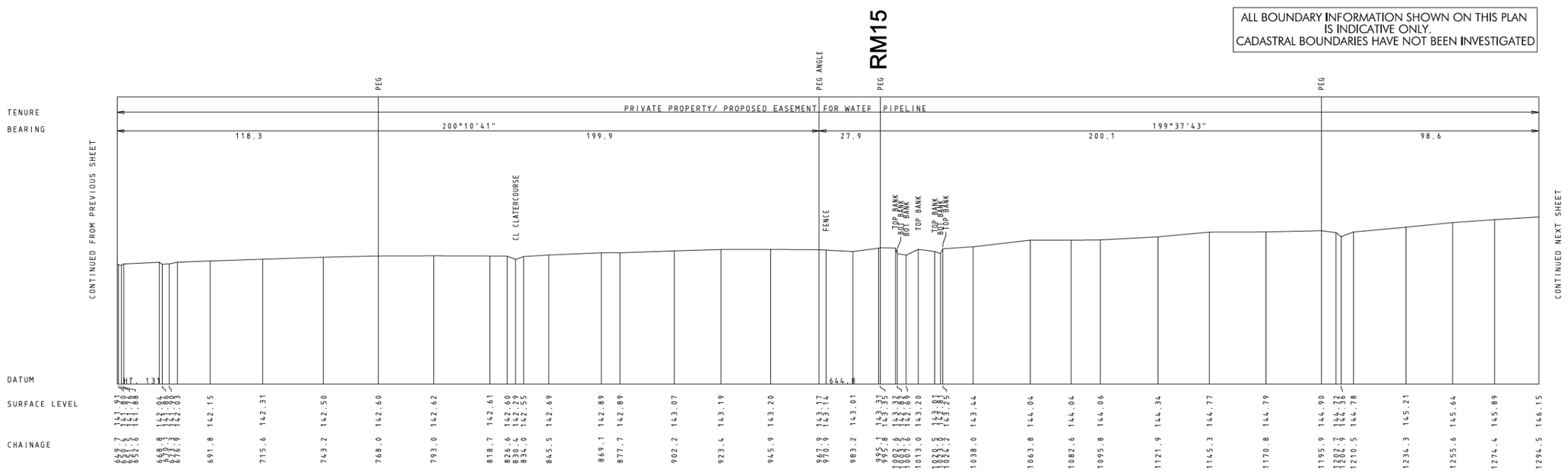


LEGEND
(all locations are approximate)

RM15 Borehole Location

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

NSW GOVERNMENT PublicWorks Advisory

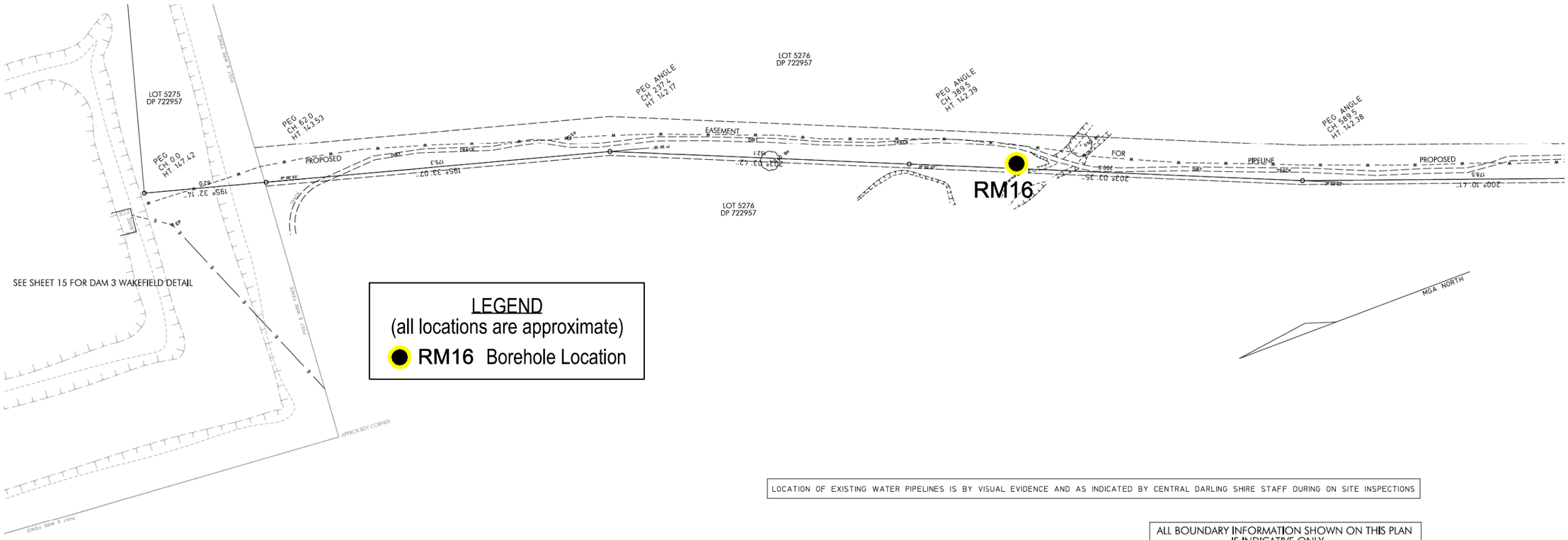
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 649.7 to CH. 1294.5

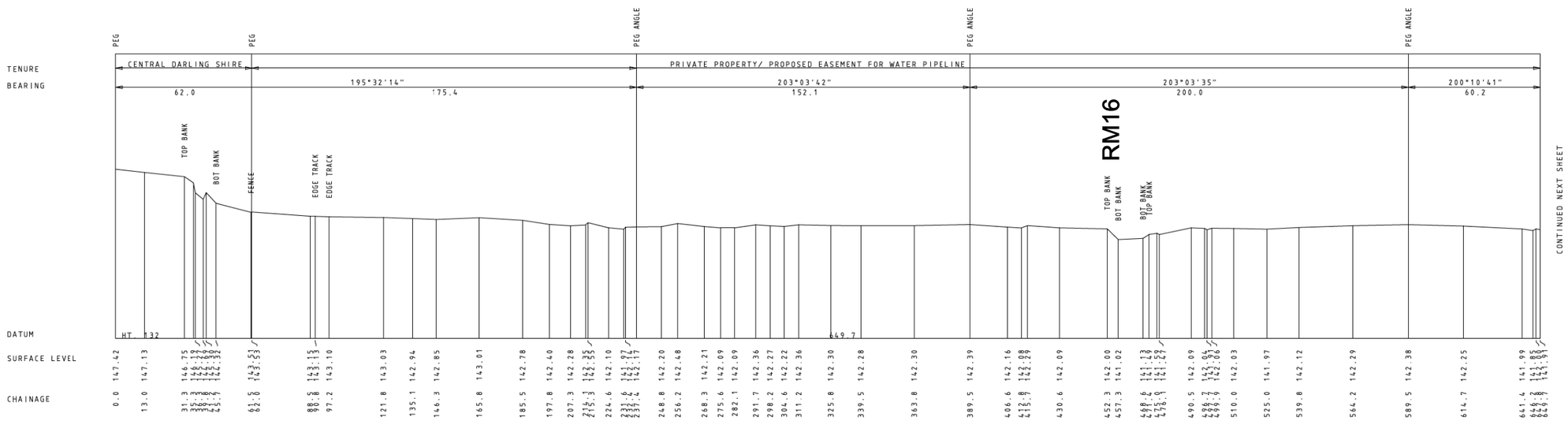
GT29A

FIGURE 13



LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED



LINE WCP3

PublicWorks Advisory
NSW GOVERNMENT

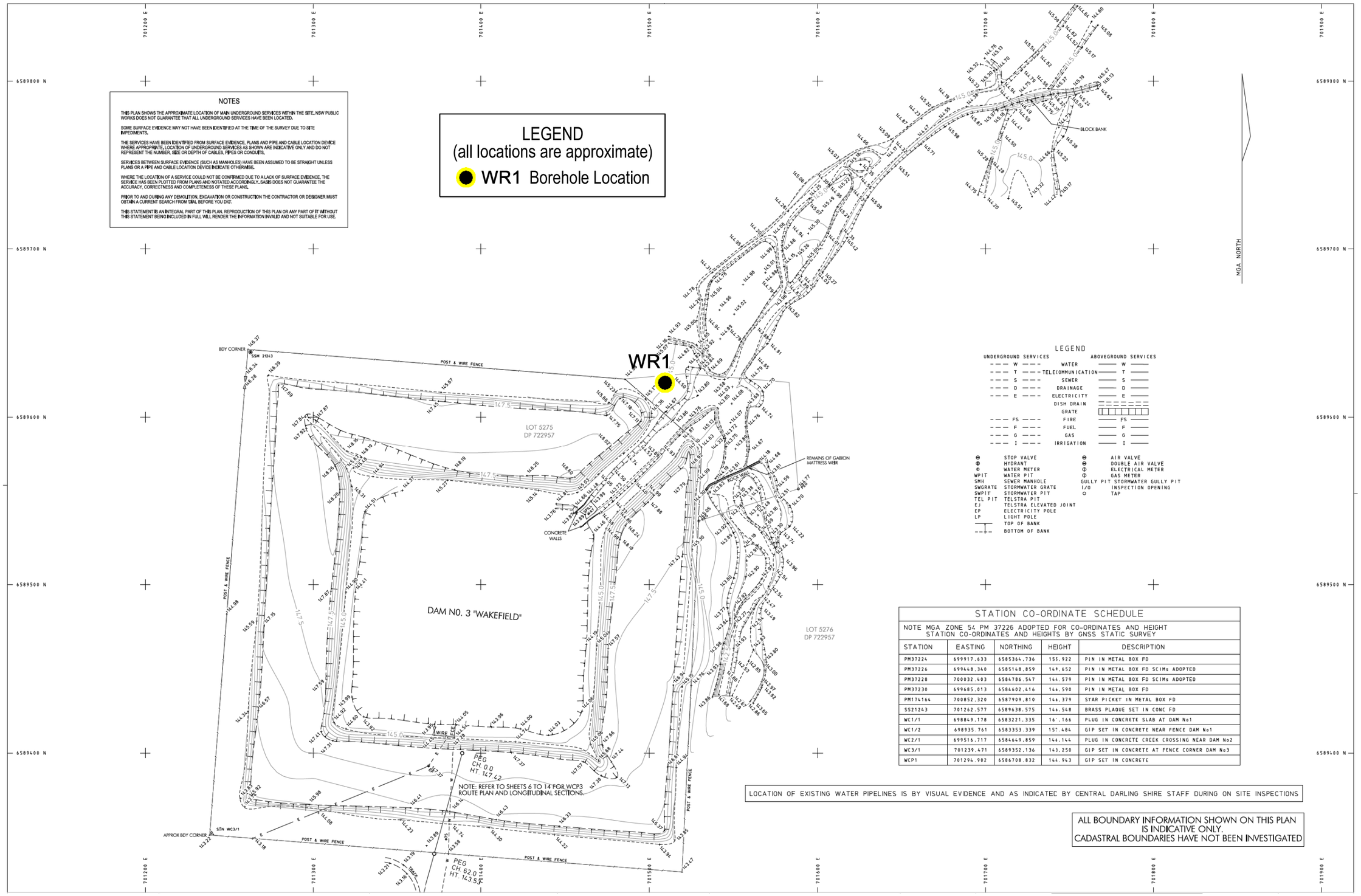
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Line WCP3 CH. 0.0 to CH. 649.7

GT29A

FIGURE
14



STATION CO-ORDINATE SCHEDULE

NOTE MGA ZONE 54 PM 37226 ADOPTED FOR CO-ORDINATES AND HEIGHT
STATION CO-ORDINATES AND HEIGHTS BY GNSS STATIC SURVEY

STATION	EASTING	NORTHING	HEIGHT	DESCRIPTION
PM37224	699917.633	6585364.736	155.922	PIN IN METAL BOX FD
PM37226	699448.340	6585148.859	149.652	PIN IN METAL BOX FD SCIMs ADOPTED
PM37228	700032.403	6584786.547	144.579	PIN IN METAL BOX FD SCIMs ADOPTED
PM37230	699685.013	6584602.416	146.590	PIN IN METAL BOX FD
PM174164	700852.320	6587909.810	146.379	STAR PICKET IN METAL BOX FD
SS21243	701262.577	6589638.575	144.548	BRASS PLAQUE SET IN CONC FD
WC1/1	698849.178	6583221.335	16'.166	PLUG IN CONCRETE SLAB AT DAM No1
WC1/2	698935.761	6583353.339	157.484	GIP SET IN CONCRETE NEAR FENCE DAM No1
WC2/1	699516.717	6584649.859	146.144	PLUG IN CONCRETE CREEK CROSSING NEAR DAM No2
WC3/1	701239.471	6589352.136	143.250	GIP SET IN CONCRETE AT FENCE CORNER DAM No3
WCP1	701294.902	6586708.832	144.943	GIP SET IN CONCRETE

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED

NSW GOVERNMENT PublicWorks Advisory
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan - Dam 3 - Wakefield

GT29A

FIGURE 15

LEGEND

(all locations are approximate)

B1 ● Borehole Location

B1 B2 B3 B4 B5 B6 B7 B8

SEE SHEET 5 FOR WCP1 PIPELINE & RETICULATION SURVEY

LEGEND

UNDERGROUND SERVICES		ABOVEGROUND SERVICES
W	WATER	W
T	TELECOMMUNICATION	T
S	SEWER	S
D	DRAINAGE	D
E	ELECTRICITY	E
	RING DRAIN	
	GRATE	
FS	FIRE	FS
F	FUEL	F
G	GAS	G
I	IRRIGATION	I

	STOP VALVE		AIR VALVE
	HYDRANT		DOUBLE AIR VALVE
	WATER METER		ELECTRICAL METER
WPIT	WATER PIT		GAS METER
SHR	SHOWER HANDSET	DSPIT	DILLY PIT STORMWATER DILLY PIT
SWGRATE	STORMWATER GRATE	I/O	INSPECTION OPENING
SWPIT	STORMWATER PIT		TAP
TEL PIT	TELSTRA PIT		
EJ	TELSTRA ELEVATED JOINT		
EP	ELECTRICITY POLE		
LP	LIGHT POLE		
	TOP OF BANK		
	BOTTOM OF BANK		

NOTES

THIS PLAN SHOWS THE APPROXIMATE LOCATION OF MAIN UNDERGROUND SERVICES WITHIN THE SITE, NEW FUSED WORKS COULD NOT GUARANTEE THAT ALL UNDERGROUND SERVICES HAVE BEEN LOCATED.

SOME SURFACE EVIDENCE MAY NOT HAVE BEEN OBSERVED AT THE TIME OF THE SURVEY DUE TO SITE IMPEDIMENTS.

THE SERVICES HAVE BEEN PLOTTED FROM SURFACE EVIDENCE, PLANS AND PITS AND CABLE LOCATION DEVICE WHERE APPROPRIATE. LOCATION OF UNDERGROUND SERVICES AS SHOWN ARE INDICATIVE ONLY AND DO NOT REPRESENT THE NUMBER, SIZE OR DEPTH OF CABLES, PIPES OR CONDUITS.

SERVICES BETWEEN SURFACE EVIDENCE SUCH AS MANHOLES, HAVE BEEN ASSUMED TO BE STRAIGHT UNLESS PLANS OR A PIPE AND CABLE LOCATION DEVICE INDICATE OTHERWISE.

WHERE THE LOCATION OF A SERVICE COULD NOT BE CONFIRMED DUE TO A LACK OF SURFACE EVIDENCE, THE SERVICE HAS BEEN PLOTTED FROM PLANS AND NOTATED ACCORDINGLY. SAID CODES NOT GUARANTEE THE ACCURACY, CORRECTNESS AND COMPLETENESS OF THESE PLANS.

PRIOR TO AND DURING ANY DEMOLITION, EXCAVATION OR CONSTRUCTION THE CONTRACTOR OR ENGINEER MUST OBTAIN A CURRENT DIAL-BEFORE-YOU-DIG (BYDY) PLOT(S).

THIS STATEMENT SHALL BE ATTACHED TO ANY COPY OF THIS PLAN, REPRODUCTION OF THIS PLAN OR ANY PART OF IT AND THAT STATEMENT SHALL INCLUDE IN FULL THE WORDS THE INFORMATION ON THIS PLAN IS AND IS NOT SUITABLE FOR USE.

STATION CO-ORDINATE SCHEDULE

NOTE MGA ZONE 54 PM 37226 ADOPTED FOR CO-ORDINATES AND HEIGHT
STATION CO-ORDINATES AND HEIGHTS BY GNSS STATIC SURVEY

STATION	EASTING	NORTHING	HEIGHT	DESCRIPTION
PM37226	699648.148	6585148.859	149.652	PIN IN METAL BOX FD SCIMs ADOPTED
PM37230	699685.813	6584482.416	144.598	PIN IN METAL BOX FD
TS 12261				

LOCATION OF EXISTING WATER PIPELINES IS BY VISUAL EVIDENCE AND AS INDICATED BY CENTRAL DARLING SHIRE STAFF DURING ON SITE INSPECTIONS

ALL BOUNDARY INFORMATION SHOWN ON THIS PLAN IS INDICATIVE ONLY.
CADASTRAL BOUNDARIES HAVE NOT BEEN INVESTIGATED

STN TS 12261 SURVEY MARK PAD

PEG CH 1993.9 HT 148.15

MESH FENCE GRAVEL ROAD METAL BUILDING TANK

NSW GOVERNMENT Public Works Advisory

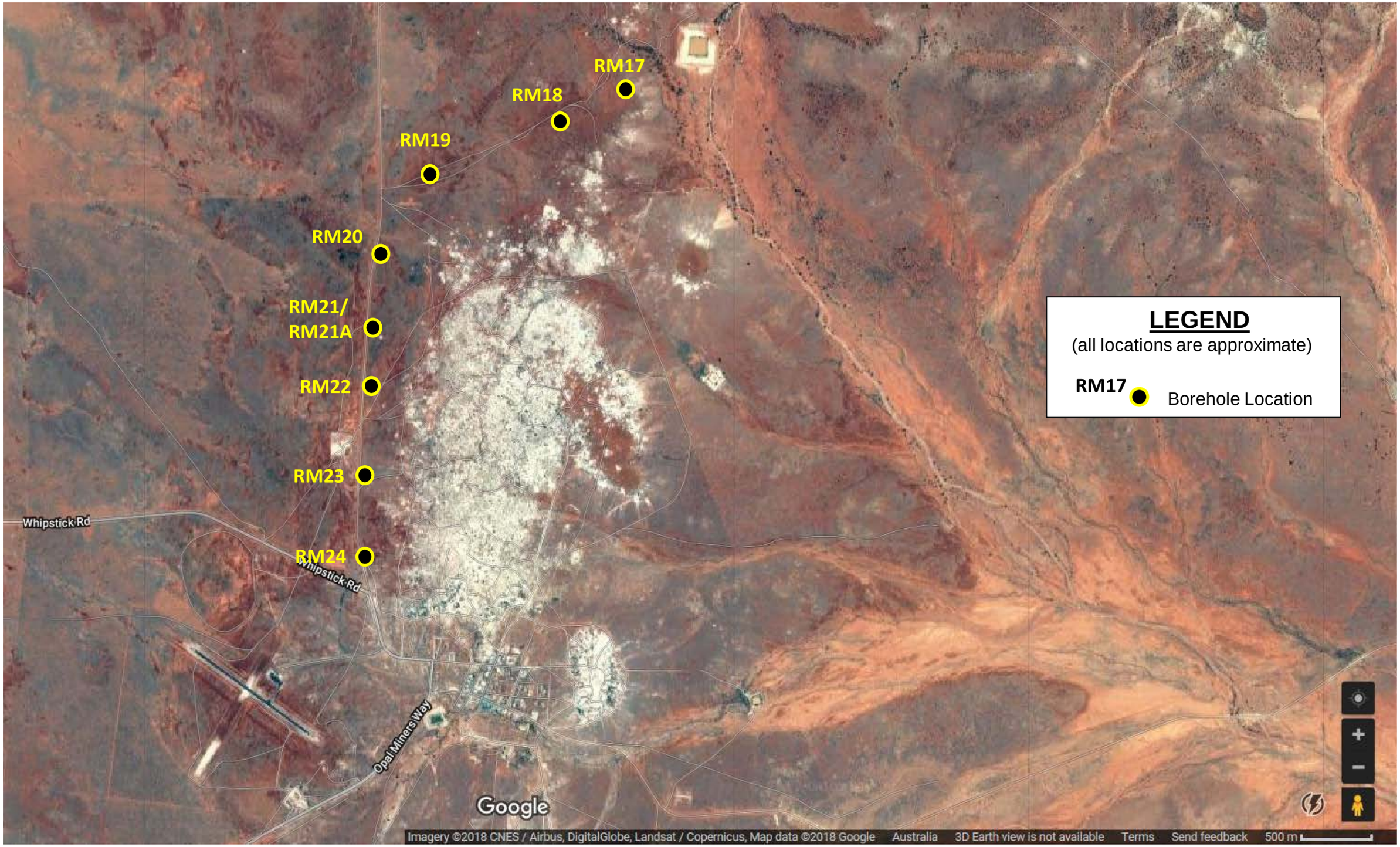
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan – Water Treatment Plant

GT29A

FIGURE 16



NSW GOVERNMENT Public Works Advisory

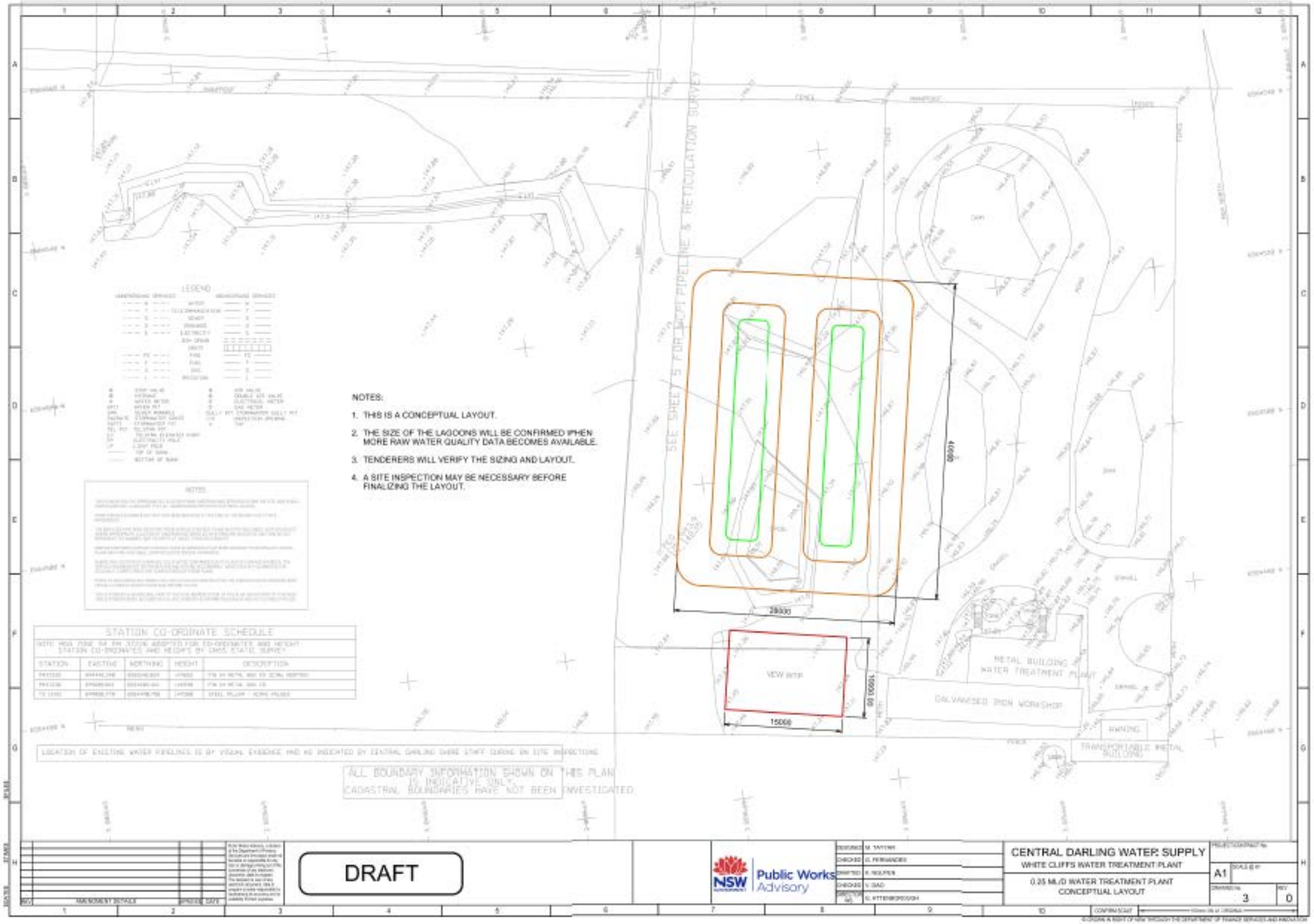
LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Borehole Location Plan – Alternate Route

GT29A

FIGURE
17



NSW GOVERNMENT Public Works Advisory

LEVEL 13, McKELL BUILDING
2-24 RAWSON PLACE, SYDNEY 2000
PHONE: (02) 9372 7834

WHITE CLIFFS WATER SUPPLY

Water Treatment Plant - Conceptual Layout

GT29A

FIGURE
18

APPENDIX A

Geotechnical Terminology and Technical Aids

CHARACTERISATION OF GEOTECHNICAL DATA

Geotechnical data generally fall into the categories of fact, interpretation and opinion, as defined by the Institution of Engineers, Australia, 1987 - Guidelines for the Provision of Geotechnical Information in Construction Contracts.

Facts are defined as the materials, statistics and properties which may be seen, measured or identified by means of accepted and preferably standardised criteria, classifications and tests. Examples of facts include: exploration locations, outcrop locations, samples and drill core, lithological names/descriptions of soils and rocks, measured water levels, laboratory test results and seismic time/distance plots.

Interpretative data is defined as information derived from competently made interpretation of facts using accepted and proven techniques, or reasonable judgement exercised in the knowledge of geological conditions or processes evident at the site. Examples of interpretative data are: borehole and test pit logs, inferred stratigraphy and correlations between boreholes or test pits, material and rock mass properties used in analysis (e.g. permeability), and seismic interpretation (yielding velocity and layer depths).

Opinion is derived from consideration of relevant available facts, interpretations and analysis and/or the exercise of judgement. Examples of opinions based on geotechnical/geological interpretations include bearing capacity and foundation suitability, need for foundation treatment, settlements, potential for grouting, excavation stability, ease of excavation, and suitability of construction materials.

SOIL DESCRIPTION

The methods of description and classification of soils are based on Australian Standard 1726, the SAA Site Investigation Code. The description of a soil is based on particle size distribution and plasticity as shown in the "GUIDE TO THE DESCRIPTION, IDENTIFICATION AND CLASSIFICATION OF SOILS".

SOIL CLASSIFICATION

The basic soil types and their subdivisions are defined by their particle sizes:

MAJOR SOIL CATEGORIES

Soil Classification	Particle Size
Boulders	Greater than 200mm
Cobbles	63 - 200mm
Gravel	2.36 - 63mm
Sand	0.075 - 2.36mm
Silt	0.002 - 0.075mm
Clay	Less than 0.002mm

MINOR SOIL CONSTITUENTS

As most natural soils are combinations of various constituents, the primary soil is further described and modified by its minor components:

Coarse grained soils			**Fine grained soils**		
% Fines		**Modifier**	**% Coarse**		**Modifier**
	≤ 5	Omit, or use 'trace'		≤ 15	Omit, or use 'trace'
> 5	≤ 12	Describe as 'with clay/silt', as applicable	> 15	≤ 30	Describe as 'with sand/gravel', as applicable
> 12		Prefix soil as 'silty/clayey', as applicable	> 30		Prefix soil as 'sand/gravelly', as applicable

COHESIVE SOILS

Clay and silt may be described according to their plasticity:

Descriptive Term	**Range of liquid limit (percent)**
Of low plasticity	≤ 35
Of medium plasticity	> 35 ≤ 50
Of high plasticity	> 50

MOISTURE CONDITION

Term	Description
Dry (D)	Cohesive soils; hard and friable or powdery, well dry of plastic limit. Granular soils; cohesionless and free-running.
Moist (M)	Soil feels cool, darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet (W)	Soil feels cool, darkened in colour. Cohesive soils usually weakened and free water forms on hands when handling. Granular soils tend to cohere.

CONSISTENCY - NON-COHESIVE SOILS

Term	Density index %		SPT "N" value
Very loose		≤ 15	< 5
Loose	> 15	≤ 35	5 - 10
Medium dense	> 35	≤ 65	10 - 30
Dense	> 65	≤ 85	30 - 50
Very dense	> 85		> 50

CONSISTENCY - COHESIVE SOILS

Term	Undrained shear strength (kPa)		Field guide to consistency	SPT "N" value
Very soft		≤ 12	Exudes between the fingers when squeezed in hand.	< 2
Soft	> 12	≤ 25	Can be moulded by light finger pressure.	2 - 4
Firm	> 25	≤ 50	Can be moulded by strong finger pressure.	4 - 8
Stiff	> 50	≤ 100	Cannot be moulded by fingers; can be indented by thumb	8 - 16
Very stiff	> 100	≤ 200	Can be indented by thumb nail.	16 - 32
Hard	> 200		Can be indented with difficulty by thumb nail.	> 32

GRAPHICAL SYMBOLS USED FOR GEOTECHNICAL BOREHOLE AND TEST PIT LOGS

SOIL - COARSE GRAINED


GW


GP


GM


GC

SW


SP


SM


SC

SOIL - FINE GRAINED


CH


CI

CL


MH


ML


OH


OL


Pt

ROCK


Sedimentary rock


Igneous rock


Metamorphic rock

FILL MATERIAL


Fill

GROUNDWATER


Level


Inflow

NGE No Groundwater Encountered

SOIL HORIZON BOUNDARIES

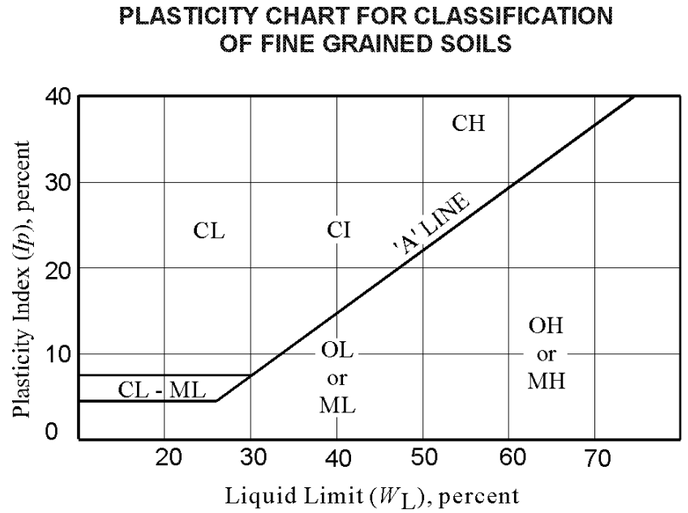
Boundary measured or determined from drilling conditions

Diffuse or uncertain boundary

GUIDE TO THE DESCRIPTION IDENTIFICATION AND CLASSIFICATION OF SOILS

Major Divisions		Particle Size (mm)	Group Symbol	Typical Names	Field Identification Sand and Gravels	Laboratory Classification				
							% < 0.06mm (see note 2)	Plasticity of Fine Fraction	$C_u = \frac{D_{50}}{D_{10}}$	$C_c = \frac{(D_{30})^2}{D_{10}D_{60}}$	Notes
COARSE GRAINED SOILS (more than half of material less than 63 mm is larger than 0.075 mm)	**BOULDERS**	200				Use the gradation curve of material passing 63mm for classification of fractions according to the criteria given in "Major Divisions"	—	—	—	—	
	COBBLES	63					—	—	—	—	
	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	coarse 20	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength		0-5	—	> 4	between 1 and 3	1. Identify lines by the method given for fine grained soils.
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength		0-5	—	Fails to comply with above	—	
		medium 6	GM	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength		12-50	Below 'A' line or $I_p < 4$	—	—	2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.06mm size) is greater than 5% and less than 12%.
		fine 2.36	GC	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength		12-50	Above 'A' line or $I_p > 7$	—	—	Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	coarse 0.6	SW	Well graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength		0-5	—	> 6	between 1 and 3	3. I_p = Plasticity Index
			SP	Poorly graded sands and gravelly sands; little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength		0-5	—	Fails to comply with above	Fails to comply with above	
		medium 0.2	SM	Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength		12-50	Below ‘A’ line or $I_p < 4$	—	—	
		fine 0.075	SC	Clayey sands, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength		12-50	Above ‘A’ line or $I_p > 7$	—	—	

GUIDE TO THE DESCRIPTION, IDENTIFICATION AND CLASSIFICATION OF SOILS (CONT.)

Major Divisions		Particle Size (mm)	Group Symbol	Typical Names	Field Identification			Laboratory Classification			Notes
					Dry* Strength	Dilatancy†	Toughness ‡			Plasticity of Fine Fraction	
FINE GRAINED SOILS (more than half of material less than 63 mm is smaller than 0.075 mm)	**SILTS & CLAYS** (liquid limit < 50%)	<0.075	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	None to low	Quick to slow	None	Use the gradation curve of material passing 63mm for classification of fractions according to the criteria given in "Major Divisions"	More than 50% passing 0.06 mm	Below 'A' line	
			CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium			Above 'A' line	
			OL ⌖	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low			Below 'A' line	
	SILTS & CLAYS (liquid limit > 50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts	Low to medium	Slow to none	Low to medium			Below 'A' line	
			CH	Inorganic clays of high plasticity, fat clays	High to very high	None	High			Above 'A' line	
			OH ⌖	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium			Below 'A' line	
	HIGHLY ORGANIC SOILS		Pt ⌖	Peat and other highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture					—	⌖ Effervesces with H_2O_2

PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS

FIELD IDENTIFICATION PROCEDURE FOR FINE GRAINED SOILS OR FRACTIONS

THESE PROCEDURES ARE TO BE PERFORMED ON THE MINUS 0.2MM SIZE PARTICLES. FOR FIELD CLASSIFICATION PURPOSES, SCREENING IS NOT INTENDED, SIMPLY REMOVE BY HAND THE COARSE PARTICLES THAT INTERFERE WITH THE TESTS.

*** Dry strength (Crushing characteristics)**

After removing particles larger than 0.2mm size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity. High dry strength is characteristic for clays of the CH group.

A typical inorganic silt possesses only very slight dry strength.

Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

† Dilatancy (Reaction to shaking)

After removing particles larger than 0.2mm size, prepare a pat of moist soil with a volume of 10 cm³. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles.

The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, shows a moderately quick reaction.

‡ Toughness (Consistency near plastic limit)

After removing particles larger than 0.2mm size, a specimen of soil about 10cm³ in size is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. The specimen is then rolled out by hand on a smooth surface or between the palms into a thread about 3mm in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together with a slight kneading action continued until the lump crumbles. The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil.

Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line. Highly organic clays have a very weak and spongy feel at the plastic limit.

EXPLANATION OF LOGGING TERMS FOR ENGINEERING GEOLOGY BOREHOLE LOGGING

ROCK SUBSTANCE WEATHERING CLASSIFICATION

RS	Residual soil
EW	Extremely weathered
HW	Highly weathered
MW	Moderately weathered
SW	Slightly weathered
F(s)	Fresh (stained defects)
F	Fresh

ESTIMATED STRENGTH CLASSIFICATION

EW	Extremely weak
VW	Very weak
W	Weak
MS	Medium strong
S	Strong
VS	Very strong
ES	Extremely strong

DEFECTS

Defects include all joints, bedding planes, fracture zones, seams, veins and cleavage partings.

RQD

Rock quality designation:

$$RQD = \frac{\text{length of core in pieces 100mm or longer}}{\text{length of run}} \times 100\%$$

WATER

Water table, with date

Water inflow

Partial drilling water loss

Complete drilling water loss

Angles of joint inclination (and other geological features and drill holes) are angles between the feature and a horizontal plane. In core, angles of joints (and other geological structures) are angles between the structure and the plane normal to the axis of the core. In vertical holes these angles are then the true inclination (dip) of the structure.

DEFINITIONS OF ENGINEERING GEOLOGICAL TERMS

This classification system provides a standard terminology for the engineering description of rock.

DEGREE OF WEATHERING [1]

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Rock is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance, and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock, usually as a result of iron bleaching or deposition. The colour and strength of the original substance is no longer recognisable.
Moderately Weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance, and the original colour of the fresh rock is no longer recognisable.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance, usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh (stained)	F_S	Rock substance unaffected by weathering. Weathering is limited to the surface of major discontinuities, for example an iron-stained joint.
Fresh	F	Rock substance unaffected by weathering.

ROCK STRENGTH [2]

Rock strength is defined by the Point Load Strength Index (Is (50)), and refers to the strength of the rock substance in the direction normal to the bedding.

TERM	Is (50)	FIELD GUIDE	APPROX. qu MPa *
Extremely Weak (EW)		Easily remoulded by hand to a material with soil properties.	
	0.03		0.7
Very weak (VW)		May be crumbled in the hand. Sandstone is "sugary" and friable.	
	0.1		2.4
Weak (W)		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	
	0.3		7
Medium Strong (MS)		A piece of core 150mm long x 50mm dia. may be broken by hand with considerable difficulty. Readily scored with a knife.	
	1		24
Strong (S)		A piece of core 150mm long x 50mm dia. cannot be broken by unaided hands, may be slightly scratched or scored with knife.	
	3		70
Very Strong (VS)		A piece of core 150mm long x 50mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	
	10		240
Extremely Strong (ES)		A piece of core 150mm long x 50mm dia. is difficult to break with hand held hammer. Rings when struck with hammer.	

* The approximate unconfined compressive strength (qu) shown in the table is based on an assumed ratio to the point load index of 24:1. This ratio may vary widely and should be calibrated on site.

STRATIFICATION SPACING [2]

TERM	SEPARATION OF STRATIFICATION PLANES
Thinly laminated	< 6mm
Laminated	6mm - 20mm
Very thinly bedded	20mm - 60mm
Thinly bedded	60mm - 200mm
Medium bedded	200mm - 600mm
Thickly bedded	600mm - 2m
Very thickly bedded	> 2m

DISCONTINUITY SPACING [3]

TERM	SPACING
Very widely spaced	> 2m
Widely spaced	600mm - 2m
Moderately widely spaced	200mm 600mm
Closely spaced	60mm - 200mm
Very closely spaced	20mm - 60mm
Extremely closely spaced	< 20mm

APERTURE OF DISCONTINUITY SURFACES [4]

The degree to which a discontinuity is open, or to which the faces of the discontinuity have been separated and the space subsequently infilled (such as in a vein, fault or joint).

TERM	APERTURE THICKNESS (Discontinuities, veins, faults, joints)
Wide	> 200mm
Moderately wide	60mm - 200mm
Moderately narrow	20mm - 60mm
Narrow	6mm - 20mm
Very narrow	2mm - 6mm
Extremely narrow	> 0 - 2 mm
Tight	Zero

BLOCK SHAPE AND SIZE [4]

The following descriptive terms define shape:

Blocky	- approximately equidimensional.
Tabular	- one dimension considerably shorter than the other two.
Columnar	- one dimension considerably larger than the other two.

Block sizes are defined by the following descriptive terms:

TERM	BLOCK SIZE	EQUIVALENT DISCONTINUITY SPACINGS IN BLOCKY ROCK
Very large	$> 8m^3$	Extremely wide
Large	$> 0.2m^3$ - $8m^3$	Very wide
Medium	$> 0.008m^3$ - $0.2m^3$	Wide
Small	$> 0.0002m^3$ - $0.008m^3$	Moderately wide
Very small	$\leq 0.0002m^3$	Less than moderately wide

REFERENCES

1. Modifications of:
   (a) McMahon, B.K., Douglas, D.J., & Burgess, P.J., 1975. Engineering classification of sedimentary rocks in the Sydney area. Australian Geomechanics Journal, G5 (1), 51-53.
   (b) Geological Society Engineering Group Working Party, 1977. The description of rock masses for engineering purposes. Quarterly Jour. Engg. Geology, 10 (4), 355-388.

2. McMahon, B.K., Douglas , D.J., & Burgess, P. J., 1975. Engineering classification of sedimentary rocks in the Sydney area. Australian Geomechanics Journal, G5 (1), 51 -53.

3. ISRM Commission on Standardisation of Laboratory and Field Tests, 1978. Suggested methods for the quantitative description of discontinuities in rock masses. J1. Rock Mechanics Min. Sci. and Geomech. Abstra., 15, 319-368.

4. Geological Society Engineering Group Working Party, 1977. The description of rock masses for engineering purposes. Quarterly Journ. Engg Geology, 10 (4), 355-388.

APPENDIX B

Borehole Logs

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B1

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST		WATER	METHOD
			CI (v)	SANDY SILTY CLAY, with rounded gravel to 15mm in size; grey red-brown; stiff; moist.				
				0.30				
0.5			SM (v)	SILTY SAND, with sub-rounded gravel and trace of clay; gravel to 15mm in size and in lenses; yellow-brown/red; medium dense; just moist.	SPT	12,17,20 N=37	0.5m EOH	
1.0				1.10				
			SM (v)	GRAVELLY SILTY SAND, with clay; yellow-brown and red; very loose; wet.				
1.5				1.70	SPT	1,1,4 N=5	1.6m when drilled	
2.0			CI (v)	CLAYEY SILT, with trace of sand; includes some large cemented nodules; light to pinkish grey with yellow pockets; stiff to very stiff; moist.				VEE
2.5								
3.0					SPT	4,7,9 N=16		
3.5								
4.0				4.10				
			ROCK (v)	CLAYSTONE/SILTSTONE; highly weathered to moderately weathered; weak; pinkish grey.				TC
				4.30				
4.5				NOTE: TC bit refusal at 4.3m depth. Hole Terminated at 4.30 m				
5.0								

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B2

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST		WATER	METHOD
			FILL (v)	GRAVELLY SILTY SAND; grey; loose; dry.				
				0.15				
				CLAYEY SILTY SAND, with gravel; gravel is sub-rounded, flat and platey up to 25mm in size with occasional 60mm; yellow red-brown; medium dense; moist.				
0.5					U			
1.0			SM/SC (v)					
1.5					SPT	4,4,7 N=11	1.5m EOH	
2.0				2.00			2.0 m when drilled	
			SM (v)	SILTY SAND, with trace of fine gravel; yellow, red-brown; very loose; wet.	D			VEE
				2.40				
2.5				SANDY CLAYEY SILT; with cemented nodules and rounded gravel up to 25mm in size; yellow-brown and grey; stiff; moist to very moist.	SPT	4,5,6 N=11		
3.0			CI (v)					
3.5				3.50				
				CLAYSTONE; extremely weathered; behaves as a very stiff Clayey Silt with rock structure evident; pinkish grey, yellow and some dark grey; moist				
4.0			ROCK (v)		SPT	8,10,12 N=22		
4.5				4.50				
				Hole Terminated at 4.50 m				
5.0								

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B3

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST		WATER	METHOD
0.0			SC (v)	GRAVELLY SILTY CLAYEY SAND gravel is sub-rounded to cobble size; red-brown; medium dense; moist.				VEE
0.80								
1.0			SM/SC (v)	SILTY SAND, with clay and trace of gravel; gravel is rounded, fine to medium grained; red-brown; loose; very moist to wet.	SPT	2,3,2 N=5		
2.0				- wet below approx. 1.9m depth.			2.1 m	
2.20								
2.5			CI (v)	SANDY CLAYEY SILT; with cemented nodules and trace of rounded medium size gravel; light pinkish grey, yellow and some dark grey; stiff; moist to very moist.	SPT	3,4,6 N=10		TC
3.80								
4.0			ROCK (v)	CLAYSTONE; extremely weathered; behaves as a very stiff Clayey Silt with rock structure evident; pinkish grey with trace of yellow.	SPT	5,10,12 N=22		
5.00								
5.0				Hole Terminated at 5.00 m				

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B4

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST		WATER	METHOD
0.5			SM/GM (v)	SILTY GRAVELLY SAND, trace of clay; gravel is sub-rounded and rounded to cobble size; red-brown; medium dense; dry.				VEE
				0.70				
1.0			SM (v)	SILTY SAND, with trace of clay and gravel; gravel is sub-rounded, some flat and platey; red-brown; medium dense; very moist to wet.	SPT	8,12,11 N=23		
				1.30				
1.5			CI (v)	SANDY CLAYEY SILT; pinkish grey with yellow and dark grey; stiff; moist.				
2.0								
2.5					SPT	6,6,8 N=14	Not Encountered	TC
3.0								
				3.50				
3.5			ROCK (v)	CLAYSTONE/SILTSTONE; extremely weathered to highly weathered; behaves as a very stiff to hard Clayey Silt with rock structure evident; pinkish grey with yellow and trace of red.				
4.0					SPT	9,11,17 N=28		
4.5								
				5.00				
5.0				Hole Terminated at 5.00 m				

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B5

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST		WATER	METHOD
			GM (v)	SANDY GRAVEL with cobbles; red-brown; loose; dry.				
				0.30				
0.5			SM/GM (v)	GRAVELLY SILTY SAND, trace of clay; gravel is fine to medium grained and sub-rounded, with some platey and flat; red-brown; medium dense to dense; dry.	B			VEE
1.0					SPT	18,-,- N=R		
1.5				1.50				
			CI/CH (v)	SANDY SILTY CLAY, with trace of gravel and crystalline gypsum; red and yellow brown; stiff; moist.			Not Encountered	
2.5				2.70	SPT	2,7,8 N=15		TC
			CI (v)	CLAYEY SILT, with sand and trace of gravel; pinkish grey with yellow and red; stiff; moist.				
3.0					B			
3.5				3.50				
			ROCK (v)	CLAYSTONE/SILTSTONE; extremely weathered to highly weathered; behaves as a hard Clayey Silt with rock structure evident; pinkish grey, yellow and trace of red.				
4.0					SPT	10,18,23 N=41		
4.5				4.50 Hole Terminated at 4.50 m				
5.0								

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B6

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST		WATER	METHOD
0.0			SM/SC (v)	GRAVELLY SILTY SAND, trace of clay; gravel is sub-rounded, siliceous to cobble size and includes calcrete nodules; red-brown; medium dense; dry.				VEE
1.0					SPT	15,22,R N=R (Cobble Wedged in SPT)		
1.80								
2.0			CI (v)	CLAYEY SILT with sand, trace of gravel and crystalline gypsum; pinkish grey, yellow and light grey to white (gypsum); very stiff; moist.			Not Encountered	TC
2.5					SPT	3,8,9 N=17		
4.00								
4.0			ROCK (v)	CLAYSTONE/ SILTSTONE; extremely weathered; behaves as a very stiff to hard Clayey Silt with rock structure evident; pinkish grey, yellow and trace red.	SPT	9,13,16 N=29		
5.00								
5.0				Hole Terminated at 5.00 m				

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B7

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			GM (v)	SANDY GRAVEL trace of silt and clay; gravel is rounded and up to large cobble size; red-brown; medium dense; dry.			VEE
				0.60			
1.0			SM/SC (v)	SILTY GRAVELLY SAND, trace of clay; gravel is rounded; fine to medium grained; red-brown; medium dense to dense; dry.			
1.5					SPT 25/130,-,- N=R		
2.0				2.00			
2.5			CI (v)	CLAYEY SILT with sand, trace of rounded gravel and calcite nodules; brown and grey; very stiff; just moist.		Not Encountered	TC
3.0							
				3.20	SPT 14,20,- N>40		
3.5			ROCK (v)	SILTSTONE; extremely weathered to highly weathered; behaves as a hard Clayey Silt with rock structure evident; grey, trace of yellow and dark grey.			
4.0							
4.5							
5.0				5.00			
				Hole Terminated at 5.00 m			

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

B8

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WATER TREATMENT PLANT
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST		WATER	METHOD
0.0			SM (v)	GRAVELLY SILTY SAND, trace of clay red-brown, medium dense to dense; dry.			Not Encountered	VEE
1.0					SPT	N=R (20 for 12cm)		
1.50								
1.5			SM (v)	CLAYEY GRAVELLY SILTY SAND; pinkish grey with some yellow, trace dark grey; medium dense; just moist.	B			TC
2.50								
2.5			ROCK (v)	SILTSTONE; extremely weathered with some highly weathered zones; behaves as a hard Clayey Silt with rock structure evident; pinkish grey with yellow and trace red.	SPT	12,18,26 N=44		
4.0					D			
5.00								
5.0				Hole Terminated at 5.00 m				

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM1

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP1
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			SM (v)	SILTY GRAVELLY SAND; grey; loose; dry.		Not Encountered	VEE
				0.20			
			CI (v)	SANDY SILTY CLAY, with calcrete nodules; red-brown with white; very stiff; moist.			
0.5				0.60	SPT Refusal on large cobble or possible calcrete		
			SC (v)	SILTY CLAYEY SAND, with fine calcrete gravel; red-brown and white; medium dense; dry to just moist.			
1.0					SPT 10,14,16 N=30		
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

NSWPW LIB 1.03.GLB Log NSW PW BOREHOLE GT29A-WHITE CLIFFS WATER SUPPLY - RM AND WR LOGS.GPJ <<DrawingFile>> 12/01/2018 15:30 8.30.004 Datgel Lab and In Situ Tool

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM2

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP1
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.0			GM (v)	SILTY SANDY GRAVEL, trace of clay; gravel includes rounded cobbles up to 100mm in size; red-brown and grey; medium dense; dry.		Not Encountered	VEE
0.50							
0.5				SILTY GRAVELLY SAND, with calcrete nodules; red-brown with white and grey; medium dense; dry.	SPT 10,20,12 N=32		
1.0			SM/GM (v)				
1.50							
1.5				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM3

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP2
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			CI/SC (v)	SANDY SILTY CLAY; red-brown; stiff; dry.		Not Encountered	VEE
				0.60			
			GM (v)	SILTY SANDY GRAVEL; gravel is rounded to cobble size; grey, dark brown and red-brown; loose to medium dense; dry;			
				0.90			
1.0			ROCK (v)	SANDSTONE, fine grained and silty; extremely weathered to highly weathered; very weak; red-brown.	SPT 22,- N=R		TC
				1.40			
1.5				Note: TC bit refusal at 1.4m. Hole Terminated at 1.40 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM4

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP1 AND LINE WCP2
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			CI (v)	SANDY SILTY CLAY, trace of fine gravel; red-brown; stiff; dry.		Not Encountered	VEE
				0.60			
1.0			CI/CH (v)	SILTY CLAY with sand; dark red-brown; very stiff; just moist.	SPT 6,10,16 N=26		
				1.10			
			ROCK (v)	SANDSTONE, fine grained and silty; extremely weathered to highly weathered; very weak; red-brown.			TC
				1.30			
1.5				Note: TC bit refusal at 1.3m. Hole Terminated at 1.30 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM5

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP1 AND LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 14/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			GM (v)	GRAVEL AND COBBLES IN A SILTY SAND MATRIX, trace of clay; red-brown; loose; dry. - (Hole collapsing SPT not possible)		Not Encountered	VEE
				0.60			
1.0			SM (v)	GRAVELLY SILTY SAND, trace of clay; gravel is rounded; fine to medium grained; red-brown; medium dense; dry.	D		TC
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM6

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			SC (v)	CLAYEY SILTY SAND; red-brown; medium dense; dry.		Not Encountered	VEE
				0.40			
0.5			GM (v)	SILTY SANDY GRAVEL, with calcrete nodules; gravel is up to cobble size; red-brown; dense; dry.			
				0.80			
1.0			GM (v)	SILTY SANDY GRAVEL, trace of clay and calcrete nodules; gravel is sub-rounded; fine to medium grained; medium dense; just moist.	SPT 23/130,-,- N=R		
1.5					D		
2.0				2.00			
				Hole Terminated at 2.00 m			
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM7

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			SM (v)	GRAVELLY SILTY SAND, trace of clay; red-brown; loose; dry.		Not Encountered	VEE
				0.20			
0.5			CH (v)	SANDY SILTY CLAY, trace of calcite; dark reddish brown; hard; just moist.	SPT 11,20,- N=R		
				0.90			TC
1.0			GC (v)	CLAYEY SANDY GRAVEL, trace cobbles; gravel is sub-rounded; medium grained; red-brown and grey; medium dense; dry.			
				1.20			
			SC (v)	GRAVELLY CLAYEY SILTY SAND; red-brown; medium dense; just moist.			
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM8

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			SM (v)	GRAVELLY SILTY SAND with some cobbles on surface; red brown; medium dense; dry.	SPT 17,25,- N=R	Not Encountered	VEE
0.90							
1.0			SC (v)	GRAVELLY CLAYEY SILTY SAND; gravel is sub-rounded; fine to medium grained; light red-brown and grey; medium dense; dry.			TC
1.50							
1.5				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM9

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			SM (v)	GRAVELLY SILTY SAND, with some surface cobbles; red brown; loose; dry.			
				0.20			
				GRAVELLY SILTY SAND, trace of clay; grey; medium dense; dry.			
0.5			SM (v)				
				0.80	SPT 8,10,12 N=22	Not Encountered	VEE
				GRAVELLY CLAYEY SILTY SAND; light grey, with some yellow; medium dense; dry.			
1.0			SC (v)				
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM10

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			CI (v)	CLAYEY SILT, with sand; dark red-brown; stiff; dry.		Not Encountered	VEE
				0.40			
0.5			CH (v)	SILTY CLAY, with sand and fine calcrete nodules; dark reddish-brown; hard; just moist.	SPT 14,16,20 N=36		
1.0				1.00			
			ROCK (v)	SANDSTONE; extremely weathered to highly weathered; very weak.			TC
				1.20			
				Note: TC bit refusal at 1.2m. Hole Terminated at 1.20 m			
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM11

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.0			GM (v)	SILTY SANDY GRAVEL; gravel is sub-rounded, to cobble size; red-brown; medium dense; dry.		Not Encountered	VEE
0.5				0.50			
			SM (v)	GRAVELLY SILTY SAND; grey and red-brown; medium dense; dry.	D		TC
1.0				1.00			
			SM (v)	GRAVELLY SILTY SAND; yellow brown and grey; medium dense; dry.			
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM12

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			GM (v)	SILTY SANDY GRAVEL; gravel is sub-rounded, to cobble size; red-brown; loose; dry.			
				0.20			
				SANDY SILT, trace of clay; light grey; firm; dry.			
0.5			ML (v)				
				0.80	SPT 3,3,9 N=12	Not Encountered	VEE
				CLAYEY SILT with gravel; gravel is siltstone fragments; grey; firm to stiff; dry.			
1.0			CL/ML (v)				
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM13

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			GM/GC (v)	CLAYEY SANDY GRAVEL; gravel is sub-rounded to cobble size; red-brown; medium dense; dry.		Not Encountered	VEE
				0.40			
0.5			SM (v)	GRAVELLY SILTY SAND,trace of clay; gravel is fine to medium size up to 20mm in size; red-brown; medium dense; dry.	SPT 28/120,-,- N=R D		TC
1.0							
1.5				1.50 Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM14

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.0			CI (v)	SANDY CLAYEY SILT, trace of gravel and some surface cobbles; red-brown; stiff; dry.		Not Encountered	VEE
0.50							
0.5			CI/CH (v)	SANDY SILTY CLAY, with trace of fine calcite; dark reddish-brown; hard; dry.	SPT 18,23,- N=R		
1.0							TC
1.20			ROCK (v)	SILTSTONE; extremely weathered; extremely weak to very weak; grey.			
1.50				Hole Terminated at 1.50 m			
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM15

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.0			GM (v)	SANDY SILTY GRAVEL, trace of clay; gravel is sub-rounded to cobble size; red-brown; medium dense; dry.		Not Encountered	VEE
0.5				0.50 SILTSTONE; extremely weathered to highly weathered ; very weak; light grey, red and yellow banded.			
1.0			ROCK (v)		SPT 20/100,-,- N=R D		TC
1.5							
2.0				2.00 Hole Terminated at 2.00 m			
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM16

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: RISING MAIN - LINE WCP3
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.0			CI (v)	SANDY CLAYEY SILT; red-brown; firm to stiff; dry to just moist.		Not Encountered	VEE
0.50							
0.5			CH (v)	SANDY SILTY CLAY, trace of fine calcite; dark reddish-brown; hard; dry.	SPT 20,20/100,- N=R		
0.90							
1.0			CI (v)	SANDY CLAYEY SILT; grey red-brown; very stiff; just moist.	D		
1.50							
1.5				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM17

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			GM (v)	GRAVEL AND COBBLES IN SILTY SAND MATRIX; red-brown; dense; dry. 0.50		Not Encountered	TC
				Note: TC bit refusal, possibly on large cobble or siltstone. Hole Terminated at 0.50 m			

1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM18

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			CL/GC (v)	GRAVELLY CLAYEY SANDY SILT; red-brown; medium dense; dry.			
				0.40			
0.5			GM (v)	GRAVEL, in a silty sand trace of clay matrix; gravel is up to 30mm in size; red-brown and grey; medium dense; dry.	D	Not Encountered	TC
1.0							
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM19

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.0			CI/CL (v)	SANDY CLAYEY SILT, trace of fine gravel; red-brown; very stiff; dry.	SPT 10,12,10 N=22	Not Encountered	TC
1.50				Hole Terminated at 1.50 m			

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM20

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			CI (v)	SANDY CLAYEY SILT; red-brown; stiff; just moist.		Not Encountered	TC
				0.60			
1.0			CI/SC (v)	CLAYEY SILTY SAND; red-brown; medium dense; just moist.	D		
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM21

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			GM (v)	SANDY SILTY GRAVEL, trace of clay; red-brown; loose; dry.		Not Encountered	VEE
				0.20			
			ROCK (v)	SANDSTONE/ CONGLOMERATE; highly weathered; very weak to medium strong; grey red-brown.	D		TC
0.5				0.60			
				Note: TC bit refusal at 0.6m. Hole Terminated at 0.60 m			
1.0							
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM21A

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.0			GM (v)	SANDY SILTY GRAVEL, trace of clay; red-brown; loose; dry.		Not Encountered	VEE
0.10				SILTSTONE/SANDSTONE, with interbedded conglomerate; highly weathered; very weak; red-brown, light grey, and dark grey.			
0.5			ROCK (v)				TC
1.0					D		
1.50				Note: Firm to hard for a TC bit. Hole Terminated at 1.50 m			
1.5							
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM22

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER

EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON

DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
0.5			CI/CH (v)	SANDY SILTY CLAY; dark red-brown; stiff; moist.	D	Not Encountered	VEE
				0.70			
1.0			ROCK (v)	SILTSTONE; extremely weathered; extremely weak; grey, red-brown, trace of yellow.			TC
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM23

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			SM (v)	SILTY SAND; grey; loose; dry.		Not Encountered	VEE
				0.20			
0.5			ROCK (v)	SILTSTONE/SANDSTONE, interbedded with conglomerate; highly weathered; very weak; grey, red, dark grey, trace of yellow.			TC
1.0							
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

NSWPW LIB 1.03.GLB Log NSW PW BOREHOLE GT29A-WHITE CLIFFS WATER SUPPLY - RM AND WR LOGS.GPJ <<DrawingFile>> 12/01/2018 15:30 8.30.004 Datgel Lab and In Situ Tool

Public Works NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

RM24

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: ALTERNATE RISING MAIN ROUTE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			SM (v)	GRAVELLY SILTY SAND; grey; loose; dry.		Not Encountered	TC
				0.20			
0.5			ROCK (v)	SILTSTONE; extremely weathered to highly weathered; extremely weak; grey, trace of yellow.			
				0.80			
1.0			ROCK (v)	SILTSTONE; extremely weathered; extremely weak; light grey, red and brown; stiff; moist.	D		
1.5				1.50			
				Hole Terminated at 1.50 m			
2.0							
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

Public Works
NSW Water Solutions

GEOTECHNICAL & ENVIRONMENTAL

BOREHOLE No.

WR1

PROJECT: WHITE CLIFFS WATER SUPPLY
LOCATION: WEIR SITE
CONTRACTOR: FICO
SITE SUPERVISOR: M.ASHOVER
EQUIPMENT: FG102
PROJECT COORDINATOR: P.ANDERSON
DATE: 15/02/2017
SURFACE RL: AHD
EASTING:
NORTHING:

DEPTH (m)	RL (m)	GRAPHIC LOG	SOIL GROUP	MATERIAL DESCRIPTION Soil type, colour, consistency, grainsize, moisture, remarks	SAMPLE or TEST	WATER	METHOD
			CI (v)	SANDY CLAYEY SILT; red-brown; stiff; dry.		Not Encountered	TC
0.40							
0.5			GC/CI (v)	GRAVEL AND COBBLES IN A SANDY CLAYEY SILT MATRIX; gravel is rounded and occurs in layers; red-brown; dense; dry.			
1.0					SPT N=Refusal		
1.5					D		
2.0							
2.30				Note: TC bit refusal on large cobble. Hole Terminated at 2.30 m			
2.5							
3.0							
3.5							
4.0							
4.5							
5.0							

v : visual
l : laboratory

SAMPLE OR TEST
Undisturbed: U
Disturbed: D
Bulk: B
Standard Penetration Test: SPT

GROUNDWATER
Water Table
Water Inflow

PROJECT No.: GT29A

SHEET: 1 OF 1

APPENDIX C

Geotechnical Test Results

Geotechnical Centre
110B King Street, Manly Vale, NSW 2093
Telephone 02- 9949 0200 Facsimile 02-9948 6185

NSW GOVERNMENT | Public Works Advisory

CLIENT:	GEOTECHNICAL & ENVIRONMENTAL	BATCH No:	17005
	SOIL SUMMARY SHEET		
PROJECT:	WHITE CLIFFS WATER SUPPLY	COMPILED BY:	ZG
LOCATION:	WATER TREATMENT PLANT	DATE:	14/03/2017

General Information Note: All test methods are as indicated on accompanying test reports.

Sample No.	**7448**	**7459**	**7471**			
Bore/Reference	B2	B5	B8			
Depth (m)	0.50 - 0.75	0.3 - 0.7	1.5 - 2.3			
Sample Type	U	Bulk	Bulk			
Soil Colour & Description (v) indicates visual classification	Yellow Red Brown Clayey Silty Sand trace of Gravel	Red Brown Gravelly Silty Sand trace of Clay	Pinkish Grey with some Yellow Clayey Gravelly Silty Sand			
Classification	SM-SC	SM	SM			

Moisture Content & Density

Field Moisture Content (%)	25.4	12.9	13.4			
Field Wet Density (t/m³)	1.90					
Field Dry Density (t/m³)	1.52					
Soil Particle Density (t/m³)						

Particle Size Distribution

Cobble Size (%)	0	0	0			
Gravel Size (%)	6	17	17			
Sand Size (%)	58	61	49			
Silt Size (%)	24	19	19			
Clay Size (%)	12	3	15			
Effective Size (mm)						
Uniformity Coefficient						
Curvature Coefficient						

Plasticity

Liquid Limit (%)	34	38	45			
Plastic Limit (%)	25	38	28			
Plasticity Index (%)	9	0	17			
Linear Shrinkage (%)	6.5	3.0	9.0			

Dispersion

Dispersal Index						
Percent Dispersion (%)						
Emerson Class No.		4	2			

Compaction

Compaction Type		Standard	Standard			
Optimum Moisture Content (%)		29.0	26.0			
Maximum Dry Density (t/m³)		1.39	1.52			

Shrink-Swell Index

Shrink Strain (%)	1.9					
Swell Strain (%)	0.0					
Shrink-Swell Index (Iss)	1.1					

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

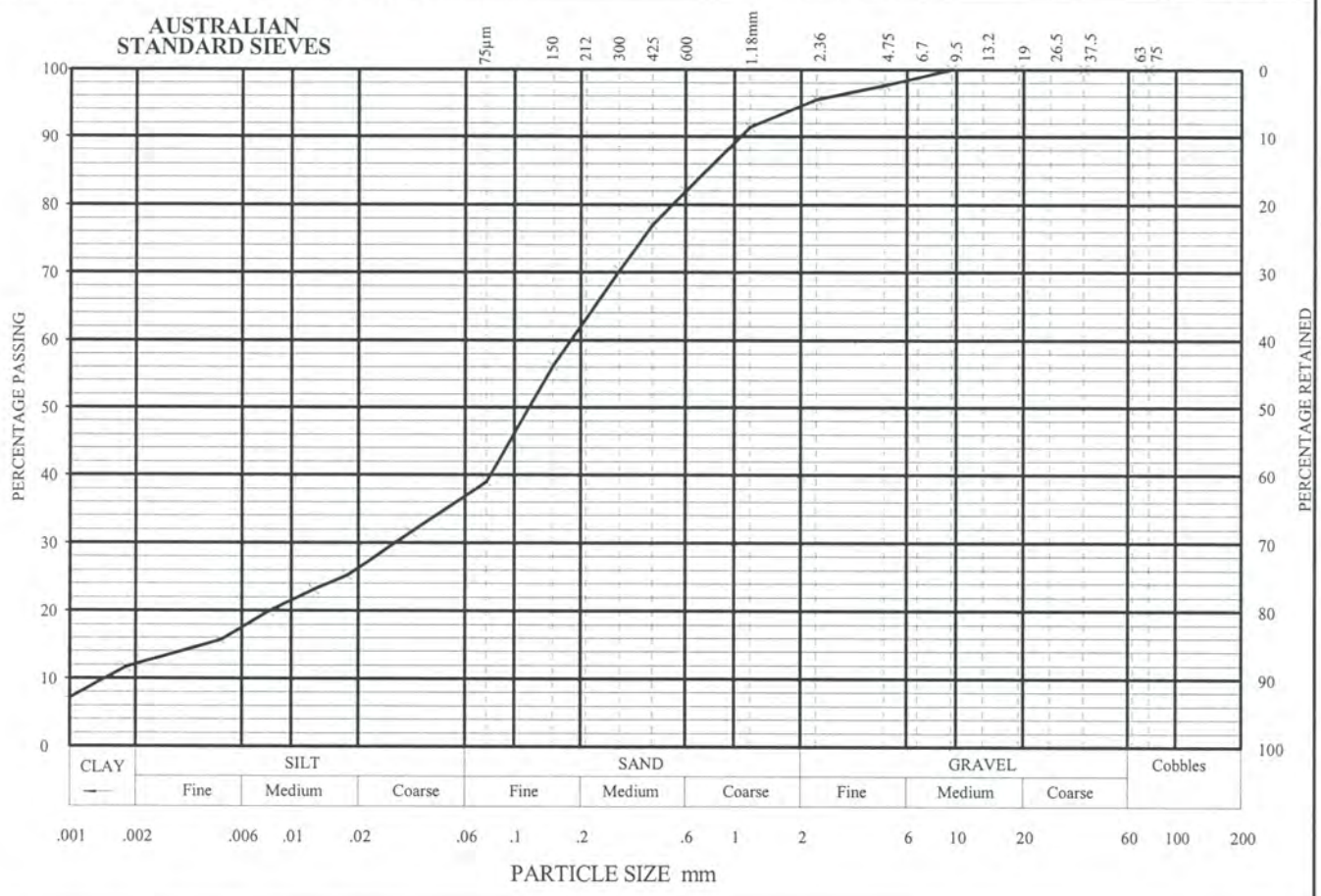
NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL | REPORT No: 17005/7448/R1119

PARTICLE SIZE DISTRIBUTION

PROJECT: WHITE CLIFFS WATER SUPPLY | SAMPLE No: 7448

LOCATION: WATER TREATMENT PLANT | HOLE No: B2 | DEPTH (m): 0.50



SIZE DISTRIBUTION	
COBBLES	0 %
GRAVEL	6 %
SAND	58 %
SILT	24 %
CLAY	12 %
EFFECTIVE SIZE D10:	-
UNIFORMITY COEFFICIENT D60/D10(Cu):	-
CURVATURE COEFFICIENT $D30^2$ /(D60 x D10) (Cc):	-

Soil Particle Density: 2.65 t/m³ (estimated for analysis)

Method of dispersion: End-over-end shaking

Hydrometer: ASTM 152H

Dispersion chemical: Sodium hexametaphosphate + Anhydrous sodium carbonate

Notes on Test: Tested as received

Loss in pre-treatment: 0 %

Test Methods:
DPWS GM 9: Determination of the Particle Size Distribution of a Soil

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: ZG | Date Tested: 03/03/2017

APPROVED SIGNATORY M. Ashover

Mark Ashover 10/03/2017

PARTICLE SIZE DISTRIBUTION R1119 (ISSUE 4, 2005)

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL | REPORT No: 17005/7448/R1115

SOIL INDEX PROPERTIES

PROJECT: WHITE CLIFFS WATER SUPPLY | SAMPLE No: 7448

LOCATION: WATER TREATMENT PLANT | HOLE No: B2 | DEPTH (m): 0.50

SOIL INDEX PROPERTIES		RESULT	TEST METHOD
Moisture Content (as received)	:	25.4 %	AS 1289.2.1.1
Liquid Limit	:	34 %	AS 1289.3.1.1
Plastic Limit	:	25 %	AS 1289.3.2.1
Plasticity Index	:	9 %	AS 1289.3.3.1
Linear Shrinkage	:	6.5 %	AS 1289.3.4.1
Soil Particle Density	:	-	GM 8
Classification	:	SM-SC	AS 1726

Sample History: ☐ Natural State ☒ Air Dried ☐ Oven Dried

Method of Preparation: ☐ Wet Sieved ☒ Dry Sieved

Linear Shrinkage Sample: ☒ Curling ☐ Crumbling ☐ No Deformation

Notes on test: Sample tested as received from client.

ATTERBERG LIMITS R1115 (ISSUE 4, 2005)

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: ZG Date Tested: 08/03/2017

APPROVED SIGNATORY M. Ashover

Mark Ashover 14/03/2017

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL		REPORT No: 17005/7448/R1155
SHRINK - SWELL		
PROJECT: WHITE CLIFFS WATER SUPPLY		SAMPLE No: 7448
LOCATION: WATER TREATMENT PLANT	HOLE No: B2	DEPTH (m): 0.50

SHRINK TEST DATA:

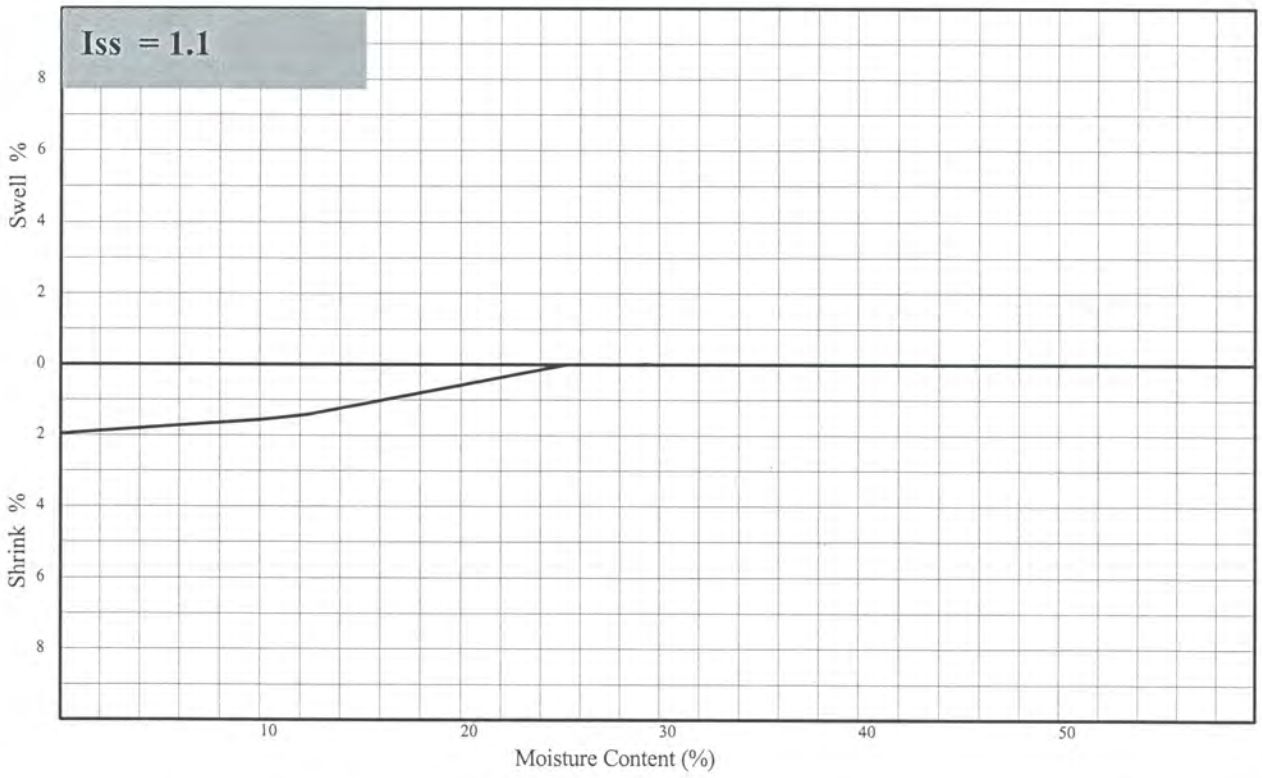
Moisture Content: 25.4 % Wet Density: 1.90 t/m³ Dry Density: 1.52 t/m³ (at placement)
Extent of cracking/crumbling: Many multi directional surface cracks. Estimated Inert Inclusions: 10 - 12 %

SHRINK STRAIN: 1.9 %

SWELL TEST DATA:

Moisture Content: 28.8 % Wet Density: 1.88 t/m³ Dry Density: 1.46 t/m³ (at placement)
Moisture Content: 29.5 % Wet Density: 1.88 t/m³ Dry Density: 1.45 t/m³ (after test)
Settlement Under Load (25 kPa) Before Saturation: 0.4 %

SWELL STRAIN: 0.0 %



Specimen Description: Yellow Red Brown Clayey Silty Sand trace of Gravel Test Method: AS 1289.7.1.1
Notes on Test: Specimen tested as received

Tested By: ZG Date Tested: 24/02/2017

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

APPROVED SIGNATORY M. Ashover

Mark Ashover 10/03/2017

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

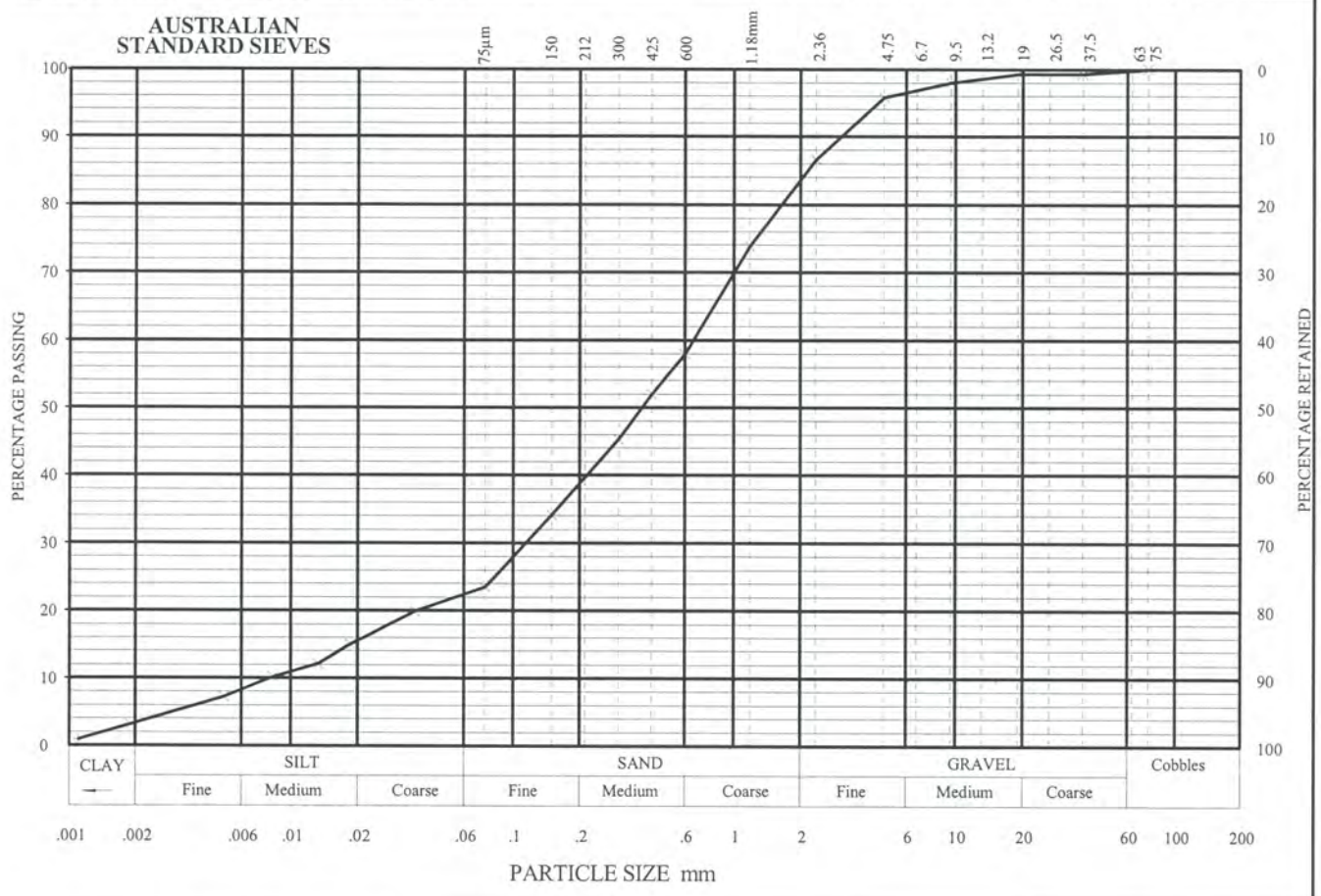
NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL | REPORT No: 17005/7459/R1119

PARTICLE SIZE DISTRIBUTION

PROJECT: WHITE CLIFFS WATER SUPPLY | SAMPLE No: 7459

LOCATION: WATER TREATMENT PLANT | HOLE No: B5 | DEPTH (m): 0.30



SIZE DISTRIBUTION	
COBBLES	0 %
GRAVEL	17 %
SAND	61 %
SILT	19 %
CLAY	3 %
EFFECTIVE SIZE D10:	-
UNIFORMITY COEFFICIENT D60/D10(Cu):	-
CURVATURE COEFFICIENT $D30^2$ /(D60 x D10) (Cc):	-

Soil Particle Density: 2.65 t/m³ (estimated for analysis)

Method of dispersion: End-over-end shaking

Hydrometer: ASTM 152H

Dispersion chemical: Sodium hexametaphosphate + Anhydrous sodium carbonate

Notes on Test: Tested as received

Loss in pre-treatment: 0 %

Test Methods:
DPWS GM 9: Determination of the Particle Size Distribution of a Soil

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: ZG | Date Tested: 01/03/2017

APPROVED SIGNATORY M. Ashover

Mark Ashover 10/03/2017

PARTICLE SIZE DISTRIBUTION R1119 (ISSUE 4, 2005)

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL		REPORT No: 17005/7459/R1115
SOIL INDEX PROPERTIES		
PROJECT: WHITE CLIFFS WATER SUPPLY		SAMPLE No: 7459
LOCATION: WATER TREATMENT PLANT	HOLE No: B5	DEPTH (m): 0.30

SOIL INDEX PROPERTIES		RESULT		TEST METHOD
Moisture Content (as received)	:	12.9	%	AS 1289.2.1.1
Liquid Limit	:	38	%	AS 1289.3.1.1
Plastic Limit	:	38	%	AS 1289.3.2.1
Plasticity Index	:	0	%	AS 1289.3.3.1
Linear Shrinkage	:	3.0	%	AS 1289.3.4.1
Soil Particle Density	:	-		GM 8
Classification	:	SM		AS 1726

Sample History: ☐ Natural State ☒ Air Dried ☐ Oven Dried

Method of Preparation: ☐ Wet Sieved ☒ Dry Sieved

Linear Shrinkage Sample: ☐ Curling ☒ Crumbling ☐ No Deformation

Notes on test: Sample tested as received from client.

ATTERBERG LIMITS R1115 (ISSUE 4, 2005)

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: ZG Date Tested: 06/03/2017

APPROVED SIGNATORY M. Ash

Mark Ashover 10/03/2017

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

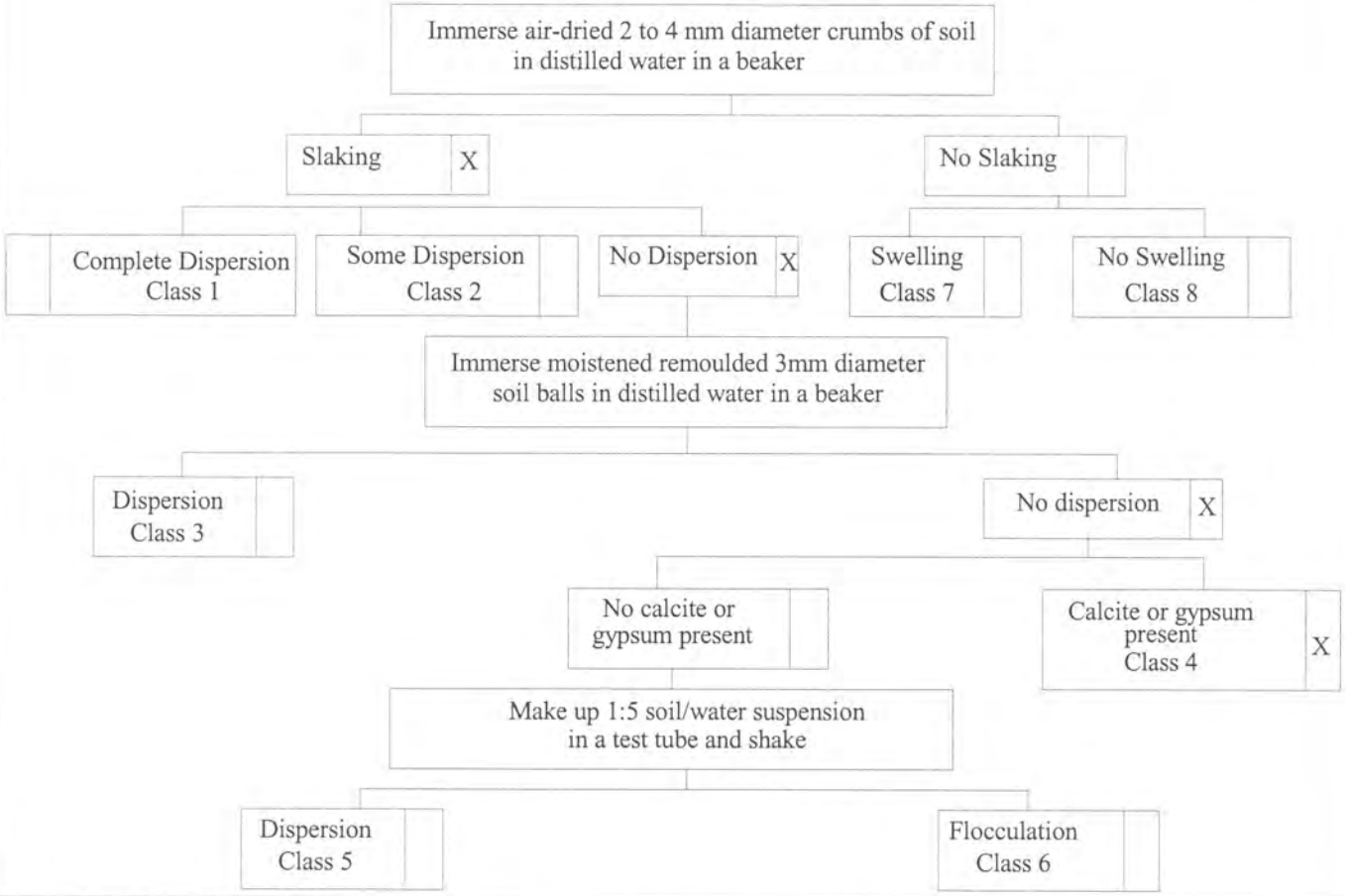
NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL	REPORT No: 17005/7459/R1118

DISPERSION TESTS

PROJECT: WHITE CLIFFS WATER SUPPLY		SAMPLE No: 7459
LOCATION: WATER TREATMENT PLANT	HOLE No: B5	DEPTH (m): 0.30

Determination of the Emerson Class Number of a soil



Emerson Class Number	(AS 1289.3.8.1)	4
Percent Dispersion	(AS 1289.3.8.2)**	No Test
Dispersal Index	(DPWS GM 15)	No Test

Sample Description: Red Brown Gravelly Silty Sand trace of Clay

Type and temperature of water: Distilled, 22.2 ° C

Notes on test: Sample tested as received from client.

** 0.05mm size interpolated from hydrometer readings taken after 21min, 1hour and 2 hours.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: MA Date Tested: 09/03/2017

APPROVED SIGNATORY M. Ashover

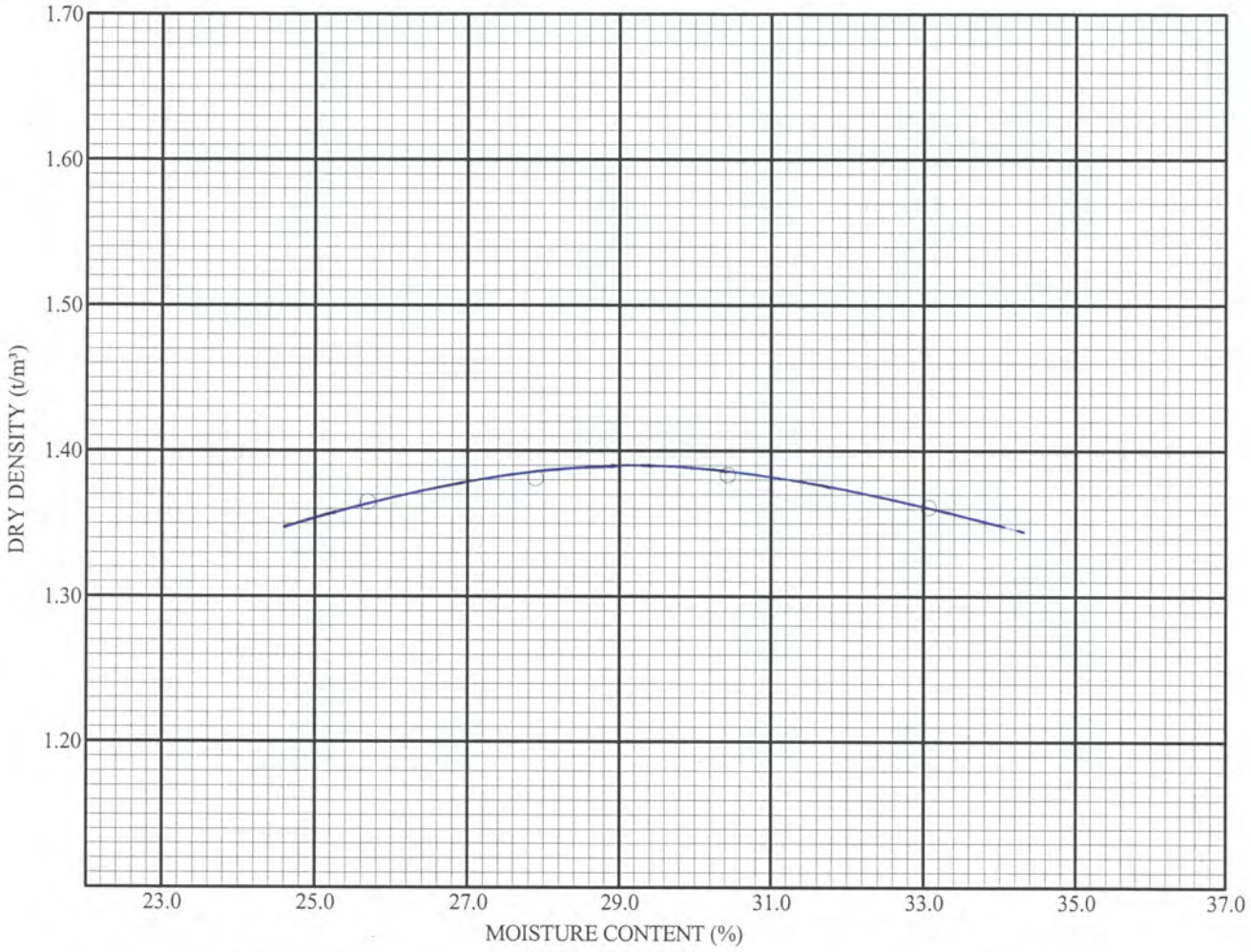
Mark Ashover 10/03/2017

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL		REPORT No: 17005/7459/R1111
STANDARD COMPACTION TEST		
PROJECT: WHITE CLIFFS WATER SUPPLY		SAMPLE No: 7459
LOCATION: WATER TREATMENT PLANT	HOLE No: B5	DEPTH (m): 0.30



Standard Maximum Dry Density:	1.39	t/m³
Standard Optimum Moisture Content:	29.0	%
Percentage of Material Retained on the 19 mm sieve	0.7	%
Notes on Test: Specimen tested as received		
Test Method: AS 1289.5.1.1 Mould: A (1 Litre) ☒ B (2 Litre) ☐		

COMPACTION R1111 (ISSUE 4, 2005)

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: MA Date Tested: 06/03/2017

APPROVED SIGNATORY M. Ashover

Mark Ashover 10/03/2017

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

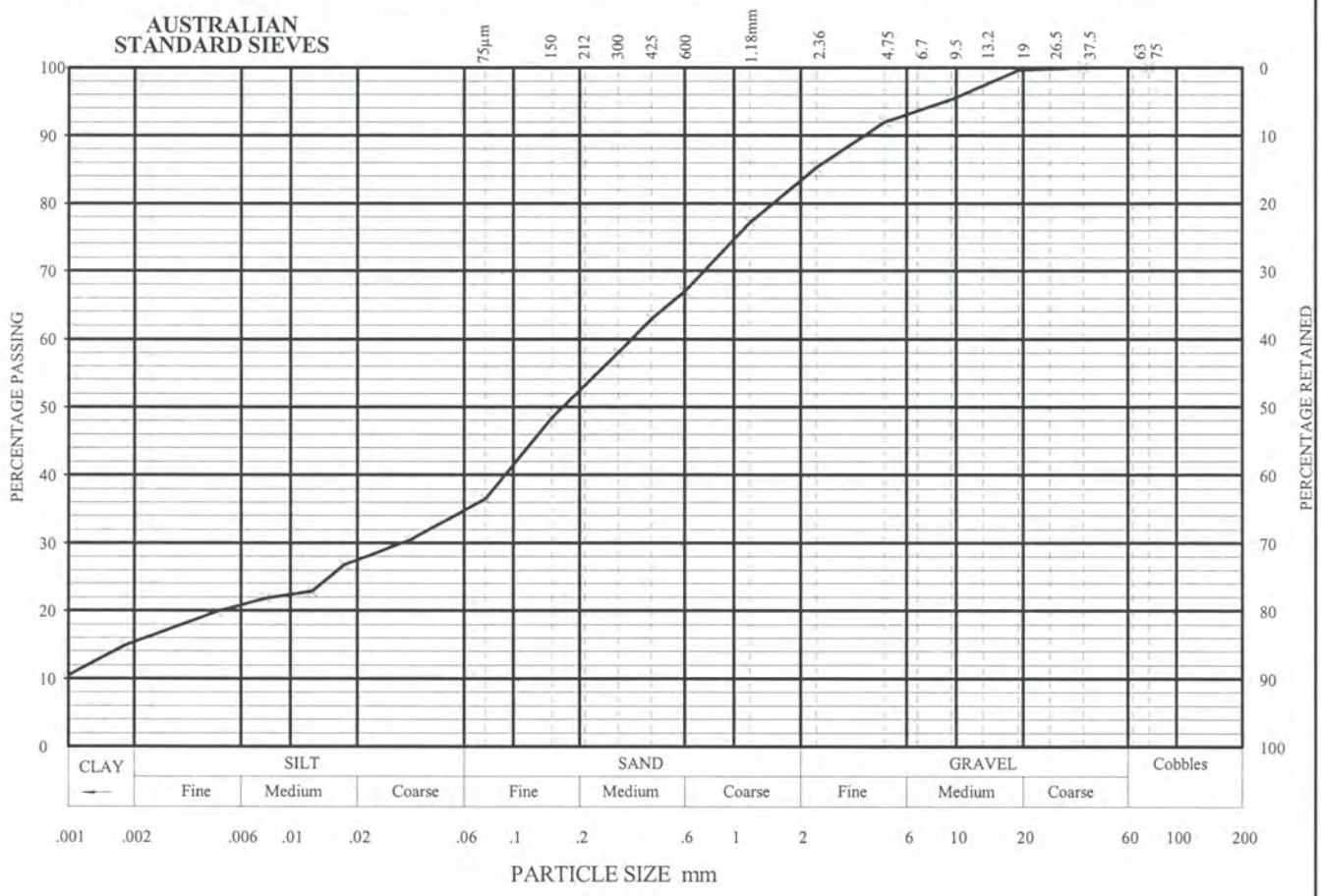
NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL | REPORT No: 17005/7471/R1119

PARTICLE SIZE DISTRIBUTION

PROJECT: WHITE CLIFFS WATER SUPPLY | SAMPLE No: 7471

LOCATION: WATER TREATMENT PLANT | HOLE No: B8 | DEPTH (m): 1.50



SIZE DISTRIBUTION	
COBBLES	0 %
GRAVEL	17 %
SAND	49 %
SILT	19 %
CLAY	15 %
EFFECTIVE SIZE D10:	-
UNIFORMITY COEFFICIENT D60/D10(Cu):	-
CURVATURE COEFFICIENT $D30^2$ /(D60 x D10) (Cc):	-

Soil Particle Density: 2.65 t/m³ (estimated for analysis)

Method of dispersion: End-over-end shaking

Hydrometer: ASTM 152H

Dispersion chemical: Sodium hexametaphosphate + Anhydrous sodium carbonate

Notes on Test: Tested as received

Loss in pre-treatment: 0 %

Test Methods:
DPWS GM 9: Determination of the Particle Size Distribution of a Soil

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: ZG | Date Tested: 01/03/2017

APPROVED SIGNATORY M. Ashover

Mark Ashover 10/03/2017

PARTICLE SIZE DISTRIBUTION R1119 (ISSUE 4, 2005)

Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL | REPORT No: 17005/7471/R1115

SOIL INDEX PROPERTIES

PROJECT: WHITE CLIFFS WATER SUPPLY | SAMPLE No: 7471

LOCATION: WATER TREATMENT PLANT | HOLE No: B8 | DEPTH (m): 1.50

SOIL INDEX PROPERTIES		RESULT		TEST METHOD
Moisture Content (as received)	:	13.4	%	AS 1289.2.1.1
Liquid Limit	:	45	%	AS 1289.3.1.1
Plastic Limit	:	28	%	AS 1289.3.2.1
Plasticity Index	:	17	%	AS 1289.3.3.1
Linear Shrinkage	:	9.0	%	AS 1289.3.4.1
Soil Particle Density	:	-		GM 8
Classification	:	SM		AS 1726

Sample History: ☐ Natural State ☒ Air Dried ☐ Oven Dried

Method of Preparation: ☐ Wet Sieved ☒ Dry Sieved

Linear Shrinkage Sample: ☒ Curling ☐ Crumbling ☐ No Deformation

Notes on test: Sample tested as received from client.

Tested By: ZG | Date Tested: 06/03/2017

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

APPROVED SIGNATORY

M. Ashover

Mark Ashover 10/03/2017

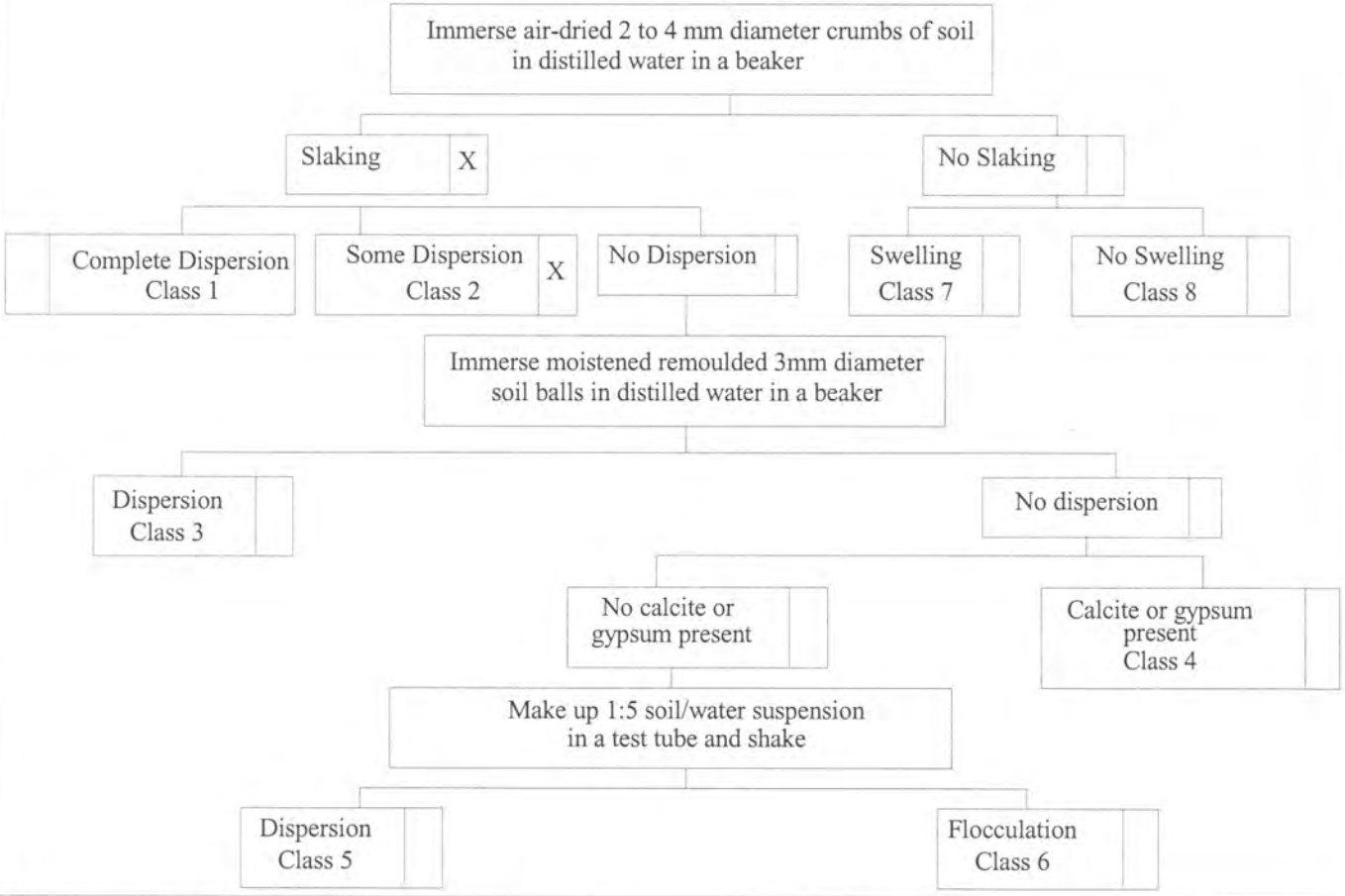
Geotechnical Centre

110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL		REPORT No: 17005/7471/R1118
DISPERSION TESTS		
PROJECT: WHITE CLIFFS WATER SUPPLY		SAMPLE No: 7471
LOCATION: WATER TREATMENT PLANT	HOLE No: B8	DEPTH (m): 1.50

Determination of the Emerson Class Number of a soil



Emerson Class Number	(AS 1289.3.8.1)	2
Percent Dispersion	(AS 1289.3.8.2)**	No Test
Dispersal Index	(DPWS GM 15)	No Test

Sample Description: Pinkish Grey with some Yellow Clayey Gravelly Silty Sand

Type and temperature of water: Distilled, 22.2 ° C

Notes on test: Sample tested as received from client.

** 0.05mm size interpolated from hydrometer readings taken after 21min, 1hour and 2 hours.

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: MA Date Tested: 09/03/2017

APPROVED SIGNATORY M. Ashover

Mark Ashover 10/03/2017

Geotechnical Centre

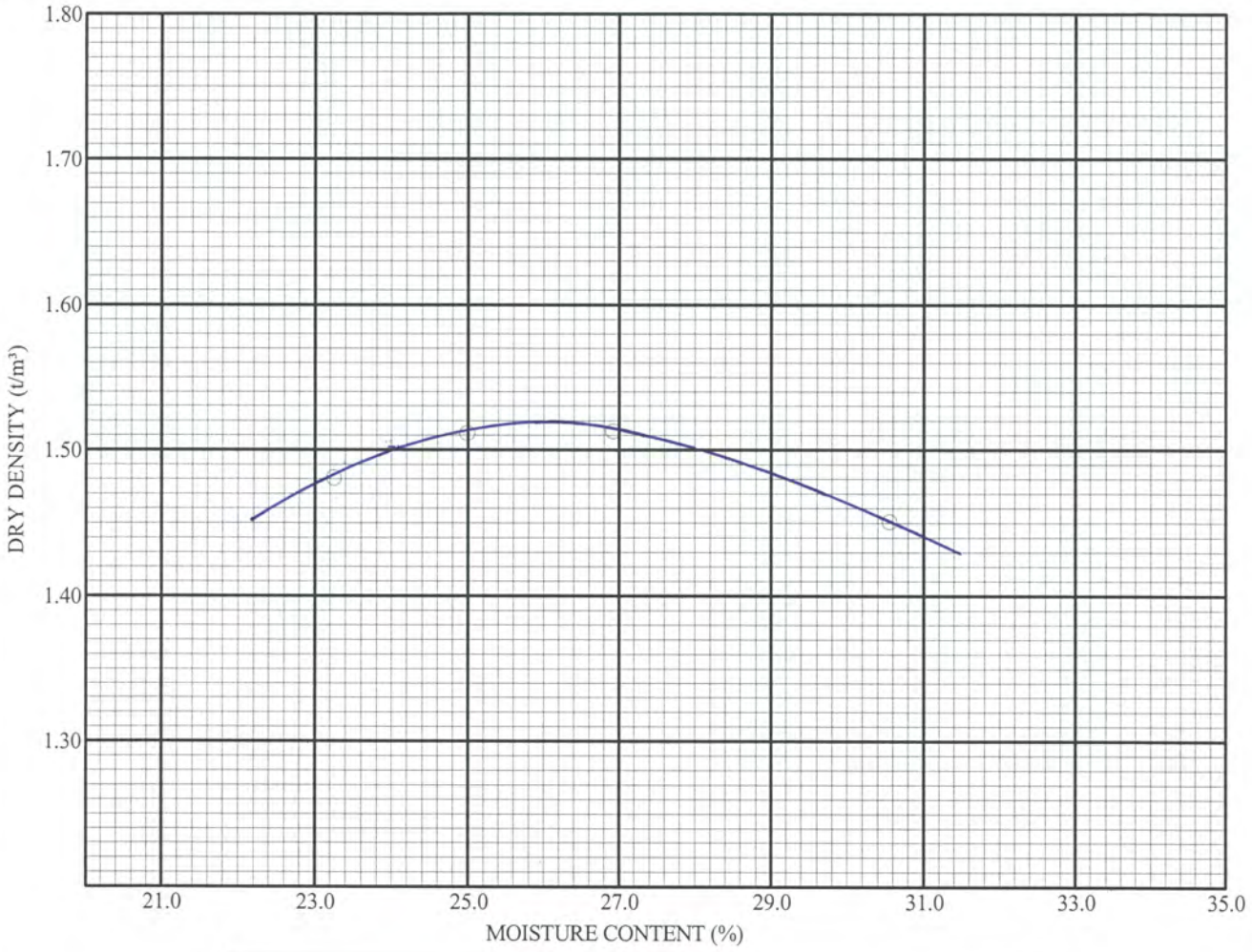
110B King Street, Manly Vale NSW 2093
Telephone 02 9949 0200 Facsimile 02 9948 6185
NATA Accreditation Number: 13380

NSW GOVERNMENT | Public Works Advisory

CLIENT: GEOTECHNICAL & ENVIRONMENTAL	REPORT No: 17005/7471/R1111

STANDARD COMPACTION TEST

PROJECT: WHITE CLIFFS WATER SUPPLY		SAMPLE No: 7471
LOCATION: WATER TREATMENT PLANT	HOLE No: B8	DEPTH (m): 1.50



Standard Maximum Dry Density:	1.52	t/m³
Standard Optimum Moisture Content:	26.0	%
Percentage of Material Retained on the 19 mm sieve	0.4	%
Notes on Test: Specimen tested as received		
Test Method: AS 1289.5.1.1 Mould: A (1 Litre) ☒ B (2 Litre) ☐		

COMPACTION R1111 (ISSUE 4, 2005)

NATA **Accredited for compliance with ISO/IEC 17025 - Testing**

Tested By: MA Date Tested: 02/03/2017

APPROVED SIGNATORY M. Ashover

Mark Ashover 10/03/2017

APPENDIX D

Corrosion and Scaling Assessment Test Results

SESL AUSTRALIA
Environment & Soil Sciences

Corrosion & Scaling Assessment:
Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 1** **Date Received: 2/3/17** **Report Status:** ○ Draft ◉ Final

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7476 - RM1 (0.5-1.0)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		6.5	Very slight acidity
EC mS/cm (1:5)		0.23	Moderate
Texture Class		Loam Fine Sandy	
Soil Condition Class (Permeability)		Low	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	mgSO_4 / kg	500	Low (non-aggressive)
Chloride (1:5)	mgCl / kg	20	Low (non-aggressive)
* Resistivity Ω.	m	-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows very slight acidity, moderate salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered non-corrosive towards concrete and non-corrosive towards steel. The low sulphate and low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is low.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee

SESL AUSTRALIA
Environment & Soil Sciences

Corrosion & Scaling Assessment:
Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 2** **Date Received: 2/3/17** **Report Status:** ○ Draft ◉ Final

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7480 - RM4 (0.5-0.95)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		8	Slight alkalinity
EC mS/cm (1:5)		0.09	Very low
Texture Class		Fine Sandy Clay Loam	
Soil Condition Class (Permeability)		Low	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	$mgSO_4$ / kg	40	Low (non-aggressive)
Chloride (1:5)	mgCl / kg	40	Low (non-aggressive)
* Resistivity Ω. m		-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, very low salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered non-corrosive towards concrete and non-corrosive towards steel. The low sulphate and low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is low.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL AUSTRALIA
Environment & Soil Sciences

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 3** **Date Received: 2/3/17** **Report Status: ○ Draft ◉ Final**

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7481 - RM5 (0.6-1.0)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		8.9	Strong alkalinity
EC mS/cm (1:5)		0.52	High
Texture Class		Loamy Sand	
Soil Condition Class (Permeability)		High	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	mgSO_4 / kg	190	Low (mildly aggressive)
Chloride (1:5)	mgCl / kg	480	Low (non-aggressive)
* Resistivity Ω.	m	-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows strong alkalinity, high salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered mildly-corrosive towards concrete (due to high permeability) and non-corrosive towards steel. The low sulphate and low chloride levels are considered mildly-aggressive towards concrete (due to high permeability) and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is mild.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee

SESL AUSTRALIA
Environment & Soil Sciences

Corrosion & Scaling Assessment:
Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 4** **Date Received: 2/3/17** **Report Status: ○ Draft ◉ Final**

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7483 - RM7 (0.5-0.8)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		8.1	Moderate alkalinity
EC mS/cm (1:5)		0.22	Moderate
Texture Class		Sandy Clay Loam	
Soil Condition Class (Permeability)		Low	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	mgSO_4 / kg	270	Low (non-aggressive)
Chloride (1:5)	mgCl / kg	90	Low (non-aggressive)
* Resistivity Ω. m		-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows moderate alkalinity, moderate salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered non-corrosive towards concrete and non-corrosive towards steel. The low sulphate and low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is low.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL AUSTRALIA
Environment & Soil Sciences

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 5** **Date Received: 2/3/17** **Report Status:** ○ Draft ◉ Final

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7487 - RM11 (0.5-1.0)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		7.9	Slight alkalinity
EC mS/cm (1:5)		1.96	Extreme
Texture Class		Loamy Sand	
Soil Condition Class (Permeability)		High	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	mgSO_4 / kg	2930	Low (mildly aggressive)
Chloride (1:5)	mgCl / kg	1560	Low (non-aggressive)
* Resistivity Ω. m		-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, extreme salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered mildly-corrosive towards concrete (due to high permeability) and non-corrosive towards steel. The low sulphate and low chloride levels are considered mildly-aggressive towards concrete (due to high permeability) and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is mild.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL AUSTRALIA
Environment & Soil Sciences

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 6** **Date Received: 2/3/17** **Report Status:** ○ Draft ◉ Final

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7496 - RM20 (0.6-1.0)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		8.9	Strong alkalinity
EC mS/cm (1:5)		0.42	Moderate
Texture Class		Fine Sandy Loam	
Soil Condition Class (Permeability)		High	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	mgSO_4 / kg	310	Low (mildly aggressive)
Chloride (1:5)	mgCl / kg	350	Low (non-aggressive)
* Resistivity Ω. m		-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows strong alkalinity, moderate salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered mildly-corrosive towards concrete (due to high permeability) and non-corrosive towards steel. The low sulphate and low chloride levels are considered mildly-aggressive towards concrete (due to high permeability) and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is mild.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee

SESL AUSTRALIA
Environment & Soil Sciences

Corrosion & Scaling Assessment:
Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 7** **Date Received: 2/3/17** **Report Status:** ○ Draft ◉ Final

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7497 - RM21 (0.4-0.6)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		8.8	Strong alkalinity
EC mS/cm (1:5)		0.29	Moderate
Texture Class		Loam Fine Sandy	
Soil Condition Class (Permeability)		Low	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	mgSO_4 / kg	160	Low (non-aggressive)
Chloride (1:5)	mgCl / kg	180	Low (non-aggressive)
* Resistivity Ω. m		-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows strong alkalinity, moderate salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered non-corrosive towards concrete and non-corrosive towards steel. The low sulphate and low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is low.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee

SESL AUSTRALIA
Environment & Soil Sciences

Corrosion & Scaling Assessment:
Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 42468 **Sample N°: 8** **Date Received: 2/3/17** **Report Status:** ○ Draft ◉ Final

Client Name:	**Office of Finance & Services**	Project Name:	**Ref: White Cliffs Water Supply**
Client Contact:	**Peta Anderson**	SESL Quote N°:	
Client Job N°:		Sample Name:	**7499 - RM22 (0.4-0.7)**
Client Order N°:	**GT29A**	Description:	**Soil**
Address:	**Level 13, McKell Building 2-24 Rawson Place SYDNEY NSW 2000**	Test Type:	**CSCSSNR**

TEST		RESULT	COMMENTS
pH in water (1:5)		7.8	Slight alkalinity
EC mS/cm (1:5)		3.9	Extreme
Texture Class		Light Clay	
Soil Condition Class (Permeability)		Low	
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	mgSO_4 / kg	10910	Mild (mildly aggressive)
Chloride (1:5)	mgCl / kg	1600	Low (non-aggressive)
* Resistivity Ω.	m	-	Did not test

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, extreme salinity, low sulphate, low chloride levels.

According to AS2159-2009, the pH is considered non-corrosive towards concrete and non-corrosive towards steel. The elevated sulphate levels and low chloride levels are considered mildly-aggressive towards concrete and non-corrosive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (d) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, based on the limited results and according to AS2159:2009 the likelihood of aggressive corrosion is mildly aggressive.

SESL recommends the analysis of sulfate reducing bacteria to be conducted, including total sulfur content based on the elevated concentration of sulfate identified in the sample.

Please note not all analysis was conducted and may not necessarily depict the actual corrosion risk.

pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998);
Resistivity, AS1289.4.4.1:1997, **Texture** - PM0003 (Texture- "Northcote" (1992))

Date Report Generated
10/03/2017

Consultant: Adam Reid

Authorised Signatory: Kelly Lee