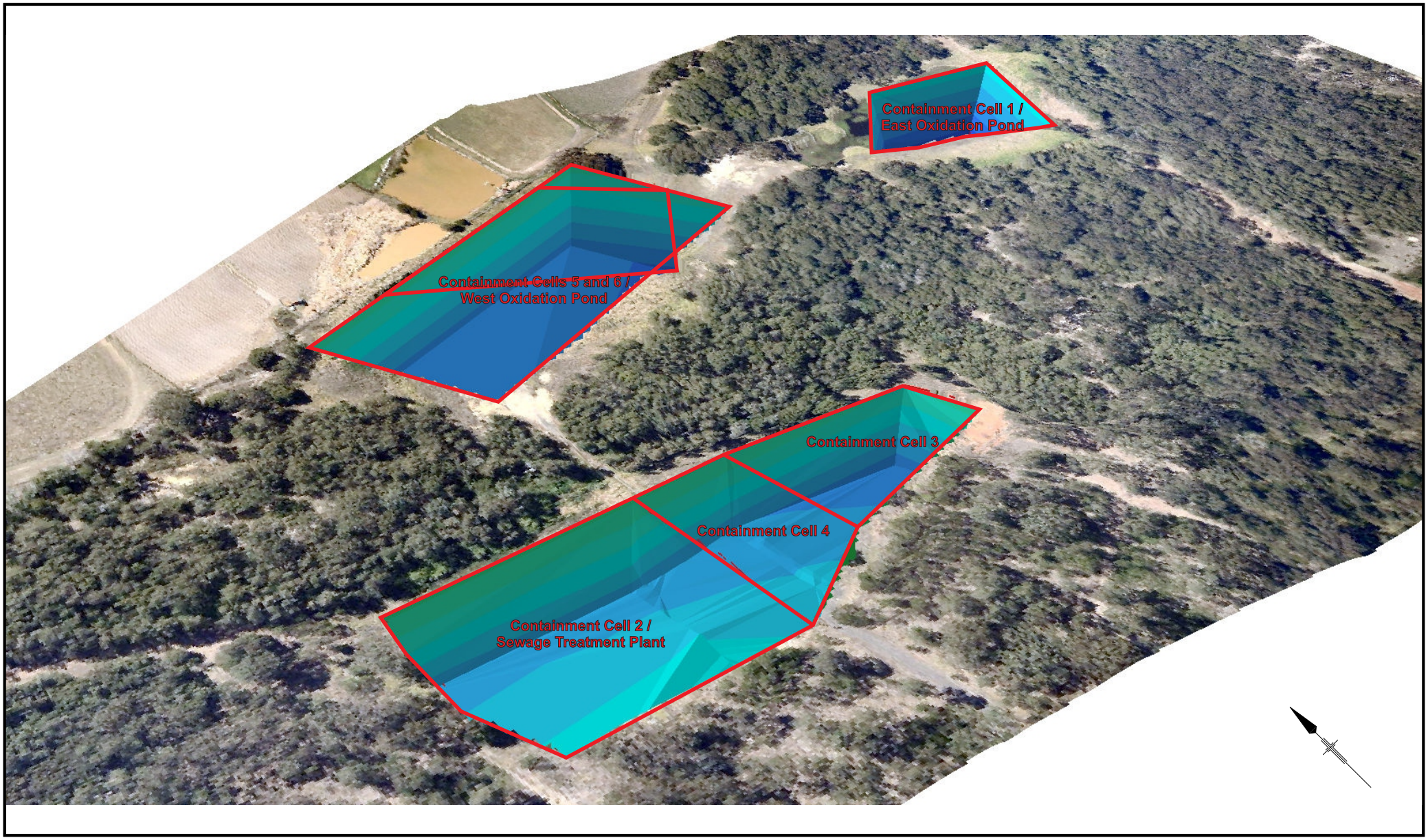


Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

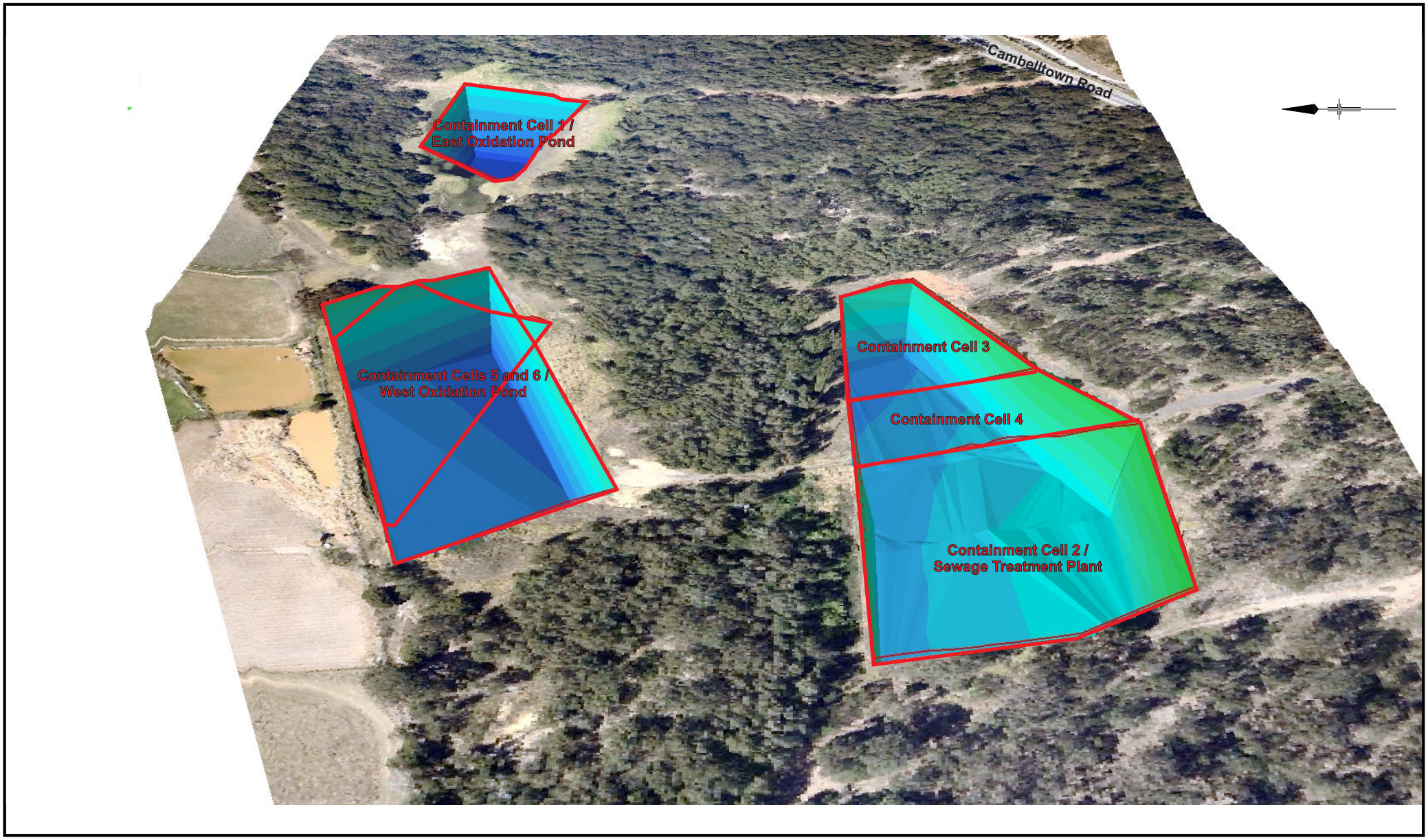
JBS&G

Figure 8B: Potential Containment Cell Layout - Viewing North East

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08B



Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

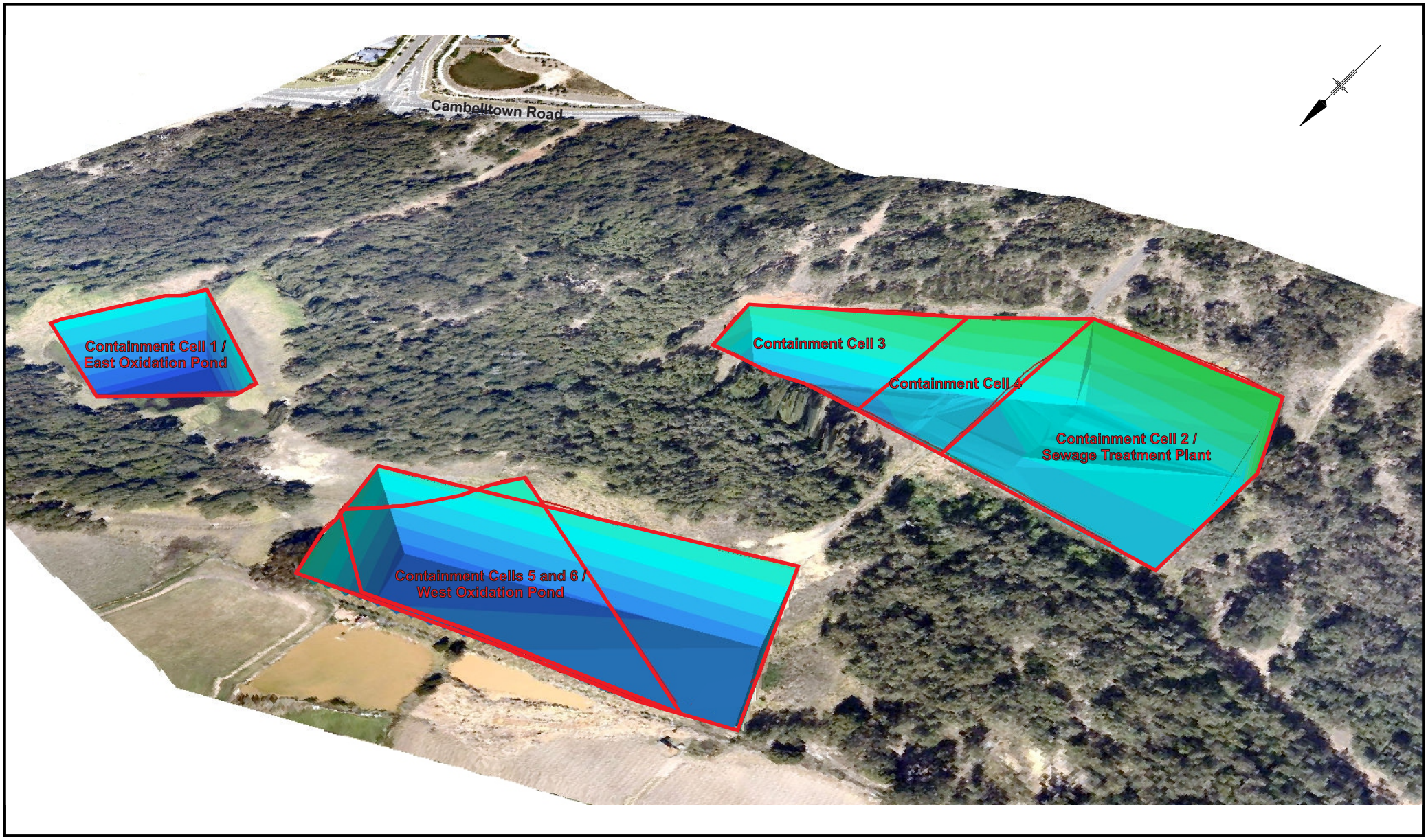
JBS&G

Figure 8C: Potential Containment Cell Layout - Viewing East

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08C



Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

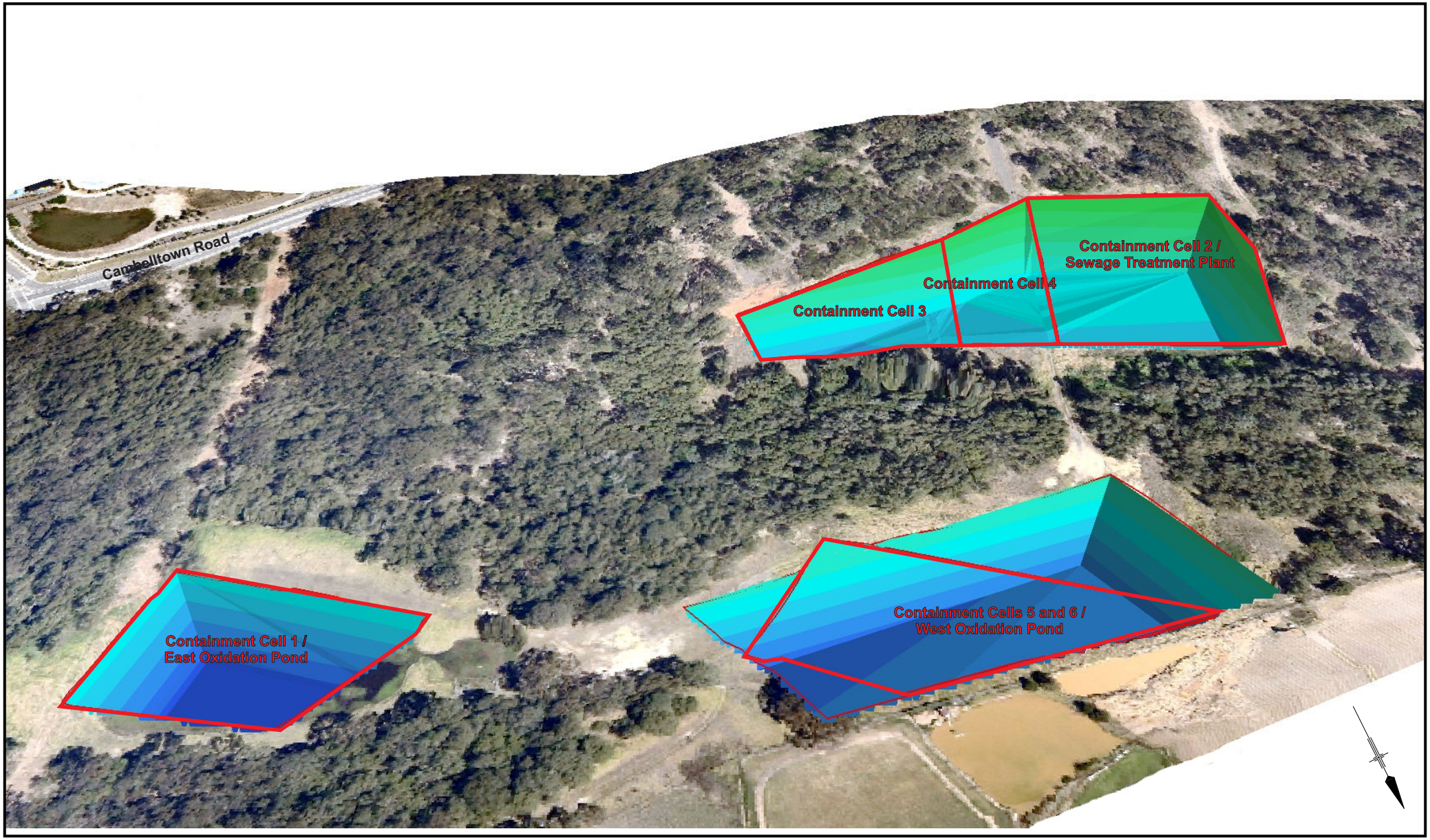
JBS&G

Figure 8D: Potential Containment Cell Layout - Viewing South East

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08D



Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

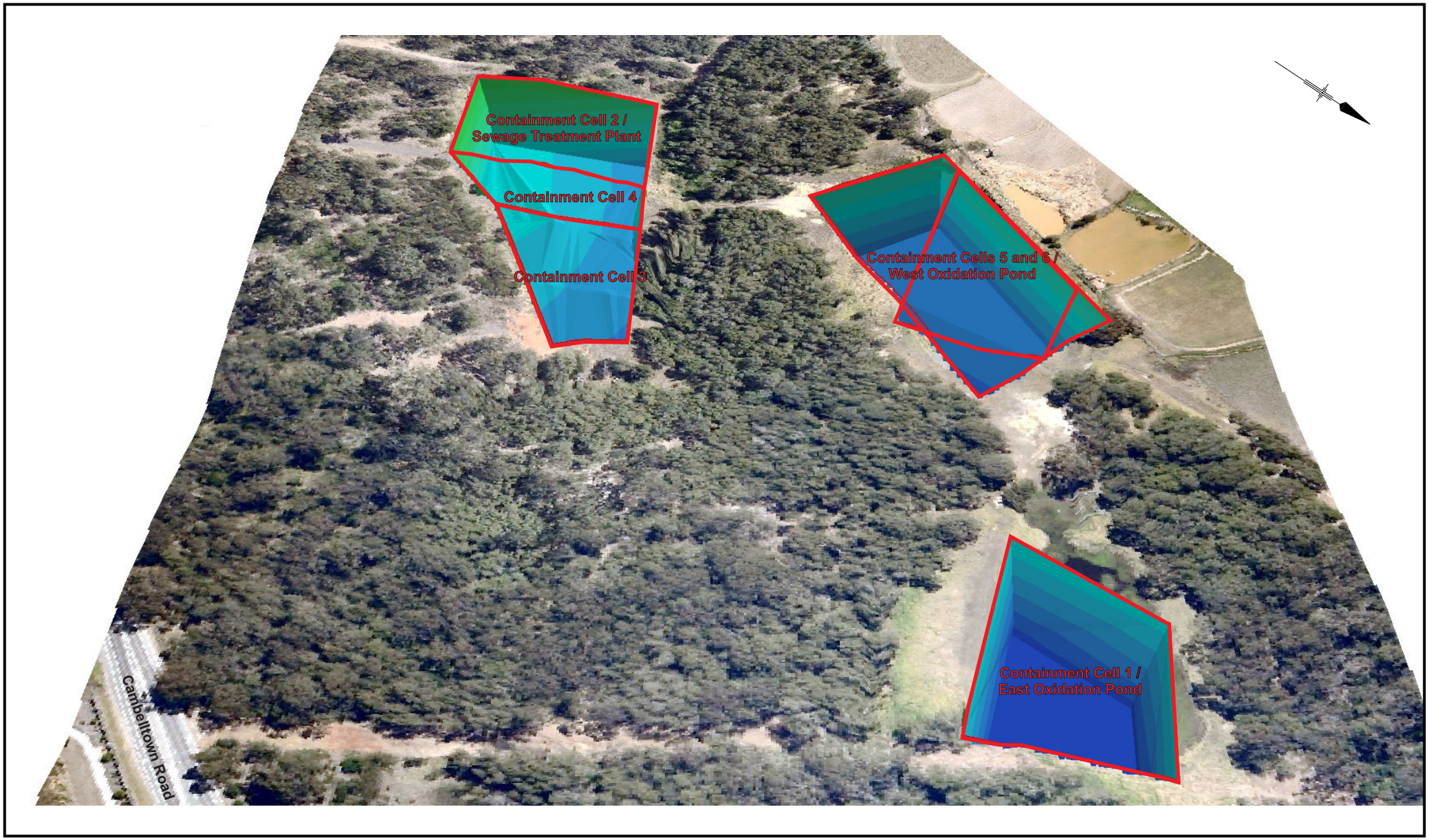
JBS&G

Figure 8E: Potential Containment Cell Layout - Viewing South

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08E



Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

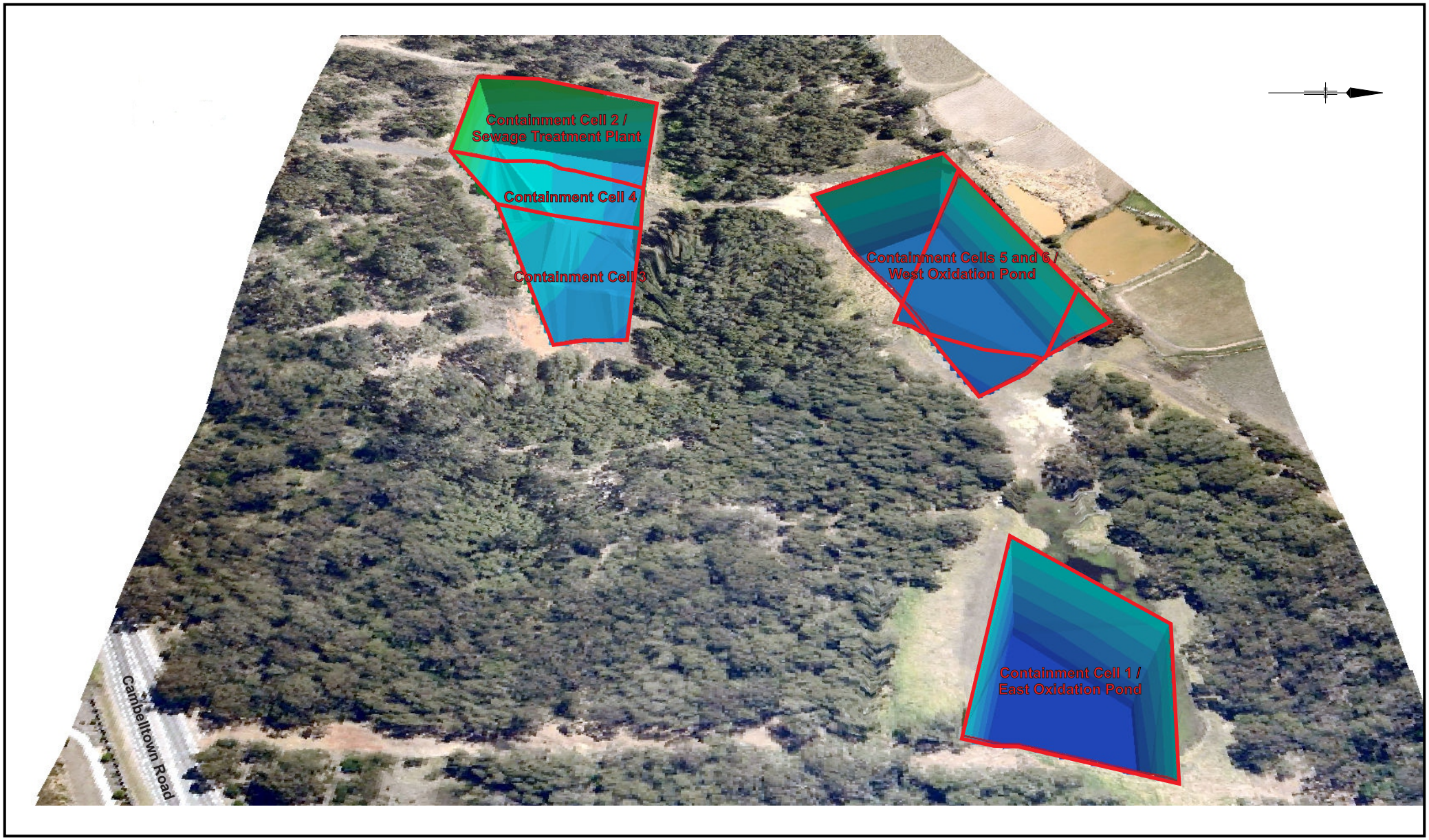
JBS&G

Figure 8F: Potential Containment Cell Layout - Viewing South West

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08F



Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

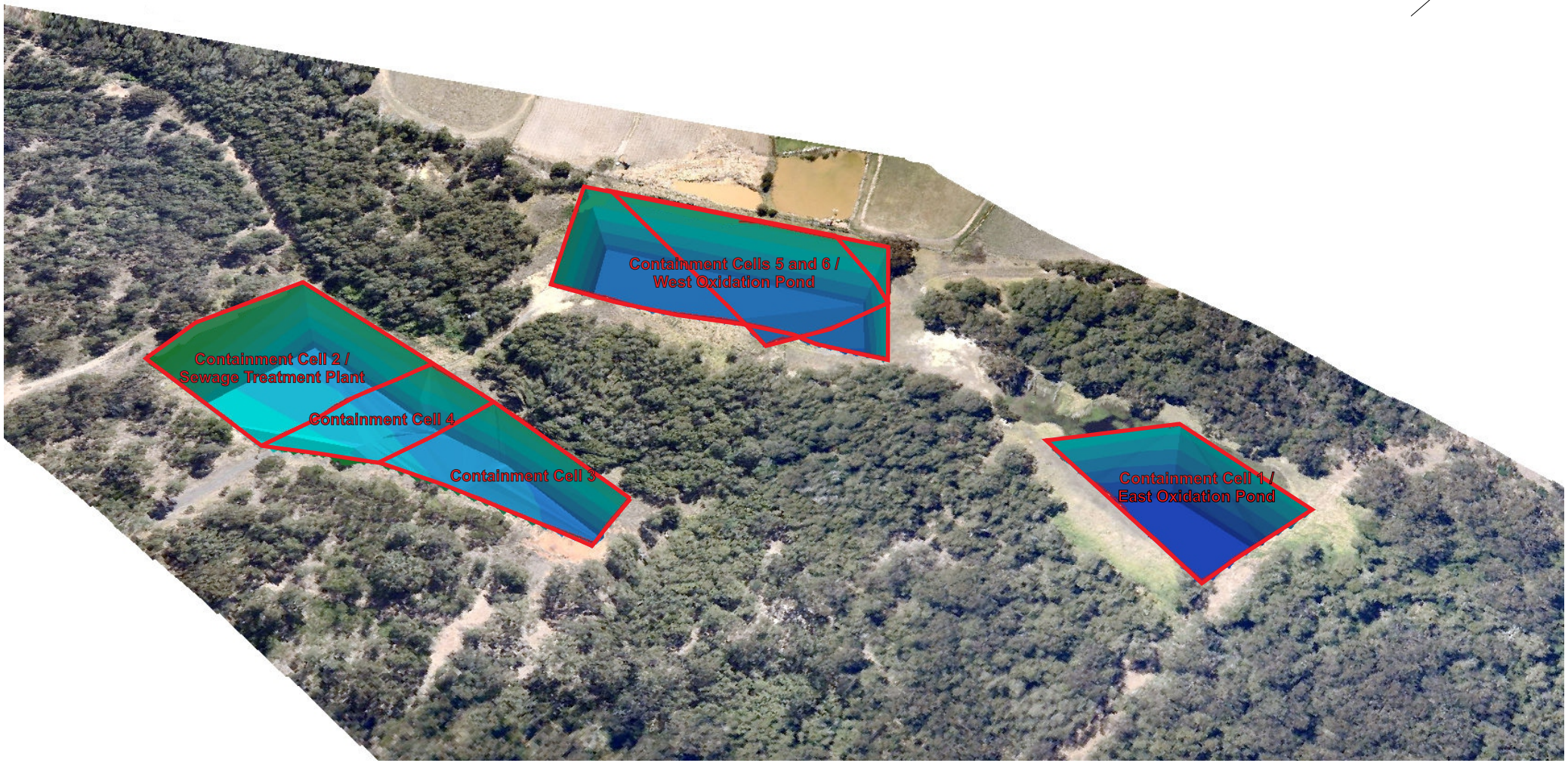
JBS&G

Figure 8G: Potential Containment Cell Layout - Viewing West

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08G



Scale: Approximate - Vertical Exaggeration: 6

Datum: MGA94 Zone 56 - AHD

Rev	Description	Drn.	Date
A4			
A	Original Issue - R03	SE	13-03-2014

Legend:

- Containment Cell Boundary
- 50m AHD
- 35m AHD

Figure 8H: Potential Containment Cell Layout - Viewing North West

Client: Urban Growth

Project: Remediation and Validation Edmondson Park

Job No: 43008 File Name: 43008_08H

Appendix A: Geotechnical Report

Pells Sullivan Meynink
Engineering Consultants
Rock-Soil-Water

G3 56 Delhi Road
North Ryde NSW 2113
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F: 61-2 9812 5001
mailbox@psm.com.au
www.psm.com.au

Our Ref: PSM2294-003R
Date: 26 November 2013

JBS&G (Aust) Pty Limited
Level 1, 50 Market Street
SYDNEY NSW 2000

ATTENTION: MATTHEW BENNETT
By email: mbennett@jbsg.com.au

Dear Matthew,

RE: SEWER TREATMENT PLANT – EDMONDSON PARK, NSW
GEOTECHNICAL INVESTIGATION

We are pleased to submit our geotechnical report at a sewer treatment plant (STP) site at Campbelltown Road, Edmondson Park, NSW.

Please do not hesitate to contact the undersigned if you have any queries.

For and on behalf of
PELLS SULLIVAN MEYNINK

DAVID PICCOLO

Distribution: 1 PDF copy JBS&G.
Original held by PSM

JBS&G (Aust) Pty Limited

SEWER TREATMENT PLANT, CAMPBELLTOWN ROAD, EDMONDSON PARK, NSW GEOTECHNICAL INVESTIGATION

Report PSM2294-003R November 2013

CONTENTS

1. INTRODUCTION

This report presents the results of the geotechnical investigation undertaken by Pells Sullivan Meynink (PSM) for a sewer treatment plant (STP) site at Campbelltown Road, Edmondson Park, NSW. The work has been undertaken in general accordance with PSM proposal dated 11 September 2013 (Ref. PSM2294-001L Rev1).

Prior to the work, PSM was supplied with the following documents:

- *Geotechnical Scope – Edmondson Park STP.docx* – providing the geotechnical scope of work.
- RPS drawing no. 114931-Sewer Plant "*Plant showing topographic detail of existing sewer treatment plant in Lot 3 in D.P.831152*", dated 3 September 2013 Rev. A.

Figure 1 presents the locality plan.

Based on the documents, we understand that:

- The site is a redundant STP for the former Ingleburn Army Camp.
- It is approximately 2 ha and currently comprises an STP compound and oxidation ponds.
- The purpose of the geotechnical investigation is to develop sufficient geotechnical information on subsurface soil, and bedrock conditions.
- For the purpose of the geotechnical investigation, the site has been divided into three (3) areas. They are as follows:
    - Sewage treatment plant (STP) area.
    - East of STP area.
    - Eastern sewage treatment pond.

2. GEOTECHNICAL INVESTIGATION

2.1. Fieldwork

The fieldwork was undertaken from 30 October to 1 November 2013. It was undertaken concurrently with JBS&G environmental investigation. Details of the fieldwork are discussed in the following sections. The test holes were named to suit JBS&G test holes.

During the fieldwork, JBS&G confirmed that the geotechnical investigation should include the area at the east of the STP.

The test locations were measured using a PSM handheld GPS with an accuracy of ± 5m. Figure 1 presents the test locations. The elevation of the test holes are estimated from the contour plans with a 0.5 m interval provided to PSM.

2.1.1. Boreholes

A total of four (4) boreholes, eg. BH19, BH30, BH31 and PSM BH01 were drilled using a 20 tonne truck mounted drill rig (Terratest's Hydrapower Scout). They were drilled to a maximum depth of 8 m.

The boreholes were drilled using augering techniques with a solid flight auger and "TC" bit. Standard penetration tests (SPTs) were undertaken in soils in each borehole.

The boreholes were drilled in the full time presence of a PSM Geotechnical Engineer who prepared engineering logs and recovered samples from each borehole. Engineering borehole logs together with the explanation sheets are presented in Appendix A.

At the request of JBS&G for environmental monitoring, two (2) standpipe piezometers were installed within the drilled boreholes, BH30 and BH31.

The remaining two boreholes were backfilled with excavated spoil upon completion of augering.

2.1.2. Test pits

A total of twenty (20) test pits, TP01 to TP08, TP10 to TP14, TP16 and PSM TP01 to PSM TP06, were excavated across the site using a 20 tonne tracked excavator.

The test pits were excavated to a maximum depth of 4.3 m. Engineering logs together with the explanation sheets are presented in Appendix A.

All test pits were excavated in the full time presence of a PSM Geotechnical Engineer. Test pit photographs were taken and are presented in Appendix B (Photo 1 to Photo 20).

The test pits were backfilled with the excavated spoil and compacted with excavator bucket upon completion of the fieldwork.

2.2. Geotechnical laboratory testing

A total of two (2) undisturbed soil samples (U50 push tubes) were recovered from the boreholes. These samples were forwarded to a geotechnical laboratory for the following testing.

- Two (2) Atterberg Limits
- Two (2) shrink swell index (I_{ss})

The results are presented in Appendix C and summarised in Table 1.

TABLE 1
SUMMARY OF CLASSIFICATION TEST RESULTS

SAMPLE	DEPTH (m)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LINEAR SHINKAGE (%)	SHIRNK SWELL INDEX, I_{ss} (%pF)
BH19	1.5	37	22	8	1.98
BH30	1.0	50	33	10	2.72

3. SITE CONDITIONS

3.1. Geological Setting

The 1:100,000 Penrith Geological map (1991) indicates the site is underlain by Bringelly Shale formation (Rwb) of Wianamatta Group. This formation comprises shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff. The site may also comprise alluvium (Qpn) comprising medium-grained sand, clay, and silt.

3.2. Surface Conditions

At the time of the fieldwork, it was observed that the site was heavily vegetated. The investigation area spans approximately 250 m (north to south), and between 375 m wide (east to west).

The eastern sewerage treatment ponds were observed to have been formed by construction of a perimeter fill embankment (bund). Water was observed within the pond to approximately 1 m below the crest of the bund.

Appendix B (Photo 21 to Photo 26) presents some selected site photos taken during the fieldwork.

3.3. Subsurface Conditions

The subsurface conditions encountered within the test pits and boreholes are summarised in Table 2. The encountered subsurface conditions were consistent with the published information in the geological map. Alluvium was not encountered in the test pits and boreholes.

TABLE 2
SUMMARY OF INFERRED SUBSURFACE CONDITIONS ENCOUNTERED IN TEST PITS AND BOREHOLES

INFERRED UNIT	INFERRED TOP OF UNIT DEPTH BELOW GROUND SURFACE (m)	DESCRIPTION
TOPSOIL	0.0	Silty SAND; fine grained, brown to red brown with some gravel.
EXISTING FILL	0.2 - 0.3	SILT, CLAY to Gravelly SAND; fine grained, brown, subangular gravel with some cobbles. Clay is medium plasticity, dark brown.
RESIDUAL SOIL	0.2 – 1.7	CLAY; medium plasticity, grey and red, very stiff to hard consistency.
SHALE 1	0.8 – 4.5	SHALE; highly to extremely weathered, grey and red, laminated, extremely low to very low strength.
SHALE 2	1.1 – 5.0	SHALE; moderately weathered, dark grey and grey and red, laminated, low to medium strength.

Refusal on the shale bedrock with a 20 t excavator has been inferred to be on a layer of SHALE 2 unit.

The EXISTING FILL unit encountered at the eastern sewage treatment pond is associated with the perimeter bund around the pond. The EXISTING FILL unit encountered within the STP area and east of the STP area was assessed to be localised.

Table 3 shows the reduced levels of the top of the inferred geotechnical units encountered in the boreholes and test pits.

TABLE 3
APPROXIMATE REDUCED LEVELS OF INFERRED GEOTECHNICAL UNITS

LOCATION	BOREHOLES / TESTPITS	APPROXIMATE REDUCED LEVEL OF TOP OF UNIT (M) AHD					
		TOPSOIL	EXISTING FILL	RESIDUAL SOIL	SHALE 1	SHALE 2	EOH
Eastern Sewage Treatment Pond	TP01	42.5	42.3	40.8	N.E.	N.E.	38.8
	TP02	42.5	42.2	41.7	39.2	N.E.	39.0
	TP03	42.5	42.2	41.8	39.4	N.E.	38.2
	TP04	42.5	42.2	41.3	39.0	N.E.	38.8
	TP05	42.5	42.2	41.5	38.9	N.E.	38.5
	TP06	42.5	42.3	41.8	N.E.	N.E.	40.0
	TP07	42.5	42.3	41.3	39.8	N.E.	38.8
	BH19	42.5	42.2	41.5	38.0	37.5	35.8
Sewage Treatment Plant (STP)	TP08	48.0	N.E.	47.7	46.2	N.E.	45.6
	TP10	47.5	N.E.	47.2	45.5	45.1	45.1*
	TP11	47.0	N.E.	46.7	45.4	44.9	44.9*
	TP12	47.5	N.E.	47.2	46.3	46.1	46.1*
	TP13	45.5	N.E.	45.1	43.6	43.2	43.2*
	TP14	45.5	N.E.	45.2	43.4	42.8	42.8*
	TP16	47.0	46.7	46.1	44.8	44.2	44.2*
	BH30	46.0	45.8	45.2	43.5	43.0	38.0
	BH31	46.5	N.E.	46.3	44.5	43.9	39.0
East of STP	PSM TP01	47.0	46.9	46.1	45.6	45.4	45.4*
	PSM TP02	46.0	N.E.	45.7	N.E.	44.8	44.7*
	PSM TP03	44.5	N.E.	44.2	N.E.	43.4	43.1*
	PSM TP04	44.0	N.E.	43.7	N.E.	42.8	42.6*
	PSM TP05	45.0	N.E.	44.8	44.2	43.2	43.0*
	PSM TP06	45.0	N.E.	44.7	44.2	43.9	43.8*
	PSM BH01	45.5	N.E.	45.3	44.1	43.5	40.3

Note: * = refusal using 20 t excavator
N.E. = Not Encountered
EOH = End of Hole

4. DISCUSSIONS AND RECOMMENDATIONS

4.1. Earthworks

PSM understand that some earthworks may be required for this site. The following advice applies where fill is required to support structures. Such fill is referred to here in as Engineered Fill.

We consider that the TOPSOIL unit is not suited for reuse as engineered fill. Topsoil may be reused for landscaping purposes. It is our opinion that most of the remaining cut material would be suitable for reuse on the site as engineered fill.

We envisage that the earthworks, eg. cutting and filling, proposed at the site, will require the preparation of a detailed earthworks specification developed following the guidelines in AS 3798 (2007), "Guidelines on earthworks for commercial and residential developments".

Preparation of earthworks specification is outside the scope of this report. We consider, however, that the specification should address at least the following:

1. Subgrade preparation and base geometry requirements. Any existing fill to be left on site as subgrade will need to be approved by the Principal / designer, eg. PSM, after inspections. The fill associated with the bund will need to be removed and replaced; there may be some softened material within the ponds that may also need to be removed and replaced. It is possible that such material may be able to be reused as engineered fill but may require some drying out or blending with more competent material.
2. Material requirements, including a clear definition of:
   - Suitable and unsuitable material.
   - Grading or maximum particle size requirements. We note that a conservative definition of maximum particle size may result in some of the materials on site being excluded from reuse as engineered fill. It is our opinion that this restriction may not significantly benefit fill performance.
3. Fill placement requirements, including a clear definition of compacted layer thickness, we suggest 300 mm.
4. Compaction requirements. We suggest that a minimum and maximum density ratio be adopted to control any potential shrink swell of the clayey fill material and to limit the effect of fill material variability on the fill performance, we suggest 98 to 102 % standard.
5. Moisture control requirements. We consider that control on placement moisture variation should be adopted to control any potential shrink swell of the clayey fill material, we suggest moisture variation of +- 2%.
6. Inspection and testing requirements, including a clear definition of:
   - Level of control testing, e.g. Level 1 as per AS3798.
   - Lot testing, this is an important aspect of earthworks control but often ignored in acceptance of the works.
   - Testing methodology.
   - Testing frequency.
7. Responsibilities of the contractor. We envisage that such responsibilities would include:
   - Undertake the earthworks in accordance with fill specification.
   - Seek approvals by the GITA as required by the fill specification, in particular prior to placing any new fill.
8. Responsibilities of the Geotechnical Inspection and Testing Authority (GITA). The fill specification should define:
   - The inspection and testing responsibilities of the GITA.
   - The reporting responsibilities of the GITA.
   - The final certification responsibilities of the GITA. We note that the specification should require the GITA to certify that "all the earthworks have been documented and have been undertaken in

accordance with the relevant fill specification". It is not adequate just to refer to AS3798 Level 1.

The design advice in the following sections is provided on the basis that:

- The earthworks have been completed in accordance with an earthworks specification developed based on the above items.
- PSM review the earthworks documents as per the specification, eg. earthworks audit, to confirm the advice.

Fill placed in accordance with such a specification is referred to herein as ENGINEERED FILL.

4.2. Site Classification

Based on the field observations and the results of the laboratory testing, we have classified the site in accordance with Australian Standard AS 2870 (2011), *Residential slabs and footings – Construction*. The following parameters were adopted for classification based on AS 2870 (2011):

We recommend that structures which are within the scope of AS 2870 be designed for a site classification of Class "H1" Highly Reactive. Our classification takes into account of cutting and filing for the site and assumes there will be no imported fill.

4.3. Excavation Condition

Excavation in the TOPSOIL, EXISTING FILL, RESIDUAL SOIL, and SHALE 1 units should be achievable using conventional earth moving equipment. Excavation of SHALE 2 unit should be achievable using a combination of conventional earth moving equipment, ripping and some rock breaking.

It is our experience that excavatability is heavily dependent on both the operator and the plant used. The earthworks contractor should satisfy itself with regard to Excavatability.

Please note that the 20 t excavator with a toothed bucket attachment refused on the inferred SHALE 2 unit in following test pits:

- STP area: test pits TP10 to TP and TP16.
- East of the STP area: test pits PSM TP01 to PSM TP06.

4.4. Permanent and Temporary Batters

The batter slope angles shown in Table 4 are recommended for the design of batters up to 4 m height subject to the following recommendations:

1. The batters shall be protected from erosion.
2. Permanent batters shall be drained.
3. Temporary batters shall not be left unsupported for more than 1 month without further advice, and inspection by a geotechnical engineer should be undertaken following significant rain events.

4. Where loads are imposed or structures/services are located within one batter height of the crest of the batter, further advice should be sought.

5. The temporary and permanent batters in the SHALE 2 unit shall be inspected by an experienced geotechnical engineer during excavation to confirm the batter advice provided and assess the need for localised support (i.e. rock bolting to control adverse jointing, and/or shotcreting for overall face support). The inspections should be carried out as the excavation progresses.

TABLE 4
BATTER SLOPE ANGLES

UNIT	TEMPORARY	PERMANENT
ENGINEERED FILL	1.5H : 1V	2H : 1V
RESIDUAL SOIL	1.5H : 1V	2H : 1V
SHALE 1	1.5H : 1V	2H : 1V
SHALE 2	0.5H:1V*	0.33H : 1V* (subject to design)

Note: * = subject to inspection.

Steeper batters may be possible subject to construction stage inspections and further geotechnical advice.

5. GENERAL

If at any time, the conditions are found to vary from those described in this report, further advice should be sought.

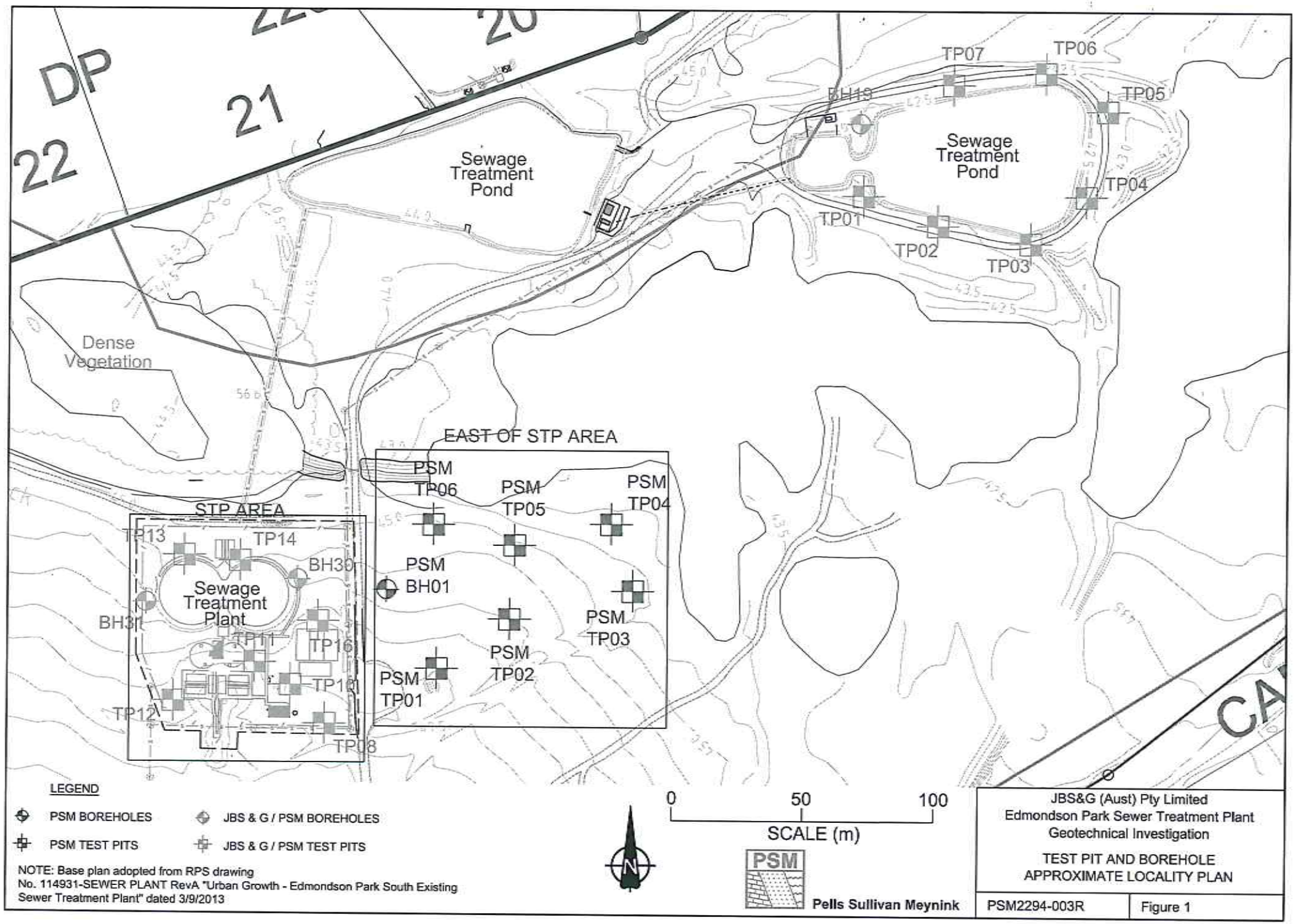
For and on behalf of
PELLS SULLIVAN MEYNINK

DAVID PICCOLO
Principal

REFERENCES

1. Australian Standard "Guidelines on earthworks for commercial and residential developments" (AS 3798), 2007.

2. Australian Standard "Residential Slab and Footings" (AS 2870), 2011.


DP
21
22
20
Sewage Treatment Pond
Sewage Treatment Pond
TP07
TP06
TP05
TP04
BH19
TP01
TP02
TP03
Dense Vegetation
EAST OF STP AREA
PSM TP06
PSM TP05
PSM TP04
PSM BH01
PSM TP03
PSM TP02
PSM TP01
STP AREA
TP13
TP14
BH30
Sewage Treatment Plant
BH31
TP11
TP16
TP15
TP12
TP08
LEGEND
PSM BOREHOLES
JBS & G / PSM BOREHOLES
PSM TEST PITS
JBS & G / PSM TEST PITS
NOTE: Base plan adopted from RPS drawing No. 114931-SEWER PLANT RevA "Urban Growth - Edmondson Park South Existing Sewer Treatment Plant" dated 3/9/2013
N
0
50
100
SCALE (m)
PSM
Pells Sullivan Meynink
JBS&G (Aust) Pty Limited
Edmondson Park Sewer Treatment Plant
Geotechnical Investigation
TEST PIT AND BOREHOLE APPROXIMATE LOCALITY PLAN
PSM2294-003R
Figure 1

APPENDIX A

ENGINEERING LOGS

EXPLANATION SHEET
EXCAVATION LOG

GENERAL

Method

Excavator
Backhoe
Others

Penetration

Symbol	Description
1	Low resistance
2	Moderate resistance
3	High resistance
4	Refusal

Water

Symbol	Description
	Water level
	Water inflow
	Complete water loss
	Partial water loss

Samples

Symbol	Description
U50	50 mm undisturbed tube sample
D	Disturbed sample
Bs	Bulk sample

SOIL DESCRIPTIONS

Unified Soil Classification System (USCS)

Major Divisions			Symbol	Typical Names
Coarse-Grained Soils More than 50% coarser than 0.075mm	Gravels (more than 50% coarser than 2mm)	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.
		Gravels With Fines	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels. gravel-sand-clay mixtures.
	Sands (more than 50% of coarse fraction finer than 2mm)	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines.
			SP	Poorly graded sands and gravelly sands, little or no fines.
		Sand With Fines	SM	Silty sands, sand-silt mixture.
			SC	Clayey sands, sand-clay mixtures.
Fine-Grained Soils 50% or more finer than 0.075mm	Silts and Clays Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour silty or clayey fine sands.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and silty clays of low plasticity.
	Silts and Clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity.
Highly Organic Soils			PT	Peat etc.

Moisture Condition

Term	Symbol
Dry	D
Moist	M
Wet	W
Wet at Plastic Limit	WP
Wet at Liquid Limit	WL

Strength

COHESIVE SOILS are described in terms of undrained shear strength, colour and structure with comments on minor constituents or apparent special features. Undrained shear strength is measured by hand penetrometer or determined by laboratory testing or estimated from experience. Classification in terms of undrained shear strength is as follows:

Term	Symbol	Description for Field Estimation	Shear Strength (kPa)	UCS (kPa)
Very Soft	VS	Easily penetrated several centimetres by fist.	<12	<25
Soft	S	Easily penetrated several centimetres by thumb. Can be moulded by light finger pressure.	12-25	25-50
Firm	F	Can be penetrated by thumb with moderate effort. Can be moulded by strong finger pressure.	25-50	50-100
Stiff	ST	Readily indented by thumb.	50-100	100-200
Very Stiff	VST	Readily indented by thumbnail.	100-200	200-400
Hard	H	Indented with difficulty by thumbnail	>200	>400

NON-COHESIVE SOILS are described in terms of density, colour, with comments on minor constituents or special features. Density (density index) is generally based on standard penetration testing (AS1289 Method 6.3.1), or other forms of penetration testing. Terms used in describing density are set out below:

Term	Symbol	Density Index	SPT N Values
Very Loose	VL	<15%	<5
Loose	L	15-35 %	5-10
Medium Dense	MD	35-65 %	10-30
Dense	D	65-85 %	30-50
Very Dense	VD	>85 %	>50

ROCK DESCRIPTIONS

Weathering

Term	Symbol	Description
Fresh	FR	Rock substance unaffected by weathering.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Moderately Weathered	MW	Rock substance affected by weathering to the extent staining extends throughout whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and signs of chemical or physical decomposition of individual minerals are usually evident. Porosity and strength may be increased or decreased when compared to the fresh rock substance, usually as a result of the leaching or deposition of iron. The colour and strength of the original fresh rock substance is no longer recognisable.
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 Soil Classification System, but the texture of the original rock is still evident.

Strength

Term	Symbol	Description for Field Estimation	UCS (MPa)
Extremely Low	R0	Thumbnail easily scratches; gentle blow with geological pick leaves deep impression.	0.7-1.5
Very Low	R1	Can be peeled by a pocket knife. Crumbles under firm blows with geological pick.	1.5-3.0
Low	R2	Can be peeled by a pocket knife with difficulty; shallow indentation made by firm blow of geological pick.	3.0-10
Medium	R3	Cannot be scraped or peeled with a pocket knife; specimen can be fractured with single firm blow of hammer end of geological pick.	10-25
High	R4	Specimen requires more than one blow with hammer end of geological pick to fracture.	25-80
Very High	R5	Specimen requires many blows of hammer end of geological pick to fracture.	>80

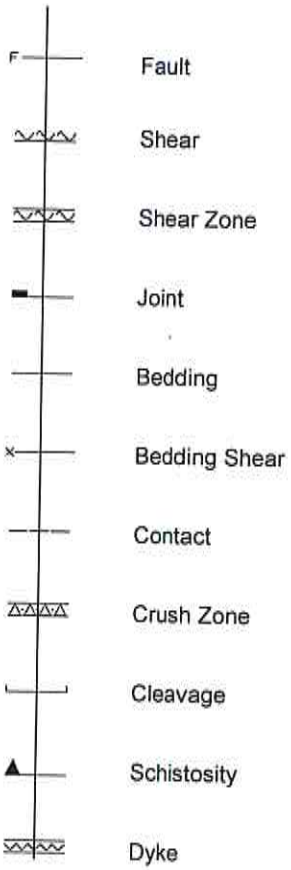
Defect Description

Order of description: type, inclination, shape, roughness, infill type, infill thickness, number

Defect Type

Symbol	Description
CL	Clay Seam
FL	Fault - fracture along which displacement is recognisable.
SR	Shear - a fracture along which movement has taken place but no displacement is recognisable. Evidence for movement may be slickensides, polishing and/or clay gouge.
SH	Sheared Zone - zone of multiple closely spaced fracture planes with roughly parallel planar boundaries usually forming blocks of lenticular or wedge shaped intact material. Fractures are typically smooth, polished or slickensided; and curved.
BG	Bedding parting - arrangement in layers of mineral grains or crystals parallel to surface of deposition along which a continuous observable parting occurs.
BSH	Bedding plane shear - a shear formed along a bedding plane
JN	Joint - a single fracture across which rock has little or no tensile strength and is not obviously related to rock fabric.
CN	Contact - surface between two lithologies.
SC	Schistosity - plane formed by the preferred orientation of the constituent minerals in a parallel arrangement in a coarse grained rock which has undergone regional metamorphism (schist).
CV	Cleavage - plane of mechanical fracture in a rock normally sufficiently closely spaced to form parallel-sided slices.
FO	Foliation
CZ	Crushed Zone - zone with roughly parallel, planar boundaries (commonly slickensided) containing disoriented usually angular rock fragments of variable size often in a soil matrix.
VN	Vein - fracture in which a tabular or sheet-like body of minerals have been intruded.
DK	Dyke - Igneous intrusion - often weathered and altered to a clay like substance.
DZ	Decomposed Zone - zone of any shape but commonly with parallel planar boundaries containing moderately to gradational boundaries into fresher rock.
FZ	Fractured Zone - a zone of closely spaced defects (mainly joints, bedding, cleavage and/or schistosity) comprised of core lengths in the order of 50 mm or less.

Standard Defect Symbols



Shape

Term	Symbol	Description
Planar	PL	Forms a continuous plane without variation in orientation.
Curved	CU	Has a gradual change in orientation.
Undulating	UN	Has a wavy surface shape.
Stepped	ST	Has one or more well defined steps
Irregular	IR	Many changes of orientation.

Roughness

Term	Symbol	Description
Slickensided or polished	Ro1	Very smooth, reflects light.
Smooth	Ro2	Roughness not detected with finger.
Defined ridges	Ro3	Sandpaper feel (fine to medium sandpaper).
Small steps	Ro4	Sandpaper feel (medium to coarse sandpaper).
Very rough	Ro5	Very well defined ridges and/or steps.

Infill Type

Symbol	Description
KL	Clean
CA	Calcite
CB	Carbonaceous
CHL	Chlorite
FE	Iron oxide
QZ	Quartz
MG	Manganese
SU	Sulphides
SE	Sericite
RF	Rock fragments
G	Gravel
S	Sand
Z	Silt
CL	Clay

Infill Thickness

Where infilling is present, the thickness of infill is recorded using the following convention:

ST Iron oxide staining of less than 1 mm
VN Veneer coating of less than 1 mm

If the infilling is greater than 1 mm, the actual thickness of infill is recorded in millimeters.

If infill is not present, a dash (-) is recorded

Number

Number of defects with similar characteristics.

Miscellaneous

CATACLASTIC – FAULT GOUGE: soft puggy, possibly foliated fault infill

CAVITY: cavity – as indicated by driller

NO_CORE: No Core

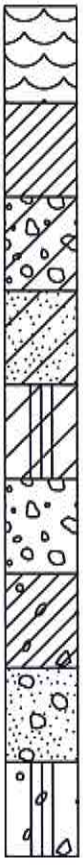
Man-Made

MAN-MADE – CONCRETE/ASPHALT: man-made surface paving

MAN-MADE – FILL: Fill (made ground)

MAN-MADE TOPSOIL: Topsoil

Soil



SOIL – ALLUVIUM: reworked material deposited by water in the past

SOIL – CLAY: Clay

SOIL – CLAYEY GRAVEL: Clayey Gravel

SOIL – CLAYEY SAND: Clayey Sand

SOIL – CLAYEY SILT: Clayey Silt

SOIL – GRAVEL: Gravel

SOIL – GRAVELLY CLAY: Gravelly Clay

SOIL – GRAVELLY SAND: Gravelly Sand

SOIL – GRAVELLY SILT: Gravelly Silt

SOIL – SAND: Sand

SOIL – SANDY CLAY: Sandy Clay

SOIL – SANDY GRAVEL: Sandy Gravel

SOIL – SANDY SILT: Sandy Silt

SOIL – SHELLS: unconsolidated marine material

SOIL – SILT: Silt

SOIL – SILTY CLAY: Silty Clay

SOIL – SILTY SAND: Silty Sand

SOIL – SILTY GRAVEL: Silty Gravel

PSM

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Geotechnical Logging

LITHOLOGY GRAPHIC SYMBOLS
SOIL, MAN-MADE & MISCELLANEOUS

Igneous

IGNEOUS – ANDESITE: mid range mafic to felsic igneous fine grained rock (moderate in quartz and in colour)

IGNEOUS – BASALT (MAFIC): mafic igneous fine grained rock (dark in colour)

IGNEOUS – DIORITE: mid range felsic to mafic igneous coarse grained rock (moderate quartz)

IGNEOUS – DOLERITE: dolerite

IGNEOUS – GABBRO (MAFIC): mafic igneous coarse grained rock (low quartz, dark in colour)

IGNEOUS – GRANITE (FELSIC): felsic igneous coarse grained rock (light in colour)

IGNEOUS – RHYOLITE (FELSIC): felsic igneous fine grained rock (light in colour)

IGNEOUS – TUFF/IGNIMBRITE: extremely fine grained air fall volcanic

Metamorphic

METAMORPHIC – AMPHIBOLITE: non-foliated metamorphic rock formed by regional metamorphism of mafic igneous rocks

METAMORPHIC – GNEISS: a foliated high grade metamorphic rock

METAMORPHIC – HORNFELS: contact metamorphic rock

METAMORPHIC – MARBLE: metamorphosed limestone

METAMORPHIC – SCHIST: a foliated high grade metamorphic rock

METAMORPHIC – SKARN: contact metamorphosed carbonate body

METAMORPHIC – SLATE/PHYLLITE: low grade regionally metamorphosed rock

Sedimentary

SEDIMENTARY – BRECCIA: consolidated clastic rock made up of angular clasts

SEDIMENTARY – CALCRETE/SILCRETE: Calcrete or silcrete

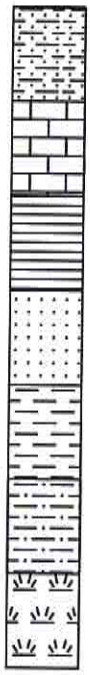
SEDIMENTARY – CHERT: chert/quartz

SEDIMENTARY – COAL: Coal

SEDIMENTARY – CONGLOMERATE: consolidated rounded clastic material

SEDIMENTARY – DOLOMITE: Dolomite

SEDIMENTARY – IRONSTONE: hard iron enriched layer



SEDIMENTARY – LAMINITE: interbedded sandstone and siltstone

SEDIMENTARY – LIMESTONE: Limestone

SEDIMENTARY – MUDSTONE: Mudstone

SEDIMENTARY – SANDSTONE: Sandstone

SEDIMENTARY – SHALE: Shale

SEDIMENTARY – SILTSTONE: Siltstone

SEDIMENTARY – SWAMP/PEAT: Peat (Swamp Symbol)

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Geotechnical Logging

LITHOLOGY GRAPHIC SYMBOLS
IGNEOUS, METMORPHIC & SEDIMENTARY

Pells Sullivan Meynink

Engineering Consultants
Rock-Soil-Water

Excavation Log

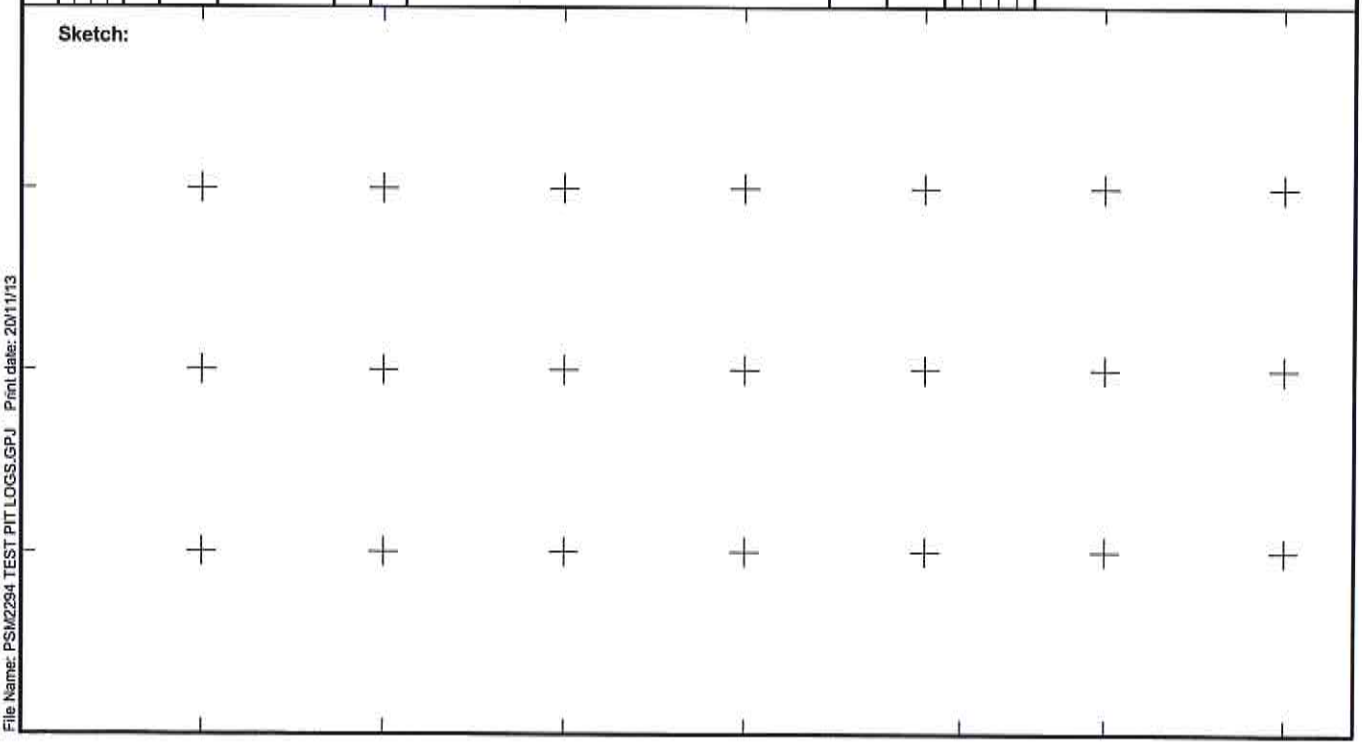
Excavation No: PSM TP01
Sheet: 1 of 1
Job No: PSM2294

Client:	JBS&G (Aust) Pty Limited	**Date commenced:**	01/11/2013
Principal:		**Date completed:**	01/11/2013
Project:	Edmondson Park Sewer Treatment Plant Geotechnical Investigation	**Logged by:**	AI/DS
Site location:	East of STP	**Checked by:**	AS

Equipment type:	CAT 20t Excavator	**R.L. surface:**	~47 m	**Vertical datum:**	AHD
Excavation dimensions:	1 m wide x 4 m long approx.	**Easting:**	302872 m	**Horizontal datum:**	MGA
		Northing:	6239200 m		

Method	Penetration (1 2 3)	Water	Samples	R.L. (m)	Depth (m)	Graphic Log	USCS Symbol	Material (SOIL TYPE; plasticity or particle characteristics, colour, secondary and minor components / ROCK TYPE; weathering, colour, secondary and minor components)	Moisture Condition	Estimated Strength	Pocket Penetrometer (kPa) 100 200 300 400	Structure and Additional Observations
Excavator		None observed			0.0		SM	Silty SAND; fine grained, red brown, with some gravel, trace rootlets	D	L		Topsoil
							ML	SILT; red, trace gravel and rootlets		VST		Inferred fill Some refuse (building rubble)
							SW	Gravelly SAND; fine grained, brown, gravel is subangular, with some cobbles, trace boulders		D		
					1.0		CL	CLAY; medium plasticity, grey and red, trace gravel (ironstone)	M	H		
								SHALE; highly weathered, grey and red, laminated	D	R1		
					2.0			Practical refusal of excavator at 1.6 m				
					3.0							
					4.0							

Sketch:



File Name: PSM2294 TEST PIT LOGS.GPJ Print date: 20/11/13