



10th May 2016

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Salinity Assessment – Lot 846, Gregory Hills Corporate Park

Dear Mr Calais,

A.D. Envirotech Australia Pty Ltd (ADE) is providing this letter in response to the request from Camden Council regarding a salinity investigation at the site within Gregory Hills Corporate Park, Lot 846, DP 1203107. The request is listed as Item #3 within the letter 'Request for SEARs for Medical Campus Precinct (SSD 7387) The Hermitage Way, Gledswood Hills, Camden LGA'.

ADE can provide the following information with regards to salinity within soil materials at the site, please refer to the following reports accompanying this letter:

- Douglas Partners Report 76510.00, 'Report on Salinity Investigation and Management Plan, Proposed Subdivision, Lot 701 in Deposited Plan 1154772, Gregory Hills Drive, Gledswood Hills NSW', dated May 2012
- ADE Report GRH-02-10383/ENV1/v1 final, 'Review of Imported Soil Materials & Gate Check Sampling – Stage 3, Gregory Hills Corporate Park, Gregory Hills Drive, Gledswood Hills NSW', dated the 4th of April 2016.

THE DP report listed above is a salinity investigation of the site prior to any fill material being imported. The investigation concluded that soils within the site are classified as mildly and moderately aggressive to concrete and steel and moderately to very saline conditions were present.

Throughout the importation of fill material into the site during the development works, ADE undertook gate check sampling of the various materials imported into the site to ensure compliance with the Fill Management Protocol with regards to contamination and salinity. ADE report GRH-02-10383 summarises the results of the sampling throughout the Stage 3 sections of the site, concluding that although there were a few minor non-conformances, the fill material imported is considered to be compliant with the FMP.

If you have any questions regarding the above information feel free to contact me on the details below.

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Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Salinity Investigation and Management Plan

Proposed Subdivision
Lot 701 in Deposited Plan 1154772
Gregory Hills Drive
Gledswood Hills

Prepared for
Gregory Hills Corporate Park Pty Ltd

Project 76510.00
May 2012

Integrated Practical Solutions





Douglas Partners

Geotechnics | Environment | Groundwater

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		21 May 2012
Reviewer		21 May 2012



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Report on Salinity Investigation and Management Plan Lot 701, in Deposited Plan 1154772, Gregory Hills Drive Gledswood Hills

1. Introduction

This report presents the results of a salinity investigation and provides a salinity management plan for the proposed subdivision at Lot 701 in Deposited Plan 1154772 at the corner of Gregory Hills drive and Camden Valley Way, Gledswood Hills. The work was commissioned by Mr Richard Harris of Gregory Hills Corporate Park.

Saline soils affect much of the Western Sydney Region. Buildings and infrastructure located on shales of the Wianamatta Group are particularly at risk. Salinity can affect urban structures in a number of ways including corrosion of concrete, break down of bricks and mortar, corrosion of steel (including reinforcement), break up of roads, attack on buried infrastructure, reduced ability to grow vegetation and increased erosion potential.

It is understood that a commercial subdivision is proposed and that an assessment of soil salinity is required for submission to Camden Council with the subdivision application and to assist in conceptual planning of the development.

The investigation comprised excavation of test pits, followed by laboratory testing of selected samples, engineering analysis and reporting. Details of the work undertaken and the results obtained are given within this report, together with comments relating to design and construction practice.

This assessment was undertaken concurrently with a Phase 2 contamination assessment at the Site (Project 76510.01) which is reported separately.

2. Scope of Works

The current report includes two parts:

1. Salinity assessment of the Site based upon:
 - Collection of samples at regular depth intervals from 87 test pits (29 deep test pits to 3 m and 58 shallow test pits to 0.5 m);
 - Inspection of the Site for signs of salinity;
 - Analysis of electrical conductivity (EC1:5), pH and soil texture test results for 227 soil and weathered rock samples determined at a NATA accredited analytical laboratory, for classification of salinity and aggressivity;

- Laboratory analysis of additional salinity, aggressivity and erodibility indicators, including chloride and sulphate concentrations (100 samples), sodicities (52 samples) and dispersibility testing (10 samples) at a NATA accredited analytical laboratory; and
 - Assessment of the results with respect to potential for salinity impacts on the development.
2. Preparation of a Salinity Management Plan (SMP) for the Site providing guidance on development strategies to reduce the impact of saline materials (if and where found). The Plan was based upon:
- Review of the salinity investigation results;
 - Review of the following documents detailing Council requirements:
 - o 'Building in Salinity Prone Environments', Camden Council, 2004;
 - o 'Map of Salinity Potential in Western Sydney', DNR (2002);
 - o 'Guidelines to Accompany Map of Salinity Potential in Western Sydney', DNR (2002);
 - o 'Western Sydney Salinity Code of Practice' (amended January 2004), Rebecca Nicholson for WSROC, DNR and Natural Heritage Trust;
 - o 'Guide to Residential Slabs and Footings in a Saline Environment', Cement, Concrete and Aggregates, Australia (2005);
 - o 'Introduction to Urban Salinity', DNR (2003);
 - o 'Building in a Saline Environment' DNR (2003);
 - o 'Roads and Salinity', DNR (2003);
 - o 'Indicators of Urban Salinity', DNR (2002);
 - o 'Site Investigations for Urban Salinity', DNR (2002);
 - o 'Urban Salinity Processes', DNR (2004);
 - o 'Waterwise Parks and Gardens', DNR (2004); and
 - o 'Broad Scale Resources for Urban Salinity Assessment' DNR (2002).

3. Previous Investigations and Results

A previous investigation within the subject site and its immediate surrounds was undertaken by Douglas Partners Pty Ltd (DP) in 2006 as part of the land capability assessment of the Turner Road Precinct. The results of the investigation were formalised in a report entitled "*Report on Land Capability and Contamination Assessment, Turner Road Precinct, Catherine Field and Currans Hill*" (Project 40741) dated 28 February 2007. The previous investigation was undertaken prior to bulk earthworks.

The investigation comprised site history searches, site inspection, non-intrusive and intrusive site investigation, laboratory testing of selected samples, engineering analysis and reporting. An electromagnetic (EM) survey was undertaken, and results were assessed taking into account salinity

analyses on 145 samples from 110 test pits (of which five test pits lie within the Site boundary) throughout the Turner Road Precinct. Soils in the area of the Site were identified generally as slightly saline to very saline.

Extracts of maps from the Land Capability Assessment showing sampling locations and findings (including Lot 71 in Deposited Plan 1153631) are provided in Appendix B.

4. Site Description

The Site is identified as Lot 701 in Deposited Plan 1154772, located on the corner of Camden Valley Way and the northern side of Gregory Hills Drive in the suburb of Gledswood Hills. The site has an irregular shape and covers an area of approximately 29 ha. The Site location and boundaries are shown on Drawing 1, Appendix B.

At the time of undertaking this assessment, the Site consisted of a grass-covered paddock with a tributary of South Creek running generally in a south-east to north-west direction within the southern and central portion of the Site. A detention basin was located in the north-western to central portion of the Site. Filling material consisting of reworked natural clays, placed for roadway construction, was present along the current Gregory Hills Drive alignment. A sewage pump station had been constructed to the north-west of the Site in the adjacent Lot 700 in Deposited Plan 1154772. An access road has been constructed through the site from Gregory Hills drive to the pump station.

Some ground disturbances and stockpiles were noted within the Site which were formed during the construction of Gregory Hills Drive, the sewage pump station (north-west of the Site) and the sewer within the Site.

5. Geology and Hydrogeology

Reference to the 1:100 000 Wollongong – Port Hacking Geological Series Sheet indicates that the site is underlain by Bringelly Shale of the Wianamatta Group of Triassic age which, in the vicinity of the site, includes an unnamed, fine to medium grained quartz-lithic sandstone member. The Bringelly Shale typically comprises shale, siltstone, claystone and laminite with coal bands, all of which weather to form clays of high plasticity.

Additional reference to the Map of Salinity Potential in Western Sydney indicates that the area surrounding the tributary of south creek running through the Site is predominantly located in an area of "Known Salinity" and "High salinity potential". The western portion of the Site is also located in an area of "High salinity potential" where "conditions are similar to areas of known salinity". The remaining portions of the Site are of "Moderate Salinity Potential" where "saline areas may occur which have not yet been identified or may occur if risk factors change adversely". The classification is based on the landform and geology and it is noted that due to the resolution at the scale of the mapping, it is not possible to delineate the zone boundaries with precision.

McNally (2005) describes some general features of the hydrogeology of Western Sydney which are relevant to this Site. The shale terrain of much of Western Sydney is known for saline groundwater, resulting either from the release of connate salt in shales of marine origin or from the accumulation of windblown sea salt. Seasonal groundwater level changes of 1 – 2 m can occur in a shallow regolith aquifer or a deeper shale aquifer due to natural influences.

Groundwater investigations undertaken by DP in the Camden area and previous studies of areas underlain by the Wianamatta Group and Quaternary river alluvium indicate that:

- the shales have a very low intrinsic permeability, hence groundwater flow is likely to be dominated by fracture flow with resultant low yields (typically < 1 L/s) in bores; and
- the groundwater in the Wianamatta Group is typically brackish to saline with total dissolved solids (TDS) in the range 4000 – 5000 mg/L (but with cases of TDS up to 31750 mg/L being reported). The dominant ions are typically sodium and chloride and the water being generally unsuitable for livestock or irrigation.

6. Field Work Methods

The current field work comprised the excavation of 87 test pits (TP) with a JCB 4CX backhoe fitted with a 450 mm bucket. These included TP 1 to 29 to depths of up to 3 m (deep test pits) and TP 29 to 87 to depths of 0.5 m (shallow test pits). The pits were logged on site by a geo-environmental engineer, who collected representative disturbed samples to assist in strata identification and for laboratory testing. After carefully backfilling each test pit, the surface was reinstated to its previous level.

The locations of the test pits are shown on Drawing 1 in Appendix A. Surface levels (relative to Australian Height Datum [AHD]) were determined by interpolation of mapping contours provided.

7. Results

The majority of the Site was covered by topsoil which was underlain by clay, silty clay, gravelly clay, silty sandy clay and gravelly silty clay, with traces of ironstone gravels noted in some locations. These soils were underlain in turn by sandstone, siltstone and shale bedrock.

Filling was encountered in twelve (12) test pits which were located adjacent to the current Gregory Hills Drive road alignment. Fill depths of 0.3 m to 2.1 m were measured and two test pits were discontinued in fill at 0.5 m bgl. The fill material appeared to be reworked natural materials and typically comprised clays, silty clays and silty gravelly clays with shale, sandstone and ironstone inclusions.

TP44, which is located on the northern boundary of the Site, also encountered filling to a depth 0.3 m and consisted of brown-grey gravelly clayey silt.

Five test pits were excavated through five stockpiles which were located within the Site. Samples from three stockpiles (TP5, TP19, TP26) consisted of brown clayey silt topsoil with rootlets. Samples from the two remaining stockpiles consisted of brown, gravelly, shaly, silty clay (TP5) and low to medium strength shale and sandstone with silty clay (TP27A).

The test pit logs are provided in Appendix C, together with notes defining classification methods and descriptive terms.

Signs of efflorescence and bare ground were noted directly to the north of the Site, within South Creek, during the inspection. No other signs of efflorescence were noted during the inspection, however, the paddock was covered in long grass.

Free groundwater was observed within TP12, TP15, TP18, TP23 and TP57 at depths of 0.6 m, 2.1 m, 2.3 m, 1.3 m and 0.4 m bgl respectively. No free groundwater was observed in the remainder of the test pits excavated during this investigation. However it is noted that test pits were immediately backfilled on completion which precluded long term monitoring of groundwater levels.

A Summary Table (Appendix D, presents the results of laboratory tests, assessments of aggressivity to concrete and steel, sodicity class, textural classification, calculated salinity E_{Ce} and salinity class inferred from E_{Ce} values using the method of Richards (1954). The Summary Table (Appendix D) also includes results of Emerson Crumb tests and derived Dispersion Potentials. The detailed laboratory test reports and chain of custody information are provided in Appendix E.

Drawing 2 (Appendix A) shows the areas of the Site which are proposed to be cut and filled and the Summary Table (Appendix D) presents approximate, interpolated cut and fill depths. The maximum proposed cut at a test pit location is 2 m at TP51 and the maximum proposed fill is up to 8.0 m at various locations over the Site. All other test pit locations had relatively shallow cut of less than 1.5 m.

A “worst case” scenario was used to classify the extent of salinity and aggressivity within the Site. This was achieved by utilising a maxima/minima analysis within four area types defined by the cut-fill diagram provided for this assessment.

For foundation depths of up to 1.0 m below the proposed surface:

- Cut areas – relevant maximum or minimum values from the sample closest to the proposed surface level (after cutting) and from 0.5 m and 1.0 m below that sample (where available) were determined at individual locations and interpolated between locations to assess future foundation zone conditions in these sub-areas of the finished site;
- Fill areas - A significant amount of fill is expected to be imported from offsite sources and a requirement for importation will be that the filling material does not exceed the aggressivity or salinity of the material on which it is placed, ie the imported materials will have similar classifications to the materials at and below the current ground surface in the areas to be filled. Without knowledge of the material to be imported, a worst case scenario can therefore be applied to the current ground surface, ie the base of fill. The relevant maximum or minimum values from the sample at the current ground surface level (0.5 m sample) and from 0.5 m below that sample (1.0 m sample where available) were determined at individual locations and interpolated between locations to assess the future imported fill limitations, ie the future foundation zone conditions in these sub-areas of the finished site;

For deep foundations (i.e. piers):

- Finished surface area – This comprised the entire site area, where minimum pH and resistivity values at individual locations (from all investigated depths below the proposed surface level), were interpolated across the site to assess soil aggressivity to future concrete and steel piles.

For Excavated Material (above proposed surface level in cut areas)

- Proposed Fill Material – The most saline and most aggressive classifications of all the material to be excavated from above the proposed surface within the cut areas, were used to classify the material to be re-used on site as filling.

These values were used for spatial mapping of aggressivities and salinities throughout the investigation area (refer Drawings 3 to 6, Appendix A).

Table 1 summaries total test sample numbers and the range of test results obtained.

Table 1: Summary of Test Results

Parameter		Units	Samples	Minimum	Maximum
pH		pH units	227	4.8	9.4
Chlorides		(mg/kg)	100	9	2100
Sulphates		(mg/kg)	100	7	340
Aggressivity	to Concrete	[AS2159]		non-aggressive	moderate
	to Steel	[AS2159]		non-aggressive	severe
Exchangeable Sodium (Na)		(meq/100g)	52	0.3	6.1
CEC (cation exchange capacity)		(meq/100g)	52	7	24
Sodicity [Na/CEC]		(ESP%)	52	2.6	30.7
Sodicity Class		[after DLWC]	-	non-sodic	highly sodic
EC1:5 [Lab.]		(mS/cm)	227	24	1200
Resistivity		Ω .cm	227	833.3	41666.7
ECe [M x EC1:5] ¹		(dS/m)	-	0.3	12
Salinity Class		[after Richards 1954]	-	non-saline	very saline

1 M is soil textural factor

7.1 Aggressivity

Figure 1 (following page) presents variations of aggressivity with depth, based on pH profiles at deep test pit locations, together with the aggressivity class ranges indicated in Australian Standard AS2159 (2009). The absence of free groundwater from the majority of test pits and the impermeability of the sampled clay-rich materials indicate that materials from most test pits are in Condition “B” as defined by AS2159. Condition “A” materials were encountered at TP12, TP15, TP18, TP23, and TP57 at depths close to groundwater level. These locations were in relatively low-lying areas and adjacent to drainage lines within and adjacent to the Site.

The pH profiles of Figure 1 indicate that the materials throughout the Site, at all investigated depths, are non-aggressive to steel. The chloride concentration guidelines of AS2159 support this non-aggressive classification. However, based on resistivity criteria (Appendix D), samples were classified as non-aggressive to severely aggressive to steel.

The Summary Table also indicates that 70% of all samples were non-aggressive to concrete, 29% were mildly aggressive, and 1% were moderately aggressive.

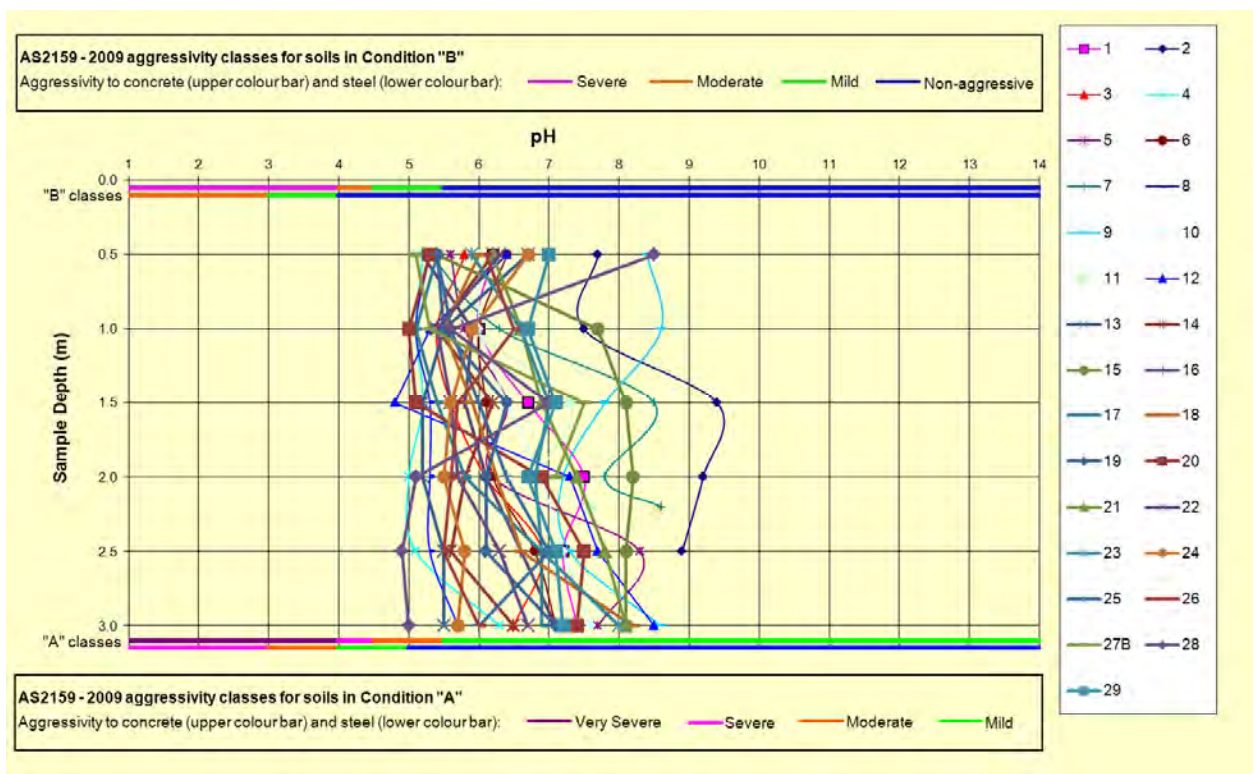


Figure 1: Vertical pH Profiles and Aggressivity Classes

The worst case results for each test pit were contoured to define areas of mild (pH 4.5 – 5.5) and moderate (pH 4 – 4.5) aggressivity to concrete foundations, represented by colour zones on Drawing 3 (Appendix A).

Similarly, the worst case results for each test pit were contoured to define areas of mild (pH 4.5 – 5.5) and moderate (pH 4 – 4.5) aggressivity to concrete piles, represented by colour zones on Drawing 4 (Appendix A).

Calculated soil resistivities indicated higher aggressivities to steel than were indicated by pH measurements, hence worst case resistivities were interpolated and contoured to define areas of mild aggressivity (1000 – 2000 Ohm-cm), moderate aggressivity (<1000 Ohm-cm for Condition B) and severe aggressivity (<1000 Ohm-cm for Condition A) to steel (Drawings 5, Appendix A).

7.2 Salinity

Figure 2 (below) presents the variations of salinity with depth, based on salinity (ECe) profiles at deep test pit locations, together with the salinity classifications of Richards (1954).

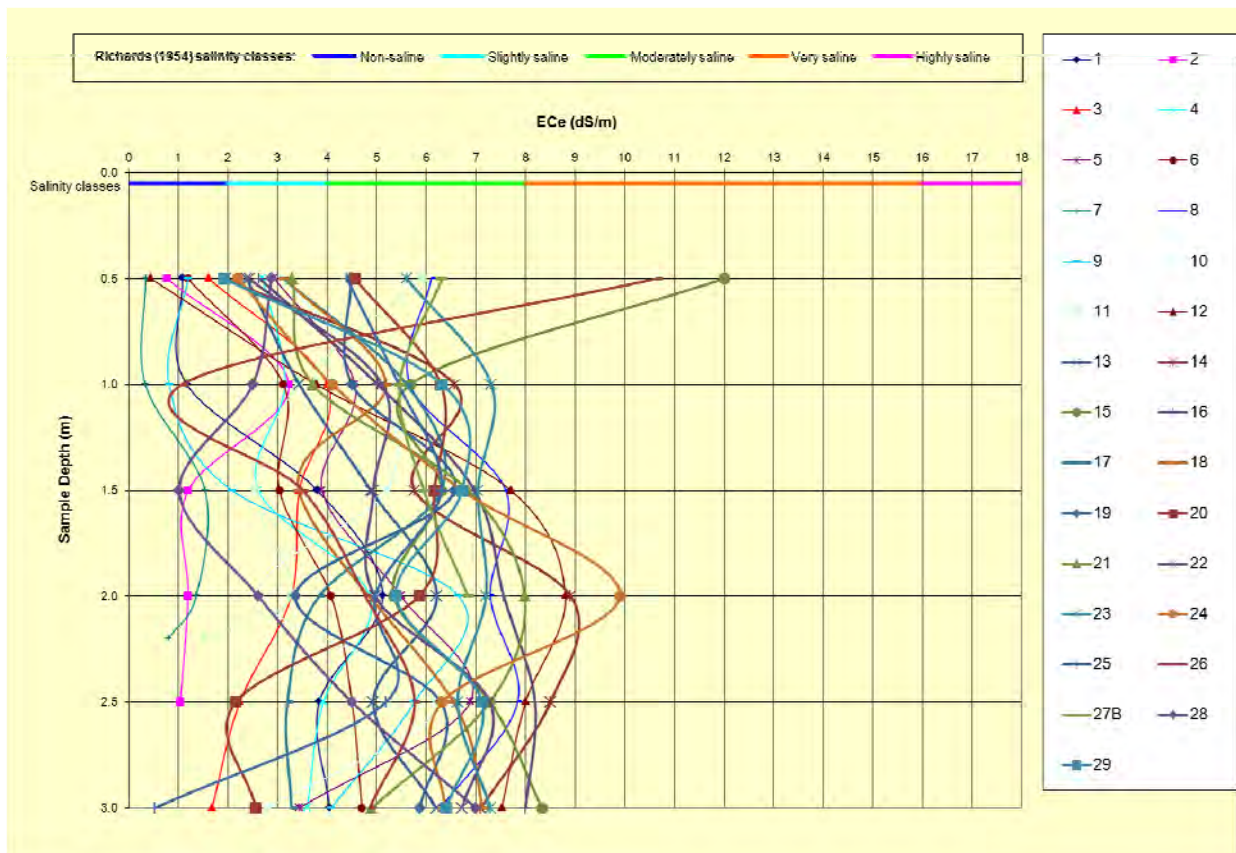


Figure 2: Vertical Salinity Profiles and Salinity Classes

The Summary Table (Appendix D) indicates that 19% of all soil samples were non-saline, 32% were slightly saline, 45% were moderately saline and 4% were very saline.

As for aggressivity, worst case ECe values were interpolated and contoured to define areas of slightly saline (ECe 2 – 4 dS/m), moderately saline (ECe 4 – 8 dS/m) and very saline (ECe 8 – 16dS/m) material (see Drawing 6, Appendix A).

7.3 Sodicty and Dispersibility

Sodicty tests reported in the Summary Table show non-sodic to highly sodic soils, indicating some potential for erodability of soils left exposed.

Dispersion potentials, tested at depths of 0.5 m by the Emerson Crumb Test (refer Summary Table, Appendix D), were determined to be classes 5 and 6 (no dispersion) over nine of the locations tested and class 3 (dispersive) in one location.

8. Impact of the Site Materials on the Proposed Development

The mild and moderate aggressivity to concrete and mild to severe aggressivity to steel of some materials, the presence of moderately saline and very saline materials in most areas and the highly sodic soils in some areas are naturally occurring features of the local landscape and are not considered significant impediments to the proposed development, provided appropriate remediation or management techniques are employed.

8.1 Aggressivity

As indicated above in Section 7.1, the site materials have been classified as mildly and moderately aggressive to concrete over substantial areas (refer Drawings 3 and 4, Appendix A), using the criteria within Australian Standard AS2159 (2009).

Concrete classifications under AS2159 allow for a 40 – 60 year lifetime, provided a minimum concrete strength of 25 MPa is applied in non-aggressive conditions, 32 MPa in mildly aggressive conditions and 40 MPa in moderately aggressive conditions. Where concrete of lower than recommended strength is employed then a shorter lifetime may be expected, however no estimates are given in the Standard of this reduced lifetime.

In areas where materials are mildly, moderately and severely aggressive to steel (refer Drawing 5, Appendix A), corrosion allowance should be taken into account by the designer as discussed in the Salinity Management Plan (Section 9).

8.2 Salinity

Moderately saline and very saline conditions were found within the investigated depth zones as indicated in Drawing 6 (Appendix A), flagging the potential for salt-induced damage to susceptible services, slabs and shallow footings and the need for appropriate salinity management

8.3 Sodicty

Results (refer Summary Table, Appendix D) indicate that soils within depths of 0.5 m below the present ground surface are sodic to highly sodic and it is considered that there is potential for sodic soils (either in situ, transported or imported as filling) to occur at the proposed ground surface. Sodic soils have low permeability due to infilling of interstices with fine clay particles during the weathering process, restricting infiltration of surface water and potentially creating perched water tables, seepage in cut faces or ponding of water in flat open areas. In addition, sodic soils tend to erode when exposed. Management of sodic soils is therefore required to prevent these adverse affects. As detailed in Section 9 below, management of sodic soils, following completion of bulk earthworks, is focussed on prevention of exposure.

8.4 Excavated Material

Worst case results from samples collected within areas to be cut indicate that the proposed excavated material is mildly aggressive to both concrete and steel and is moderately saline. However, a deep test pit adjacent to an area of cut (TP11), indicates very saline material at the proposed cut depth in the vicinity of the shallower test pits TP49, 50 and 51. The worst case classifications of the proposed excavated material local to TP49, 50 and 51 are therefore revised to: mildly aggressive to concrete and steel; and very saline.

The excavated fill material will be required to be placed in areas of similar or higher aggressivity and salinity classification. For the case of the cut area surrounding TP49, 50 and 51 the excavated material will need to be placed in the adjacent deep fill area surrounding TP15 and TP60 (refer Drawing 2, Appendix A) which has a very saline classification.

9. Salinity Management Plan

The current salinity investigation indicates that materials within the Site are non-saline to very saline. Testing of other parameters associated with salinity indicates that the materials are non-aggressive to severely aggressive to steel in all locations (by the resistivity and chloride criteria of AS2159) and mildly aggressive to moderately aggressive to concrete within the Site (by the pH and sulphate criteria of AS2159). In addition, shallow soils were highly sodic.

The following management strategies are confined to the management of those factors with a potential to impact on the development.

- A. Management should focus on capping of the upper surface of the sodic soils, both exposed by excavation and placed as filling, with a more permeable material to prevent ponding, to reduce capillary rise, to act as a drainage layer and to reduce the potential for erosion.

- B. When possible, place excavated materials in fill areas with similar salinity characteristics (ie: place material onto in-situ soils with a similar or higher aggressivity or salinity classification). With respect to imported fill material, testing should be undertaken prior to importation, to determine the salinity characteristics of the material, which should be non-aggressive and non-saline to slightly saline where possible but in any case not more aggressive or more saline than the material on which it is to be placed.
- C. Sodic soils can also be managed by maintaining vegetation where possible and planting new salt tolerant species. The addition of organic matter, gypsum and lime can also be considered where appropriate. After gypsum addition, reduction of sodicity levels may require some time for sufficient infiltration and leaching of sodium into the subsoils, however capping of exposed sodic material should remain the primary management method. Topsoil added at the completion of bulk earthworks is, in effect, also adding organic matter which may help infiltration and leaching of sodium.
- D. Avoiding water collecting in low lying areas, in depressions, or behind fill. This can lead to water logging of the soils, evaporative concentration of salts, and eventual breakdown in soil structure resulting in accelerated erosion.
- E. Any pavements should be designed to be well drained of surface water. There should not be excessive concentrations of runoff or ponding that would lead to waterlogging of the pavement or additional recharge to the groundwater through any more permeable zones in the underlying filling material.
- F. Surface drains should generally be provided along the top of batter slopes to reduce the potential for concentrated flows of water down slopes possibly causing scour.
- G. Salt tolerant grasses and trees should be considered for landscaping, to reduce soil erosion as in Strategy A above and to maintain the existing evapo-transpiration and groundwater levels. Reference should be made to an experienced landscape planner or agronomist.

The following additional strategies are recommended for completion of service installation and for building construction. These strategies should be complementary to standard good building practices, including cover to reinforcement within concrete and correct installation of a brick damp course (where used), so that it cannot be bridged to allow moisture to move into brick work and up the wall.

- H. Where materials are classified as non-aggressive to concrete piles (refer Drawing 4), piles should nevertheless have a minimum strength of 32 MPa and a minimum cover to reinforcement of 45 mm (as per AS2159).
- I. Where materials are classified as mildly aggressive to concrete piles (refer Drawing 4), piles should have a minimum strength of 32 MPa and a minimum cover to reinforcement of 60 mm (as per AS2159) to limit the corrosive effects of the surrounding materials (in accordance with AS2159).
- J. Where materials are classified as moderately aggressive to concrete piles (refer Drawing 4), piles should have a minimum strength of 40 MPa and a minimum cover to reinforcement of 65 mm (as per AS2159) to limit the corrosive effects of the surrounding materials (in accordance with AS2159).

- K. With regard to concrete structures, for non-saline and slightly saline materials with salinities less than 4 dS/m (refer Drawing 6):
- Where materials are classified as non-aggressive to concrete (refer AS3600 – A1 and Drawing 3), slabs and foundations should have a minimum strength of 20 MPa, and should be allowed to cure for a minimum of three days (as per AS3600) to limit the corrosive effects of the surrounding materials;
 - Where materials are classified as mildly aggressive to concrete (refer AS3600 – A2 and Drawing 3), slabs and foundations should have a minimum strength of 25 MPa, and should be allowed to cure for a minimum of three days (as per AS3600) to limit the corrosive effects of the surrounding materials; and
 - Where materials are classified as moderately aggressive to concrete (refer AS3600 – B1 and Drawing 3), slabs and foundations should have a minimum strength of 32 MPa, and should be allowed to cure for a minimum of seven days (as per AS3600) to limit the corrosive effects of the surrounding materials.
- L. With regard to concrete structures, for moderately saline materials with salinities of 4 – 8 dS/m (refer Drawing 6):
- Where materials are classified as non-aggressive to concrete (refer AS3600 – A1 and Drawing 3), slabs and foundations should have a minimum strength of 25 MPa, a minimum cover to reinforcement of 45 mm from unprotected ground and should be allowed to cure for a minimum of three days (as per AS3600) to limit the corrosive effects of the surrounding materials;
 - Where materials are classified as mildly aggressive to concrete (refer AS3600 – A2 and Drawing 3), slabs and foundations should have a minimum strength of 25 MPa, a minimum cover to reinforcement of 45 mm from unprotected ground and should be allowed to cure for a minimum of three days (as per AS3600) to limit the corrosive effects of the surrounding materials; and
 - Where materials are classified as moderately aggressive to concrete (refer AS3600 – B1 and Drawing 3), slabs and foundations should have a minimum strength of 32 MPa, a minimum cover to reinforcement of 45 mm from unprotected ground and should be allowed to cure for a minimum of seven days (as per AS3600) to limit the corrosive effects of the surrounding materials.
- M. With regard to concrete structures, for very saline materials with salinities of 8 – 16 dS/m (refer Drawing 6):
- Where materials are classified as non-aggressive to concrete (refer AS3600 – A1 and Drawing 3), slabs and foundations should have a minimum strength of 32 MPa, a minimum cover to reinforcement of 50 mm from unprotected ground and should be allowed to cure for a minimum of seven days (as per AS3600) to limit the corrosive effects of the surrounding materials;
 - Where materials are classified as mildly aggressive to concrete (refer AS3600 – A2 and Drawing 3), slabs and foundations should have a minimum strength of 32 MPa, a minimum cover to reinforcement of 50 mm from unprotected ground and should be allowed to cure for a minimum of seven days (as per AS3600) to limit the corrosive effects of the surrounding materials; and

- Where materials are classified as moderately aggressive to concrete (refer AS3600 – B1 and Drawing 3), slabs and foundations should have a minimum strength of 32 MPa, a minimum cover to reinforcement of 50 mm from unprotected ground and should be allowed to cure for a minimum of seven days (as per AS3600) to limit the corrosive effects of the surrounding materials.
- N. Any future installation of concrete pipes up to a maximum diameter of 750 mm, in the defined areas of moderately saline to very saline or mildly aggressive to moderately aggressive material at services depths, should employ fibre reinforced cement. Alternatively, concrete pipes in these areas should be encased in outer PVC conduits or should have a minimum equivalent strength as defined in L and M above.
- O. Concrete pipes with a larger diameter than 750 mm should utilise sulphate resistant cement.
- P. Resistivity results indicate materials that are aggressive to steel (Drawing 5, Appendix A). This drawing identifies mild aggressivity to steel (1000 – 2000 Ohm-cm), moderate aggressivity to steel (<1000 Ohm-cm, Condition B) and severe aggressivity to steel (<1000 Ohm-cm, Condition A) over the Site. For these areas, the following corrosion allowances (as per AS 2159 – 2009) should be taken into account by the designer:
- Mild: uniform corrosion allowance 0.01 – 0.02 mm/year;
 - Moderate: uniform corrosion allowance 0.02 – 0.04 mm/year.
 - Severe: uniform corrosion allowance 0.04 – 0.1 mm/year
- In instances where a coating is applied to the pile, if the design life of the pile is greater than the design life for the coating, consideration must be given to corrosion of the pile in accordance with the above list.
- Q. In all masonry buildings a brick damp course should be installed so that it cannot be bridged either internally or externally. This will prevent moisture moving into brickwork and up the wall.
- R. The use of a bedding layer of sand (100 mm thick), overlain by a membrane of thick plastic (damp proof as opposed to vapour proof), is recommended under concrete slabs to act as a moisture barrier and drainage layer and to restrict capillary rise under the slab. As an alternative method for protection of concrete slabs for non-residential construction, high strength (32 MPa) concrete may be placed directly on a layer of crushed rock. Such rock should be sourced locally from an area classified as non-saline or slightly saline or should be imported after stockpiling, testing and classification as non-saline or slightly saline.

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11. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Lot 701 in Deposited Plan 1154772, Gregory Hills Drive, Gledswood Hills. This report is provided for the exclusive use of Gregory Hills Corporate Park Pty Ltd for this project only and for the purpose(s) as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions across the site between and beyond the sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as a part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About this Report
Drawings 1 – 6

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough





Other

fg	fragmented
bnd	band
qtz	quartz



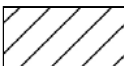
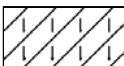
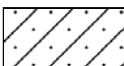

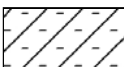

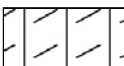


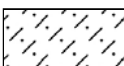


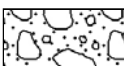
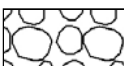

Symbols & Abbreviations

Graphic Symbols for Soil and Rock




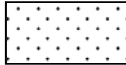
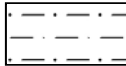
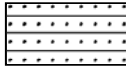
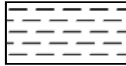


General

	Asphalt
	Road base
	Concrete
	Filling

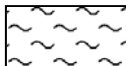
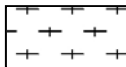
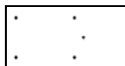
Soils

	Topsoil
	Peat
	Clay
	Silty clay
	Sandy clay
	Gravelly clay
	Shaly clay
	Silt
	Clayey silt
	Sandy silt
	Sand
	Clayey sand
	Silty sand
	Gravel
	Sandy gravel
	Cobbles, boulders
	Talus

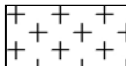
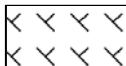
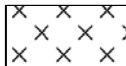
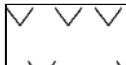
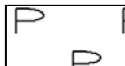
Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
	Coal
	Limestone

Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 - 5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.



Rock Strength

Rock strength is defined by the Point Load Strength Index ($IS_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $IS_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $IS_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

DEPTH RANGE FROM SURVEY* TO LEVEL

-5 TO -4	[Pink]
-4.5 TO -4	[Light Pink]
-4 TO -3.5	[Light Purple]
-3.5 TO -3	[Purple]
-3 TO -2.5	[Dark Purple]
-2.5 TO -2	[Blue-Black]
-2 TO -1.5	[Dark Blue]
-1.5 TO -1	[Blue]
-1 TO -0.5	[Light Blue]
-0.5 TO 0	[Cyan]
0 TO 0.5	[Light Green]
0.5 TO 1	[Green]
1 TO 1.5	[Light Green]
1.5 TO 2	[Green]
2 TO 2.5	[Light Green]
2.5 TO 3	[Green]
3 TO 3.5	[Light Green]
3.5 TO 4	[Yellow-Green]
4 TO 4.5	[Yellow]
4.5 TO 8	[Orange]

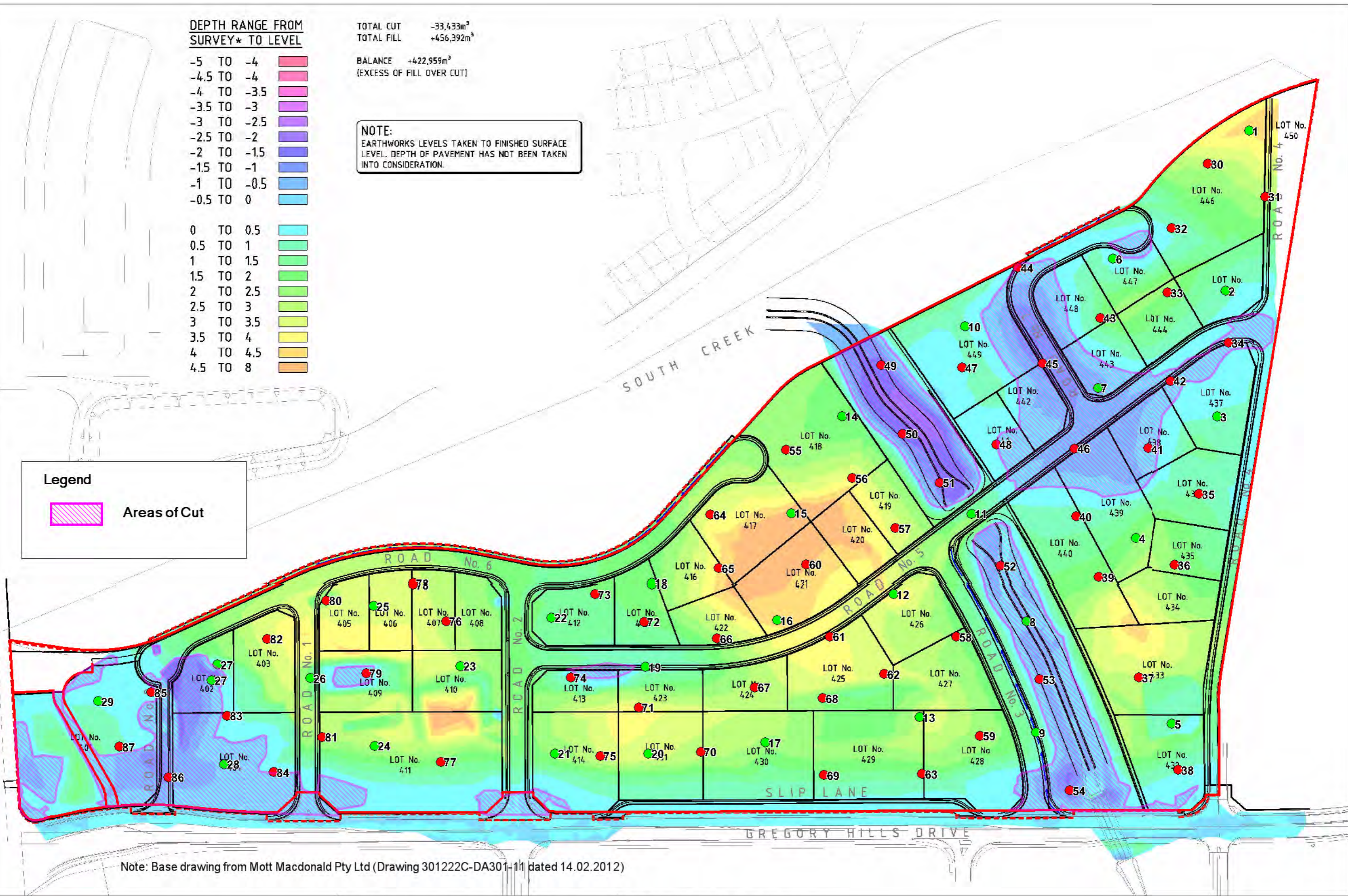
TOTAL CUT -33,433m³
TOTAL FILL +456,392m³

BALANCE +422,959m³
(EXCESS OF FILL OVER CUT)

NOTE:
EARTHWORKS LEVELS TAKEN TO FINISHED SURFACE LEVEL. DEPTH OF PAVEMENT HAS NOT BEEN TAKEN INTO CONSIDERATION.

Legend

[Pink Hatched Box] Areas of Cut

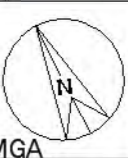


Note: Base drawing from Mott Macdonald Pty Ltd (Drawing 301222C-DA301-111 dated 14.02.2012)

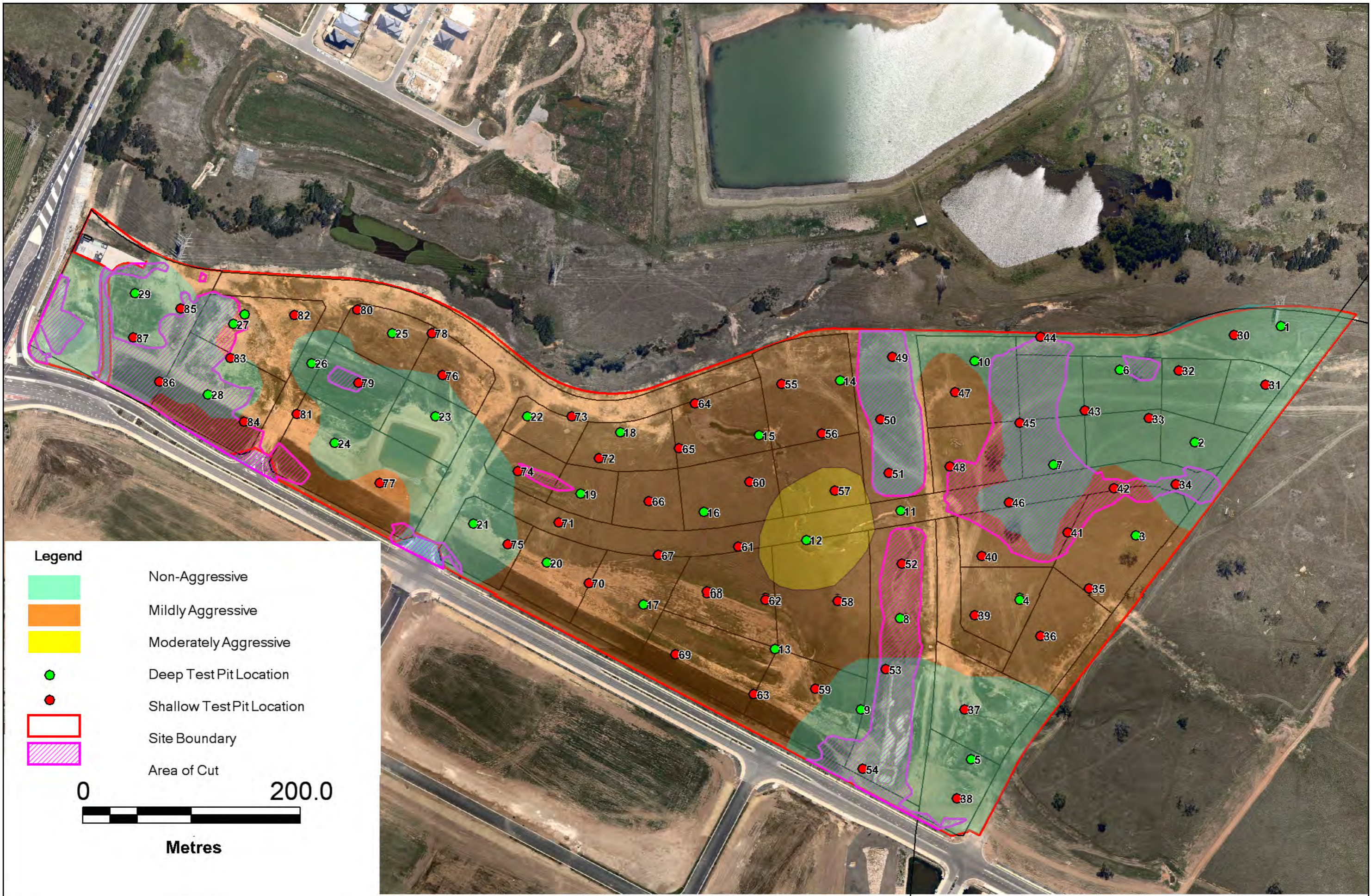


CLIENT: Gregory Hills Corporate Park Pty Ltd
OFFICE: Campbelltown DRAWN BY: BAH
SCALE: As shown DATE: 21.02.2012

TITLE: Cut and Fill Diagram
Salinity Investigation And Management Plan
Lot 701 in Deposited Plan 1154772, Gregory Hills Drive, Gledswood Hills

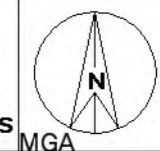
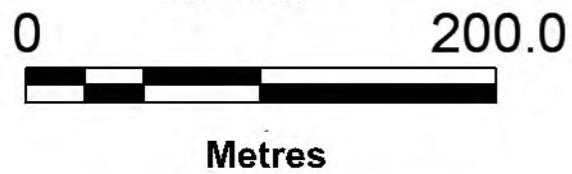


PROJECT No: 76510.00
DRAWING No: 2
REVISION: A



Legend

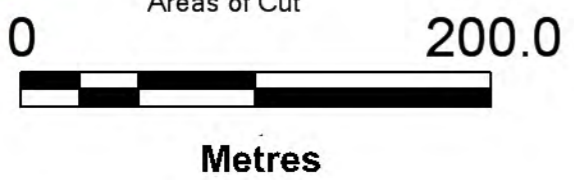
- Non-Aggressive
- Mildly Aggressive
- Moderately Aggressive
- Deep Test Pit Location
- Shallow Test Pit Location
- Site Boundary
- Area of Cut





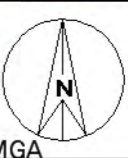
Legend

- Non-Aggressive
- Mildly Aggressive
- Moderately Aggressive
- Deep Test Pit Location
- Shallow Test Pit Location
- Site Boundary
- Areas of Cut

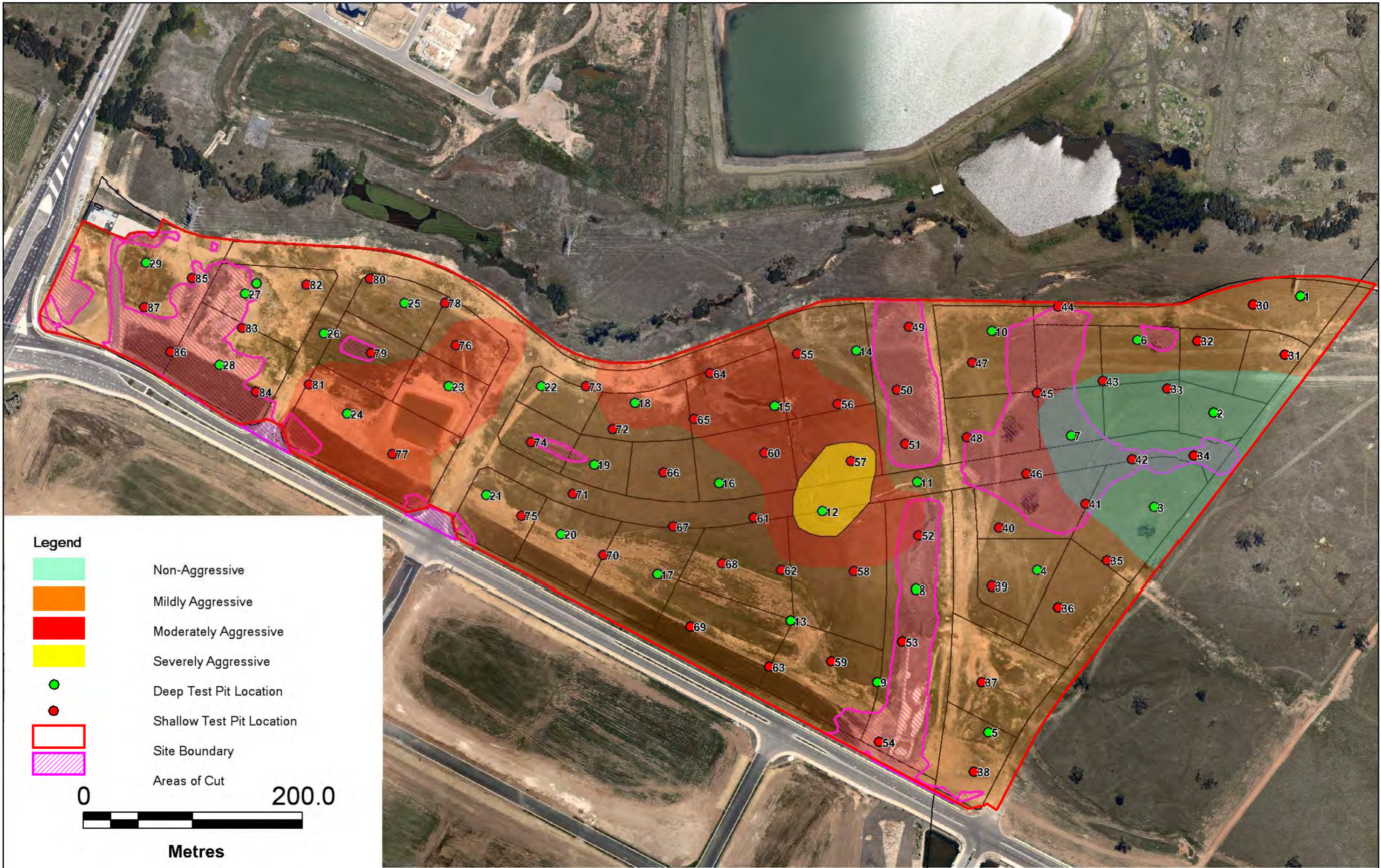


CLIENT: Gregory Hills Corporate Park Pty Ltd
 OFFICE: Campbelltown DRAWN BY: BAH
 SCALE: As shown DATE: 17.05.12

TITLE: **Aggressivity to Concrete Piles below Proposed Cut Surface and Fill Base**
Salinity Investigation And Management Plan
 Lot 701 in Deposited Plan 1154772, Gregory Hills Drive, Gledswood Hills

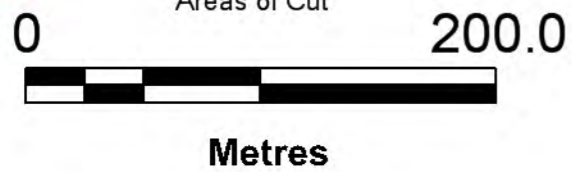


PROJECT No: 76510.00
 DRAWING No: 4
 REVISION: B



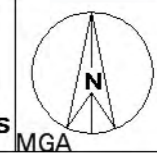
Legend

- Non-Aggressive
- Mildly Aggressive
- Moderately Aggressive
- Severely Aggressive
- Deep Test Pit Location
- Shallow Test Pit Location
- Site Boundary
- Areas of Cut



CLIENT: Gregory Hills Corporate Park Pty Ltd
 OFFICE: Campbelltown DRAWN BY: BAH
 SCALE: As shown DATE: 17.05.12

TITLE: **Aggressivity to Steel Piles below Proposed Cut Surface and Fill Base**
Salinity Investigation And Management Plan
 Lot 701 in Deposited Plan 1154772, Gregory Hills Drive, Gledswood Hills



PROJECT No: 76510.00
 DRAWING No: 5
 REVISION: B