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C/- Terroir

Preliminary Salinity and Geotechnical Assessment:
Lot 14 DP 1120290, 37 Worcester Road, Rouse Hill, NSW

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

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Contents

1 Introduction

1.1 Overview

This report, prepared by Martens & Associates (MA), documents the findings of a preliminary salinity and geotechnical assessment completed to support a State Significant Development Application with the Department of Planning and Environment NSW Government for a proposed Junior School at Lot 14 DP 1120290, 37 Worcestor Road, Rouse Hill, NSW (the site).

1.2 Proposed Development

Proposed development (refer plans in Attachment B), as described by the Client, includes:

- o Junior school area at north of site expanded via relocation and further student growth with 3 new classroom modules, new roadway and carparking and associated landscaped areas.
- o New library, multi-purpose building and associated landscaped areas shared between the junior school and senior school.

From review of proposed development plans, MA understands bulk earthworks are to include:

- o Excavation up to approximately 3.6 m below ground level (mBGL) for the individual blocks and 2.0 mBGL for the proposed road.
- o Filling up to approximately 4.0 m above existing ground level for the individual blocks and 1.2 m above existing ground level for the proposed car park.

Based on review of plans, cut and fill areas are proposed to be supported by retaining walls, batter slopes or a combination of both.

1.3 Assessment Objectives

1.3.1 Salinity Assessment

The objective of the salinity assessment was to assess the risk of soil salinity so that consideration can be given to local prevailing salinity conditions and the impacts of, and on, the proposed development. The assessment has been carried out in general accordance with the following guidelines:

- Department of Infrastructure, Planning and Natural Resources (DIPNR, 2002), *Salinity Potential in Western Sydney Map*.
- Department of Land and Water Conservation (DLWC, 2002), *Site Investigations for Urban Salinity*.
- Australian Standard (AS) 3600 (2009), *Concrete structures.*

1.3.2 Geotechnical Assessment

The objectives of the geotechnical assessment included:

- Assess geotechnical conditions for management of geotechnical risks that may affect the proposed development, the site and surrounding land and infrastructure.
- Provision of preliminary recommendations for initial design and construction of the proposed development.

The assessment was undertaken in general accordance with the principles of the following guidelines/ standards:

- AS 1289.6.3.2 (1997), *Determination of the penetration resistance of a soil - 9kg dynamic cone penetrometer test.*
- AS 1289.6.3.1 (1999) *Determination of the penetration resistance of a soil – Standard Penetration Test (SPT).*
- AS 1726 (1993), *Geotechnical site investigations*.
- AS 2870 (2011), *Residential slabs and footings*.
- AS 3798 (2007), *Guidelines on earthworks for commercial and residential developments.*
- Austroads (2010), *Guide to Pavement Technology Part 2: Pavement Structural Design.*
- Blacktown Council (2005), *Engineering Guide for Development.*

1.4 Investigation Scope of Works

Site investigation undertaken on 30 September 2015, included:

- A site walkover survey to confirm expected topography, geology and geomorphology based on desktop study results, to assess existing site conditions such as soil/rock exposures, surface drainage and vegetation and to identify evidence of possible saline soil or groundwater conditions.

- 11 boreholes, BH101 to BH111, to characterise sub-surface materials, drilled up to 2.7 mBGL using a 4WD truck-mounted hydraulic drill rig with spiral augers fitted with a V-shaped bit (V-bit) or tungsten carbide bit (TC-bit).

- Seven Dynamic Cone Penetrometer (DCP) tests, up to 1.45 mBGL, to assist with soil characterisation and estimation of soil strength in accordance with AS 1289.6.3.2 (1997) and assess depth to top of rock.

- Collection of soil samples for laboratory testing (electrical conductivity (EC), pH and soluble sulphate).

- Collection of two soil samples (CBR1 and CBR2) for laboratory Californian Bearing Ratio (CBR) testing.

Investigation locations are shown in Figure 1, Attachment A.

2 Site Conditions and Description

2.1 Site Details

Table 1 presents a summary of general site details. Existing site features are shown in Figure 1, Attachment A.

Table 1: Site background information.

Item	Description/Detail
Site address	37 Worcester Road, Rouse Hill, NSW (Lot 14 DP 1120290)
Local Government Area (LGA)	Blacktown City Council
Site area	2.023 ha
Existing site development	At the time of inspection the majority of the site comprised managed grass paddock. A residential brick dwelling existed near the central portion of the northern site boundary. We understand this has since been demolished. The site is bordered by a rural residential property to the north, Worcester Road to the east and allotment(s) containing Rouse Hill Anglican College infrastructure (buildings, playing field, tennis courts and car park/road) to the south west and south.
Proposed development	Relocation and expansion of junior school
Typical slopes/aspect/elevation	The site has low to moderate grades of approximately 10 % generally to the south east and south. Site elevation is between approximately 67.5 mAHD in the central north, to 52.5 mAHD in the south eastern corner.
Drainage	Via overland flow to the south east and south

2.2 Sub-Surface Conditions

2.2.1 Expected Geology

The Penrith 1:100,000 Geological Series Sheet 9030 DME, (1991) indicates that the site is underlain by Bringelly Shale comprising shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone and rare coal/ tuff.

The Penrith 1:100,000 Soil Landscape Series Sheet 9030 (Soil Conservation Service of NSW, 1989) identifies the site as having soils of the Blacktown soil landscape group consisting of shallow to moderately deep hardsetting mottled texture contrast soils with red and brown podzolic soils on crests grading to yellow podzic soils on lower slopes and in drainage lines.

2.2.2 Sub-Surface Materials

Table 2 summarises sub-surface materials and conditions, inferred from borehole and field penetration test (DCP/SPT) results, to investigation termination depth. Encountered conditions are described in more detail on borehole logs, Attachment C, and associated explanatory notes, Attachment H. For DCP test results refer to Attachment D.

Table 2: Generalised inferred sub-surface profile to investigation termination depth.

Layer [1]	Depth (mBGL)[2]
TOPSOIL: Silty SAND (loose to medium dense) and Silty CLAY (firm to stiff)	0.0 up to 0.40
RESIDUAL SOIL: CLAY and Silty CLAY (stiff to hard)	up to between 0.90 – 1.45
ROCK: DISTINCTLY WEATHERED SHALE (inferred low strength) [3]	up to between 1.40 – 2.70

Notes:

[1] Refer to borehole logs for more detailed material descriptions at test locations.

[2] Indicative depth range of layer below ground level.

2.3 Groundwater

Groundwater inflow was not observed in the boreholes up to a depth of 2.7 mBGL.

Review of NSW Department of Primary Industries' 'All Groundwater Map' indicated 4 groundwater bores (with available information) exist within approximately 1 km of the site (Table 3). Groundwater depth was noted for 2 bores. These bores access a deep groundwater system. Given the deep depths and limited numbers of bores with groundwater data, the data is considered unsuitable for use in assessing groundwater conditions at the site.

Further investigations would be required to better characterise site groundwater conditions.

Table 3: Available hydrogeological information (NSW DPI).

Groundwater Bore Identification	Distance/ Orientation From Site	Depth To Groundwater (mBGL)	Intended Use	Water Bearing Zone Substrates
GW107600	0.7 km east	ND [1]	Monitoring bore	ND [1]
GW054878	0.8 km north	ND [1]	Stock	ND [1]
GW107940	0.85 km north	72.00	Test bore	Sandstone
GW108452	1.0 km northwest	46.00	Stock, domestic	Sandstone and quartz

Notes:
[1] ND = no data.

3 Salinity Assessment

3.1 Documented Salinity Risk Potential

The 1:100,000 Salinity Potential in Western Sydney map (DNR, 2002) indicates that the site is located in an area of moderate salinity potential (Figure 2, Attachment A).

3.2 Broad Scale Salinity Processes

In producing the Salinity Potential Map, DNR developed a number of alternative models of processes by which salinity may occur in Western Sydney (WSROC, 2004, pg. 16).

A list of key broad scale salinity processes likely to impact the site, including summarised descriptions of each process, is presented in Table 4.

3.3 Signs of Potential Saline Soils at the site

No obvious signs of saline conditions were observed at the site:

- Vegetation growth appeared healthy and uninhibited.
- No water marks or salt crystals were observed on the ground surface.
- Site surface drainage appeared generally good.
- No evidence of concentrated surface erosion was observed.

3.4 Possible Site Conditions Impacting Site Salinity

Site conditions that may impact salinity potential at the site include:

- Mid-slope site location.
- Clay subsoils.
- Bringelly Shale parent geology underlying the site.

3.5 Assessed Salinity Risk Potential

In Table 4, the broad scale salinity processes have been assessed in terms of likelihood of occurring at the site, considering the proposed development, site observations and investigation findings.

Table 4: Potential for broad scale salinity processes at the site.

Key Salinity Process	Description	Potential at subject site
Localised concentration of salinity	Localised concentration of salts due to relatively high evaporation rates, usually associated with waterlogged soil and poor drainage. Exacerbated by increased water use and/ or blocking of surface and sub-surface water flow associated with urban development	Low to moderate – No areas of poor drainage or waterlogged areas were observed during site walkover. No evidence of localised salt concentration observed. Deep cutting/filling may impede surface and subsurface water flow.
Shale Soil Landscapes	In poorly drained duplex (texture contrast) soils, shallow sub-surface water flows laterally across a clayey upper B-Horizon with salt usually accumulating in the clayey sub-soil. Salt concentrations may increase where sub-surface water accumulates and evaporates, e.g. on lower slopes or natural and constructed flats in mid-slope. Exacerbated by sub-soils exposure through deep cutting, by installing buildings into the B-horizon and by impeding sub-surface water flows. Highly dispersive, erodible and poorly draining sodic soils due to salinity.	Moderate to High – The site is underlain by low permeable clays overlying shale. No evidence of impeded surface vegetation growth and surface soil erosion observed. Deep cutting/filling may impede surface and subsurface water flow.
Deep Groundwater Salinity	Brackish or saline groundwater rises to a level where, through capillary action in the soil, the water with dissolved salts reaches the ground surface and evaporates, resulting in localised salt concentration. Groundwater rises are typically caused by increased water infiltration, e.g. above average rainfall, vegetation loss, irrigation, increased water use in urban areas, construction of surface pits. Exacerbated by buildings or infrastructure intercepting the zone of groundwater level fluctuation.	Low – Groundwater was not encountered in boreholes to 2.7 mBGL. Proposed retaining structures are to be constructed with appropriate drainage measures installed.
Deeply Weathered Soil Landscape	High salt loads with high sulphate levels related to un-mapped deeply weathered soil landscapes beneath fluvial gravel, sand and clay. Usually in mid-slope or on hilltops affected by perched saline groundwater.	Low – soils and underlying shale are not deeply weathered.

3.6 Salinity Laboratory Results

3.6.1 Overview

18 soil samples from 7 boreholes were submitted to Envirolab Services, a National Association of Testing Authorities (NATA) accredited laboratory, for chemical testing (EC, pH and soluble sulphate (SO_4)). The testing was carried out for salinity classification and to assess an exposure classification for design of buried concrete structures. Sampling was targeted to achieve a representative coverage of site conditions in line with assessed subsurface profiles, proposed earthworks and limited investigation scope.

Groundwater was not observed down to investigation depth limits, being 2.7 mBGL. Perched groundwater from surface water seepage inflow may occur as a result of rainfall events and should be tested if encountered during construction.

3.6.2 Results – Salinity Classification

Testing results are summarised in Table 5. A laboratory test certificate is provided in Attachment E.

Table 5: Salinity test results.

Sample ID [1]	Material	$EC_{(1:5)}$ (dS/m)	EC_e (dS/m) [2]	Salinity Classification [3]
4946/101/0.2	Silty SAND	0.041	0.70	Non-Saline
4946/101/0.5	Silty CLAY	0.037	0.31	Non-Saline
4946/101/1.0	CLAY	0.096	0.77	Non-Saline
4946/102/0.2	Silty SAND	0.039	0.66	Non-Saline
4946/102/0.5	CLAY	0.037	0.30	Non-Saline
4946/102/1.0	CLAY	0.071	0.57	Non-Saline
4946/103/0.2	Silty SAND	0.046	0.78	Non-Saline
4946/103/0.5	CLAY	0.038	0.30	Non-Saline
4946/103/1.0	CLAY	0.027	0.22	Non-Saline
4946/104/0.2	Silty SAND	0.039	0.66	Non-Saline
4946/104/0.5	Silty CLAY	0.028	0.24	Non-Saline
4946/104/1.0	CLAY	0.040	0.32	Non-Saline
4946/105/0.2	Silty SAND	0.031	0.53	Non-Saline
4946/105/0.5	CLAY	0.046	0.37	Non-Saline
4946/106/0.2	Silty SAND	0.033	0.56	Non-Saline
4946/106/0.5	CLAY	0.031	0.25	Non-Saline
4946/109/0.2	Silty SAND	0.063	1.07	Non-Saline
4946/109/0.5	CLAY	0.051	0.41	Non-Saline

Notes:

[1] Project#/Borehole#/Depth (mBGL)

[2] Based on EC to EC_e multiplication factors from Table 6.1 in DLWC (2002).

[3] Based on Table 6.2 of DLWC (2002) where EC_e <2 dS/m = non-saline, EC_e of 2-4 dS/m = slightly saline, EC_e of 4-8 dS/m = moderately saline, EC_e of 8-16 dS/m = very saline and EC_e of >16 dS/m = highly saline.

Results indicate sub-surface materials are classified as non-saline.

3.6.3 Results – Exposure Classification

Soluble sulphate and pH test results are summarised in Table 6. Laboratory test certificates are presented in Attachment E.

Table 6: Exposure classification test results.

Sample ID[1]	Material	EC (dS/m) [2]	pH	Sulfate (SO_4) (mg/kg)	Exposure Classification[2]
4946/101/0.2	Silty SAND	0.041	5.8	10	A1
4946/101/0.5	Silty CLAY	0.037	5.8	28	A1
4946/101/1.0	CLAY	0.096	5.7	<10	A1
4946/102/0.2	Silty SAND	0.039	5.7	20	A1
4946/102/0.5	CLAY	0.037	5.7	31	A1
4946/102/1.0	CLAY	0.071	5.4	72	A2
4946/103/0.2	Silty SAND	0.046	6.1	20	A1
4946/103/0.5	CLAY	0.038	5.8	31	A1
4946/103/1.0	CLAY	0.027	5.8	22	A1
4946/104/0.2	Silty SAND	0.039	5.8	20	A1
4946/104/0.5	Silty CLAY	0.028	6.1	22	A1
4946/104/1.0	CLAY	0.040	5.7	34	A1
4946/105/0.2	Silty SAND	0.031	5.7	10	A1
4946/105/0.5	CLAY	0.046	5.2	53	A2
4946/106/0.2	Silty SAND	0.033	5.7	10	A1
4946/106/0.5	CLAY	0.031	5.7	28	A1
4946/109/0.2	Silty SAND	0.063	6.6	24	A1
4946/109/0.5	CLAY	0.051	5	47	A2

Notes:

[1] Project#/Borehole#/Depth (mBGL)

[2] Exposure classification for buried reinforced concrete based on Tables 4.8.1 and 4.8.2 of AS 3600 (2009).

In accordance with AS3600 (2009), an exposure classification for concrete of 'A2' should be adopted for preliminary design of all buried concrete structures.

3.7 Recommendations

Future buried concrete structures should be designed in accordance with the concrete cover specifications in AS 3600 (2009) for an exposure classification of 'A2'.

Although soil testing indicates site soils are non saline, and no further testing/assessment is considered necessary, we recommend that the following generic saline soil management strategies are considered in the design and construction of the proposed development.

Management strategies for earthworks and landscaping may include:

- Maintaining natural water balance.
- Limiting irrigation.
- Limiting soil disturbance, where possible, such as cut and fill, so saline or sodic subsoils are not exposed or groundwater is not intercepted.
- Where consistent with future land use and landscaping plan, planting of deep-rooted, preferably native, trees to increase water absorption.
- Sealing, e.g. by lining, of stormwater detention ponds and water features to reduce infiltration.
- Preparing sediment and erosion control plans.
- Replacing excavated soils in their original order.
- Any long term irrigation or watering on-site is to be at a level that does not cause groundwater to become perched.

Management strategies for new buildings and services should include, but not be limited to:

- Designing and building structures to limit interference with natural water flow on site.
- Using appropriate construction materials and techniques to salt proof buildings and infrastructure.
- Correctly installing and maintaining damp proof courses in buildings and water proofing of slabs.
- Using exposure grade bricks/masonry below damp course or in retaining walls.
- Providing concrete strength and cover to steel reinforcing in accordance with AS 3600 (2009) and the exposure classifications outlined in Table 6.
- Limiting excess surface water infiltration into the soil by designing, installing and maintaining appropriate stormwater drainage (gutters, downpipes, pits and pipes).

4 Geotechnical Assessment

4.1 Laboratory Testing Results

4.1.1 Atterberg Limits Results

Three soil samples were collected and submitted to Resource Laboratories, a NATA accredited laboratory, for Atterberg Limits testing. Results are summarised in Table 7 and indicate that site clays range from moderate to high plasticity. A laboratory test certificate is provided in Attachment F.

Table 7: Laboratory Atterberg Limit test results summary.

Sample Identification	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Linear shrinkage (%)
4946/BH101/0.8-1.2m	42	17	25	11.5
4946/BH104/0.4-0.6m	38	19	19	8.5
4946/BH104/1.0-1.2m	58	20	38	14.0

4.1.2 CBR Results

Two bulk soil samples were collected and submitted to Resource Laboratories, for CBR testing. A 4 day soaked CBR test was conducted in accordance with AS 1289.1.1; 2.1.1; 5.1.1; and 6.1.1. Test results are summarised in Table 8. A laboratory test certificate is provided in Attachment F.

Table 8: Laboratory CBR test results summary.

Sample Identification	Material	Sample Depth (mBGL)	CBR[1] Value (%)
CBR101	Clay – low to medium plasticity	0.3 – 0.5	8
CBR102	Clay – low to medium plasticity	0.4 – 0.6	6

Notes:

1 Four day soak, compacted to 98 % SMDD (±2 % of OMC), applying a 4.5 kg surcharge.

4.2 Preliminary Soil and Rock Strength Properties

Soil and rock strengths were estimated from field penetration test (DCP/SPT) results in conjunction with borehole derived soil profile data. Preliminary soil and rock strength properties are summarised in Table 9.

Table 9: Preliminary estimated soil and inferred rock strength properties.

Layer [1]	$\gamma_{in-situ}$ [2] (kN/m^3)	Cu [3] (kPa)	Φ' [4] (°)	E' [5] (MPa)	k_a [6]	k_p [6]
TOPSOIL: Silty SAND (loose to medium dense) and Silty CLAY (firm to stiff)	16	25 (CLAY)	27 (SAND)	5	0.42	2.37
RESIDUAL SOIL: CLAY and Silty CLAY (stiff)	17	50	NA[7]	10	0.40	2.55
RESIDUAL SOIL: CLAY and Silty CLAY (very stiff to hard)	19	150	NA[7]	30	0.36	2.77
DISTINCTLY WEATHERED ROCK: SHALE (inferred low strength) [3]	23	NA[7]	28	200	NA[7]	NA[7]

Notes:

[1] Refer to borehole logs in Attachment C for material description details.

[2] Inferred average *in-situ* unit weight for layer, based on visual assessment only (± 2 kN/m^3)

[3] Undrained shear strength (± 5 kPa) assuming normally consolidated clay.

[4] Effective internal friction angle (±2 %) assuming drained conditions.

[5] Effective Elastic Modulus (±10 %).

[6] k_a = Coefficient of active earth pressure; k_p = Coeffecient of passive earth pressure, assuming ground behind retaining wall is level and drained.

[7] Not applicable.

4.3 Risks of Slope Instability

No evidence of former land instability was observed during the site walkover survey.

As site grades are typically <10%, the risk of landslides impacting the proposed development is considered negligible, subject to the recommendations in this report and adoption of industry standard design and construction methodologies. Consequently, a slope risk assessment in accordance with Australian Geomechanics Society (2007) guidelines was not undertaken.

4.4 Initial Design and Construction Advice and Recommendations

From a geotechnical viewpoint, we consider the site to be suitable for the proposed development, subject to the recommendations presented in this report.

Table 10 presents a summary of preliminary geotechnical recommendations for initial design and developing construction methodologies for the proposed development.

Table 10: Preliminary geotechnical recommendations for initial design and construction.

Recommendation	Description
Footings (general)	Footings should be founded on suitable bearing material and designed adopting preliminary geotechnical design parameters provided in Table 11. Subject to further investigations, these parameters may be able to be refined spatially and vertically. All footings should found on material with similar end bearing capacity to limit differential movement across the building footprint. Individual pad footings should not span the interface between different foundation materials. Development plans show the majority of buildings to span both cut and fill. It is recommended, where necessary, that deepened footings such as piers extend through the fill and into low strength shale. All footings should be inspected by a Geotechnical Engineer or Principal Certifying Authority (PCA) and constructed with minimal delay following excavation. The Geotechnical Engineer is to confirm encountered conditions satisfy design assumptions and that the base of all excavations is free from loose or softened material and water prior to footing construction. Water that has ponded in the base of excavations and any resultant softened material is to be removed prior to footing construction. If a delay in construction is anticipated, a concrete blinding layer of at least 50mm thickness should be placed to protect the foundation material of shallow footings.
Footings (Block K)	For the design of Block K, we recommend that piers/piles be adopted in order to limit differential settlement as a result of likely variable foundation conditions across the building platform, and ensuring footings found on material with similar end bearing capacity. Void formers may be adopted under beams to allow for shrinkage/swelling of plastic soils under the beams.
Soil and Rock Excavation	<u>Excavation Method</u> Soils and extremely low to low strength shale may be readily excavated using conventional earthmoving equipment. A ‘toothed’ bucket or a ripping tyne (or similar) may be required to excavate low strength rock. Rock breaker or ripping tyne attachments will likely be required for excavation of medium strength, or stronger, shale, if encountered. All excavation work should be completed with reference to the Code of Practice 'Excavation Work', dated July 2015, by Safe Work Australia. Excavation method statements will need to be prepared by the excavation contractor prior to the issue of construction certificate (CC). <u>Soil Batters</u> Any excavations exceeding 0.75m in height should be supported by suitably designed and installed retaining or shoring structures. Alternatively, soil overburden may be excavated without structural supports but with a maximum temporary (less than 1 month) batter slope of 1V (vertical):1.5H (horizontal) and permanent batter slope of 1V:3H. <u>Rock Batters</u> Excavations into low and medium strength shale can be temporarily battered back at maximum grades of 1.5V:1H and 8V:1H respectively. Permanent

Recommendation	Description
	excavations in low and higher strength rock can be battered back at 2V:1H, provided they are covered by shotcrete to limit rock weathering. Batter angles may need to be revised depending on the presence of adversely oriented joints or defects in the rock. Allowances for installation of rock bolts and mesh reinforced shotcrete to support potential unstable rock blocks or weathered zones should be made. It is recommended that excavated rock faces be inspected by a geotechnical engineer to determine whether any additional support, such as rock bolts or shotcrete, is required. Where there is insufficient room for batters, excavations will need to be supported by temporary (or permanent) shoring. A soldier pile with shotcrete or timber infill panel wall system may be adopted. These may be designed for inclusion as permanent support.
Retaining Structures	Where retaining structures are to be constructed as part of site works, they are to be engineer designed and backfilled with suitable gravel and free-draining materials. Preliminary design may adopt active and passive earth pressure coefficients based on preliminary soil strength parameters presented in Section 4.1, Table 9. Retaining wall design should consider additional surcharge loading from sloping ground, existing and proposed structures, construction equipment, backfill compaction and static water pressures unless subsoil drainage is provided behind retaining walls. Suitable drainage measures, such as a geotextile enclosed 100mm agricultural pipes, should be included to redirect water that may collect behind the retaining walls.
Overland Flows	All surface runoff should be diverted away from excavation areas during construction works and from any retaining structures, footings or the crest and base of embankments to prevent water accumulation, foundation/ embankment material strength reduction and pore water pressure increases.
Soil Erosion	Soil overburden should be removed in a manner that reduces the risk of sedimentation of existing stormwater drainage systems in the vicinity of the site. All spoil on site should be properly controlled by erosion control measures to prevent transportation of sediments off-site. The following erosion control measures should be considered, in conjunction with recommendations by Landcom (2004), to limit surface run-off and associated risk of surface scour, soil erosion and sedimentation: o Maintain vegetation where possible. o Disturb minimal area during excavation. o Landscape disturbed areas following completion of constructions. o Use gabion mattress, or other suitable energy reduction solutions, where required. o Direct water away from structures.
Filling	Fill placement should be carried out in accordance with the recommendations presented in Section 5.5.4.

4.5 Preliminary Geotechnical Design Parameters

Preliminary design parameters for footing design are presented in Table 11. These have been estimated from field test results in conjunction with borehole derived soil profile data.

Table 11: Preliminary recommended geotechnical design parameters.

Layer	Shallow Footings	Bored Piers	
	AEB[1] (kPa)	AEB[2] (kPa)	ASF[3] (kPa)
TOPSOIL: Silty SAND (loose to medium dense) and Silty CLAY (firm to stiff)	NA[4]	NA[4]	NA[4]
RESIDUAL SOIL: CLAY and Silty CLAY (stiff)	100	150	NA[4]
RESIDUAL SOIL: CLAY and Silty CLAY (very stiff to hard)	200	300	15
DISTINCTLY WEATHERED ROCK: SHALE (inferred low strength) [3]	500	1000	150

Notes:

[1] Allowable end bearing pressure estimate for shallow footings, assuming square footing with $D_f/B < 0.5$, $D_f > 0.5m$ and minimum 0.5m embedment into relevant layer, factor of safety of 3 and settlement of 1% of least footing dimension. For horizontal bearing we recommend adopting an allowable bearing pressure of 1/3 AEB.

[2] Allowable end bearing pressure for piles/piers assuming an embedment of at least 0.5m or one pile diameter, whichever is greater, a geotechnical strength reduction factor of 0.45, and a maximum settlement of 1% of pile diameter.

[3] Allowable skin friction (kPa) for bored pile in compression, assuming intimate contact between pile and foundation material. For uplift, we recommend reducing the ASF by 50%. [4] Effective internal friction angle (±2%) assuming drained conditions.

[4] Not applicable or not recommended.

The above design parameters assume the base of excavation is free of loose or soft soils and water prior to placement of concrete and approved following inspection by an experienced geotechnical engineer. Estimates are preliminary only and should be confirmed by additional investigations and testing prior to issuing of a Construction Certificate or preparation of detailed design.

4.6 Site Classification

Based on linear shrinkage and Atterberg limits laboratory testing (Section 4.1.1), and clay depth, a preliminary site classification of 'M' may be adopted for design of lightly loaded shallow footings, in accordance with AS 2870 (2011), subject to the recommendations presented in this report and CSIRO Sheet BTF 18, Attachment G.

5 Preliminary Pavement Design

5.1 Overview

A preliminary pavement thickness design was undertaken for the proposed carpark. Adopted traffic loading of Equivalent Standard Axles (ESA) are based on Blacktown City Council's Engineering Guide for Development (2005). The design has been completed in accordance with Austroads (2010) *Guide to Pavement Technology Part 2 Pavement Structural Design*. A CBR value, adopted for the preliminary design, was estimated using laboratory and field test results.

5.2 Equivalent Standard Axles

Table 12 presents the ESA value adopted for design of the proposed car park (i.e. ESA equivalent to that for local road). ESA is to be confirmed prior to adopted final design.

Table 12: ESA value for proposed carpark.

Road Type	N (ESA)
Carpark	$2x10^5$

5.3 CBR Assessment

In light of laboratory and field test results (Section 4.1.2), we have adopted a CBR value of 6% for preliminary design purposes. If material of inferior quality or differing in substance/texture is uncovered during excavation for pavement subgrade, or used as fill material, lower CBR values may be applicable and pavement material thickness may need to be revised.

Additional CBR testing is recommended to provide a better indication of subgrade conditions across pavement areas, considering final design levels, and/or provide statistical means to support a higher CBR design value. The additional testing may be undertaken at Construction Certification stage. Additionally, offsite fill, if utilised as subgrade, should also be CBR tested to confirm test CBR values are in line with adopted design CBR values.

5.4 Pavement Thickness

Table 13 presents preliminary recommended pavement material thicknesses for the proposed carpark.

Table 13: Preliminary pavement material thickness design for CBR of 6.

Road Type	Layer	Thickness (mm) [1]
Local road	2x25mm layers of AC10 (pavement surfacing)	50
	Base (DGB)	100 [3]
	Sub-base (DGS)	190
	Total pavement depth	340

Notes:

1. Based on Austroads (2010) Guide to Pavement Technology Part 2: Pavement Structural Design.
2. Assumes that impact of turning or stopping vehicles is included in adopted ESA.
3. Minimum based on Blacktown Council's Engineering Guide for Development (2005).

5.5 Earthworks

5.5.1 Subgrade Preparation

The subgrade is to be trimmed and compacted with density testing of the upper 300 mm layer at a rate of 1 test per 50 m of pavement length or 250 m², whichever is greater. Minimum density shall be 100 % Maximum Dry Density (MDD) at a standard compactive effort within 0 % and -3 % of optimum moisture content (OMC). Prior to placement of pavement material, the subgrade shall be proof rolled and approved by a Geotechnical Engineer.

Soft spots can be treated by one of the following methods subject to final assessment by site superintendent or nominated geotechnical testing authority (GTA).

1. Removal and replacement with approved fill under GTA supervision.

2. *In-situ* stabilisation with cement, lime or similar binding agent to a depth of at least 300mm below finished level. Use of this method and extent will depend on the condition of material to be stabilised and whether water is impacting subgrade.

3. Subgrade improvement using suitable geosynthetic reinforcement.

5.5.2 Subsoil Drainage

Surface and subsoil drainage should be provided in accordance with Council requirements. Typically sub-surface drains are installed on the upslope side of all internal roads and generally extend 500 mm below pavement level.

5.5.3 Placement and Testing of Pavement Material

Pavement materials shall be placed in layers (when compacted) not thicker than 200 mm (loose) or less than 75 mm. Pavement materials shall be compacted to the following condition:

- Sub-base - Minimum 98 % MDD at modified compactive effort (±2 % OMC).
- Base - Minimum 98 % MDD at modified compactive effort (±2 % OMC).

Compaction testing shall be undertaken by a NATA accredited laboratory in accordance with procedures as outlined in AS1289. Testing should be carried out at a rate of minimum 1 per 250 m^2 per layer or 3 per layer placed, whichever is the greater. Each pavement layer shall be proof rolled under GTA's supervision. Subsequent pavement layers shall not be placed prior to approval of underlying layer by the GTA.

5.5.4 Fill Placement

Where filling is required to raise subgrade levels, the use of site-won excavated materials may be considered. Plasticity Index level are somewhat elevated, however the material should be acceptable, subject to implementing stringent moisture conditioning controls or mixing with lime, if necessary, to assist material placement. Alternatively, suitable granular fill, approved for use by a geotechnical engineer may be adopted.

For construction of fill batters, fill should be overplaced, compacted to 98% SMDD ±2 % OMC and trimmed back to form the final batter.

All earthwork and fill material testing and preparation is to be approved by a Geotechnical Engineer, undertaken in accordance with AS 3798 (2007) and Blacktown Council's engineering guidelines (2005) and Level 2 tested by the nominated GTA.

6 Proposed Additional Assessments

6.1 Proposed Additional Assessment

We recommend the following additional assessments are carried out during development of final design and prior to issuing of a construction certificate to better manage geotechnical risks, where applicable:

- Where higher geotechnical design parameters are desired, we recommend considering undertaking supplementary investigations, including but not limited to, rock coring to at least 3 m below final bulk excavation and/or pile foundation levels, and assessment of rock core (such as rock quality designation (RQD) and point load testing).
- Review of construction staging plans and structural designs by a Geotechnical Engineer.
- An additional 2 – 3 CBR tests to provide a better indication of subgrade conditions across pavement areas, considering final design levels, and/or provide statistical means to support a higher CBR design value.
- CBR testing, where applicable, of offsite fill, if utilised as subgrade for road/car park.

6.2 Proposed Monitoring and Inspection Program

To maintain site stability during site works and limit adverse geotechnical impacts on the site and surrounding areas as a result of the proposed development, we recommend the following is inspected and monitored (Table 14) during site works. This program may be updated following further detailed investigations.

Table 14: Recommended inspections/monitoring requirements during site works.

Scope of Works	Frequency/Duration	Who to Complete
Inspect excavation retention (any shoring, retaining wall) installations and batters and monitor associated performance.	Daily/ As required	Builder/ MA[1]
Monitor groundwater seepage from excavation faces to assess adequacy of drainage provision	When encountered	Builder/ MA
Monitor sedimentation downslope of excavated areas	During and after rainfall events	Builder
Monitor sediment and erosion control structures to assess adequacy and for removal of built up spoil	After rainfall events	Builder
Inspect exposed material to verify suitability as foundation/ lateral support/ subgrade	Prior to reinforcement set-up and concrete placement for footing construction and fill placement	MA
Pavement testing	As specified in Section 5.5	GTA [2]
Inspect fill materials and verify suitability for placement at the site	Prior to placement	MA

Notes:

[1] MA = Martens and Associates geotechnical engineer.

[1] GTA = Superintendent nominated geotechnical testing authority.

6.3 Contingency Plan

In the event that the proposed development works cause an adverse impact on overall site stability or on neighbouring properties, works shall cease immediately. The nature of the impact shall be documented and the reason(s) for the adverse impact investigated. This might require site inspection by a qualified Geotechnical or Structural Engineer.

7 Limitations

The recommendations presented in this report are based on limited preliminary investigations and include specific issues to be addressed during the design and construction phases of the project. In the event that any of the recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Martens & Associates accept no responsibility whatsoever for the performance of the works undertaken where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, sub-surface conditions between and below the completed boreholes or other tests may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact Martens & Associates.

8 References

Australia Standard 3798 (2007), *Guidelines on earthworks for commercial and residential developments.*

Australian Standard 1726 (1993) *Geotechnical Site Investigations.*

Australian Standard 2870 (2011) *Residential Slabs and Footings.*

Australian Standard 3600 (2009) *Concrete structures.*

Austroads (2010) Guide to Pavement Technology Part 2 Pavement Structural Design.

Blacktown City Council (2006), *Development Control Plan*.

Blacktown Council (2005), *Engineering Guide for Development.*

Department of Infrastructure Planning and Natural Resources (DIPNR, 2002) *Salinity Potential in Western Sydney Map.*

Department of Land and Water Conservation (2002), *Site Investigations for Urban Salinity.*

Geological Survey of NSW Department of Minerals and Energy (1991), *Penrith 1:100,000 Geological Series Sheet 9030.*

The Penrith 1:100,000 Soil Landscape Series Sheet 9030 (Soil Conservation Service of NSW, 1989)

Western Sydney Regional Organisation of Councils (2004), *Western Sydney Salinity Code of Practice.*

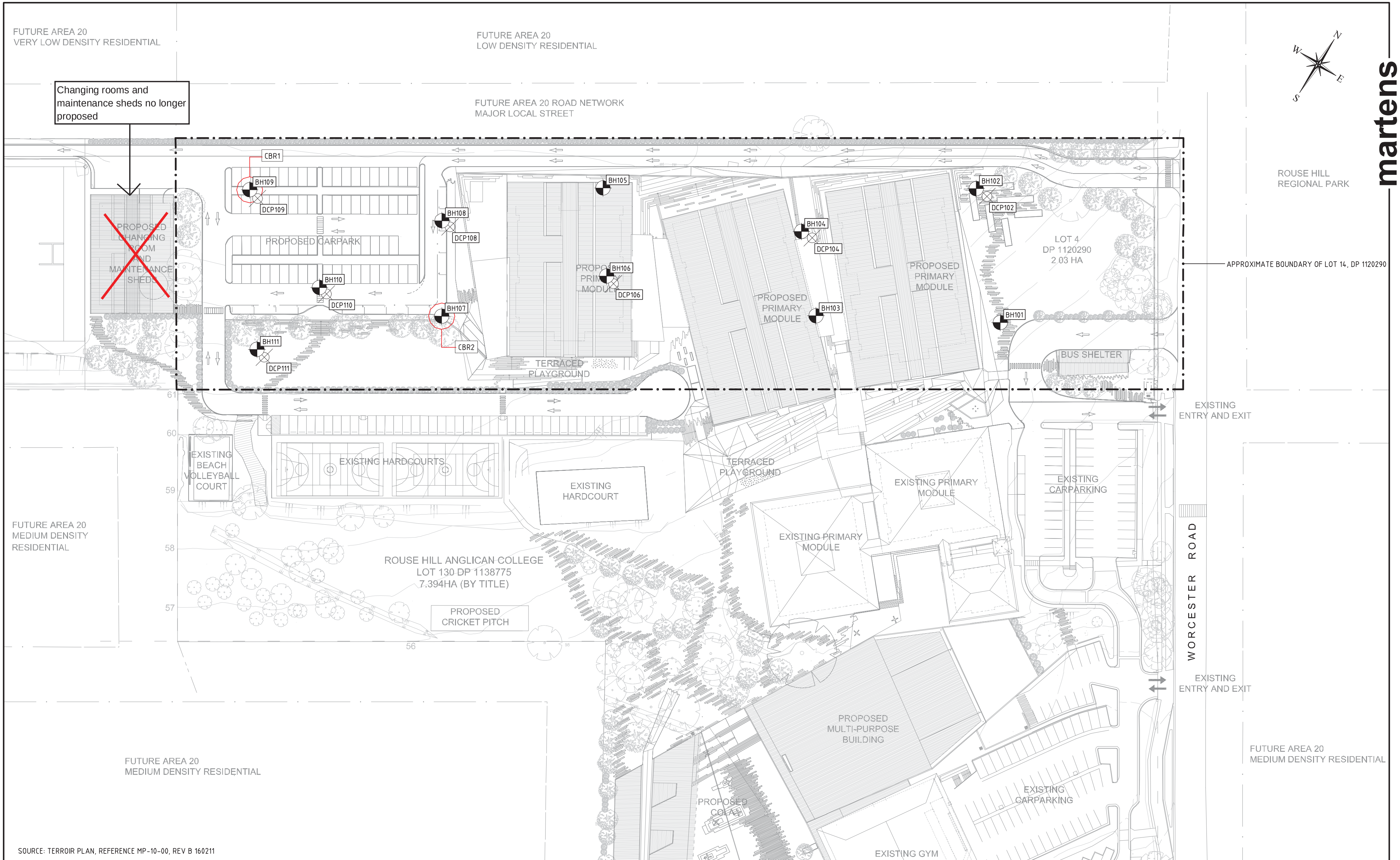
NSW Department of Primary Industries, online 'All Groundwater Map'.

Australian Standard 1289.6.3.1 (1999) *Determination of the penetration resistance of a soil – Standard Penetration Test (SPT).*

Australia Standard 1289.6.3.2 (1997), *Determination of the Penetration Resistance of a Soil using the 9kg Dynamic Cone Penetrometer.*

Australian Geomechanics Society (March 2007), *Landslide Risk Management*, Australian Geomechanics 42 (1).

9 Attachment A – Figures



KEY

- BH111 APPROXIMATE BOREHOLE LOCATION AND IDENTIFIER
- DCP111 APPROXIMATE DCP LOCATION AND IDENTIFIER
- APPROXIMATE CBR LOCATION AND IDENTIFIER

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UNITS - METRES

Martens & Associates Pty Ltd	ABN 85 070 240 890
Designed:	BR
Approved:	JF
Date:	12/02/2016
Scale @A3:	1:1000

Environment | Water | Wastewater | Geotechnical | Civil | Management

Subsurface Testing Locations
37 Worcester Road, Rouse Hill, NSW

Drawing No./ID: **Figure 1**

Project:	File:	Revision:
P1504946	JD01V02	A

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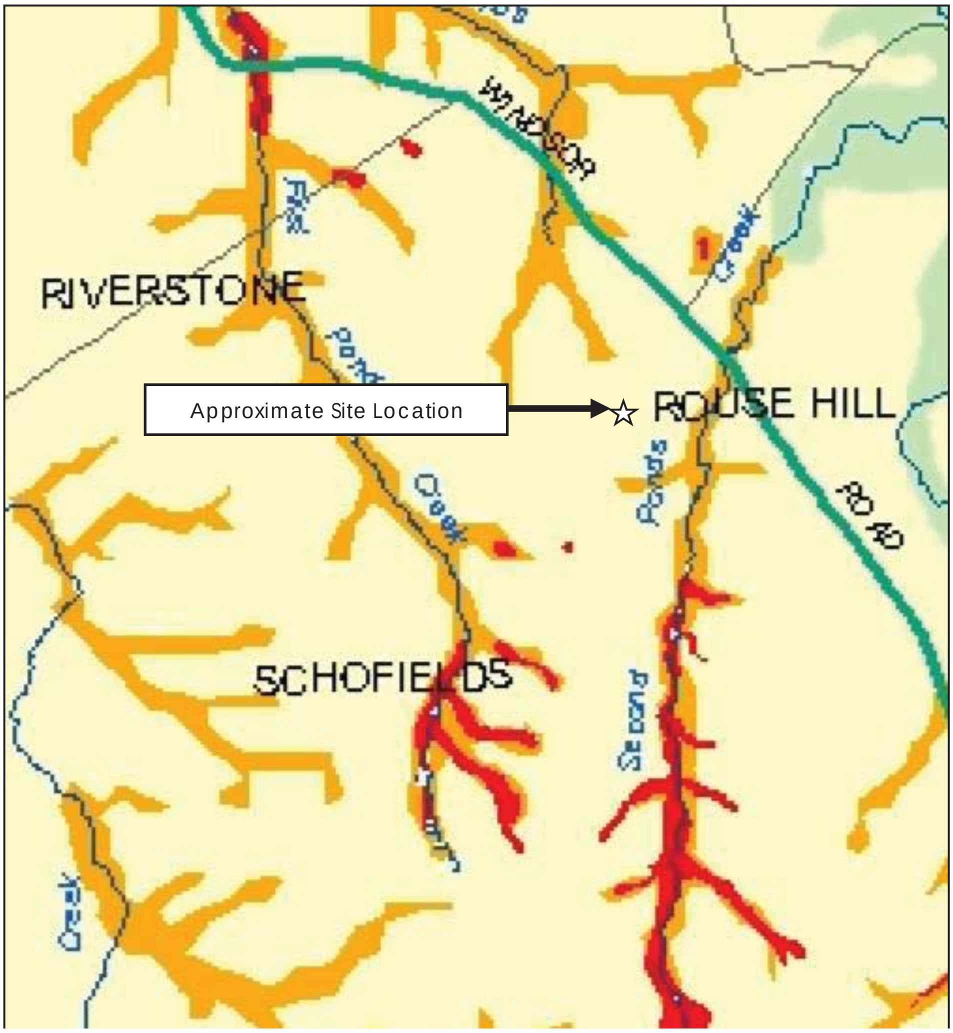

MAPPING CATEGORY	ASSOCIATED SOIL LANDSCAPES	LANDFORM - GEOLOGY
KNOWN SALINITY Areas where there is a known occurrence of saline soil, or where air photo interpretation and field observations have confirmed more than one of these: a - scalding b - salt efflorescence c - vegetation dieback d - salt tolerant plant species e - waterlogging A high relative wetness index occurs in these areas.	* Salinity outbreaks occur in Blacktown (bt), Luddenham (lu) and Richmond (ri) Soil Landscapes - common at breaks of slope, lower slopes and drainage lines. * Berkshire Park (bp) and Upper Castlereagh (up) Soil Landscapes have localised salinity due to the impermeable nature of the clay parent material. * South Creek (sc), Monkey Creek (mk), Freemans Reach (fr) and Theresa Park (tp) Soil Landscapes have common saline outbreaks due to high run-on and low local relief. * Soils in the above landscapes have high clay content in subsoils and are imperfectly to poorly drained.	* Break of slope, lower slope and drainage lines of Wianamatta Shales (Rwb, Rwa and Rwn). * Localised salinity also occurs at the geological boundary between Tertiary Gravels (Tl, Tr) and underlaying Wianamatta Shales (Rwb, Rwa/ Quaternary Alluvials (Qpd, Qpa, Qpl, Qal). * Localised salinity occurs in Quaternary Alluvium (Qal, Qpn. Qpd) which underlies many of the drainage systems and wetland margins.
HIGH SALINITY POTENTIAL Areas where soil, geology, topography and groundwater conditions predispose a site to salinity. These conditions are similar to areas of known salinity (see above). These areas are most common in lower slopes and drainage systems where water accumulation is high (ie. high relative wetness index).	* Soil Landscapes include Birrong (bi), Blacktown (bt) Berkshire Park (bp), Freemans Reach (fr), South Creek(sc0, Theresa Park (tp), Richmond (ri) and Luddenham (lu). Drainage systems and convergent slopes are areas of highest risk. * Soils in these landscapes have high clay content in the subsoils, low permeability and high run-on. * Soil profiles may display signs of high salt concentrations at depth (i.e. >0.5m).	* Salinity is most likely to occur in lower slopes, foot-slopes, floodplains and creek lines on Quaternary Sediments (Qal, Qpn, Qpd, Qpc, Qpp, Qha)/Wianamatta Shales (Rwb, Rwn, Rwa) where run-on is high, resulting in seasonally high water tables and soil saturation.
MODERATE SALINITY POTENTIAL Areas on Wianamatta Group Shales and Tertiary Alluvial Terraces. Scattered areas of scalding and indicator vegetation have been noted but no concentrations have been mapped. Saline areas may occur in this zone, which have not yet been identified or may occur if risk factors change adversely.	* Areas of Agnes Banks (ab), Berkshire Park (bp), Blacktown (bt), Luddenham (lu) and Lucas Heights (lh). * Steeper areas with moderate to high local relief and well drained subsoils such as Picton (pn), West Pennant Hills (wp) and Glenorie (gn) are at a lower risk of developing salinty. * Soils are moderate to well-drained due to their elevated position in the landscape.	* Hill-slopes and hill-crests on Wianamatta Shales (Rwb, Rwn, Rwa). * Raised abandoned alluvial terraces and drainage lines on Quaternary Alluvium (Qal, Qpn, Qpd, Qpc, Qpp) from Richmond to Camden and east to Rookwood. Localised areas of elevated, well-drained Tertiary Gravels (Ta, Tl, Tr).
VERY LOW SALINITY POTENTIAL Areas where salinity processes do not operate or are of minor significance. Soils are rapidly drained and underlaying strata (Hawkesbury/Narrabeen Sandstone) are highly permeable, resulting in continual flushing and removal of salts in the landscape. No salinity has been observed in these areas and is not expected to occur.	* Rapidly drained soil landscapes with shallow soils include Warragamba (wb) and Hawkesbury (ha). * Gymea (gy) and Faulconbridge (fb) Soil Landscapes consist of highly permeable sands with well-drained subsoils. * Soils are well to rapidly drained. * Soils have high sand content.	* Occurring on Hawkesbury and Narrabeen Sandstone (Rh, Rno). * Groundwater is relatively fresh in these areas due to the sandstone's elevated position in the landscape and highly permeable nature, resulting in continuous flushing of the system (removal of any accumulated salts).

SOURCE: 1:100,000 SALINITY POTENTIAL IN WESTERN SYDNEY MAP (DNR, 2002)

Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	BR	**1:100,000 SALINITY POTENTIAL IN WESTERN SYDNEY MAP** **37 Worcestor Road, Rouse Hill, NSW** **Source: DNR, 2002**	Drawing No: **FIGURE 2**
Approved:	RE		
Date:	27.10.2015		
Scale:	Not to Scale		Job No: P1504946

10 Attachment B – Proposed Development Plans

01 SITE PLAN
1:1000

GENERAL NOTES

DO NOT SCALE FROM THIS DRAWING

CONFIRM ALL DIMENSIONS AND SETOUTS ON SITE PRIOR TO MANUFACTURE & INSTALLATION

ALL WORK IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS

TO BE READ IN CONJUNCTION WITH ENGINEERS DOCUMENTS

LEGEND

0 50m

- EXISTING TURF & SOFT LANDSCAPING ZONES
- PROPOSED TURF
- PROPOSED SOFT LANDSCAPING
- PROPOSED SOFTFALL
- PROPOSED HARD LANDSCAPING
- EXISTING BUILT FORM AND ROADS
- EXISTING BUILDINGS
- EXISTING GRAVEL ROAD
- PROPOSED ROADWAY
- METAL DECK ROOFING
- POLYCARBONATE ROOFING
- LIGHTWEIGHT
- GLAZING
- BRICK FACE
- EXISTING TREES
- PROPOSED TREES
- AREA 20 ROAD NETWORK

Rev	Date Description
01	25.07.17 SSDA SUBMISSION

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TERROIR

Project:
ROUSE HILL ANGLICAN COLLEGE
MASTERPLAN 2016

Drawing Description:
PROPOSED SITE PLAN

Drawn by: AM Checked by: TD Scale1:1000@A1

PROJECT NO:	DWG NO:	REV NO:
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Drawing Status: SSDA

Date Plotted:

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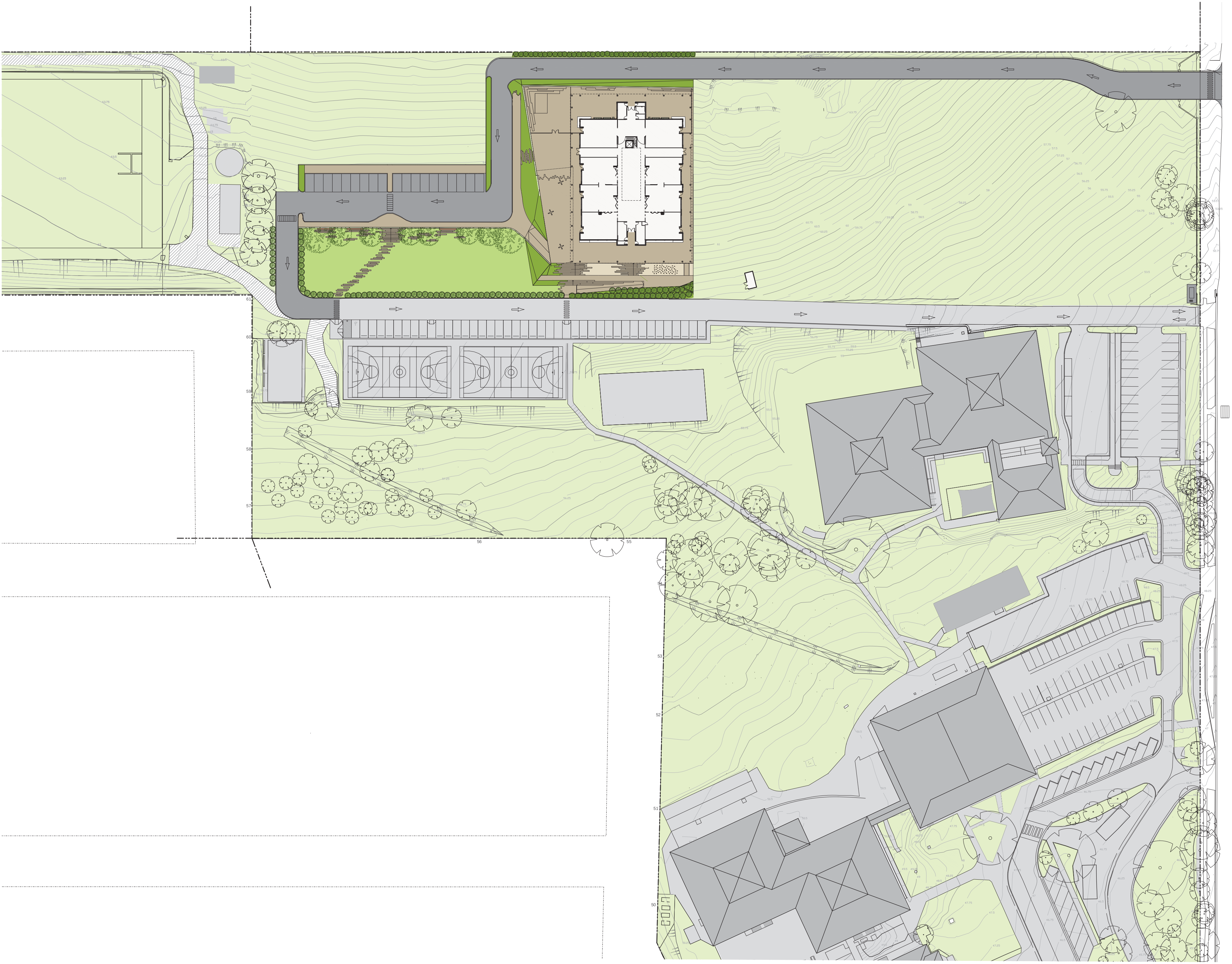

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LEGEND

0 25m

- EXISTING TURF & SOFT LANDSCAPING ZONES
- PROPOSED TURF
- PROPOSED SOFT LANDSCAPING
- PROPOSED SOFTFALL
- PROPOSED HARD LANDSCAPING
- EXISTING BUILT FORM AND ROADS
- EXISTING BUILDINGS
- EXISTING GRAVEL ROAD
- PROPOSED ROADWAY
- METAL DECK ROOFING
- POLYCARBONATE ROOFING
- LIGHTWEIGHT
- GLAZING
- BRICK FACE
- EXISTING TREES
- PROPOSED TREES
- FUTURE GLA LOCATIONS (WORKS TO BE APPROVED UNDER FUTURE CDC APPLICATION)

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MASTERPLAN 2016

Drawing Description:
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K BLOCK AND CARPARK

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LEGEND

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- PROPOSED TURF
- PROPOSED SOFT LANDSCAPING
- PROPOSED SOFTFALL
- PROPOSED HARD LANDSCAPING
- EXISTING BUILT FORM AND ROADS
- EXISTING BUILDINGS
- EXISTING GRAVEL ROAD
- PROPOSED ROADWAY
- METAL DECK ROOFING
- POLYCARBONATE ROOFING
- LIGHTWEIGHT
- GLAZING
- BRICK FACE
- EXISTING TREES
- PROPOSED TREES

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ROUSE HILL ANGLICAN COLLEGE
MASTERPLAN 2016

Drawing Description:
PROPOSED JUNIOR SCHOOL EXTENSION
GROUND PLAN

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LEGEND

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- PROPOSED TURF
- PROPOSED SOFT LANDSCAPING
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- PROPOSED HARD LANDSCAPING
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- EXISTING BUILDINGS
- EXISTING GRAVEL ROAD
- PROPOSED ROADWAY
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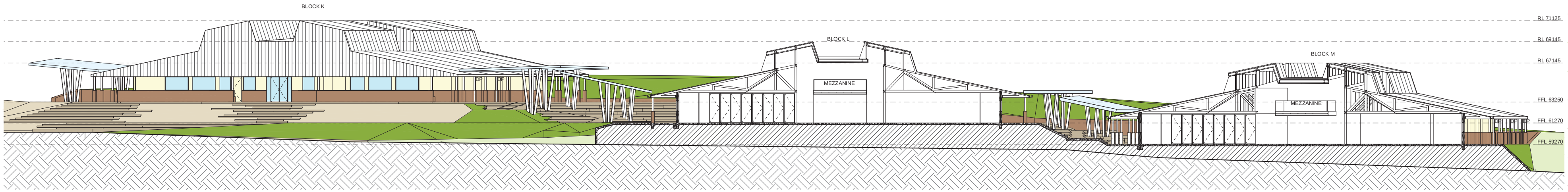
- POLYCARBONATE ROOFING
- LIGHTWEIGHT
- GLAZING
- BRICK FACE



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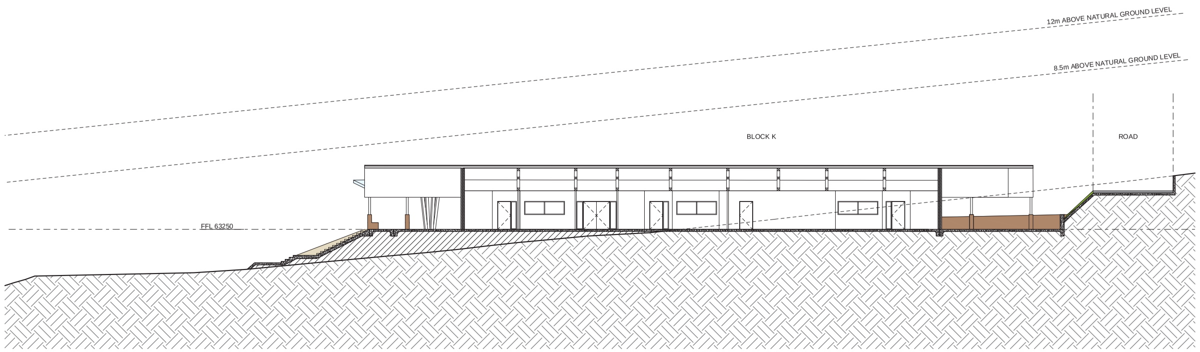

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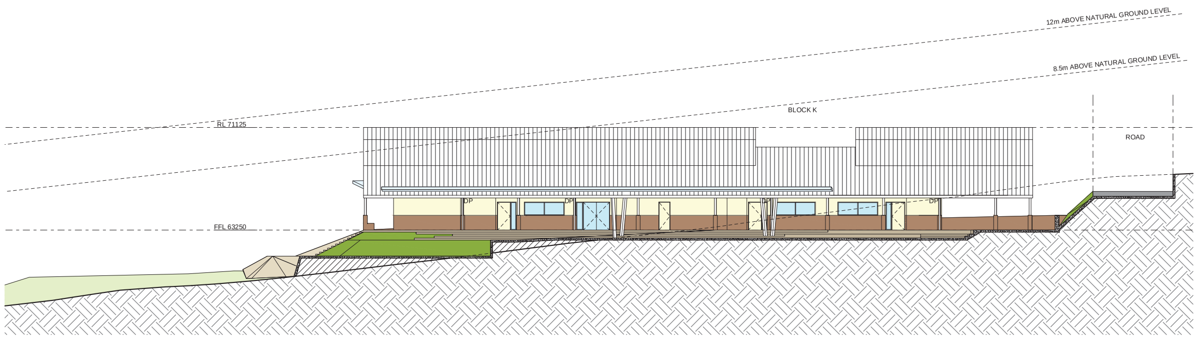

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PROPOSED JUNIOR SCHOOL EXTENSION SECTIONS 1

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PROJECT NO: 14301 DWG NO: MP-JS-30-00 REV NO: 01

Drawing Status: SSDA

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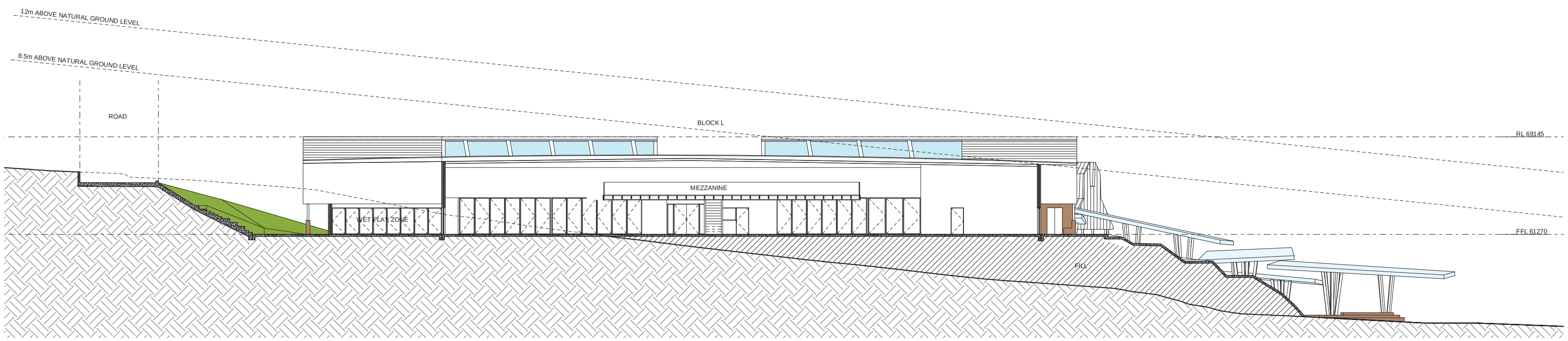

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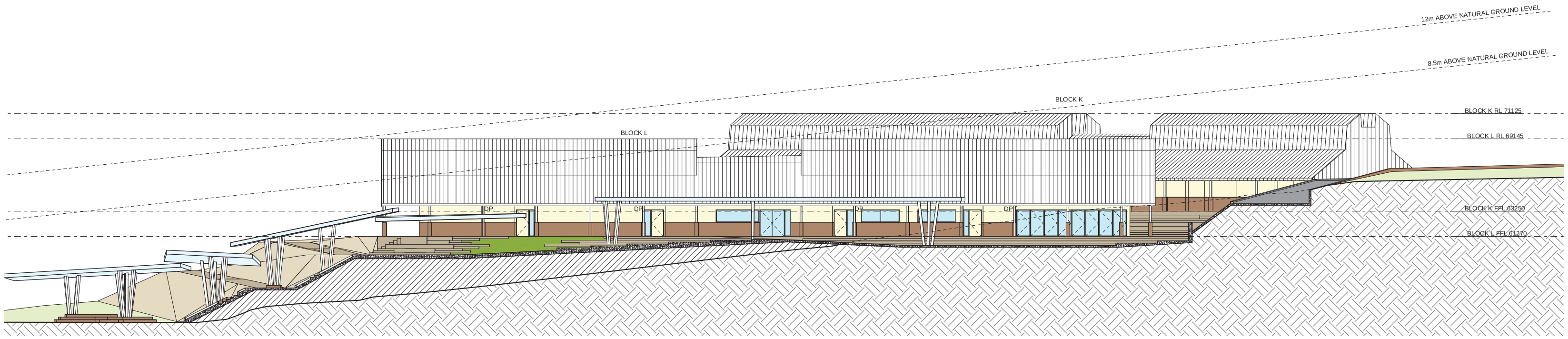

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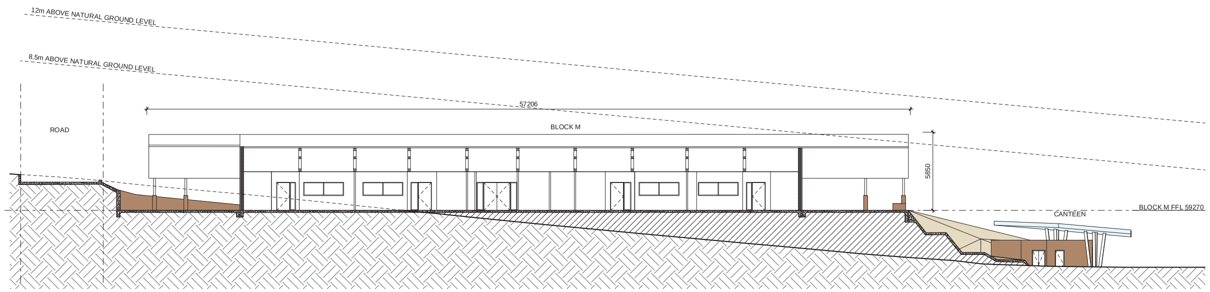

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ALL WORK IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS

TO BE READ IN CONJUNCTION WITH ENGINEERS DOCUMENTS

LEGEND

0 10m

- EXISTING TURF & SOFT LANDSCAPING ZONES
- PROPOSED TURF
- PROPOSED SOFT LANDSCAPING
- PROPOSED SOFTFALL
- PROPOSED HARD LANDSCAPING
- EXISTING BUILT FORM AND ROADS
- EXISTING BUILDINGS
- EXISTING GRAVEL ROAD
- PROPOSED ROADWAY
- METAL DECK ROOFING
- POLYCARBONATE ROOFING
- LIGHTWEIGHT
- GLAZING
- BRICK FACE

Rev	Date Description
01	25.07.17 SSDA SUBMISSION

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Project:
ROUSE HILL ANGLICAN COLLEGE MASTERPLAN 2016

Drawing Description:
PROPOSED JUNIOR SCHOOL EXTENSION SECTIONS 2

Drawn by: AM Checked by: TD Scale1:200@A1

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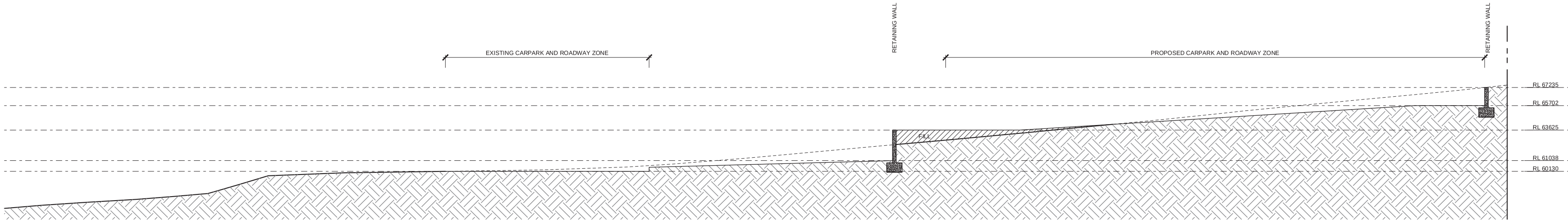

01 JS-10-04 CARPARK SHORT SECTION
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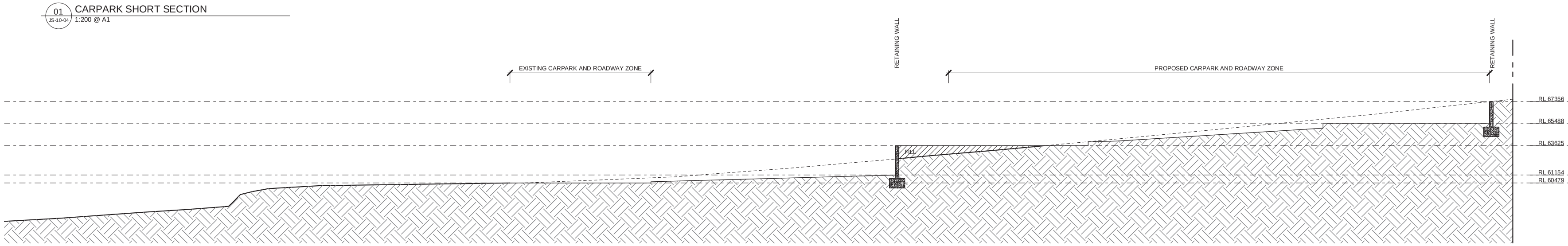

02 JS-10-04 CARPARK SHORT SECTION
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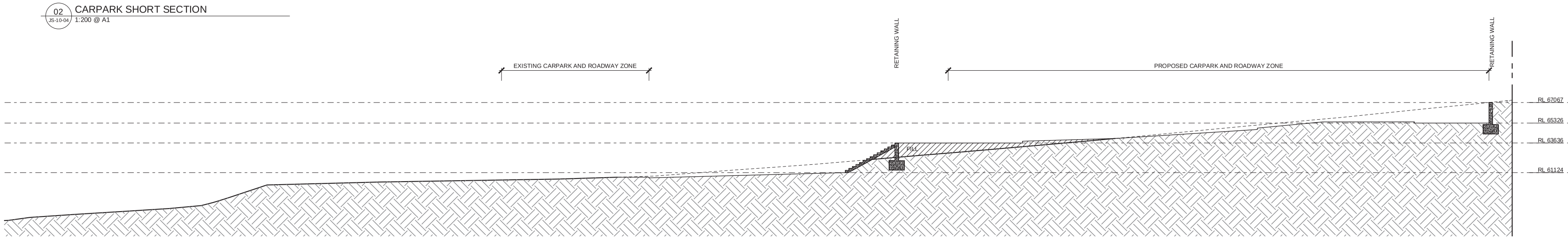

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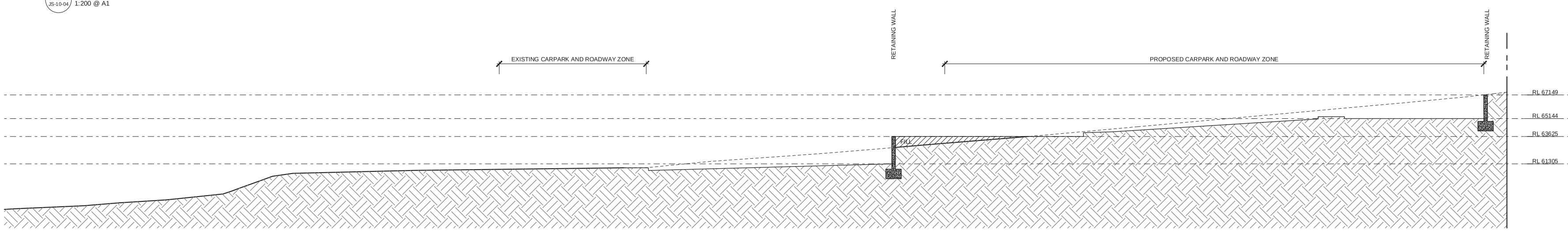

04 JS-10-04 CARPARK SHORT SECTION
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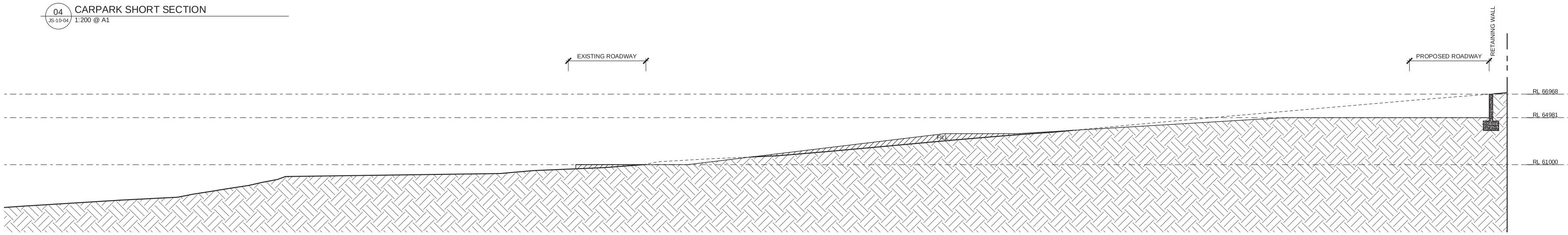

05 JS-10-04 CARPARK SHORT SECTION
1:200 @ A1

GENERAL NOTES

DO NOT SCALE FROM THIS DRAWING

CONFIRM ALL DIMENSIONS AND SETOUTS ON SITE PRIOR TO MANUFACTURE & INSTALLATION

ALL WORK IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS

TO BE READ IN CONJUNCTION WITH ENGINEERS DOCUMENTS

LEGEND

0 10m

- EXISTING TURF & SOFT LANDSCAPING ZONES
- PROPOSED TURF
- PROPOSED SOFT LANDSCAPING
- PROPOSED SOFTFALL
- PROPOSED HARD LANDSCAPING
- EXISTING BUILT FORM AND ROADS
- EXISTING BUILDINGS
- EXISTING GRAVEL ROAD
- PROPOSED ROADWAY
- METAL DECK ROOFING
- POLYCARBONATE ROOFING
- LIGHTWEIGHT
- GLAZING
- BRICK FACE

Rev	Date / Description
01	25.07.17 SSDA SUBMISSION

sydney
Level 2, 79 Myrtle St
Chippendale 2008
Nominated Architect: Gerard Reinmuth 6629
T 02 9279 2226
F 02 9279 2227

hobart
181 Elizabeth St
Hobart 7000
Nominated Architect: Scott Balmforth 564
T 03 6234 6372
F 03 6231 4939

TERROIR

Project:
ROUSE HILL ANGLICAN COLLEGE MASTERPLAN 2016

Drawing Description:
PROPOSED JUNIOR SCHOOL EXTENSION
CARPARK SECTIONS

Drawn by: CY Checked by: TD Scale1:200@A1

PROJECT NO:	DWG NO:	REV NO:
14301	MP-JS-30-02	01

Drawing Status: SSDA

Date Plotted: File Path: X:\14301 Rouse Hill Anglican College\06.00 Documentation\06.01 CAD\06.01.01 Current CAD\Masterplan\Sections\SE-JS-30-02.dwg