GEOTECHNIQUE PTY LTD

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NSW Department of Education

Proposed Newington Public School Upgrade

Newington Boulevard
Newington

Additional Geotechnical Investigation

Report No 20659/3-AB R2

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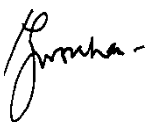
Author Signature	
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NSW Department of Education
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Attention: Mr Daniel Rickard

Dear Sir

Re **Newington Public School Upgrade (ID 4627)**
Newington Boulevard, Newington
Additional Geotechnical Site Investigation

This report details the results of additional Intrusive Geotechnical Investigation (IGI) carried out for proposed activity involving redevelopment or upgrade of school at the above site.

Based on review of available relevant information geotechnical investigation reports and information from three additional boreholes and laboratory tests on representative soil and rock core samples, this report provides the following assessment and recommendations:

- Assessment of subsurface profile and recommendation of a Geotechnical Model for the proposed school building.
- Assessment of presence of dispersive/erodible, saline and acid sulfate soils and recommendations of appropriate soil management plans.
- Geotechnical recommendation on bulk earthworks and design of floor slabs and footings for proposed buildings and car park pavement.
- Assessment on potential geotechnical constraints on proposed activity or school redevelopment.

If you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully
GEOTECHNIQUE PTY LTD

INDRA JWORCHAN
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EXECUTIVE SUMMARY

Geotechnique Pty Ltd prepared this additional geotechnical investigation report to assess the potential environmental impacts that could arise from the proposed activity, that involves redevelopment of Newington Public School at 49A Newington Boulevard, Newington Lot 320 DP1285196 (the site).

Based on review of previously prepared geotechnical investigation reports relevant to the site and information from three boreholes drilled during the current investigation, this additional geotechnical investigation report provides the following assessments and recommendations.

1. The proposed activity or Newington Public School redevelopment includes construction of a new two storey building comprising general and specialist learning areas, staff facilities, covered walkway, etc.
2. The subsurface profile across Newington Public School is likely to comprise a sequence of topsoil/fill and natural soils underlain by bedrock. The thickness of topsoil/fill and depth to bedrock across the school vary significantly. However, within the footprint of proposed new school building, the thickness of topsoil/fill varies from about 0.5m to 1.5m and the depth to bedrock varies from about 7.5m to 11.0m from existing ground surface.
3. Depth to regional groundwater level at the site is anticipated to be more than 7.5m. However, localised minor seepage was encountered at depths of 2.5m from existing ground surface. Furthermore, it should be noted that the groundwater level might vary due to rainfall and other factors.
4. Fill generally comprises silty clay of low to high plasticity with some fine to coarse gravel. Foreign materials like glass and woods, not expected in controlled fill, were also encountered in some locations. Although fill is moderately to well compacted, variability in compaction level and presence of foreign materials indicate that the fill might not have been placed in controlled manner.
5. Natural soils are assessed to be residual soils and predominantly comprising silty clay of medium to high plasticity, stiff to very stiff, with trace of fine grain gravel and roots. Bedrock is shale.
6. Soils (fill and natural soils) across the site are dispersive and susceptible to excessive erosion. Therefore, earthworks for the proposed activity should be carried out in accordance with an appropriate Soil Management Plan to manage impacts from the erodible soils. The Soil Management Plan should be developed by earthwork contractor, in general accordance with NSW Department of Housing guidelines, before earthworks commence.
7. Soils across the site are non-saline up to depths of about 0.5m and saline at depths exceeding 0.5m. Therefore, to manage impacts from saline soils, disturbance and excavation of soil at depths exceeding 0.5m should be carried out in accordance with recommended Saline Soil Management Plan presented in this report.
8. Soils across the site are not acid sulfate soils and potential acid sulphate soils. Therefore, earthwork may be carried out without an Acid Sulfate Soil Management Plan.
9. Soils across the site are assessed to be reactive and susceptible to shrink swell movements. Therefore, soils obtained from excavation within the site are considered not ideal material for use in controlled fill.
10. The subsurface profile across the proposed school building site may be represented by a generalised Geotechnical Model comprising four Geotechnical Units, two soil units (Units 1 and 2) and two bedrock units (Units 3 and 4) detailed in this report.

11. Site preparation for construction of proposed school building is anticipated to involve some excavation and fill placement. The depth of excavation is unlikely to exceed 2.5m. Recommended stepwise procedure or sequence for bulk earthworks includes (1) site mobilisation, (2) installation of sediment erosion control measure suggested by Soil Management Plan, and (3) commence earthworks or cut and fill operations.
12. The materials to be excavated during proposed earthworks are anticipated to comprise topsoil/fill and residual soils. No rock excavation is anticipated. Therefore, proposed excavation can be achieved using conventional earthmoving equipment. The ground vibration during proposed excavation works is unlikely to adversely impact on the stability of existing structures (houses, road and services etc) in the vicinity of the site.
13. The depth to groundwater level across the site is likely to exceed about 7.5m from existing ground surface. Therefore, it is unlikely that the proposed excavation will encounter groundwater inflow. However, localised seepage may be encountered at depth of about 2.8m. Minor groundwater or seepage inflow, if any, may be managed by a conventional sump and pump method.
14. Fill, where required, should be placed and compacted in accordance with recommendations provided in this report and only suitable materials should be used in the fill. Soils obtained from excavation within the site are not ideal material for use in controlled fill. However, these soils may be used in controlled fill only (1) at depths exceeding 0.5m from final design level and/or (2) after blending with crushed sandstone or lime stabilisation as recommended in this report.
15. Controlled fill should be placed in layers 200mm to 250mm and compacted to Minimum Dry Density Ratio (MDDR) of 98% Standard, at moisture content within 2% of Optimum Moisture Content (OMC). However, upper 500mm of foundation/subgrade for roads should be compacted to MDDR of 100% Standard, at moisture content within 2% OMC.
16. Cut and fill slopes should be battered for stability or retained by engineered retaining structures. This report provides recommendations on batter slopes for short term and long term stability and earth pressure parameters for design of retaining structures, if required.
17. At the completion of earthworks, the subgrade/foundation materials across the site are anticipated to include controlled fill and residual soil and therefore, the proposed building site is assessed to belong to Site Class M in accordance with Australian Standard AS2870. Therefore, floor slabs for the proposed building may be constructed as ground bearing slabs or suspended slabs supported by footings designed in accordance with recommendations provided in this report.
18. Ground floor slabs bearing on controlled fill and natural soils may be designed to suit recommended Site Classification. Alternatively, a Modulus of Subgrade Reaction value of 25kPa/mm is recommended.
19. Appropriate footings for future proposed school building would comprise deep footings (bored piers) socketed into bedrock at depths exceeding 7.5m from existing ground surface. However, shallow footings founded on controlled fill and residual soils may be considered for light weight structures. As Sydney Water pipelines are located in proximity of the proposed building, it is recommended that the footings with significant loads are socketed into bedrock at depths lower than the invert level of pipelines so that the proposed activity does not impact stability of the pipelines adversely. The recommended allowable bearing pressures for design of footings founded on controlled fill and residual soils are anticipated to vary from about 125.0kPa to 250.0kPa and that for deep footings founded/socketed into bedrock are anticipated to vary from about 800.0kPa to 3000.0kPa.

20. Car park and access road pavement on residual soil or/and controlled fill subgrade may be designed for indicative California Bearing Ratio (CBR) of 3%.
21. The geotechnical limitations for the proposed activity include (1) variability in thickness of fill and natural soils (2) depths to bedrock of varying strengths, and (3) presence of reactive, dispersive and saline soils. However, above mentioned geotechnical limitations impose no major limitations.
22. For existing site conditions, the risk of slope failures across the site is “Very Low”. Therefore, the site is suitable for construction of the proposed school building from slope stability considerations. It is also our assessment that the risk of slope instability across the site can be maintained at “Very Low” even during and after construction of the proposed school building if (1) earthworks are completed in accordance with recommendations provided in this report, and (2) design and construction proposed school building are carried out in accordance with geotechnical recommendations provided in this report.
23. The geotechnical risks associated with variabilities in thickness and depth to various types of soils and bedrock can be addressed by conducting inspections during construction stage. Additional investigation may also be considered. Likewise, limitations associated with reactive, dispersive and saline soils can be addressed if earthworks are carried out in accordance with appropriate SMP to be developed before earthwork is commenced and Saline Soil Management Plan provided in this report.

Based on results of additional Intrusive Geotechnical Investigation (IGI) detailed in this report, it is our assessment that the nominated site in Newington Public School is suitable for construction of proposed new school building provided earthworks and designs of proposed building are carried out in accordance with recommendations provided in this report and proposed structures are located outside the zone of influence of existing structures (Sydney Water pipelines) and vice versa.

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Appendix A Drawing No 20659/1-AA3 - Borehole Locations Plan
Borehole Logs with Core Photos

Appendix B Laboratory Test Results

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Description
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
COLA	Covered Outdoor Learning Area
CSM	Conceptual Site Model
DCP	Dynamic Cone Penetrometer
DoE	Department of Education
DPE	Department of Planning and Environment
DPI	Department of Primary Industries
EC	Electrical Conductivity
ECe	Equivalent Electrical Conductivity
EFSG	Educational Facilities Standards and Guidelines
ESP	Exchangeable Sodium Percentage
GLS	General Learning Spaces
IGI	Intrusive Geotechnical Investigation
IGIR	Intrusive Geotechnical Investigation Report
OSHC	Out of School Hour Care
PGDR	Preliminary Geotechnical Desktop Report
PGDS	Preliminary Geotechnical Desktop Study
PS	Public School
PTS	Permanent Teaching Spaces
REF	Review of Environmental Factors
SGM	Site Geotechnical Model
SINSW	School Infrastructures NSW
SMP	Soil Management Plan
SPT	Standard Penetration Test
SSMP	Saline Soil Management Plan
SWMS	Safe Work Method Statement

1.0 INTRODUCTION

This additional Intrusive Geotechnical Investigation (IGI) report has been prepared by Geotechnique Pty Ltd on behalf of Department of Education (the proponent) to assess the potential environmental impacts that could arise from the redevelopment of Newington Public School at 49A Newington Boulevard, Newington Lot 320 DP1285196 (the site). This report has been prepared in general accordance with Australian Standard AS1726 (Reference 1) to assess subsurface conditions across the site for the following:

- To provide geotechnical recommendations on site preparation (earthwork) and design of floor slabs and footings of proposed new school buildings and car park pavement.
- To provide assessment of geotechnical risks, if any, and recommend remedial measures to address the limitations so that the site is suitable for construction of the proposed new school building from geotechnical engineering considerations.

This report accompanies a Review of Environmental Factors (REF) that seeks approval for the redevelopment of Newington Public School, which involves the following works:

- Construction of a new two storey building comprising;
    - General and specialist learning areas.
    - Staff facilities.
    - External stairwell and lift.
- Construction of a new covered walkway and partial demolition of an existing covered walkway.
- Landscaping.
- Ancillary services and infrastructure upgrades.

Figure 1 on the following page shows the existing school infrastructures and footprint of the proposed two storey building.

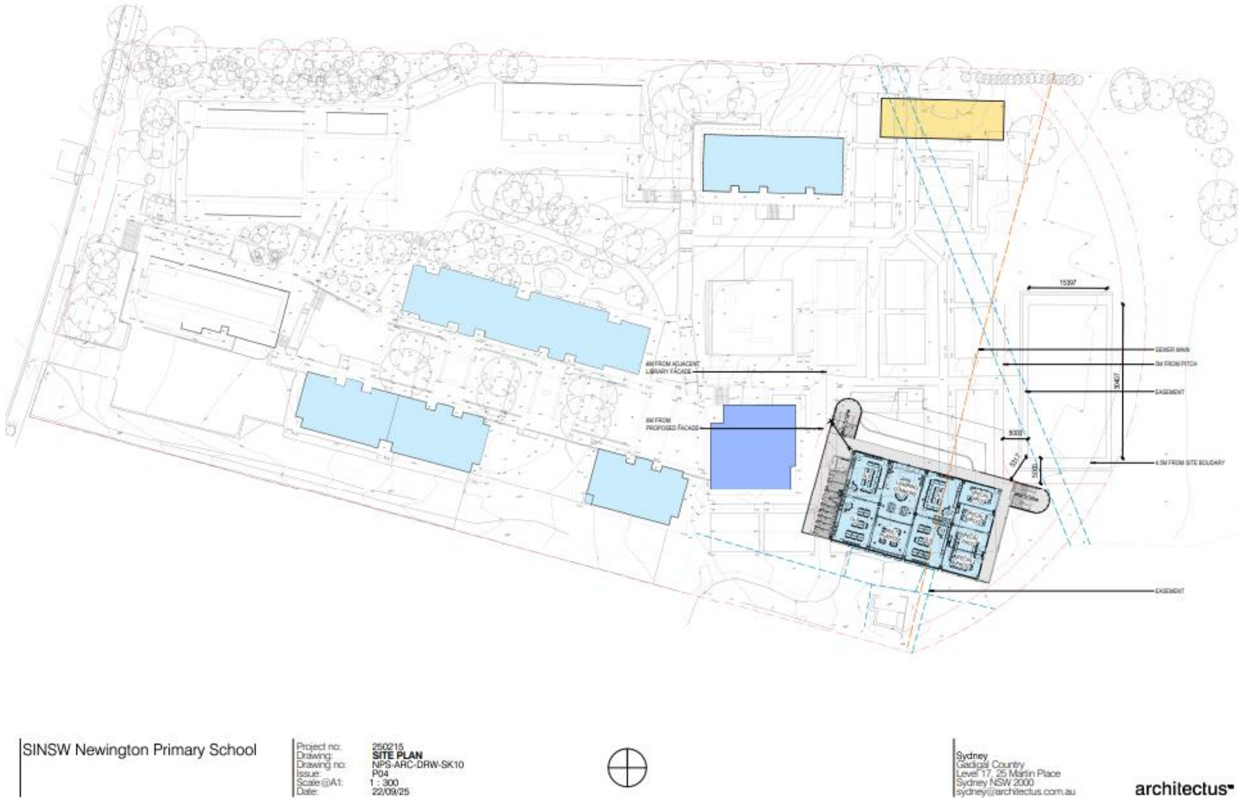

Figure 1 Site Plan Showing Footprint of Proposed Two Storey Building

2.0 SCOPE OF WORKS

The scope of works for Additional IGI included the following:

- Reviewing available geological, soil landscape, salinity potential and acid sulfate soil risk maps and geotechnical investigation report relevant to the site.
- Preparing Safe Work Method Statement (SWMS) and Environmental Management Plan (EMP) detailing procedures to complete the field works safely and with minimal environmental damage.
- Carrying out a walk over survey to assess existing site conditions.
- Reviewing services plans obtained from “Before You Dig Australia” to determine locations of services across the site.
- Drilling boreholes to assess subsurface conditions across the site.
- Conducting field and laboratory tests to assess nature of subsurface materials/soils.
- Preparation of this report detailing assessment of subsurface conditions and geotechnical recommendations on earthwork and design of proposed new school buildings.

3.0 REVIEW OF AVAILABLE INFORMATION

3.1 Regional Geology

Reference to Website MinView indicates that the bedrock across the Newington PS is Ashfield shale with reclaimed estuarine land in the eastern portion (Reference 2). Ashfield shale comprises dark grey to black shale and laminite. Figure 2 on the following page is an extract of geological map covering the school site.

3.2 Soil Landscape

Reference to eSPADE v2.2 prepared by the NSW Department of Planning and Environment (DPE), indicates that the landscape in most portions of the school belong to Birrong Group with Blacktown Group in the western portion (Reference 3). Figure 3 on the following page is an extract of soil landscape map covering the site:

- Birrong Group is characterised by level to gently undulating floodplain draining Wianamatta Group shales, local relief to 5m, ground surface slopes of less than 3% and broad valley flat. Soil in this landscape is deep (more than 2.5m), saline and subjected to localised flooding and seasonal water logging.
- Blacktown Group is characterised with gently undulating rises on Wianamatta Group shales, with local relief to 30.0m, ground slope of less than 5 percent and broad rounded crests. Soil within this landscape is likely to be up to 3.0m thick, moderately reactive, highly plastic and with poor drainage.

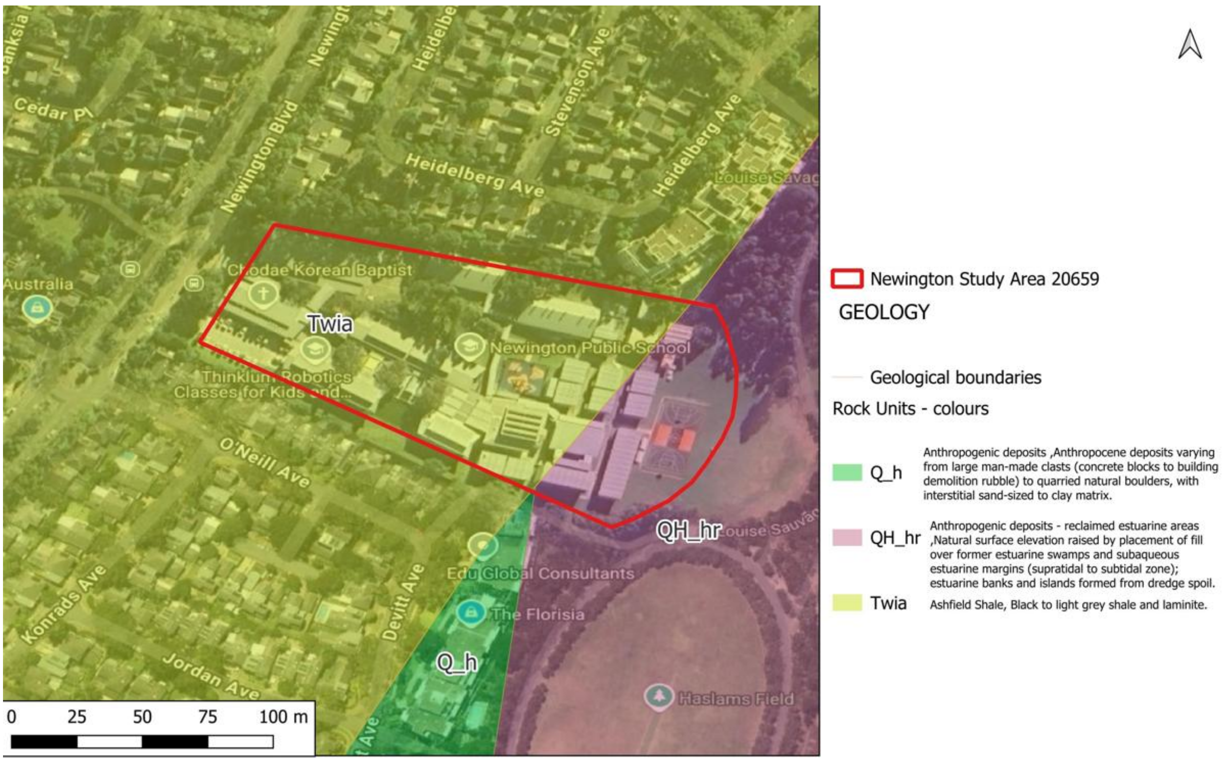

Figure 2 Geological Map of Newington Public School

Figure 3 Soil Landscape Map of Newington Public School

3.3 Soil Salinity

Reference to Map showing Salinity Potential in Western Sydney (Scale Approximate 1:143,000) prepared by Department of Infrastructures, Planning and Natural Resources (2002) indicates moderately salinity potential across the school site (Reference 4).

3.4 Acid Sulfate Soils

Department of Land and Water Conservation has produced Acid Sulfate Soil Risk Maps for areas with known or potential occurrence of acid sulfate soils in NSW. Reference to the Acid Sulfate Soil Risk Map for Prospect/Parramatta indicates there are no known or probabilities of occurrences of acid sulfate soils across Newington PS (Reference 5). However, the eastern half of the school is disturbed terrain where possibility of occurrence of acid sulfate soils cannot be ruled out. Likewise, ground surface elevation in the eastern portion of the site is about RL 5.0m AHD, where excavations deeper than 1.0m may encounter acid sulfate soils or potential acid sulfate soils.

3.5 Groundwater

A search of the website of Department of Primary Industries (DPI), Office of Water for registered groundwater bore data shows three registered bores within radius of 500.0m of the school site and these bores show depths to depth to groundwater bearing strata varies from about 7.5m to 10.0m from existing ground surface (Reference 6). However, no information is available on standing groundwater level.

3.6 Geotechnical Conditions

Geotechnique Pty Ltd completed a Preliminary Geotechnical Desktop Study (PGDS) and Intrusive Geotechnical Investigation (IGI) at the above site and prepared Report No 20659/3-AA dated 27 January 2025 (Reference 7). Figure 4 extracted from Reference 7 shows locations of 14 test pits, designated TP1 to TP15 excluding TP11, and one borehole, designated as BH11, drilled for preparation of Reference 7.

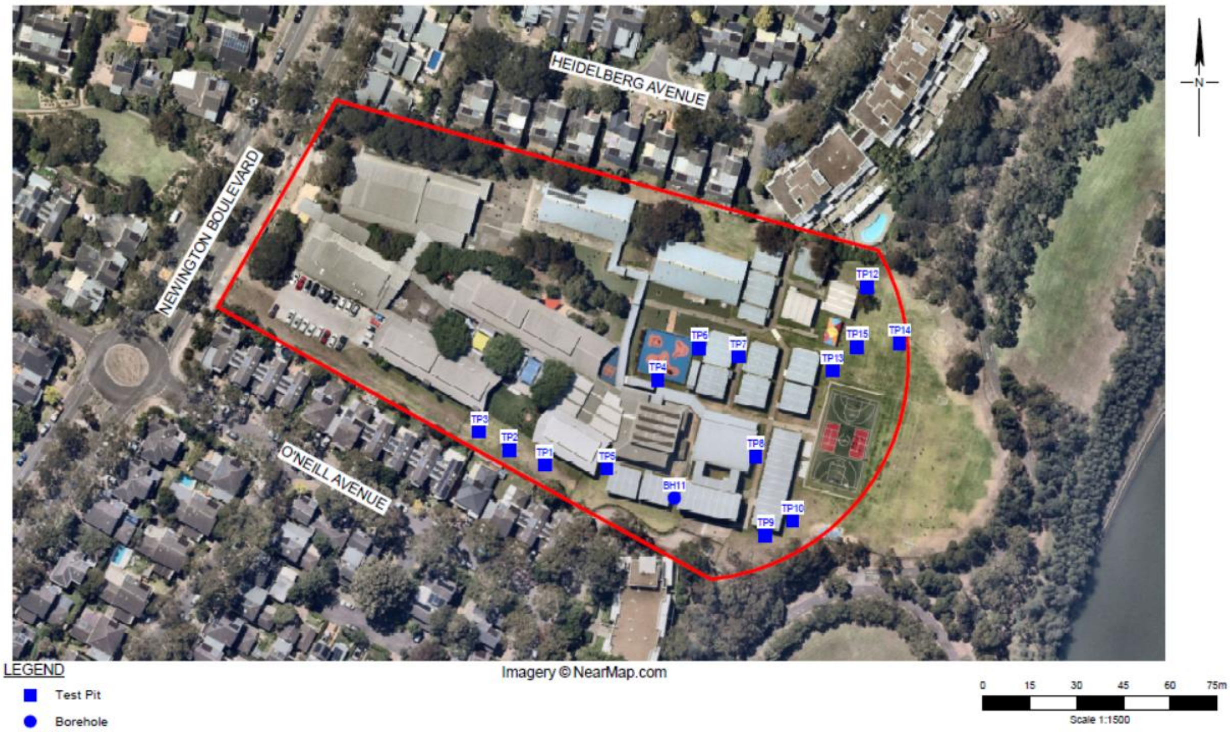

Figure 4 Locations of Test Pits and Boreholes for Preparation of Reference 7

Based on information from test pits/borehole and results of laboratory tests on limited soil samples, this report (Reference 7) provides the following assessments and recommendations for Conceptual Design of the proposed school upgrade works:

- The subsurface profile across Newington PS site is likely to comprise a sequence of topsoil/fill and natural soils underlain by bedrock. Topsoil is generally 200mm thick and thickness of fill varies from about 0.3m to more than 2.5m. Bedrock was encountered only in three test pits excavated in the mid southern boundary of the site. Remaining test pits/borehole did not encounter bedrock up to their termination depths of about 2.5m from existing ground surface.
- The depth to groundwater level is anticipated to be more than 2.5m from the existing ground surface under normal climatic conditions. It should however be noted that fluctuations in the level of groundwater might occur due to variations in rainfall and/or other factors.
- Fill is predominantly silty clay of low to high plasticity. Although fill is moderately to well compacted, variability in compaction level and presence of foreign material like glass indicates that the fill might not have been placed and compacted in controlled manner. Natural soils are predominantly silty clay of medium to high plasticity and bedrocks encountered in boreholes include shale and siltstone.

- Natural soils across the site are generally non-saline in most portions of the site. However, saline soil will be encountered to the east of existing school buildings. Therefore, to manage impacts from saline soil, disturbance and excavation of soil in the eastern portion of the site should be carried out in accordance with Saline Soil Management Plan (SSMP).
- Natural soils across most portion of the school site are unlikely to be acid sulfate or potential acid sulfate soils. However, if excavations exceed 1.0m in depth in areas where ground surface elevation is lower than RL 5.0m AHD (east of existing school buildings), we recommend for sampling and testing of soils to ascertain if earthworks are to be carried out in accordance with an Acid Sulfate Soil Management Plan to manage impacts from acid sulfate soils or potential acid sulfate soils.
- Based on results of PGDS and IGI, the site is assessed to be suitable for proposed upgrade works provided earthworks and designs of proposed upgrade works are carried out in accordance with appropriate geotechnical recommendations.

4.0 FIELD WORKS

Field works for the additional IGI were carried out during 29 and 30 September 2025 and consisted of the following:

- Review site plan showing footprint of proposed school building.
- Reviewing services plans obtained from "BYDA" to assess underground services across the site.
- Briefing Safe Work Method Statement (SWMS), Environmental Management Plan (EMP) and Heritage risks to subcontractors attending the site.
- Carrying out a walk over survey to assess existing site conditions and nominate three borehole locations, designated as BH1, BH2 and BH3, in consultation with SINSW. These boreholes were located within the footprint of proposed school building and approximate borehole locations are indicated on Drawing No 20659/3-AB1 presented in Appendix A.
- Scanning the proposed borehole locations for underground services to ensure boreholes are located away from existing services. We engaged a specialist services locator for this purpose.
- Drilling three boreholes, designated as BH1 to BH3, using a truck mounted drilling rig fully equipped for geotechnical investigation. These boreholes were drilled using TC-bit and rock coring method and terminated in bedrock at target depths of 11.5m to 12.0m from existing ground surface. Borehole logs with photograph of rock cores are presented in Appendix A.
- Carrying out Standard Penetration Tests (SPT) in at regular depth intervals in boreholes to assess the strength of sub-surface soils. SPT results are included in appropriate borehole logs.
- Recovering representative undisturbed (U50 Tubes) and disturbed soil samples and rock cores from boreholes for visual classification and laboratory tests.
- Measuring the depth to groundwater level in boreholes, where encountered.
- Backfilling the boreholes with recovered materials after logging and sampling.
- Locating the borehole locations using out inhouse GPS.

Field works were supervised by a team of two Field Engineers from this company, responsible for walk over survey, locating borehole locations, supervising drilling and SPT, conducting DCP tests, sampling, and preparation of field logs.

5.0 SITE CONDITIONS

5.1 Surface Conditions

The site has frontage to Newington Boulevard (76 metres along the western lot boundary), public open space (140m along the eastern boundary) and medium density residential development (179m along the northern lot boundary and 181m along the southern boundary). The site comprises a single allotment, legally described as Lot 320 in deposited plan (DP) 1285196 with an approximate area of 2.0ha.

The site is located in the suburb of Newington on the western side of Haslams Creek, opposite the Sydney Olympic Park Precinct and Auburn waste resource facility. The site's location is approximately 5.2km southeast of the Parramatta central business district, approximately 2.5km north of the Lidcombe town centre and approximately 3km southwest of the Rhodes town centre.

In general, the ground surface across the site is dipping gently towards the east at about 3 to 4 degrees and ground surface elevation varies from about RL 14.0m AHD along the western school boundary to about 4.0m AHD along the eastern boundary.

Figure 5 below is site location plan of the Newington Public School.

Figure 5 Location of the Newington Public School (NSW Spatial Viewer)

5.2 Subsurface Condition

The subsurface profiles encountered in boreholes BH1, BH2 and BH3 drilled during current investigation are detailed in borehole logs presented in Appendix A and summarised below in Table 1.

Preparation of Reference 7 included excavation of 14 test pits (designated ad TP1 to P15, excluding TP11) and drilling of a borehole (designated as BH11). Locations of these test pits and borehole are indicated on Figure 4. Test pits designated as TP8, TP9 and TP10 and borehole designated BH11 are located within or in closed proximity of the footprint of the proposed school building. Subsurface profiles encountered in these test pits and borehole are also summarised in Table 1.

Table 1 - Sub-surface Profiles encountered in Boreholes and Test Pits

Test Pit/ Borehole	Easting (m)	Northing (m)	Ground Surface RL (m AHD)	Termination Depth (m)	Depth for Topsoil/Fill (m)	Depth for Natural Soil (m)	Depth to Bedrock (m)
BH1	6253701.6	320091.1	4.9	11.8	0.0-0.8	0.7-7.5	7.5
BH2	6253727.2	320120.2	4.6	12.0	0.0-0.7	0.7-10.5	10.5
BH3	6253699.4	320113.9	4.3	11.5	0.0-0.7	0.5-10.7	10.7
TP8	320115.8	6253711.5	6.0	2.5	0.0-1.2	1.2->2.5	-
TP9	320113.9	6253693.9	4.0	2.5	0.0-0.4	0.4->2.5	-
TP10	320130.4	6253702.9	3.8	2.5	0.0-0.3	0.3->2.5	-
BH11	320086.6	6253700.5	6.5	2.5	0.0-0.9	0.8->2.5	-

Note Ground surface RL are approximate only
Co-ordinates of BH1 might have been impacted by overhead lines
Subsurface profiles for TP8, TP0 and BH11 are extracted form Reference 7.

Based on results of current and previous investigation, the subsurface profile across the school site is assessed to comprise a sequence of top/fill and natural soils, assessed to be residual soils, underlain by bedrock. The thickness of topsoil/fill and depth to bedrock across the school site vary significantly. However, for the subsurface profile within the footprint of proposed building the following are our assessments:

- Thickness of topsoil/fill varies from about 0.5m to 1.5m. Topsoil is about 100mm to 200mm thick.
- Depth to bedrock varies from about 7.5m to 11.0m from existing ground surface.

The subsurface materials may in general be described as follows:

Topsoil Silty CLAY, low plasticity, dark brown, moist, with some fine grained sand and gravel and roots.

Fill Silty CLAY, low to high plasticity, orange, brown, red mottled pale grey, moist, with fine to medium grained gravel, trace of glass, moderately to well compacted.

Natural Soil Silty CLAY, medium to high plasticity, red, brown, mottled pale grey, moisture content generally lower than or equal to plastic limit, stiff to very stiff, moisture content generally lower than plastic limit, firm to very stiff, trace of fine grained gravel and roots.

Bedrock SHALE, brown, pale grey, grey, extremely weathered to fresh, very low to medium strength.

5.3 Groundwater Condition

During current investigation, boreholes BH1 did not encounter groundwater level up to termination depth of 11.8m from existing ground surface. However, boreholes BH2 and BH3 did encounter some seepage at depth of 9.0m and 2.8m respectively. Likewise, 14 of 15 test pits/borehole drilled for preparation of Reference 7 did not encounter groundwater level up to their termination depth of 0.5m to 2.5m. One of the test pits (TP8) encountered minor seepage at depth of about 2.5m. Therefore, it is our assessment that the seepages encountered in BH2, BH3 and TP8 do not represent regional groundwater but localised infiltrated surface water.

We anticipate the depth to regional groundwater across the proposed building site to be more than 7.5m during normal climatic conditions. However, it should be noted that the groundwater level might vary due to rainfall and other factors not evident during field work.

5.4 Existing Fill

Test pits/borehole distributed across the site encountered topsoil/fill. The topsoil/fill thickness is anticipated to be variable, generally in range of 0.5m to 1.5m. But about 2.0m to 2.5m thick topsoil/fill was encountered in some locations (TP6 and TP12) outside the footprint of proposed building during previous investigation. However, it is our assessment that the thickness of topsoil/fill within the footprint of proposed building varies from about 0.5m to 1.5m.

Fill generally comprises silty clay of low to high plasticity with some fine to coarse gravel. Foreign materials like glass and woods, not expected in controlled fill, were also encountered in some locations.

We do not have information on how existing fill was placed. Although visual assessment as well and SPT and DCP tests indicate the fill might have been moderately to well compacted, variability in compaction level and presence of some foreign materials indicate that the placement of fill might not have been adequately controlled. Therefore, if records on fill placement and results of field density tests indicating that the existing fill has been placed and compacted in controlled manner are not available, the existing fill should be considered as uncontrolled fill and therefore unsuitable as foundation materials. Alternatively, field density tests may be carried out to ascertain whether or not the existing fill is adequately compacted to be suitable as foundation materials for proposed upgrade works.

6.0 LABORATORY TESTS

Representative soil samples and rock cores recovered from boreholes were tested in the NATA accredited laboratories of SGS Environmental Services and Geotech Testing Pty Ltd, in accordance with relevant Australian Standards, to determine the following:

- Physical properties to assess reactivity and computability in terms of Atterberg Limits, shrink swell index, maximum dry density, optimum moisture content, California Bearing Ratio.
- Chemical properties to assess soil salinity and aggressivity in terms of Electrical Conductivity, pH, chloride, sulfate and resistivity.
- Chemical properties to assess erodibility of soil in terms of Exchangeable Sodium Percentage.
- Chemical properties to assess acid sulfate soils in terms of pH of KCl extract (pH_{kcl}), pH of KCl extract after peroxide digestion (pH_{ox}), Total Potential Acidity TPA), Total Actual Acidity (TAA), Total Sulphidic Acidity (TSA), Percent Peroxide Oxidisable Sulphur (S_{POS}) and Chromium Reducible Sulphur (S_{cr}).

Rock cores recovered from borehole BH1 were photographed and tested for determination of point load strength index.

Detailed results of laboratory tests on representative soil samples are presented in Appendix B, and summaries are presented below in Tables 2 to 5. These tables also include results of laboratory tests conducted during preparation of Reference 7 that are relevant to the proposed school building.

Table 2 - Results of Atterberg Limits and Shrink Swell Index Tests

Test Pit/ Borehole	Sample Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Shrink Swell Index (%/pF)
BH1	0.8-1.0	85.0	30.0	55.0	-
BH2	0.7-1.0	-	-	-	1.4
TP8	1.2-1.7	-	-	-	1.3
TP9	0.5-0.8	-	-	-	1.2

Note Results for TP8 and TP9 are extracted form Reference 7.

Results for samples from test pits TP8 and TP9 are extracted form Reference 7.

Table 3 - Results of Compaction and California Bearing Ratio Tests

Borehole	Sample Depth (m)	Natural Moisture Content (%)	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)	California Bearing Ratio (%)
BH3	0.3-1.0	18.7	1.84	16.5	4.0

CBR sample was compacted to dry density ratio of about 100.0% standard close to optimum moisture content and submerged for 4 days under surcharge load of 6.75kg.

Table 4 – Results of Salinity, Aggressivity and Erodibility Assessment Tests

Test Pit/ Borehole	Sample Depth (m)	EC (µS/cm)	pH	Chloride (ppm)	Sulfate (ppm)	Resistivity (ohm-cm)	Exchangeable Sodium Percentage (%)
BH1	0.3-0.5	-	-	-	-	-	10.5
BH1	0.5-0.95	520	7.6	480	280	1000	-
BH1	1.3-1.5	-	-	-	-	-	32.4
BH1	3.0-3.45	830	7.9	1000	160	720	-
BH1	6.0-6.45	600	7.9	820	66	940	-
BH2	0.5-0.95	370	7.9	260	130	1600	17.3
BH2	4.5-4.95	1300	7.6	1600	200	480	-
BH2	7.5-7.95	1300	7.5	1900	180	430	-
BH3	0.5-0.95	-	-	-	-	-	7.5
BH3	1.5-1.95	600	6.1	580	160	1200	-
BH3	6.0-6.45	1100	7.2	1200	98	590	-
BH3	9.0-9.45	970	7.7	1500	110	540	-
TP8	0.6-1.0	120	7.6	33	170	3800	-
TP8	1.5-1.8	350	5.7	330	200	1700	-
TP9	0.5-0.8	460	7.2	310	340	1100	-
TP9	1.5-1.8	580	4.9	740	220	820	-
TP10	0.5-0.8	310	5.3	320	160	1500	-
TP10	1.7-2.0	640	7.1	900	140	800	-
BH11	0.5-0.8	420	8.2	280	120	1400	-

Note Results for TP8 to TP11 are extracted form Reference 7.

Results for samples from test pits TP8, TP9, TP10 and BH11 are extracted form Reference 7.

Table 5 - Results Acid Sulfate Soil Assessment Tests

Borehole No	Depth (m)	pH_{KCl}	pH_{ox}	TPA (pH6.5)	TPA (pH6.5)	TSA (pH6.5)	S_{POS} % w/w	S_{cr} % w/w
BH 1	0.8-1.1	6.4	6.1	<5	<5	<5	0.009	<0.005
BH 1	4.2-4.5	6.3	6.9	<5	<5	<5	<0.005	<0.005
BH 2	2.4-2.6	6.2	6.3	<5	11	9	<0.005	<0.005
BH 3	7.3-7.5	6.3	6.7	<5	<5	<5	<0.005	<0.005

Notes

pH_{KCl} = pH of filtered 1:20, 1M K_{Cl} extract, overnight shake
pH_{ox} = pH of filtered 1:20, 1M K_{Cl} after peroxide digestion
TPA = Total Potential Acidity (mol H^+/tonne)
TAA = Total Actual Acidity (mol H^+/tonne)
TSA = Total Sulphidic Acidity (mol H^+/tonne)
S_{POS} = Peroxide Oxidisable Sulphur (%w/w)
S_{cr} = Chromium Reducible Sulphur (% w/w)
Limit of Reporting for TAA, TPA and TSA is 5 moles H^+/tonne, and for S_{POS} and Scr is 0.005% w/w.

Rock cores obtained from borehole BH1 were photographed and tested at regular depth intervals for determination of Point Load Strength Index (I_{S50}). The I_{S50} and the assessed rock strengths, in accordance with Australian Standard AS1726 (Reference 1), are summarised in the following Table 6.

Table 6 - Results of Point Load Strength Index Tests

Borehole No	Depth (m)	Diametral $I_{s(50)}$ MPa	Axial $I_{s(50)}$ (MPa)	Assessed Diametral Strength	Assessed Axial Strength
BH1	9.18	0.04	0.22	Very Low	Low
BH1	10.35	0.05	0.38	Very Low	Medium
BH1	11.14	0.18	0.41	Low	Medium
BH1	11.84	0.04	0.56	Very Low	Medium

It should be noted that Point Load Strength tests could only be carried out on intact (stronger) portions of rock cores. Therefore, strength assessments presented in Table 5 indicate the upper limits of rock strengths.

7.0 PROPERTIES OF SUBSURFACE SOILS

7.1 Soil Reactivity

Subsurface profile across the building site comprises a sequence of topsoil/fill and residual soils underlain by bedrock. Topsoil/fill is anticipated to be about 0.5m to 1.0m thick. The thickness of natural soil is anticipated to vary from about 7.0m to 11.0m. A representative sample of natural soil recovered from proposed building site indicates liquid limit of 85% and plastic limit of 30% (Table 2). Therefore, based on Atterberg limits, the natural soils across the proposed building site are assessed to be of high reactivity. Representative samples of natural soils from proposed building site also indicate shrink swell index of 1.2%/pF to 1.4%/pF (Table 2). Therefore, natural soils are assessed to be susceptible to shrink swell movements.

Therefore, it is our assessment that the foundation soils for the proposed building site are reactive and susceptible to shrink swell movements.

7.2 Soil Erodibility

Erosion is the detachment and movement of soil materials. Soil erodibility (or dispersivity) is generally assessed by conducting chemical tests such as Exchangeable Sodium Percentage (ESP) and Sodium Absorption Ratio (SAR), and physical tests such as Emerson Class and Dispersion Percentage.

During current investigation, ESP values for 4 representative soil samples were determined. Soils with ESP of more than 5% are assessed to be potentially dispersive and soils with ESP values of 10% or more are assessed to be dispersive and susceptible to excessive erosion (Reference 8). ESP values of 4 representative soil samples presented in Table 4 vary from 7.5% to 32.4.2%. But only one samples out of four samples have ESP values of less than 10.0%.

Therefore, based on ESP values, it is our assessment that the soils likely to be disturbed or excavated during proposed school construction are dispersive and susceptible to excessive erosion. Therefore, we recommend that earthworks for the proposed activity are carried out with in accordance with an appropriate Soil Management Plan (SMP) to manage the impacts from the erodible soils. Before the commencement of earth works, the earthwork contractor should develop an appropriate SMP in accordance with recommendations provided by NSW Department of Housing (Reference 9).

7.3 Soil Salinity

Soil salinity is generally assessed by measuring Electrical Conductivity (EC) of a soil sample made up of 1:5 soil water suspension. Thus, determined EC is multiplied by a factor varying from 6 to 23, based on the texture of the soil sample, to obtain Corrected Electrical Conductivity designated as Ece. Alternatively, ECe may be directly measured in soil saturation extracts. Soils are classified as saline if ECe of the saturated extracts exceed 4.0dS/m. The criteria for assessment of soil salinity classes are shown in the following Table 7 (Reference 10).

Table 7 – Criteria for Soil Salinity Classification

Classification	EC_e (dS/m)	Comments
Non-saline	<2	Salinity effects mostly negligible
Slightly saline	2–4	Yields of very sensitive crops may be affected
Moderately saline	4–8	Yields of many crops affected
Very saline	8–16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few tolerant crops yield satisfactorily

Electrical conductivity (EC) values for 16 representative soil samples are summarised in Table 4. For clayey soils encountered across the site, appropriate multiplying factor is assessed to vary from 8 to 10. For these factors, ECe for representative soil samples are estimated to vary from about 1.2dS/m to 13.0dS/m. Only four samples from depth shallower than about 0.5m show ECe of less than 4.0dS/m and five samples of at depths exceeding 3.0m show ECe of more than 8.0dS/m. Therefore, the following are our assessments:

- Soils up to depth of about 0.5m are non-saline
- Soils from depth of about 0.5m to 3.0m are moderately saline
- Soils from depths exceeding 3.0m are very saline

Therefore, if earthworks for the proposed activities involve disturbance and excavation of soil at depths exceeding 0.5m from existing ground surface, the earthworks should be carried out in accordance with an appropriate Saline Soil Management Plan (SSMP) to manages impacts from saline soils on proposed activity and vice versa. Recommended SSMP for the proposed activity is presented in Appendix C. No SSMP is required if proposed activity does not involve excavation and disturbance of soils at depths exceeding 0.5m.

7.4 Exposure Classification

Australian Standard AS2870 (Reference 11) provides guidelines to assess Exposure Classification for saline and sulfate soils. Table 7 below provides Exposure Classifications for saline soils based on EC_e, and Table 8 provides Exposure Classification for sulfate soils.

Table 8 - Exposure Classifications for Saline Soils

Electrical Conductivity, EC_e (dS/m)	Exposure Classification	Salinity Classification
<2	A1	Non-saline
2–4	A1	Slightly saline
4–8	A2	Moderately saline
8–16	B1	Very saline
>16	B2	Highly saline

Table 9 - Exposure Classifications for Sulfate Soils

Sulfate expressed as SO_3		pH	Exposure Classification*	
In Soil (ppm)	In Groundwater (ppm)		Soil Condition A	Soil Condition B
<5000	<1000	>5.5	A2	A1
5000-10000	1000-3000	4.5-5.5	B1	A2
10000-20000	3000-10000	4.0-4.5	B2	B1
>20000	>10000	<4.0	C2	B2

*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater
*Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

Soils across the site are clayey and therefore appropriate Soil Condition is "Condition B". Therefore, based on laboratory test results presented in Tables 4 and guidelines on Exposure Classifications presented in Tables 7 and 8, the Exposure Classifications for soils across site are assessed belong to Class A1 or A2 or B2. EC_e values are dominant. However, Class B2 is applicable only for soils at depths exceeding 3.0m.

Therefore, we recommend that the proposed activity use construction materials, such as concrete, steel, brick etc, and construction techniques that are appropriate for Exposure Class A2 if such construction materials come in contact with soils at depths sallower than 3.0m and Exposure Class B2 if such construction materials come in contact with soils at depths exceeding 3.0m (Reference 11).

7.5 Aggressivity Classification

The Aggressivity Classification of soil and groundwater applicable to design of iron/steel and concrete piles, in accordance with Australian Standard AS2159 (Reference 22), are given below in Tables 9 and 10.

Table 10 - Aggressivity Classification for Steel/Iron

Chloride		pH	Resistivity (ohm cm)	Soil Condition A*	Soil Condition B#
In Soil (ppm)	In Water (ppm)				
<5000	<1000	>5.0	>5000	Non-aggressive	Non-aggressive
5000-20000	1000-10000	4.0-5.0	2000-5000	Mild	Non-aggressive
20000-50000	10000-20000	3.0-4.0	1000-2000	Moderate	Mild
>50000	>20000	<3.0	<1000	Severe	Moderate

*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater
#Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

Table 11 - Aggressivity Classification for Concrete

Sulfate expressed as SO_4		pH	Chloride in Water (ppm)	Soil Condition A	Soil Condition B
In Soil (ppm)	In Groundwater (ppm)				
<5000	<1000	>5.5	<6000	Mild	Non-aggressive
5000-10000	1000-3000	4.5-5.5	6000-12000	Moderate	Mild
10000-20000	3000-1000	4.0-4.5	12000-30000	Severe	Moderate
>20000	>10000	<4.0	>30000	Very Severe	Severe

As indicated above in this report, appropriate Soil Condition for the site is "Soil Conditions B". Therefore, based on laboratory test results presented in Table 4 and guidelines on Aggressivity Classifications presented in Tables 9 and 10, the subsurface soils across the site are assessed to be non-aggressive to mildly aggressive to concrete piles and non-aggressive to moderately aggressive to steel piles. pH is critical for concrete piles and resistivity is critical for steel piles. Therefore, it is recommended that the proposed activity use steel and concrete piles that are appropriate to moderately and mildly aggressive sites respectively (Reference 12).

7.6 Acid Sulfate Soil

Review of existing information and site assessment indicated the following:

- The sub-surface profile across the site comprises a sequence of topsoil/fill and natural soil underlain by bedrock shale. Although bedrock is not of concern, fill and natural soils could possibly be acid sulfate or potentially acid sulfate soils.

- Ground surface elevation across the site varies from about RL3.8m AHD to 6.0m AHD. Therefore, the elevation of the site indicates that the soils at the site could be acid sulfate or potentially acid sulfate soils.
- Although no regional groundwater level was encountered up to depth of about 7.5m, localised seepage was encountered at depths as shallow as 2.5m. Therefore, lowering of the groundwater level during proposed activity is unlikely to adversely impact acid sulfate or potentially acid sulfate soils.

As general field and site assessments are inconclusive to confirm absence of acid sulfate or potentially acid sulfate soils, four representative soil samples from various depths were tested for acid sulfate or potentially acid sulfate soils. The laboratory test results summarised in Table 5 indicate the following:

- The pH_{kcl} (field pH) values of all samples are in range of 6.2 to 6.4, indicating actual acid sulfate soils are absent, but does not give an indication whether potential acid sulfate soils are present or not.
- The pH_{ox} values (pH after oxidation) of 3 samples are higher than pH_{kcl}, whereas pH_{ox} value of one sample is only slightly lower than the pH_{kcl} value, indicating oxidation of soils is unlikely to produce significant acid. This means the soils are unlikely to be actual and potential acid sulfate soils.

Acid sulfate soils are a problem because they produce significant acid (sulphuric acid) by oxidation when exposed to oxygen, which might occur during excavation or disturbance of soils containing iron sulphides/oxidisable sulphur. Lowering the groundwater level might also encourage oxidation.

The New South Wales Acid Sulfate Soils Management Advisory Committee (Reference 13) recommends "Action Criteria" (Table 12) based on results of acid sulfate soils analysis for three broad texture categories. Works in soils that exceed these "Action Criteria" must be carried out in accordance with an approved Acid Sulfate Soils Management Plan.

Table 12 - Action Criteria for Acid Sulfate Soils

Type of Material		**Action Criteria 1-1000 tonnes of soil is disturbed**		**Action Criteria More than 1000 tonnes of soil is disturbed**	
Texture Range	**Approximate Clay Content <0.002mm** (%)	**Sulphur Trail** % S oxidisable (S_{TOS} or S_{POS})	**Acid Trail** mol H^+/tonne (TPA or TSA)	**Sulphur Trail** % S oxidisable (S_{TOS} or S_{POS})	**Acid Trail** mol H^+/tonne (TPA or TSA)
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5-40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥40	0.10	62	0.03	18

The borehole logs indicate that soils likely to be disturbed or excavated during the proposed activity are clayey soils and therefore of fine texture.

It is anticipated that the volume of soil to be disturbed or excavated during the proposed activity will be more than 1000 tonnes. Therefore, based on Action Criteria presented in Table 12, the excavation and disturbance of soil should be carried out in accordance with an approved "Acid Sulfate Soil Management Plan" if S_{POS} exceeds 0.03% and TPA or TSA exceeds 18.0 mol H^+/tonne.

Laboratory test results presented in Table 5 indicates the following:

- Both S_{POS} and S_{cr} for all samples are lower than instrument detection level of less than 0.03%. In fact, 3 samples out of 4 samples show S_{POS} values of less than instrument detectable value of 0.005% and all 4 samples show S_{cr} values of less than instrument detectable value of 0.005%.
- Both TPA and TSA for all samples are less than 18.0 mol H^+/tonne. In fact, 3 samples out of 4 samples show TPA and TSA values of less than instrument detection level of 5.0 mol H^+/tonne.

Therefore, it is our assessments that the soils likely to be disturbed or excavated during construction of the proposed school building are unlikely to be acid sulfate or potentially acid sulfate soils, based on both Acid and Sulphur Trails. Therefore, excavations and disturbance of soils during the proposed activity may be carried out without an approved "Acid Sulfate Soils Management Plan".

8.0 DISCUSSIONS AND RECOMMENDATIONS

8.1 Rock Classification for Foundation Design

Based on rock strengths presented in Table 6 and rock discontinuities shown in the borehole log, bedrock shale from BH1 drilled within the footprint of the proposed building is classified for foundation design in accordance with Pells et al (Reference 14) and presented below in Table 13. This table also includes assessments of depth to various rock classes anticipated in boreholes BH2 and BH3.

Table 13 – Rock Classification for Foundation Design

Borehole No	Ground Surface RL (m AHD)	Termination Depth (m)	Depth Range for Class V Rock (m)	Depth Range for Class III Rock (m)
BH1	4.9	11.8	7.5-10.5	≥10.5
BH2	4.6	12.0	10.5-12.0	≥12.0
BH3	4.3	11.5	10.5-11.5	≥11.5

8.2 Geotechnical Model

Based on site observation and information obtained from boreholes drilled during current geotechnical investigation, a Geotechnical Model, constituting four Geotechnical Units, is suggested for the proposed school building site. Each Geotechnical Unit represents a specific nature of soil and/or bedrock encountered across the site. Recommended Geotechnical Model is provided in Table 14.

Table 14 - Recommended Geotechnical Model

Geotechnical Unit	Material Description	Depth Range to the top of Unit (m)	Range of RL at the top of Unit (m AHD)
Unit 1	Natural Soil/Controlled Fill	0.0	4.0 to 5.0
Unit 2	Natural Soil	3.0-4.0	1.5 to 2.5
Unit 3	Shale - Class V	7.5-10.5	-2.5 to -6.5
Unit 4	Shale - Class III	10.5-12.0	-5.5 to -7.5

* Ranges of Depth and RLs are approximate only

In describing bedrock shale encountered across the site, the Geotechnical Units and rock classifications in accordance with Reference 12 are used interchangeably. Assessed strength parameters, in terms of cohesion and internal friction angle, as well as modulus for each Geotechnical Unit are presented below in Table 15.

Table 15 - Recommended Strength Parameters and Modulus

Geotechnical Unit	Unit Weight (kN/m^3)	Undrained Shear Strength (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (deg)	Effective Young's Modulus (MPa)	Poisson's Ratio
Unit 1	18.0	75.0	2.0	26.0	10.0	0.30
Unit 2	19.0	120.0	8.0	27.0	20.0	0.30
Unit 3	21.0	250.0	10.0	27.0	75.0	0.25
Unit 4	22.0	-	50.0	30.0	300.0	0.20

8.3 Earthwork Methodology

Earthwork for proposed activity will include construction of building platform and preparation subgrade for construction of access ways. The earthwork should be completed in accordance with recommended Soil Management Plan (SMP) and Saline Soil Management Plan (SSMP), if relevant, to manage adverse impacts from erodible and saline soils. However, recommended stepwise procedures for bulk earthworks are listed below:

- Site Mobilisation including setting up the construction site with temporary access roads, facilities, utilities, and safety measures. Equipment and materials are brought in to prepare for earthwork.
- Installation of sediment erosion control measures recommended in SMP, including silt fences and sediment basins to protect the environment during construction. SMP should be prepared by earthwork contractor in accordance with recommendations provided by NSW Department of Housing (Reference 9) before earthwork is commenced.
- Commence earthwork including cut and fill operations.

8.4 Excavation Conditions

Although earthwork plan is yet to be finalised, we anticipate earthworks for the proposed activity will involve some excavation and fill placement. It is unlikely that the excavation depth will exceed 2.5m from existing ground surface. Therefore, the materials to be excavated are anticipated to comprise topsoil/fill and residual soils. No rock excavation is anticipated.

It is our assessment that the excavation of topsoil/fill and residual soils can be achieved using conventional earthmoving equipment such as excavators and dozers.

Based on site observations during field work, it is our assessment that the depth to groundwater level across the building site is more than 2.5m from existing ground surface. However, localised seepage may be encountered within the depth of about 2.5m. Therefore, we do not anticipate proposed excavation to encounter significant groundwater inflow. Minor groundwater inflow, if any, may be managed by a conventional sump and pump method. However, trafficability problem may arise in wet ground.

Ground vibration during excavation works is generally represented by maximum peak particle velocity. The currently existing structures in the vicinity of the site are anticipated to tolerate ground vibration of about 5.0mm/s to 10.0mm/s. We anticipate that excavations into soils will result in ground vibrations that are likely to be within tolerable limits for stability of existing structures in the vicinity of the site. Therefore, ground vibration during earthwork is unlikely to impose any limitation on the proposed activity.

8.5 Fill Placement

Bulk earthworks for proposed activity are anticipated to involve some placement of fill. The fill should be placed in a controlled manner, and we recommend the following procedures for placement of controlled fill:

- Strip existing topsoil/fill and stockpile separately for possible future uses or dispose off the site. Topsoil may be used in landscaping and fill materials may be selectively used in controlled fill.
- Undertake proof rolling (using an 8 to 10 tonnes roller) of the exposed residual soils to detect potentially weak spots (ground heave). Excavate areas of localised heaving to a depth of about 300mm and replace with granular fill/crushed sandstone, compacted as described below.

- Undertake proof rolling of soft spots backfilled with granular fill/crushed sandstone, as described above. If the backfilled area shows movement during further proof rolling, this office should be contacted for additional recommendations, which may include stripping additional soft soils and replacing with granular materials with or without geogrid reinforcement.
- Place suitable fill materials on proof rolled surface of residual soil in horizontal layers of 200mm to 250mm maximum loose thickness and compact to a Minimum Dry Density Ratio (MDDR) of 98% Standard, at moisture content within 2% of Optimum Moisture Content (OMC). However, the upper 500mm of controlled fill forming subgrade for access road should be compacted to a MDDR of 100% Standard, at moisture content within 2% of OMC. Controlled fill should preferably comprise non-reactive fill (e.g. crushed sandstone), with a maximum particle size not exceeding 75mm, or low plasticity clay. Fill materials and residual soils obtained from excavation within the site are of medium to high plasticity and are considered not ideal material for use in controlled fill. Therefore, fill materials and residual soils obtained from excavations within the site may be used only (1) at depths exceeding 500mm from the final surface level, and (2) after blending with crushed sandstone or lime stabilisation. Exact proportion of crushed sandstone for blending and lime for stabilisation will have to be ascertained after sampling and testing, but 30.0% of crushed sandstone by weight or 5.0% lime by weight are considered appropriate.
- Fill placement should be supervised to ensure that material quality, layer thickness, testing frequency and compaction criteria conform to the specifications. We recommend "Level 1" supervision and testing, in accordance with AS3798 (Reference 3). It should be noted that a Geotechnical Inspection and Testing Authority will generally provide certification on quality of entire compacted fill only if Level 1 supervision and testing is carried out.

8.6 Batter Slopes and Retaining Structures

As described above, earthwork for the proposed activity involves cut and fill operations. Cuts are anticipated to be limited in fill and residual soil. The cut and fill slopes should be battered for stability or retained by engineered retaining structures. If cut and fill slopes are to be battered for stability, we recommend the following batter slopes:

- For short-term stability in controlled fill and residual soils = 1 vertical to 1 horizontal
- For long-term stability in controlled fill and residual soils = 1 vertical to 2.5 horizontal

It is also recommended that batter slopes are provided with adequate surface and sub-surface drainage, and the crest of the batter slope is at least 1.0m away from the property boundary.

However, if cut and fill slopes steeper than those recommended above are required for whatever reason, these slopes should be retained by engineered retaining structures. Appropriate retaining structures for the proposed activity are anticipated to include gravity walls and cantilever walls. The pressure distribution on abovementioned types of retaining walls is assumed to be triangular in shape and estimated as follows:

$$p_h = \gamma k H$$

Where,

p_h = Horizontal pressure (kN/m^2)
γ = Total unit weights of retained materials (kN/m^3)
k = Coefficient of earth pressure (k_a or k_o)
H = Retained height (m)

For design of flexible retaining structures where some lateral movement is acceptable, an active earth pressure coefficient (k_a) is recommended. However, if it is critical to limit the horizontal deformation, use of an earth pressure coefficient at rest (k_o) is recommended. Recommended earth pressure coefficients for the design of retaining structures are presented below:

- Unit Weight, γ = 18.5kN/m^3
- Active Earth Pressure Coefficient, K_a = 0.35
- At Rest Earth Pressure Coefficient, K_0 = 0.55
- Ultimate Passive Earth Pressure = 100.0kPa

The above coefficients are based on the assumptions that the ground surface behind the retaining walls is horizontal, and the retained material is effectively drained. Additional earth pressures resulting from surcharge loads (buildings, infrastructures, etc) on retained materials and groundwater pressure, if any, should also be allowed for in design of retaining wall. The design of any retaining structure should also be checked for bearing capacity, overturning, sliding and overall stability of the slope.

8.7 Site Classification

The foundation of the proposed building is anticipated to comprise controlled fill or residual soils. Therefore, ground floor slabs of the proposed buildings may be designed as ground bearing slabs or suspended slabs. For design of ground bearing slabs, Australian Standard AS2870 (Reference 11) recommends that the building sites are classified based on anticipated shrink swell movements of foundation soils, which depend on thickness and reactivity (shrink swell movements) of foundation soils.

Earthwork for the proposed activity is anticipated to involve some cut and fill operations. It is anticipated that the reactivity of controlled fill materials will be similar to that of natural soils at the site or better. Therefore, result of shrink swell tests on representative soil samples presented in Table 2 can be considered to be indicative value for the foundation soils. Although design levels of building platforms are not known, the thickness of foundation soils (including natural soils and controlled fill) within footprint of the proposed building is anticipated to be more than 1.5m.

Therefore, based on assumption that the thickness of foundation soils at the completion of earthwork is at least 1.5m, the site for proposed building is anticipated to belong to Class M in accordance with Australian Standard AS2870 (Reference 11). However, site classification for final design should be confirmed by sampling and testing of foundation material after construction of building platform is completed.

8.8 Floor Slabs and Footings

We anticipate foundation materials at ground floor levels of proposed buildings will include controlled fill or natural soils. Under such circumstances, ground floor slabs of proposed buildings may be designed and constructed as ground bearing slabs, or suspended slabs supported by footings designed in accordance with recommendations provided in this report.

Ground bearing floor slabs for proposed activity may be designed for recommended site classification in accordance with Australian Standard AS2870 (Reference 11). Alternatively, we recommend a Modulus of Subgrade Reaction value of 25kPa/mm for design of ground-bearing slabs on controlled fill and natural soils.

Loading condition from the proposed school buildings is not known. However, we understand that the building will be supported by footings founded below Sydney Water pipelines anticipated at depth of about 7.5m from existing ground surface. Therefore, we recommend that the building is supported by deep footings (bored piers) socketed into bedrock anticipated at depth of 7.0m to 11.0m from existing ground surface. However, light weight ancillary structures may be supported by footings founded at shallower depths. The recommended bearing pressures and shaft adhesion for design of deep footings are presented in the following Table 16.

Table 16 – Recommended Allowable Bearing Pressures

Founding Material	Founding Depth (m)	Ultimate Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)	Allowable Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)
Unit 1 - Natural Soil/Controlled fill	0.0	350.0	Ignore	125.0	Ignore
Unit 2 – Natural Soil	3.0-4.0	600.0	50.0	250.0	25.0
Unit 3 – Shale Class V	7.5-10.5	3000.0	150.0	800.0	80.0
Unit 4 – Shale Class III	10.5-12.0	15000.0	500.0	3000.0	300.0

The following should be noted:

- If footings are founded above the 1 Horizontal to 1 Vertical line projected from the edge at the base of excavations, if any, the recommended bearing pressures presented in Table 16 are not applicable and appropriate allowable bearing pressure will have to be determined by reassessment of materials exposed in the excavation face.
- Founding depths presented in Table 16 are approximate from existing ground surface at the time of geotechnical investigation, which may change during earthwork. As depths to natural soils and bedrock with the recommended bearing pressures could vary across the site, the founding depths of footings to be constructed will also vary. Therefore, an experienced Geotechnical Engineer should confirm bearing pressures at founding levels during construction, on the basis of assessment made during footing excavation or pier hole drilling.
- The ultimate bearing pressure and shaft adhesion are based on the ultimate capacities mobilised at large displacements, about 5.0% to 10.0% of pile diameter or minimum footing width. These values assume a clean rock socket with a roughness Category of R2 or better (Reference 4).
- The allowable bearing pressure and shaft adhesion are based on the capacities mobilised at displacements of about 1.0% of pile diameter or minimum footing width.
- The ultimate and allowable bearing pressures for Units 3 and 4 are based on the assumptions that the piers are socketed at last 0.3m into appropriate rock units.
- Differential settlements under allowable bearing pressure are estimated to be about halves the estimated total settlements.
- The shaft adhesions against uplift pressures are halves of the shaft adhesions for compressive loads presented in above table.
- For limit state design, geotechnical strength reduction factor ϕg of 0.50 to 0.55 is recommended in accordance with AS2159 (Reference 12). However, reduction factor ϕg can be increased up to 0.7 to 0.8 if pile design is verified by analyses of pile load tests and sufficient construction monitoring is carried out.

8.9 Rock Anchor

It is unlikely that the proposed activity will require installation of rock anchors. If rock anchors are required for whatever reason, we suggest that all anchors are socketed in bedrock (Units 3 and 4). The allowable grout to rock stress for use in rock anchorage design may be taken as 10.0% of the allowable bearing pressure presented in Table 16. However, the anchors should have sufficient bond length outside the 1 Vertical to 1 Horizontal line drawn from the edge of excavations, if any.

8.10 Design for Earthquake

Australian Standard AS1170.4 (Reference 17) sets out procedures for determining earthquake actions and detailing requirements for structures and component to be used in the design of structures. In accordance with Reference 17, the recommended earthquake design parameters for the proposed activity are as follows:

- Earthquake Hazard Factor (Z) = 0.08
- Site Subsoil Class = Ce - Shallow Soil

However, if the proposed school building is supported entirely by footings founded and socketed into bedrock, "Site Subsoil Class Be- Bedrock" may be considered for design of the proposed building.

8.11 Slope Stability

It is general practice that the risk of slope instability in a site is carried out in stages, which may include the following:

Stage 1 – Desktop study and site inspection

Stage 2 – Test pit excavation/Borehole drilling

Stage 3 – Installation of inclinometer casing and standpipes

Stage 4 – Monitoring groundwater levels and slope movements

Stage 5 – Sampling and testing of soil samples

Stage 6 – Analysis and preparation of a final engineering report

Completion of Stage 1 assessment will determine the need for Stage 2, which in turn will determine the need for Stage 3 and so on. If any stage of assessment is adequate to confirm that the risk of slope stability is tolerable for the proposed school redevelopment or provide recommendation on appropriate slope stabilisation works to reduce the risk to tolerable level, subsequent stages of assessments will not be required. This report presents results of Stages 1 and 2 assessments.

Site factors such as slope angles, depth of insitu soils, strengths of sub-surface materials, and concentrations of water generally govern the stability of a site. "Practice Note Guidelines for Landslide Risk Management", prepared by Australian Geomechanics Society (Reference 58), recommends that the landslide risk (slope instability) at a site is assessed on the basis of the likelihood of a landslide event and the consequences of that event.

Applying the Australian Geomechanics Society guidelines, the risk of landslide for the site of proposed activity is as follows:

- Qualitative Measures of Likelihood - For the existing site conditions, it is our assessment that an event of a landslide is "Rare", which means event a landslide conceivable but only under exceptional circumstances, with indicative annual probability of $\approx 10^{-5}$.
- Qualitative Measures of Consequences to Property - It is our assessment that the consequences of landslide in the site to the property would be "Insignificant", resulting little damage.

Based on the above Qualitative Measures, the site for the proposed activity is assessed to have a "Very Low" risk to the properties.

Rare landslides at the site are assessed to be creep movement (slow moving) with small volume of soils involved in movements. People can move away from slow moving landslide if any. Therefore, the risk to loss of life due to unlikely landslides at the site assessed to be tolerable.

Therefore, based on a "Very Low" risk to property and tolerable risk to the loss of life, it is considered that the site is suitable for proposed activity from slope stability consideration provided proposed activity does not increase the risk of slope instability. Stages 1 and 2 assessments are deemed adequate to ascertain the risk of slope instability at the above site and therefore no additional stages of slope stability assessments are deemed necessary.

8.12 Pavement Design

Design of road or car park pavement depends on strength of subgrade, which is usually represented by CBR value and traffic load.

Subgrade preparation for access road within the school may involve some cut and fill and this may mean that the subgrade for the access road will include controlled fill or residual soils. It is anticipated that the fill placement, including selection of fill materials, will be carried out in accordance with the recommendations provided in this report. Result of CBR test on a represented soil sample obtained from the site indicates a CBR value of 4.0% (Table 3). Therefore, allowing for potential variation on strength of subgrade materials across the site, we recommend an indicative design CBR value of 3.0% for pavement design.

The design traffic load depends on the street types. The Austroads recommends that local access roads with buses are designed for indicative design traffic load of $1.5.0 \times 10^5$ Equivalent Standard Axles (ESA) (Reference 19). We consider this traffic load to be appropriate for design of pavement for internal access roads and car park in the school.

For recommended indicative design subgrade CBR value of 3.0% and recommended design traffic loading of $1.5.0 \times 10^5$ ESA, the recommended flexible pavement design for internal access road and car park, in accordance with Austroads are presented below in Table 17 (Reference 6).

Table 17 – Recommended Flexible Pavement Design

Pavement Materials	Thickness
Asphaltic Concrete (AC14)	40mm
Two coats flush seal	
Basecourse Material (DGB20)	150mm
Sub-base Material (DGS40)	325mm

Recommended pavement thicknesses presented in Table 17 are valid only if the subgrade and pavement materials are compacted to the following Minimum Dry Density Ratios.

Basecourse	98% Modified
Sub-basecourse	98% Modified
Subgrade	100% Standard

The pavement design assumes provision of adequate surface and sub-surface drainage of the pavement and adjacent areas.

It should be noted that the pavement design may change if actual traffic load and subgrade CBR values after subgrade preparation differ from those assumed in preparation of this report.

9.0 SUITABILITY OF SITE FOR PROPOSED SCHOOL BUILDING OR ACTIVITY

9.1 Geotechnical Limitations or Risks

The geotechnical risks or limitations for the proposed activity or school building include the following:

- The subsurface profile across the site comprises a sequence of topsoil/fill and residual (natural) soils underlain by bedrock. Thickness of topsoil/fill varies from about 0.5m to 1.5m and the depth to bedrock across the site is variable, ranging from about 7.5m to 11.0m from existing ground surface. Therefore, variability in the thicknesses and depths to different types of subsurface materials (Geotechnical Units) may impose some limitation on the earthworks and design of proposed activity or school redevelopment work.
- Soils likely to be disturbed or excavated during earthworks are dispersive and susceptible to excessive erosion. Therefore, susceptible of soils to excessive erosion may impose some limitations on the earthworks for the proposed activity.
- Soils at depths exceeding 0.5m are saline. Therefore, salinity of soils may impose some limitations on the earthworks for the proposed activity.
- Soils obtained from excavations within the site are of medium to high plasticity (reactive soil) and are considered not ideal material for use in controlled fill.

None of the geotechnical limitations listed above impose major limitations on the proposed activity or school building. Therefore, it is our assessment that the geotechnical limitations can be mitigated if earthworks and design of proposed school building are carried out in accordance with the recommendations provided below in this report. Therefore, the site is assessed to be suitable for proposed activity from geotechnical engineering considerations.

9.2 Mitigation Measures to Address Geotechnical Risks

As discussed above, the potential geotechnical risks on the proposed redevelopment of Newington Public School or activity include (1) variabilities in thickness and depths to various types of subsurface materials (Geotechnical Units) (2) presence of erodible soils (3) presence of saline soils and (4) presence of reactive soils.

We recommend implementation of site specific mitigation measure to address the above geotechnical risks. The geotechnical risks associated with variabilities in thickness and depth to subsurface soils and bedrock of varying strengths can be addressed by conducting inspection(s) during the construction stage. However, geotechnical information presented in this report is adequate for assessment of variability of depth to bedrock for earthwork design and cost management purposes. Likewise, constraints associated with saline and erodible soils can be addressed if earthworks are carried out in accordance with an appropriate Soil Management Plan to be developed by the earthwork contractor before earthworks are commenced and Saline Soil Management Plan presented in Appendix C.

Therefore, it is our assessment that the geotechnical conditions across the site impose only minor limitations to the proposed activity, and these limitations can be easily mitigated. Therefore, the site is suitable for the proposed school redevelopment provided the geotechnical limitations are mitigated by carrying out earthworks and design of proposed structures in accordance with recommendations provided in this report. Table 18 in the following page presents recommended mitigation measures to address these geotechnical constraints or risks so that the residual risks are "Low" and the site is suitable for the proposed activity.

Table 18 – Recommended Mitigation Measures to Manage Geotechnical Risks

Project Stage Design (D) Construction (C) Operation (O)	Mitigation Measures	Reason for Mitigation Measure	Relevant Section of Report
D & C	The designer should recognise variability in the thicknesses and depths to various types of subsurface materials (soils and bedrocks of varying strengths) to ascertain that the design of building is appropriate to actual foundation conditions and its impact on project design and costing. The depth to appropriate foundation materials will need to be confirmed by inspections during the construction stage	To reduce the risk or uncertainties due to variation in the thicknesses and depths to varying types of subsurface materials so that actual founding depths for footings supporting building and other major structures are known. This means appropriate, economical and reliable foundation design can be achieved and potential variation claims during the construction stage can be minimised. Appropriate and economical design will ensure optimal use of steel, concrete etc and minimal environmental impacts.	Sections 3.6, 5.2, 5.3 & 8.2
D, C & O	The designer should recognise that the subsurface soils across the site are susceptible to erosion and therefore disturbance and excavation of soils across the site should be carried out in accordance with a Soil Management Plan (SMP) to be developed by the earthworks contractor in accordance with recommendations provided in Department of Housing Guidelines. The cost for management of erodible soil should be considered in project costing.	To manage adverse impacts from the erodible soils to the proposed activity and vice versa and to develop an appropriate soil management plan to reduce impact on environment and variation claims during construction stage.	Sections 6.0, 7.2, 8.3

Project Stage Design (D) Construction (C) Operation (O)	Mitigation Measures	Reason for Mitigation Measure	Relevant Section of Report
D, C & O	Earthworks, including disturbance and excavation of soils, during the proposed redevelopment work should be carried out in accordance with an appropriate Saline Soil Management Plan (SSMP) presented in Attachment C to manage and minimise impacts from saline soils to the proposed redevelopment works and vice versa. The designer should recognise that the subsurface soils at depths exceeding about 0.5m are saline. The cost for management of saline soil should be considered in project costing.	To manage adverse impacts from saline soils to the proposed redevelopment works and vice versa and to reduce variation claims during the construction stage.	Sections 6.0, 7.3, 8.3 & Appendix C
D, C & O	The designer should recognise that the subsurface soils across the site are reactive and therefore design of ground bearing slabs should be appropriate to the assessed site classification	To ensure design is appropriate to the site conditions and minimise variation claims during the construction stage.	Sections 6.0 & 7.1

10.0 LIMITATIONS

It is our assessment that the geotechnical conditions across the site impose only minor limitations to proposed school redevelopment and these limitations can be easily mitigated if earthworks and design of proposed building and other structures are carried out in accordance with recommendations provided in this report.

Assessments and recommendations presented in this report are based on site observation and information from limited number of boreholes. Although we believe that the sub-surface profile presented in this report is indicative of the general profile across the proposed building site, it is possible that the sub-surface profile including depth to groundwater level could differ from that encountered in the boreholes. Therefore, we recommend that this company is contacted for further advice if soils or bedrock encountered during the construction stage differ from those presented in this report.

References

1. Australian Standard, Geotechnical Site Investigation, AS1726-2017.
2. NSW Government, Regional NSW,Website MinView | Regional NSW | Mining, Exploration and Geoscience, 2023.
3. eSPADE v2.2, NSW Government, Office of Environment and Heritage website: https://www.environment.nsw.gov.au/eSpade2WebApp#
4. Department of Infrastructure, Planning and Natural Resources, Salinity Potential in Western Sydney (scale approximately 1:140,000), 2002.
5. NSW Department of Land and Water Conservation, Acid Sulfate Soil Risk Map of Prospect/Parramatta (Edition 2, 1:25,000) 1997.
6. NSW Department of Primary Industries, Office of Water Website, Registered Groundwater Bore Data.
7. Geotech Nique Pty Ltd, Preliminary Geotechnical Desktop and Intrusive Geotechnical Investigation Report, Proposed Newington Public School Upgrade, Newington Boulevard, Newington, Report No 20659/3-AA, 27 February 2025.
8. Fell, R., MacGregor, P, Stapledon, D., Bell, G. and Foster, M., Geotechnical Engineering of Embankment Dams, Second Edition, 2017.
9. NSW Department of Housing, Managing Urban Stormwater, Soils and Construction, 1998.
10. Lillicrap, A and McGhie, S., Site Investigation for Urban Salinity, Department of Land and Water Conservation, 2002.
11. Australian Standard AS2870-2011, Residential Slabs and Footings, 2011.
12. Australian Standard AS2159-2009, Piling – Design and Installation, 2009.
13. *New South Wales, Acid sulfate Soil Management Advisory Committee, 1988 – Acid sulfate Sulfate Soil Manual.*
14. Pells, P J N, Mostyn, E, Bertuzzi, B. and Wong, P. K, Classification of Sandstone and Shale in the Sydney Region: A Forty Years Review, Australian Geomechanics Journal, Vol 54, No 2, June 2019.
15. Australian Standard AS3798-2007, Guidelines on Earthworks for Commercial and Residential Developments, 2007.
16. Pells, P. J. N, State of Practice for the Design of Socketed Piles in Rocks, Proceeding 8th Australian New Zealand Conference on Geomechanics, Hobart, pp 1-307-327.
17. Australian Standard AS1170.4-2007, Structural Design Action, Part 4, Earthquake Actions in Australia, 2007.
18. Australian Geomechanics Society (AGS) Landslide Taskforce, Landslide Practice Note Working Group, "Practice Note Guidelines for Landslide Risk Management", March 2007.
19. Austroads, Pavement Design for Light Traffic, A Supplement to Austroads Pavement Design Guide, AP-T36/06, 2006.

APPENDIX A

Drawing No 20597/3-AA1 - Borehole Locations Plan
Borehole Logs with Core Photos

Imagery © NearMap.com

LEGEND

● Borehole

0 15 30 45 60 75m

Scale 1:1500

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NOTES

1. Site features are indicative and are not to scale.
2. This drawing has been produced using a base plan provided by others to which additional information e.g test pits, borehole locations or notes have been added. Some or all of the plan may not be relevant at the time of producing this drawing

NSW Department of Education - School Infrastructure
Proposed Primary School Upgrade
Newington Boulevard
Newington

Borehole Locations

Drawing No: 20659/3-AB1
Job No: 20659/3
Drawn By: MH
Date: 9 October 2025
Checked By: BJ

File No: 20659-3
Layers: 0, AB1

engineering log - borehole

Client :	NSW Department of Education	**Job No. :**	20659/3
Project :	Newington Public School Upgrade (ID 4627)	**Borehole No. :**	1
Location :	Newington Boulevard, Newington	**Date :**	29/09/2025
		Logged/Checked by:	BJ/IJ

drill model and mounting : Comacchio Geo 205 **slope :** 90 **deg.** **R.L. surface :** ≃4.9

hole diameter : 100 **mm** **bearing :** N/A **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
TC-bit	Dry	G+P				0			TOPSOIL: Silty Clay, low plasticity, dark brown, trace fine grained gravel, trace fine grained sand, with rootlets	D			Grass cover
				DS									Variably compacted
		G+P			N=19 4,8,11				FILL: Silty Clay, medium to high plasticity, orange-brown-red mottled pale grey, with fine to medium grained gravel, trace fine grained sand				
		G		DS		1		CH	Silty CLAY, high plasticity, brown mottled grey, trace fine grained gravel, trace rootlets	M<PL	St-VSt		Residual
				DS					Silty CLAY, high plasticity, yellow-brown mottled grey				
					N=9 3,3,6	2			@ 2.0m, trace fine grained ironstone gravel				
					N=20 5,9,11	3			@ 3.0m, yellow-brown-red mottled grey, trace fine to medium grained ironstone gravel				
				DS		4							
					N=26 9,11,15	5			Silty CLAY, high plasticity, pale grey mottled brown, with fine to medium grained gravel				
									@ 5.5m, trace fine grained gravel				
					N=29 7,11,18	6							
						7			@ 7.0m, with medium to coarse grained gravel				
					N=R 7,20,5/10				SHALE, grey-brown, very low to low strength, extremely to highly weathered				Bedrock
						8							
									Started coring at 8.1m				
						9							

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engineering log
cored borehole

Client : NSW Department of Education
Job No. : 20659/3
Project : Newington Public School Upgrade (ID 4627)
Borehole No. : 1
Location : Newington Boulevard, Newington
Date : 29/09/2025
Logged/Checked by : BJ/IJ

drill model and mounting : Comacchio Geo 205 **slope :** 90 **deg.** **R.L. surface :** ≃4.9
core size: NMLC **bearing :** N/A **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	defect spacing (mm) 2000 1000 500 300 100 50	DEFECT DETAILS DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific	General
		8		Started coring at 8.1m						
		8.5		SHALE, grey-brown	XW	EL-VL			8.1-8.2m Cz=100mm 8.2-8.52m XWs=320mm 8.52-8.74m Cz=220mm 8.74-8.9m XWs=160mm 8.9-9.0m Fz=100mm	
		9 9.5		@ 9.0m, dark grey	HW-MW	L-M			9.01m Jo=85°, Ir 9.03m Jo=10°, Ir 9.09-9.19m:4xBp=0°,33.33mm 9.2m Jo=85°, Ir 9.21-9.24m:2xBp=0°,30mm 9.26m Jo=25° 9.3-9.34m Fs=40mm 9.35m Jo=65° 9.37-9.38m Cs=10mm 9.38-9.51m Fz=130mm	
					XW-HW	EL-VL			9.55-9.6m Fs=50mm 9.6-9.7m Cz=100mm 9.7-9.75m Fs=50mm 9.75-9.92m XWz=170mm	
		10 10.5 11 11.5			SW-FR	M			9.95m Bp=0°, Ir, Sn 9.96m Bp=0° 10.03m Jo=75°, Ir 10.05m Bp=5°, Ir 10.08m Jo=85° 10.13m J=15°, Ir 10.17m Jo=85° 10.19m Bp=5°, Sn 10.23-10.25m XWs=20mm 10.29-10.31m XWs=20mm 10.38m Bp=0°, Pr 10.52-10.54m:2xBp=0°,20mm 10.88m Bp=0°, Pr, Cn 11.09m Jo=5°, Pr 11.57m Bp=0°	
		12		Borehole terminated at 11.87m						

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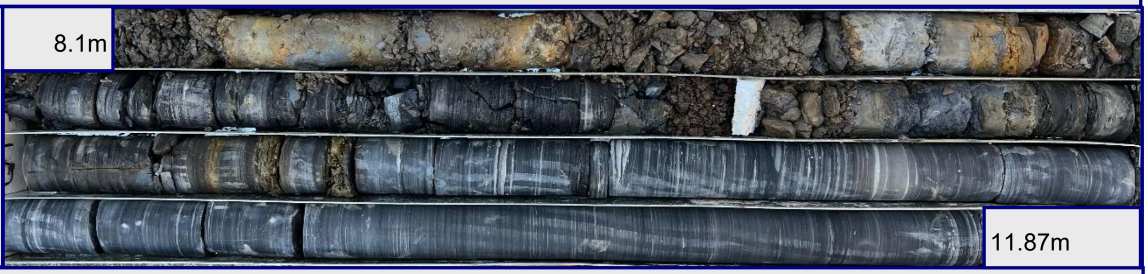
Job No 20659/3 BH1 Started Coring at 8.1m

8.0m	
9.0m	
10.0m	
11.0m	



BH1 terminated at 11.87m

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engineering log - borehole

Client : NSW Department of Education
Project : Newington Public School Upgrade (ID 4627)
Location : Newington Boulevard, Newington

Job No. : 20659/3
Borehole No. : 2
Date : 30/09/2025
Logged/Checked by: BJ/IJ

drill model and mounting : Comacchio Geo 205 **slope :** 90 **deg.** **R.L. surface :** 4.641
hole diameter : 100 **mm** **bearing :** N/A **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
TC-bit		G+P				0			TOPSOIL: Silty Clay, low plasticity, dark brown, with fine grained sand, with rootlets	D			Grass cover
		G+P			N=11 3,5,6				FILL: Silty Clay, medium plasticity, red-brown mottled grey, with fine to medium grained gravel, with fine grained sand				Variably compacted
		G		U50				CH	Silty CLAY, high plasticity, grey-brown, trace rootlets	M<PL	St		Residual
						1			Silty CLAY, high plasticity, grey mottled red-brown, trace fine grained gravel				
					N=10 3,4,6				@ 1.3m, red-orange-brown mottled grey, trace fine to medium grained ironstone gravel				
				DS		2							
					N=18 3,8,10	3			@ 3.0m, pale grey mottled yellow-brown		VSt		
						4							
					N=18 4,8,10				@ 4.5m, grey mottled yellow and red				
						5							
					N=17 3,7,10	6			@ 6.3m, red mottled grey, with ironstone gravel				
						7							
					N=20 6,8,12				Silty CLAY, high plasticity, grey mottled yellow-brown, trace gravel				
						8							
	▶				N=27 1,10,17	9			@ 9.0m, yellow-brown mottled grey, with fine to medium grained gravel				@ 9.0m, Seepage

GEOTECHNIQUE PTY LTD

engineering log - borehole

Client : NSW Department of Education
Project : Newington Public School Upgrade (ID 4627)
Location : Newington Boulevard, Newington

Job No. : 20659/3
Borehole No. : 2
Date : 30/09/2025
Logged/Checked by: BJ/IJ

drill model and mounting : Comacchio Geo 205 **slope :** 90 **deg.** **R.L. surface :** 4.641
hole diameter : 100 **mm** **bearing :** N/A **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						10							
					N=R 16,15/50				SHALE, grey-brown, very low to low strength, extremely to highly weathered				Bedrock
						11							
									@ 11.5m, low strength				
						12			Borehole terminated at 12.0m				
						13							
						14							
						15							
						16							
						17							
						18							

GEOTECHNIQUE PTY LTD

engineering log - borehole

Client : NSW Department of Education
Project : Newington Public School Upgrade (ID 4627)
Location : Newington Boulevard, Newington

Job No. : 20659/3
Borehole No. : 3
Date : 29/09/2025
Logged/Checked by: BJ/IJ

drill model and mounting : Comacchio Geo 205 **slope :** 90 **deg.** **R.L. surface :** 4.284
hole diameter : 100 **mm** **bearing :** N/A **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
TC-bit		G+P				0		TOPSOIL: Silty Clay, low plasticity, dark brown, with fine grained sand, with rootlets				Grass cover
		G+P		DB	N=6 3,3,3			FILL: Silty Clay, high plasticity, red orange-brown mottled grey, with fine grained gravel	D-M			Variably compacted
		G					CH	Silty CLAY, high plasticity, red-brown mottled grey, trace fine to medium grained gravel	M≤PL	F		Residual
					N=6 2,3,3			@ 1.5m, brown mottled red and pale grey, with fine grained ironstone gravel				
						2		@ 1.9m, pale grey mottled yellow-brown, trace ironstone gravel				
	▶				N=17 5,7,10	3				St-VSt		@ 2.9m, Seepage
					N=16 3,6,10			@ 4.7m, red mottled pale grey and yellow-brown, with ironstone gravel				
					N=10 1,4,6	6						
				DS								
					N=11 3,4,7			Silty CLAY, high plasticity, grey mottled red-brown, trace fine grained gravel				
					N=23 7,11,12	9		@ 9.0m, pale grey mottled yellow-brown				

form no. 002 version 04 - 05/11

engineering log - borehole

Client : NSW Department of Education
Project : Newington Public School Upgrade (ID 4627)
Location : Newington Boulevard, Newington

Job No. : 20659/3
Borehole No. : 3
Date : 29/09/2025
Logged/Checked by: BJ/IJ

drill model and mounting : Comacchio Geo 205 **slope :** 90 **deg.** **R.L. surface :** 4.284
hole diameter : 100 **mm** **bearing :** N/A **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						10							
					N=33 6,12,21				SHALE, grey-brown, very low to low strength, extremely to highly weathered @ 11.3m, low to medium strength				Bedrock
						11							
									Borehole terminated at 11.5m due to TC bit refusal				
						12							
						13							
						14							
						15							
						16							
						17							
						18							

Log Symbols & Abbreviations (Non-cored Borehole Log)

Log Column	Symbol/Value	Description
Drilling Method	V-bit	Hardened steel 'V' shaped bit attached to auger
	TC-bit	Tungsten Carbide bit attached to auger
	RR	Tricone (Rock Roller) bit
	DB	Drag bit
	BB	Blade bit
Groundwater	Dry	Groundwater not encountered to the drilled or auger refusal depth
		Groundwater level at depths shown on log
		Groundwater seepage at depths shown on log
Environment Sample	GP	Glass bottle and plastic bag sample over depths shown on log
	G	Glass bottle sample over depths shown on log
	P	Plastic bag sample over depths shown on log
PID Reading	100	PID reading in ppm
Geotechnical Sample	DS	Disturbed Small bag sample over depths shown on log
	DB	Disturbed Bulk sample over depths shown on log
	U_{50}	Undisturbed 50mm tube sample over depths shown on log
Field Test	N=10 3,5,5	Standard Penetration Test (SPT) 'N' value. Individual numbers indicate blows per 150mm penetration.
	N=R 10,15/100	'R' represents refusal to penetration in hard/very dense soils or in cobbles or boulders. The first number represents10 blows for 150mm penetration whereas the second number represents 15 blows for 100mm penetration where SPT met refusal
	DCP/PSP: 5 6 R/10	Dynamic Cone Penetration (DCP) or Perth Sand Penetrometer (PSP). Each number represents blows per 100mm penetration. 'R/10' represents refusal after 10mm penetration in hard/very dense soils or in gravels or boulders.
Classification	GP	Poorly Graded GRAVEL
	GW	Well graded GRAVEL
	GM	Silty GRAVEL
	GC	Clayey GRAVEL
	SP	Poorly graded SAND
	SW	Well graded SAND
	SM	Silty SAND
	SC	Clayey SAND
	ML	SILT / Sandy SILT / clayey SILT, low plasticity
	MI	SILT / Sandy SILT / clayey SILT, medium plasticity
	MH	SILT / Sandy SILT / clayey SILT, high plasticity
	CL	CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, low plasticity
	CI	CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, medium plasticity
	CH	CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, high plasticity
Moisture Condition Cohesive soils	M<PL	Moisture content less than Plastic Limit
	M=PL	Moisture content equal to Plastic Limit
	M>PL	Moisture content to be greater than Plastic Limit
Cohesionless soils	D	Dry - Runs freely through hand
	M	Moist - Tends to cohere
	W	Wet - Tends to cohere

Log Column	Symbol/Value	Term	Undrained shear strength, C_u (kPa)	Hand Penetrometer (Qu)
Consistency Cohesive soils	VS	Very Soft	≤12	<25
	S	Soft	>12 & ≤25	25 – 50
	F	Firm	>25 & ≤50	50 – 100
	St	Stiff	>50 & ≤100	100 – 200
	VSt	Very Stiff	>100 & ≤200	200 – 400
	H	Hard	>200	>400

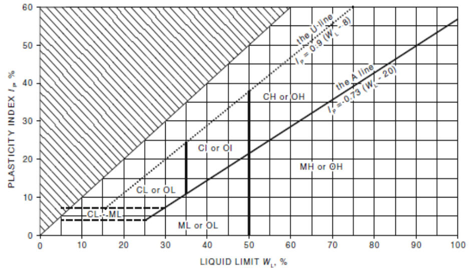
Log Column	Symbol/Value	Term	Density Index, I_D (%)	SPT 'N' (blows/300mm)
Density Index Cohesionless soils	VL	Very Loose	≤15	≤5
	L	Loose	>15 & ≤35	>5 & ≤10
	M	Medium Dense	>35 & ≤65	>10 & ≤30
	D	Dense	>65 & ≤85	>30 & ≤50
	VD	Very Dense	>85	>50

Log Column	Symbol/Value	Description
Hand Penetrometer	100 200	Unconfined compressive strength (q_u) in kPa determined using pocket penetrometer, at depths shown on log
Remarks		Geological origin of soils
	Residual	Residual soils above bedrock
	Alluvium	River deposited Alluvial soils
	Colluvial	Gravity deposited Colluvial soils
	Aeolian	Wind deposited Aeolian soils
	Marine	Marine Soils

AS1726 : 2017– Unified Soil Classification System

Major Divisions		Particle size (mm)	Group Symbol	Typical Names	Field Identifications Sand and Gravels	Laboratory classification	% Fines (2)	Plasticity of Fine Fraction	$C_u = D_{60}/D_{10}$	$C_c = (D_{30})^2/(D_{10}D_{60})$	Notes
OVERSIZE	BOULDERS	>200				Use the gradation of material passing 63mm for classification of fractions according to the criteria given in 'Major Divisions'					
	COBBLES	63									
COARSE GRAINED SOIL (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm)	Coarse 19	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength		≤5	-	>4	between 1 and 3	1. Identify lines by the method given for fine grained soils 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.075mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength		≤5	-	Fails to comply with above		
		Medium 6.7	GM	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength		≥12	Below 'A' line or I_p<4	-	-	
		Fine 2.36	GC	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength		≥12	Above 'A' line or I_p>7	-	-	
	SAND (more than half of coarse fraction is smaller than 2.36mm)	Coarse 0.6	SW	Well-graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength		≤5	-	>6	between 1 and 3	
		Medium 0.21	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength		≤5	-	Fails to comply with above		
			SM	Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength		≥12	Below 'A' line or I_p<4	-	-	
		Fine 0.075	SC	Clayey sand, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength		≥12	Above 'A' line of I_p>7	-	-	

Major Divisions		Group Symbol	Typical Names	Dry Strength	Dilatancy	Toughness		Laboratory classification	
FINE GRAINED SOIL (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT (0.075mm to 0.002mm) & CLAY (<0.002mm) Liquid Limit<50%	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	None to low	Slow to rapid	Low		More than 35% passing 0.075mm	Below 'A' line
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium			Above 'A' line
		OL	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low			Below 'A' line
	SILT (0.075mm to 0.002mm) & CLAY (<0.002mm) Liquid Limit>50%	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Low to medium	None to slow	Low to medium			Below 'A' line
		CH	Inorganic clays of medium to high plasticity, fat clays	High to very high	None	High			Above 'A' line
		OH (1)	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium			Below 'A' line
	HIGHLY ORGANIC SOILS	Pt (1)	Peat and highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture				Effervesces with H_2O_2	



Log Symbols & Abbreviations (Cored Borehole Log)

Log Column	Symbol / Abbreviation	Description		
Core Size		Nominal Core Size (mm)		
	NQ	47		
	NMLC	52		
	HQ	63		
Water Loss	——◀	Complete water loss		
	——◁	Partial water loss		
Weathering (AS1726:2017)	RS	Residual Soil	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported	
	XW	Extremely Weathered	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible	
	HW	Highly Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.	
	MW	Moderately Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock	
	SW	Slightly Weathered	Rock is partially discoloured with staining or bleaching along joints but shows little or no change in strength from fresh rock	
	FR	Fresh	Rock shows no sign of decomposition of individual minerals or colour changes	
		Note : Where it is not possible to distinguish between HW and MW rock the term Distinctly Weathered (DW) may be used. DW is defined as 'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased by deposition of weathering products in pores'		
Strength (AS1726:2017)		**Term**	**Point Load Strength Index (I_{s50}, MPa)**	
	VL	Very Low	≥0.03	≤0.1
	L	Low	>0.1	≤0.3
	M	Medium	>0.3	≤1
	H	High	>1	≤3
	VH	Very High	>3	≤10
	EH	Extremely High	>10	
Defect Spacing		**Description**	**Spacing (mm)**	
		Extremely closely spaced	<20	
		Very closely spaced	20 to 60	
		Closely spaced	60 to 200	
		Medium spaced	200 to 600	
		Widely spaced	600 to 2000	
		Very widely spaced	2000 to 6000	
		Extremely widely spaced	>6000	
Defect Description (AS1726:2017) Type				
	Pt	Parting		
	Jo	Joint		
	Sh	Sheared Surface		
	Sz	Sheared Zone		
	Ss	Sheared Seam		
	Cs	Crushed Seam		
	Is	Infilled Seam		
	Ews	Extremely Weathered Seam		
Macro-surface geometry	St	Stepped		
	Cu	Curved		
	Un	Undulating		
	Ir	Irregular		
	Pl	Planar		
Micro-surface geometry	Vro	Very Rough		
	Ro	Rough		
	Sm	Smooth		
	Po	Polished		
	Sl	Slickensided		
Coating or infilling	cn	clean		
	sn	stained		
	vn	veneer		
	cg	coating		

GEOTECHNIQUE PTY LTD

AS1726 – Identification of Sedimentary Rocks for Engineering Purposes

Grain Size mm		Bedded rocks (mostly sedimentary)							
More than 20	20	Grain Size Description				At least 50% of grains are of carbonate		At least 50% of grains are of fine-grained volcanic rock	
	6 2	RUDACEOUS		CONGLOMERATE Rounded boulders, cobbles and gravel cemented in a finer matrix Breccia Irregular rock fragments in a finer matrix		LIMESTONE and DOLOMITE (undifferentiated)	Calcirudite	Fragments of volcanic ejecta in a finer matrix Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	SALINE ROCKS Halite Anhydrite
	0.6	ARENACEOUS	Coarse	SANDSTONE Angular or rounded grains, commonly cemented by clay, calcite or iron minerals			Calcarenite	Cemented volcanic ash TUFF	Gypsum
	0.2		Medium	Quartzite Quartz grains and siliceous cement					
	0.06		Fine	Arkose Many feldspar grains Greywacke Many rock chips					
	0.002	ARGILLACEOUS		MUDSTONE	SILTSTONE Mostly silt	Calcareous Mudstone	Calcisiltite (CHALK)	Fine-grained TUFF	
	Less than 0.002			SHALE Fissile	CLAYSTONE Mostly clay		Calcilutite (CHALK)	Very fine-grained TUFF	
Amorphous or crypto-crystalline				Flint: occurs as hands of nodules in the chalk Chert: occurs as nodules and beds in limestone and calcareous sandstone					COAL LIGNITE
				Granular cemented – except amorphous rocks					
				SILICEOUS		CALCAREOUS		SILICEOUS	CARBONACEOUS
				SEDIMENTARY ROCKS Granular cemented rocks vary greatly in strength, some sandstones are stronger than many Igneous rocks. Bedding may not show in hand specimens and is best seen in outcrop. Only sedimentary rocks, and some metamorphic rocks derived from them, contain fossils Calcareous rocks contain calcite (calcium carbonate) which effervesces with dilute hydrochloric acid					

AS1726 – Identification of Metamorphic and Igneous Rocks for Engineering Purposes

Obviously foliated rocks (mostly metamorphic)		Rocks with massive structure and crystalline texture (mostly igneous)						Grain size (mm)
Grain size description		MARBLE	Grain size description	Pegmatite		GABBRO	Pyrosenite	More than 20 20
COARSE	GNEISS Well developed but often widely spaced foliation sometimes with schistose bands Migmatite Irregularly foliated: mixed schists and gneisses	QUARTZITE Granulite HORNFELS	COARSE	GRANITE These rocks are sometimes phorphyritic and are then described, for example, as porphyritic granite	Diorite		Peridorite	6 2
MEDIUM	SCHIST Well developed undulose foliation; generally much mica	Amphibolite Serpentine	MEDIUM	Micorgranite These rocks are sometimes phorphyritic and are then described as porphyries	Microdiorite	Dolerite		0.6 0.2 0.06
FINE	PHYLLITE Slightly undulose foliation; sometimes 'spotted' SLATE Well developed plane cleavage (foliation)		FINE	RHYOLITE These rocks are sometimes phorphyritic and are then described as porphyries	ANDESITE	BASALT		0.002 Less than 0.002
	Mylonite Found in fault zones, mainly in igneous and metamorphic areas			Obsidian	Volcanic glass			Amorphous or cryptocrystalline
CRYSTALLINE				Pale<-->Dark				
SILICEOUS		Mainly SILICEOUS		ACID Much quartz	INTERMEDIATE Some quartz	BASIC Little or no quartz	ULTRA BASIC	
METAMORPHIC ROCKS Most metamorphic rocks are distinguished by foliation which may impart fissility. Foliation in gneisses is best observed in outcrop. Non-foliated metamorphics are difficult to recognize except by association. Any rock baked by contact metamorphism is described as 'hornfels' and is generally somewhat stronger than the parent rock Most fresh metamorphic rocks are strong although perhaps fissile			IGNEOUS ROCKS Composed of closely interlocking mineral grains. Strong when fresh; not porous Mode of occurrence : 1 Batholith; 2 Laccoliths; 3 Sills; 4 Dykes; 5 Lava Flows; 6 Veins					

APPENDIX B

Laboratory Test Results

STS Geotechnics
Sydney Laboratory
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P 02 9756 2166
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E enquiries@stsgeo.com.au
NATA Accredited Laboratory Number: 2750

Quality of Materials Report

Report No: SAR-W-SY-25-00255-3 | Issue No: 1

Client:	GEOTECHNIQUE PTY LTD	**Project Number:**	33024
Address:	PO Box 880, Penrith, 2751	**Report Date:**	13/10/2025
Project Name:	33024 - MATERIAL TESTING	**Order Number:**	
Project Location:	1359E-L NEWINGTON BOULEVARD, NEWINGTON, 2127	**Job Description:**	

Sample Details

Sample ID:	S-SY-25-01189	**SAMPLE LOCATION**	
Sampling Method:	AS 1289.1.3.1 Clause-3.1.3.2 - Open-drive samplers - Thin-walled sampler	BH2 (0.70m - 1.0m)	
Sampled By:	External		
Date/Time Sampled:	29/09/2025 /		
Sample Preparation	AS 1289.1.1		
Material Type:		**Lot Number:**	
Rock Type:		**Field Sample Id:**	1
Material Source:	Onsite Material	**TRN:**	
Soil Description:	Gravelly Silty CLAY, Brown	**Specification:**	

AS 1289.7.1.1 Shrink Swell Index

Date Tested	**07-10-2025**	**S-SY-25-01189**
Result	**Result Value**	**Limits**
Inert Material Inclusions (%)	10.0	
Pocket Penetrometer Before (kPa)	6	
Pocket Penetrometer After (kPa)		
Shrinkage Moisture Content (%)	15.5	
Shrinkage Strain (εsh) (%)	2.4	
Swell Moisture Content Before (%)	14.5	
Swell Moisture Content After (%)	18.6	
Swell Strain (εsw) (%)	0.1	
Shrink Swell Index Iss (%)	1.4	
Soil Visual Description		
Extend of Cracking	Slightly Cracked	
Soil Crumbling ?	Nil	

Accredited for Compliance with ISO/IEC 17025 - Testing No. 2750

APPROVED SIGNATORY

Name: Sarahana Pokharel
Date Of Issue: 13/10/2025 | Issue#: 1

NATA Accredited Laboratory Number: 2750

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

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Sydney Laboratory
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W https://www.stsgeo.com.au/
A Unit 14/1 Cowpasture Place, Wetherill Park, 2164
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NATA Accredited Laboratory Number: 2750

Quality of Materials Report

Report No: SAR-W-SY-25-00255-4 | Issue No: 1

Client:	GEOTECHNIQUE PTY LTD	**Project Number:**	33024
Address:	PO Box 880, Penrith, 2751	**Report Date:**	13/10/2025
Project Name:	33024 - MATERIAL TESTING	**Order Number:**	
Project Location:	1359E-L NEWINGTON BOULEVARD, NEWINGTON, 2127	**Job Description:**	

Sample Details			
Sample ID:	S-SY-25-01190	**SAMPLE LOCATION**	
Sampling Method:	Sampling method unknown	BH1 (0.80m-1.00m)	
Sampled By:	External		
Date/Time Sampled:	29/09/2025 /		
Sample Preparation	AS 1289.1.1		
Material Type:		**Lot Number:**	
Rock Type:		**Field Sample Id:**	2
Material Source:	Onsite Material	**TRN:**	
Soil Description:	Silty CLAY, grey brown	**Specification:**	

AS 1289.3.1.2 3.2.1 3.3.1 3.4.1 One Point Atterberg Limits

Date Tested	08-10-2025	S-SY-25-01190
Result	**Result Value**	**Limits**
Liquid Limit (%)	85	
Plastic Limit (%)	30	
Plastic Index (%)	55	
Linear Shrinkage (%)	20.0	
Sample History	Oven Dried	
Preparation Method	Dry Sieved	
Nature Of Shrinkage	, Curling ,	

Accredited for Compliance with ISO/IEC 17025 - Testing No. 2750

APPROVED SIGNATORY

Name: Sarahana Pokharel
Date Of Issue: 13/10/2025 | Issue#: 1

NATA Accredited Laboratory Number: 2750

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@smectesting.com.au

Accredited for Compliance with ISO/IEC 17025 - Testing No. 2750

California Bearing Ratio Determination Report

Project: 20659/3_NEWINGTON BOULEVARD, NEWINGTON — Project No.: 33024

Client: GEOTECHNIQUE PTY LTD — Report No.: 25/2563

Address: PO Box 880, Penrith, 2751 — Report Date: 17/10/2025

Test Method: AS1289.6.1.1,2.1.1 — Page: 1 of 1

No. of Days Soaked: 4 — Compactive Effort: Standard

Target Compaction (%): 100

Surcharge (Kg): 6.75

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.		1359E-L/1					
Sample Location		BH3					
Material Description		Silty CLAY, brown, trace Gravel					
Depth of Sample (m)		0.3- 1.0					
Sample Date		29-30/09/2025					
Oversize on Wet Basis +19mm (%)		1.7					
Field Moisture Content (%)		18.7					
Optimum Moisture Content (%)		16.5					
Maximum Dry Density (t/m³)		1.84					
Dry Density (t/m³)	Before Soaking	2.00					
	After Soaking	2.00					
Relative Compaction (%)	Before Soaking	100					
	After Soaking	98					
Moisture Content (%)	Before Soaking	16.5					
	After Soaking	18.0					
Moisture Ratio Before Soaking (%)		100.0					
Moisture Content after test (%)	Top 30mm	20.9					
	Entire Depth	18.2					
Swell after Soaking (%)		2.5					
CBR Value (%)		**4.0**					
Penetration (mm)		**2.5**					

Remarks: +19mm material excluded from test

Approved Signatory................................ ....

Technician: SN/BV

Bala Velupillai - Laboratory Supervisor

APPENDIX C

Saline Soil Management Plan

Saline Soil Management Plan

Soils encountered across the site are dispersive and susceptible to erosion. In addition, soils at depths exceeding 0.5m from existing ground surface are saline. Therefore, bulk earthworks for the proposed school development should be carried out in accordance with a Soil Management Plan (SMP) to be developed by earthwork contractor before earthworks are commenced. The earthworks should also be carried out in general accordance with this Saline Soil Management Plan (SSMP) if development works involve disturbance and excavation of soils at depths exceeding 0.5m. The SSMP aims to address the following:

- Minimise the potential for excessive soil erosion
- Minimise the disruption to natural surface water drainage
- Minimise the potential for waterlogging or surface water pooling
- Minimise the potential for raising the water table beneath the site
- Minimise the potential for cyclic wetting and drying area
- Minimise the potential impacts due to presence of saline soils

The following are recommended for adoption as part of SSMP during the bulk earthworks for the proposed school development:

- SMP should be implemented to minimise impacts of dispersive soils to the proposed development works. All sediment and erosion controls recommended in the SMP should be installed prior to commencement of any earthwork and aimed at the following;
    - To control the drainage to manage volumes and velocity of stormwater runoff to prevent formation of concentrated flows that cause rill and gully erosion. This can be achieved by grading the ground surface and diverting the stormwater away from the site by constructing appropriate drainage system.
    - To control erosion by (1) minimising exposure of erodible soils; (2) protecting exposed soil surfaces to prevent or reduce erosion caused by stormwater surface flows; and (3) protect the soil surface by providing grass cover or other ground covers (jute, geotextile etc) and chemical stabilisation of exposed soil surfaces.
    - To control sediment by trapping and retaining sediment and preventing it from being lost off site or accumulating in local waterways. Buffer zones with good ground cover and grass filter strips can be used for this purpose. Other sediment control measures include sediment basins, filter dams/bags, check dams, sediment fence etc.
- Utilise native and deep-rooted plants (salt tolerant) in order to minimise soil erosion. Western Sydney soils are generally prone to dispersion and erosion. Therefore, where vegetation cover is not adequate to control erosion, improve soil resistance to erosion by stabilising dispersive soils with hydrated lime and gypsum.
- Cut and fill batters should be provided with secured turf overlay to guard against erosion. Construction of a V-drain behind the crest of any slope, to divert water away from the slope, is also recommended.

- Map the current primary drainage lines and incorporate these into the surface water drainage system for the site. Do not fill in or block these drainage lines unless appropriate alternative drainage is provided.
- Develop the best use of the existing topography in order to minimise cut and fill operations.
- Where the earthworks require substantial cut and/or fill (i.e. on relatively steep slopes) consider the terracing of the site to minimise the obstruction of the natural surface water flow.
- Minimise the use of retaining structures; use safely inclined slopes, with grass and plant cover as an alternative. Free draining walls such as gabion walls may however be used as retaining structures.
- Reduce groundwater recharge through appropriate land use and land management practices including the following;
    - Minimising deep infiltration by maximising vegetation cover, planting deep-rooted trees and the use of salt tolerant plants
    - Preventing water ponding
    - Providing appropriate ground surface slope to drain water away to natural creek or stormwater system
    - Preventing use of unlined on-site water detention basins. Lined basins, relying solely on evaporation are preferable
    - Ensuring finished ground surface at the completion of earthworks has adequate fall to the natural creek or stormwater system to allow run-off of water and prevent water ponding, waterlogging and infiltration of rainwater
- Ensure groundwater encountered during excavations for proposed development are diverted to stormwater system or creeks by providing appropriate surface and sub-surface drainage. Groundwater modelling may be required to design the dewatering system if excavation encounters significant groundwater inflow.
- Use construction materials (concrete, steel, brick, mortar etc) and methods suitable for assessed salinity and aggressivity of the site.