Explorer Street Precinct - Eveleigh South

Geotechnical Desk Study

Department of Planning Industry & Environment

Reference: SYDEN323908-R01 GDS

2 August 2023

EXPLORER STREET PRECINCT - EVELEIGH SOUTH

Geotechnical Desk Study

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PREPARED FOR

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1. INTRODUCTION

Tetra Tech Coffey Pty Ltd (Coffey) was commissioned by NSW Dept. of Planning, Industry & Environment (DPIE) to provide contamination and initial geotechnical advice to inform urban planning activities and support an application to rezone the land referred to as the Explorer Street Precinct, Eveleigh NSW (referred to herein as the Site). The Site locality and footprint is outlined in Figure 1 below.

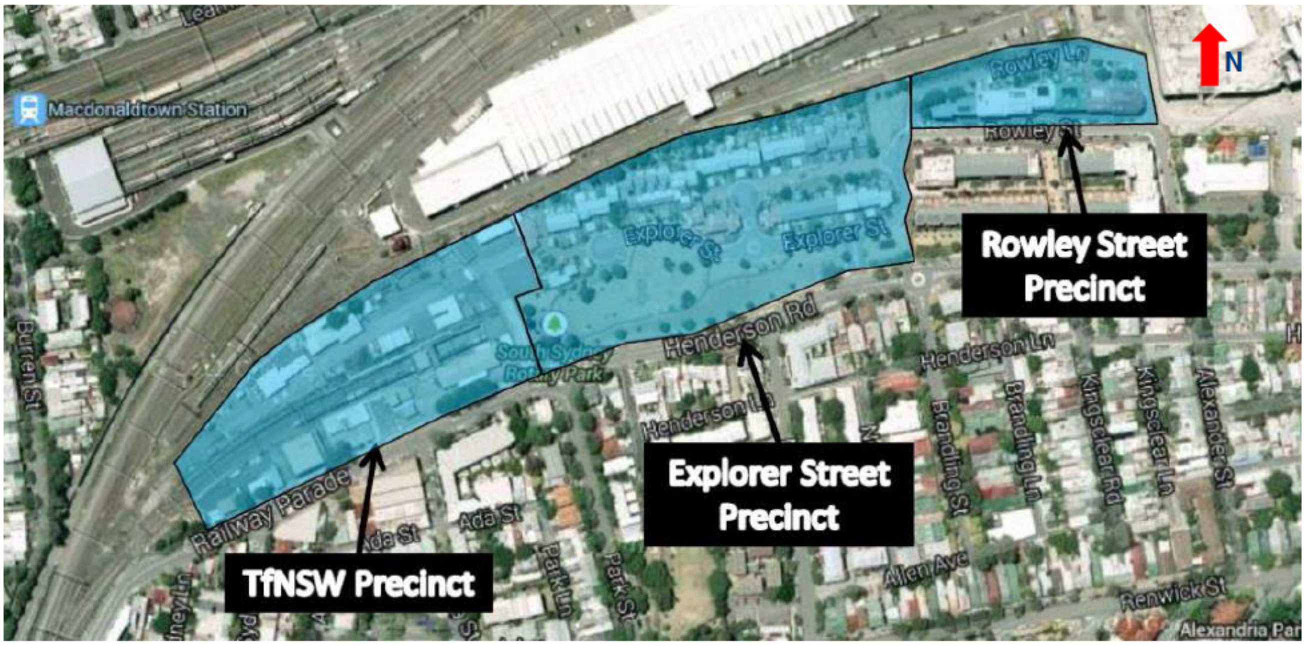

Figure 1: The Site (Explorer Street Precinct) and adjacent Precincts

The Site is currently occupied by the South Sydney Rotary Park in the south and low-rise housing in the north. The ESR Illawarra Relief Line is orientated east-west and is situated in a cut and cover twin box tunnel at a relatively shallow depth beneath the park.

The tunnel and associated easement present geotechnical constraints to future development of the Site. Previous contamination assessments by Coffey have identified moderate to high potential for contamination resulting from historic land uses on the Site and surrounding land.

We understand that there is intent to rezone the Site to facilitate high density residential redevelopment. To progress this outcome, Coffey has been commissioned to complete:

A. An initial geotechnical desktop review and assessment to provide a preliminary understanding of site geotechnical/ground conditions and constraints for future site rezoning and redevelopment planning, followed by,

B. A Detailed Site Investigation (DSI) to assess contamination risks and address the ‘site suitability’ considerations set out under State Environmental Planning Policy (Resilience and Hazards) 2021 to support the rezoning application.

2. SCOPE OF WORK

This report addresses Item A, the initial site geotechnical desktop study. The aim of the desktop study was to critically review and consolidate currently available geotechnical information for the site locality to develop an initial Site geotechnical model of likely ground/geotechnical conditions. This initial model was then used to identify and discuss perceived potential geotechnical issues and constraints for future development.

Our geotechnical desktop study includes:

- Review of relevant published, publicly available geological, soil and groundwater information pertaining to the site locality.
- Coffey archive searches for previous site investigation information in the vicinity of the site together with information provided by the client.
- A site walkover by a Geotechnical Engineer from Coffey to characterise the site conditions and surrounding topographical, geological, and hydrogeological environment.

Following completion of our desktop study, this initial geotechnical assessment report was prepared containing:

- A preliminary geotechnical/ground model for the Site.
- Identification / discussion of perceived geotechnical issues and constraints for site development.
- Initial comments on building footings and foundations, excavation conditions, retaining structures and groundwater in relation to the identified geotechnical issues and constraints.
- Recommendations for intrusive geotechnical site investigations and strategies to support detailed planning and engineering design.

3. THE SITE

3.1 SITE IDENTIFICATION

Table 1: Site Identification Summary

Site Name	**Explorer Street Precinct**
Site Address	Explorer Street, Aurora Place and Progress Place, Eveleigh
Site area	23,613m^2 (approximately 2.3ha)
Title identification details	Lot 21, DP835061, Lot 22, DP835061 and Lot 122, DP1030021
Current zoning	Residential zone – General Residential (Lot 21, DP835061, Lot 22, DP835061); Recreational Zone – Public Recreation (Lot 122, DP1030021).
Proposed zoning	R1 General Residential and RE1 Public Recreation
Current site use	Residential and recreational open space. The Eastern Suburbs railway tunnel traverses beneath the site.
Local Government Authority	City of Sydney
Current owner and occupier	NSW Land and Housing Corporation and City of Sydney
Surrounding site uses	North: Main railway line to Redfern Station, Eveleigh Carriage Works. South: Residential housing and parks. East: Rowley Street Precinct. Residential housing and commercial buildings (part of Australian Technology Park). West: Transport for NSW Precinct, South-west Residential housing

3.2 LOCAL TOPOGRAPHY & LANDUSE

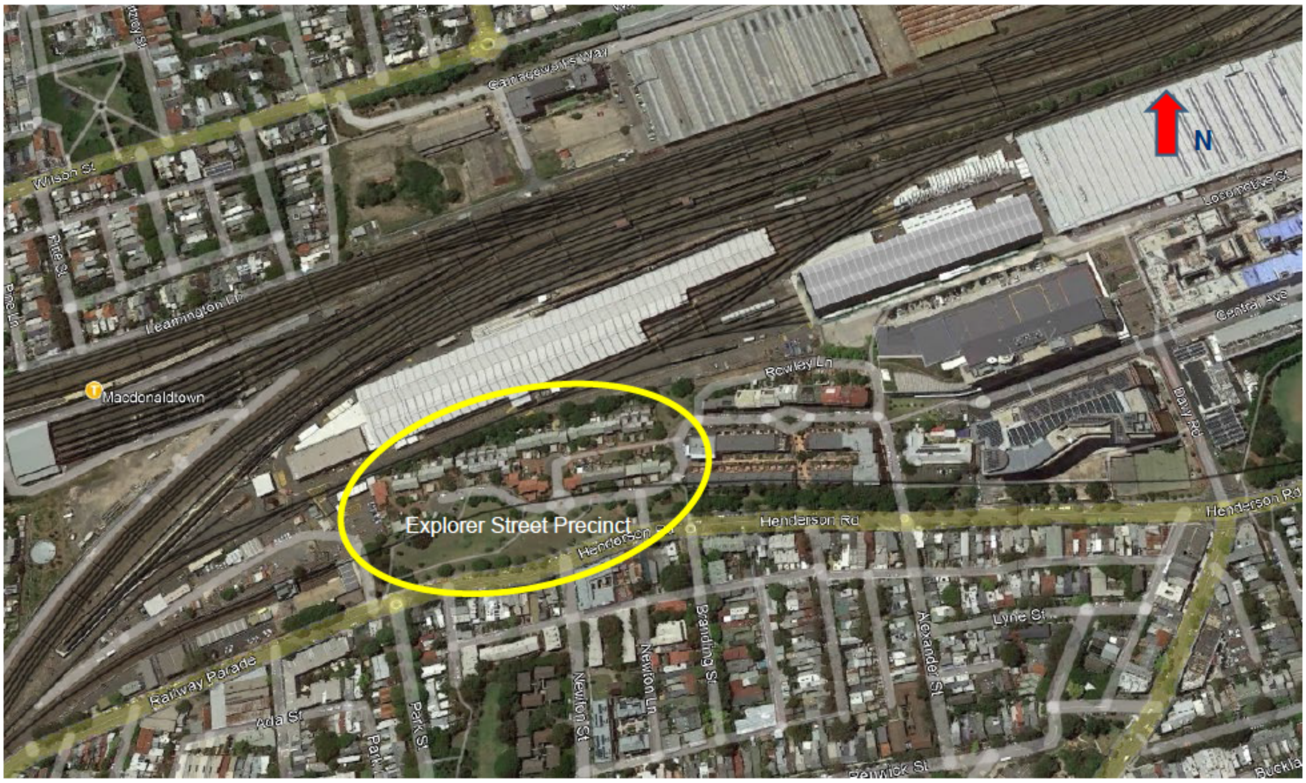

Figure 2 – Site locality and built environment

The Site is bounded by Macdonaldtown Railyards in the north (at slightly higher elevation) and Henderson Street to the south (at slightly lower elevation). Explorer Street winds through the Precinct from east to west, and with Aurora Place, provides access to the existing residences.

Explorer St Precinct housing is located north of Explorer St. The buildings generally consist of two-storey townhouses. Much of this area is paved with concrete or bitumen, with nominal landscaping.

South Sydney Rotary Park is located south of Explorer St and is mainly grass covered with east-west oriented pathways. A large fill mound several metres high runs through South Sydney Rotary Park roughly parallel to Henderson Road. The soil mound slopes toward the Henderson Street frontage. North of the mound is a parallel depression with several stormwater drainage inlets along the invert of the depression.

The neighbouring Rowley Street housing estate is located to the east of the site, comprising double to four-storey apartment or townhouse buildings. The ground surfaces were generally covered with small areas of landscaping.

The surrounding land falls gradually in a south to south-westerly direction. Around the site perimeter, the site elevation is about 19m AHD near the north boundary falling to about 14m AHD in the south near Henderson Road. On the site, the fill mound raises the site elevation by several metres.

3.3 LOCAL GEOLOGY

Figure 3: Local geology (from Minview website)

The Sydney geological map indicates that the Site locality in near the mapped boundary of Ashfield Shale (shaded blue-grey) of the Wianamatta Group and Quaternary Sands (shaded brown) to the south of the site. The site is located to the north of the interface, where the bedrock is overlain by residual clay soils of the Blacktown Soil Landscape. South of the site the Ashfield Shale is buried beneath the coastal sand dunes of the Tuggerah Soil Landscape.

There are several large faults known to pass beneath the Sydney CBD to the north. If the mapped alignment of these faults is extended southwards, then these may pass through the Site.

Local acid sulfate soil risk mapping indicates no known occurrence at the site locality.

3.4 THE BUILT ENVIRONMENT

It is evident from the terrain and land use that the railyards to the north of the Site have been cut in the north and filled in the south. Historically, these railyards extended to Henderson Road predating the urban development on the Site. Hence it is likely that Railyard Fill may extend onto the Site, possibly to significant depths.

The Eastern Suburbs Railway Tunnel (known as the Illawarra Relief Line) runs beneath the Site. The alignment footprint is inferred to be roughly parallel to Henderson Road, beneath the northern half of Rotary Park (to be confirmed by accurate survey).

The tunnel was constructed by cut and cover methods. Excess spoil from the tunnel excavation is expected to have been used to form the current mounds on site. These are not expected to have been compacted in a controlled manner.

As a result of the built environment, considerable depths of Railyard Fill and Tunnel Spoil Fill may overlie the natural soils described in Section 3.3.

3.5 TUNNEL CONSTRUCTION

Coffey archives contain a few Department of Railways Drawings from c. 1971 that show:

- Cross sections to the east of the Site that indicate tunnel cross sections and indicative ground conditions.
- A long section passing through the Site.

Figure 4 shows an extract tunnel section at 1 mile 14 chains down line (about 400m to the east of the Explorer Street Precinct). At that chainage, the tunnel is at higher elevation and located where the Quaternary (Botany) Sands overlie the Ashfield Shale, but it can be seen that the tunnel is founded below the sand in the residual clays.

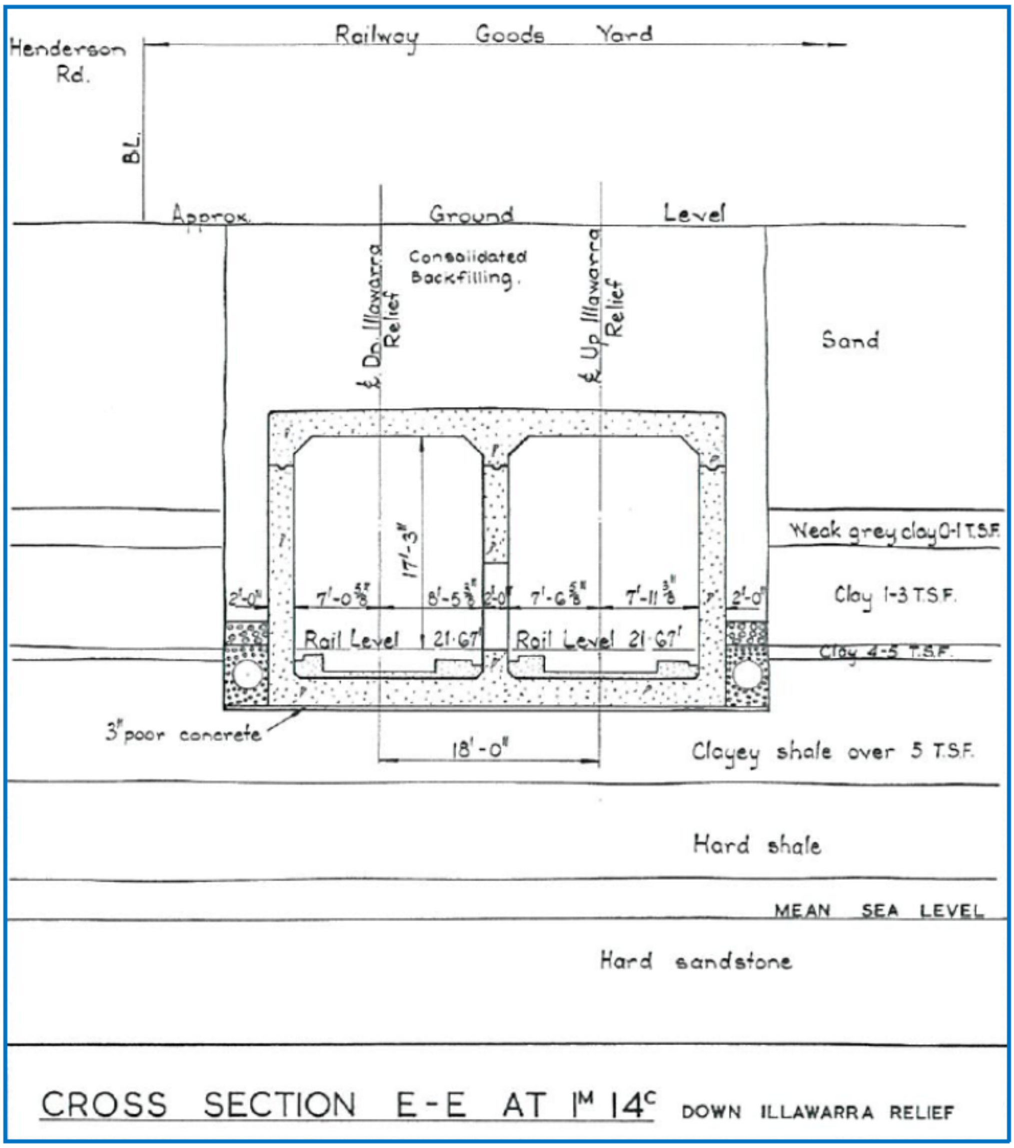

Figure 4: Duel cell concrete cast tunnel formed in cut and cover excavation.

The Long Section through the Site show that the rail formation descends from the east to level out below the site at 10 to 12 feet relative to mean sea level (about 3m to 3.5m AHD) until 1 mile 43 chains down line (approximately beneath the western intersection of Explorer Rd and Aurora Place). From there, the tunnel climbs to the west. The roof daylights about 150m to the west (at the western Site boundary).

4. NEARBY GEOTECHNICAL INVESTIGATIONS

4.1 NORTH EVELEIGH WEST

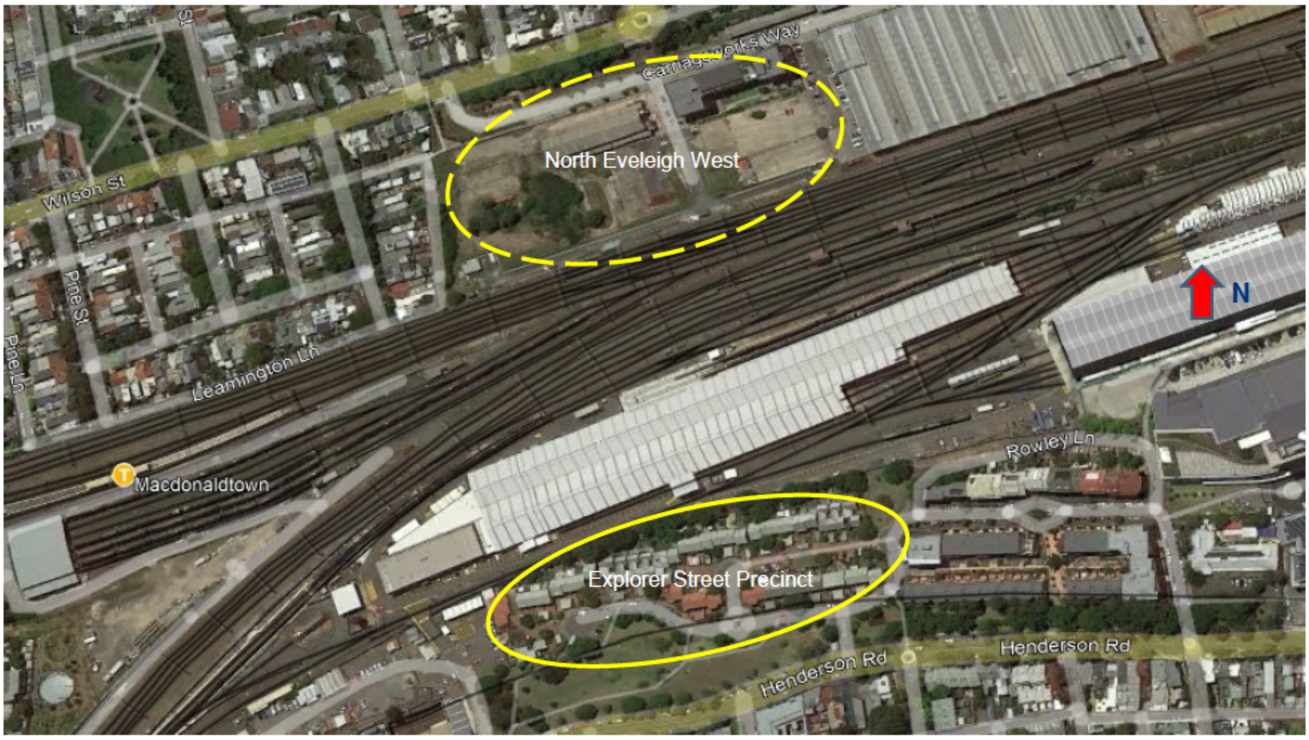

Figure 5 – Site of North Eveleigh West Investigation

This site had been subject to many prior geotechnical investigations. In 2016 Coffey conducted geotechnical investigation (reference ENAURHOD04867-R06a) for Urban Growth NSW the site shown north of the railway lines in Figure 5. The proposed development was four multi storey residential buildings with three levels of basement. The site is located over Ashfield Shale geology and had been levelled by previous cutting and filling, leading to deep fill to the south and cuts into Units 1 and 2 in the north, refer to Table 2.

Table 2: Geotechnical model for North Eveleigh West

Geotechnical Unit	Description	Layer thickness (m)	Depth to base of layer (m)
Fill	Clay and Sand with variable gravel content. Foreign materials including metal, ash, concrete fragments and possible slabs, other obstructions	0.5 to 5.0	0.5 to 5.0
Residual Soil	Silty Clay, medium and high plasticity, stiff to hard	0.0 to 3.0	Up to 5.6
Class V/IV Shale	Shale and Siltstone, very low and low rock strength, some soil strength bands	1.6 to 4.5	2.7 to 9.5
Class II Shale	Shale and Siltstone, slightly weathered to fresh, medium and high strength	Not proven	Not proven

Groundwater was located near the residual soil/weathered shale interface at depths of between 3 m and 4 m below ground level (23m to 24m AHD) and a shallow discontinuous perched aquifer was interpreted in the Fill between 1 m and 2 m depth below ground surface.

In 2013, JK Geotechnics conducted a geotechnical investigation at this site, with broadly similar findings.

4.2 136 RAILWAY PARADE, EVELEIGH

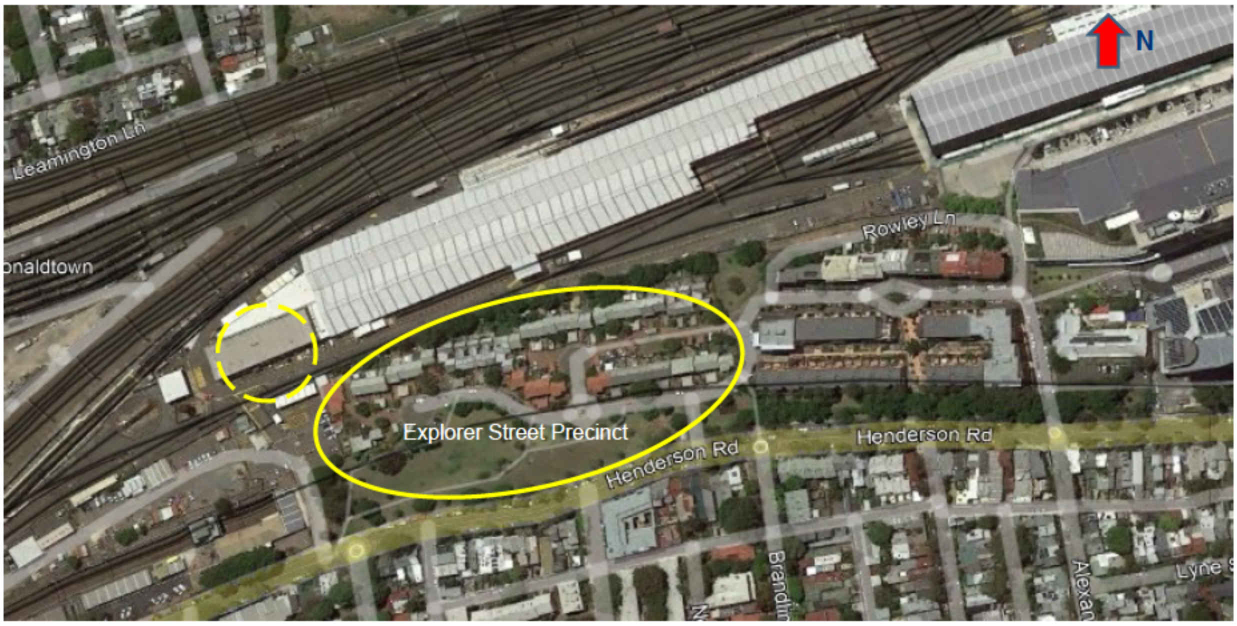

Figure 5 – Site locality 136 Railway Parade, Eveleigh

In 2011, JK Geotechnics conducted geotechnical investigation (reference 25132Vrpt Eveleigh) for RailCorp. Two boreholes were drilled but the exact locations and levels were not recorded. The site locality is immediately west of the subject Site. Two boreholes were drilled to approximately 8 m depth.

These boreholes encountered:

- **Fill** comprising various mixtures of clay, sand and gravel. Moderately compacted in the upper 1 or 2m but poorly compacted below that (N values 2 to 6). The fill depths encountered were 7m and greater than 8m.
- **Residual Clay** comprising very stiff Silty Clay of high plasticity.

Drilling terminated above the Ashfield Shale. Groundwater seepage occurred in Fill at depths of 3.5m and 4m.

4.3 35-39 HENDERSON ROAD EVELEIGH

This site is located 550m due east of the Explorer Precinct. In 2015, Coffey drilled one cored borehole at this site (reference GEOTLCOV25401AA-AB) to about 14m depth. Table 3 summarises the ground profile.

Table 3: Geotechnical Model at 35-39 Henderson Road

Geotechnical Strata	Description	Typical Condition	Depth Encountered
Fill	Clayey sands	Loose	0 to 1.5m
Alluvial Sands	Botany Sands	Loose Medium dense Very dense	1.5 to 2.7 2.7 to 6.5m 6.5 to 8.0
Alluvial Clays	Silty clays	Stiff to very stiff	8.0 to 11.5m
Class V and IV Shale	Siltstone/mudstone	Very low strength	11.5 to 12.6
Class III/II	Siltstone/mudstone	Medium strength	12.6 to >14.1m

Note 1: Rock classified using system presented in Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Australian Geomechanics Journal, December 1998.

5. PRELIMINARY GEOTECHNICAL MODEL

5.1 STRATIGRAPHY

In the absence of site-specific geotechnical investigation to assess geotechnical conditions on the Site, Table 4 presents a preliminary ground model for the site based on site history, observations and extrapolation of the geotechnical information from nearby sites. Focused site-specific geotechnical investigation will be required to inform detailed design.

Table 4: Preliminary Geotechnical Model for Explorer Street Precinct

Unit	Material	Description	Indicative thickness
Unit 1	Fill	Various layers of fill derived from the sources listed below, but not necessarily formed as continuous layers across the site. • Railyard Fill (predating tunnel construction) • Uncontrolled Tunnel Spoil Fill (placed during tunnel construction) • Fill associated with subsequent Urban development The fill may be widespread across the site.	The total fill thickness and various fill layer thicknesses are unknown and likely highly variable.
Unit 2	Residual Soil & Class V Shale	Silty Clay, medium and high plasticity, generally stiff to hard consistency, grading into Class V Shale with very low rock strength.	Possibly up to 3m to 4m thick.
Unit 3	Class IV Shale	Shale and Siltstone, variable degree of weathering, mainly very low and low strength with some stronger bands.	Possibly up to 1m to 3m thick.
Unit 4	Class II Shale or better	Shale and Siltstone, moderately weathered to fresh, generally medium or high strength, local low strength or fractured zones	Not known but may be underlain by sandstone

Notes to Table 4

1. Rock classifications are based on the system presented in Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Australian Geomechanics Journal, December 1998. However, the model is dependent on classifications conducted by other parties whose classifications may have been constrained by the scope of investigation conducted.
2. The Units described in Table 4 may not be continuous or regular across the Site. With respect to rock units, we would expect the rock profile to be gradational from Class V to Class II or better. The units are intended to represent engineering behaviour rather than geological uniformity. For example, Unit 2 may contain weak rock bands but is expected to perform more as a soil. Unit 3 may contain some Class III Shale, but we are not able to delineate where that may occur.
3. The geology map suggests that the Botany Sands do not encroach onto the site, but isolated shallow encroachments could occur. This possibility is not considered in the preliminary geotechnical model.
4. The historical railway sections to the east of the site indicate Sandstone underlying Shale near or below Mean Sea Level. This may be Hawkesbury Sandstone that underlies the Ashfield Shale. Future investigation may reveal the presence or otherwise of this Unit at a feasible foundation depth.

5.2 GROUNDWATER

Groundwater depths are not known. The permanent groundwater level is likely to be near mean sea level (i.e. below the ESR rail tunnel invert level). There may be perched groundwater within the Fill units, and groundwater seepage along the Fill/Residual Soil and natural soil/rock interfaces. It is expected that these seepages would drain towards the tunnel.

6. GEOTECHNICAL CONSIDERATIONS FOR DESIGN

6.1 PROPOSED DEVELOPMENT & SITE CONSTRAINTS

The proposed development is multi-storey buildings, each with several basement levels, or a common basement. Anticipated site constraints include:

- Building locations may be limited by the ESR corridor and associated reserves, which are not presently accurately defined.
- The basement excavation and/or the temporary and permanent supports for excavation retention system may impact or encroach on the rail assets and surrounding development.
- The building footings will need to be founded near or below the tunnel invert level to avoid transfer of load to the rail assets.
- Detailed impact assessments due to excavations on the adjacent properties and infrastructure are likely to be required.

At this stage, the number of basement levels is uncertain, as is the depth to a suitable rock foundation.

In the following sections, any reference to Geotechnical Units are those Units described in Table 4.

6.2 EXCAVATION CONDITIONS

The excavation conditions will depend on the local depth of Unit 1 Fill, the proposed ground floor level and the number of basement levels. Excavation for two basement levels may fully penetrate Unit 1, and most of Unit 2. Three basements could penetrate most of Unit 3 and partial penetration into Unit 4.

It is expected that most Unit 1, Unit 2 and some Unit 3 could generally be excavated using conventional earthmoving plant such as a large excavator with a tooth bucket. Rock breaking techniques may be required for possible buried concrete slabs within Unit 1.

The use of high powered excavation plant fitted with rippers and rock breakers would likely be required for the excavations in Unit 4 and some Unit 3. Rotary rock grinder or rock saw attachments to the hydraulic excavator may be required to avoid both over-break and excessive vibrations below shoring and adjacent to vibration sensitive structures.

The depths and thicknesses of the various units will need to be determined by further investigations, from which contractors should make their own evaluation of the plant required for excavation.

6.3 POTENTIAL IMPACT ON ADJACENT & UNDERGROUND FACILITIES

The main impact to nearby roads, railyards, structures, underground infrastructure and the ESR tunnel located below the south of the site will be basement excavation during construction and the adequacy of the temporary and permanent site retention systems.

The basement excavation will result in vibrations that could affect nearby structures and infrastructure and the removal of ground support can cause damage or collapse as a result of lateral and/or vertical ground movements and soil pore pressure changes. To assess potential risks, the following will need to be assessed for each nearby development prior to formulation of excavation plans, temporary and permanent retention design and construction methodology:

- Size, location, nature, footing system, founding level, building fabric and deformation tolerance, and;
- Location, depth and nature of existing underground services near the basement footprints.

Appropriate investigation, design, and monitoring is required to assess the footings of existing adjacent structures and services and to protect them from adverse impacts from ground movements and/or loss of support arising from excavation, vibrations due to excavation plant and the potential changes to local groundwater conditions. Prior to commencement of the bulk excavation works dilapidation surveys of the adjacent structures be carried out to provide a baseline condition for excavation monitoring and management.

Where it is important to limit adjacent ground movements due to the presence of nearby structures, the use of relatively stiff shoring with bracing or tie-back anchors designed to resist higher than active earth pressures is likely to be required. In these cases, detailed numerical analysis to assess ground/structure interaction may be required for more efficient design of the shoring system.

Even suitably designed and constructed retention systems will result in some ground movements outside the basement footprint. Published data suggests that an adequately designed and installed retention system in soil and weathered rock can experience lateral movements between 0.1% and 0.3% of the retained height at the excavation face. The magnitude of lateral ground movements diminishes with distance from the edge of excavations, but the zone of influence can extend to 1.5 to 2 times the basement depth.

The risks of ground movements are not restricted to basement excavation. Any temporary or permanent excavation can cause ground movements that affect nearby development, particularly in unsupported excavations. Most of the existing near-surface soils are expected to comprise fill that may be uncontrolled. Unsupported excavations in these materials could collapse or erode, if cut too steep, too deep or if perched groundwater is present. Such excavations should be avoided. We are not presently able to suggest short or long term batter slope or depth limits for unsupported excavations of any type on the Site.

6.4 EXCAVATION RETENTION

For basement excavation, unsupported cuts are not recommended in Geotechnical Units 1, 2 and 3. Because of the site constraints and adjacent development, shoring systems and permanent retaining walls are likely to be required for basement construction, irrespective of proposed basement depth.

Unit 4 (Class II or better Shale) may be encountered near the base of excavation if three levels are proposed. Whilst it is common for vertical cuts in this material to remain stable in the short term (with local rock bolting and shotcrete support as required), it may be preferable to adopt a full depth shoring system for the excavations, because it is not uncommon for pervasive inclined joints to occur in Ashfield Shale. These joints are difficult to identify in boreholes. The joints can have serious consequences to excavation stability if they daylight below the shoring system.

Common support systems used for deep excavations in Ashfield Shale include, anchored soldier pile walls with shotcrete infill panels and/or contiguous piled walls. Anchors installed beneath adjacent properties would need permission from neighbouring land and infrastructure owners and would need to consider the impact on adjacent properties. Consideration may need to be given to using glass fibre anchors near the rail corridors due to potential for stray currents.

If the use of anchors is not possible then top-down construction or internal bracing would be required. For basements of only one level, cantilevered walls may be feasible in the temporary case, depending on wall performance requirement and the presence of any settlement sensitive services.

Final assessment of shoring options will be dictated by basement depth, ground conditions revealed by intrusive investigation, excavation requirements with respect to tolerable ground movements and the condition of rock revealed during the excavation.

6.5 GROUNDWATER

The local topography slopes gently sloping down from northeast to southwest. It is typical for groundwater to flow in the same direction. At the North Eveleigh site, groundwater level was recorded at about RL 22 to 23 m with perched (likely discontinuous) groundwater in the fill at about RL 24m. This groundwater is likely to seep downslope towards the Site, through the soil and rock mass.

Geotechnical literature indicates the range of mass permeability for fresh Sydney shales is typically in the range 10^{-7} to 10^{-9} m/s. Shallower aquifers can occur within the residual clay and weathered shale and that typical permeability in weathered shale aquifers are 10^{-6} to 10^{-9} m/s.

Groundwater inflows into basement excavations will depend on many factors, including groundwater level, basement wall and floor area, and the distribution of defects in the rock mass where higher permeability zones occur. Whilst the inflow rate in weathered shales can often be controlled by sump and pump methods, whether drained basements can be adopted will depend on the total volume of collected groundwater that needs disposal from site and the groundwater chemistry. Groundwater collected would require water quality testing and regulatory approval for discharge into the stormwater system.

Longer term groundwater monitoring and further detailed groundwater analysis and groundwater modelling would need to be carried out to assess the feasibility of drained basement in terms of dewatering and pumping requirements and long term groundwater drawdown that may affect surrounding structures/properties. Such analysis would be necessary to obtain groundwater extraction approvals from DPI Water. The drainage interaction effects of the basement and adjacent tunnel would need to be considered.

If a drained basement is possible then adequate drainage will need to be provided behind the walls, and a permanent water collection system will be required together with flushing points for drainage system periodic maintenance. Discharge to the public stormwater drainage system may be carried out through the use of pumps, however further groundwater quality test will need to be carried out to assess the suitability of water quality. An allowance of potential water pressure build-up equivalent to one-third the wall height is often adopted when such drainage measures are installed.

Alternatively, if a tanked basement is the preferred option, basement walls and floor slabs would need to be designed to resist anticipated hydrostatic uplift pressures.

Because groundwater conditions and basement excavation depths are unknown at present, there is a possibility that dewatering may be required during basement construction, which could cause ground settlement affecting adjacent property.

7. GEOTECHNICAL DESIGN

7.1 FOOTINGS

It is anticipated that the basements of proposed buildings will generally be founded on bored piles embedded into Unit 4 Shale. Table 5 provides preliminary parameters for bored pile design.

Table 5: Preliminary Parameters for foundation design

Geotechnical Unit	Unit Description	Ultimate End Bearing (MPa)	Ultimate Shaft Adhesion (kPa)	Elastic (Young's) Modulus E_v (MPa)	Elastic (Young's) Modulus E_h (MPa)
Unit 1	Fill	-	-	5	3.5
Unit 2	Residual Soil & Class V Shale	Not recommended as a foundation	50	50	35
Unit 3	Class IV	7	150	400	300
Unit 4	Class II Shale or better	30	800	1000	1050

Notes to Table 5:

1. For tension design the unit shaft friction values may in Table 5 should be multiplied by a factor of 0.7. This factor is in addition to the geotechnical strength reduction factor.
2. Pile end bearing values assume total embedment of at least 5 pile diameters and one pile diameter into the foundation stratum
3. Shaft adhesion assumes a rough socket (at least grooves of depth 1 mm to 4 mm and width greater than 5 mm at spacing of 50 mm to 200 mm. Piles in the vicinity of the rail corridor may be subject to sleeving, affecting shaft capacity.
3. For ultimate limit state design, serviceability should also be assessed using the elastic modulus to check that settlements are within tolerable limits.
4. For limit state design a geotechnical reduction factor $Ø_g$ is to be applied to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in Table 5 to derive the design ultimate geotechnical pile capacity.
5. Per AS2159-2009, $Ø_g$ is dependent on assignment of an Average Risk Rating (ARR) which takes into account various geotechnical uncertainties, redundancy of the foundation system, construction supervision, and the quantity and type of pile testing. The assessment of $Ø_g$ therefore depends on the structural design of the foundation system as well as the design and construction method, and testing (if any) to be employed by the designer and piling contractor.

In addition to calculation of pile capacity, design must incorporate detailed serviceability assessment to assess the total and differential settlements under the pile loads and whether those settlements are structurally tolerable.

7.2 RETAINING WALLS AND SITE RETENTION

The design of retaining walls for multi-anchored or braced walls is geotechnically complex. The relative stiffness of the wall and support system to that of the soil/rock will strongly influence the resulting earth pressure magnitude and distribution. Earth pressure coefficients adopted for design will depend on the analytical tools utilised in the design, and whether the numerical analysis methods used allow for stress re-adjustment associated with wall movements.

Detailed analysis should be undertaken to develop a cost-effective retention support system. As a guide, Table 6 presents general parameters for conventional earth pressure design to assist preliminary design and consideration of retention options.

Whilst conventional earth pressure design could be applied for support of soil and Unit 3a Shale, earth pressures on retaining walls in weathered rock may be associated with potential release of “locked-in” stresses in the rock units and potential wedge or block failures in the rock mass.

Table 6: Preliminary parameters for retaining wall and lateral design

Geotechnical Unit	Bulk unit Weight γ (kN/m^3)	‘At Rest’ Earth Pressure Coefficient, K_0	C’ (kPa)	ϕ’ (degrees)	Elastic (Young’s) Modulus E_v (MPa)	Horizontal Modulus E_h (MPa)
Unit 1	20	0.5	0	25	5	3.5
Unit 2	20	0.5	2	25	50	35
Unit 3	23	0.5	50	35	500	350
Unit 4	23	0.5	250	40	1500	1050

The “at rest” coefficients assume that some movement of the order of 0.1% to 0.3% of the wall will occur. If this is not suitable then significantly higher “at rest” pressures may apply. Coffey can aid in detailed analysis of retaining wall movements should this be required.

Retaining walls should be designed for hydrostatic pressures unless permanent and effective drainage can be provided. Applicable surcharge loads should be added to earth pressures.

7.3 EARTHQUAKE DESIGN CONSIDERATIONS

Based on AS 1170.4 – 2007, the Earthquake Hazard Factor, Z, for the Sydney region is 0.08.

For annual probability of exceedance (P) of 1/1000, the probability factor (k_p) is 1.3. Depending on the depth of fill, the site in its present condition may be marginal between Sub-Soil Class C_e – Shallow Soil Site and Class B_e - Rock Site. It is expected that the buildings will be founded on Unit 4 Shale but partially embedded into soil and weathered rock.

The classification will need to be revisited based on the details of the final proposed structure and results of the detailed geotechnical investigations.

8. FUTURE GEOTECHNICAL INVESTIGATION

As standard practice, Coffey encloses the attached Important Information sheet to provide guidance on the limitations of geotechnical reports that we have conducted for sites where specific development details are known and site specific investigation has been conducted.

This geotechnical desk study relies on extrapolation of geotechnical data from outside the site boundaries to form a preliminary ground model for planning concept design and assessing geotechnical constraints for the project. The geotechnical model discussed herein is not based on site specific data, and the geotechnical considerations for development are based on non-specific development data.

Based on our preliminary ground model, future high rise residential development should be geotechnically feasible, but considerable geotechnical investigation will be required to address detailed design. The extent of geotechnical investigation required for high rise residential development at the Site will depend on many factors, including:

- The available footprint for development (considering the rail reserves for the existing tunnel);
- The number of proposed basement levels (affecting excavation depth and support systems)
- The building configurations and loadings

Coffey will be able to provide more advice on investigation planning when the concept details of the development are available. The investigation objectives will be to plan an investigation that allows geotechnical modelling of:

- The extent, nature and depth of Geotechnical Units 1, 2 and 3 because his will influence the excavation and site retention design and construction costs
- The depth to, and characteristics of Geotechnical Unit 4 because this will likely form the most suitable foundation for buildings
- The groundwater conditions because this will influence basement design and the impacts on or from surrounding development.

APPENDIX A: IMPORTANT INFORMATION

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.