Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Industrial Development
5 Skyline Crescent, Horningsea Park

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

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1. Introduction

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for a proposed industrial development at 5 Skyline Crescent, Horningsea Park. The work was commissioned by ESR Australia (ESR) and was carried out in accordance with the scope of works outlined in DP's proposal (Ref: P213088.00.P.001.Rev0, dated 22 February 20221, including subsequent field work scope revisions).

It is understood that the proposed development includes the construction of a new warehouse covering approximately 4,500 m^2, including associated offices, loading docks, car parking and truck access pavements across a total site area of approximately 12,800 m^2. Two new site entry access roads are proposed along the northern and western sides of the site, each entering from the southern side of the Skyline Crescent cul-de-sac. The proposed site layout is shown on the architectural site plan prepared by SBA Architects, Drawing No. 22118 SK02, Rev A, dated February 2022, presented in Appendix B.

Geotechnical investigation was undertaken to provide information on the subsurface conditions and included the drilling of boreholes, excavation of test pits, laboratory testing and engineering assessment. Details of the field work and comments relevant to design and construction practice are given herein.

2. Background

In 2019, DP provided geotechnical consulting and testing services to the Bringelly Road Business Hub (BRBH) project. The project included the construction of a new business park that included five industrial lots and the reconstruction of a former section of Bringelly Road that had been realigned as part of the Bringelly Road duplication project to form the current Skyline Crescent. The construction of Skyline Crescent occurred during 2019 and was completed by early 2020. The four industrial lots to the north of the new road were developed throughout 2020 and 2021. The remaining lot at the south-western end of the business park was used as a site compound. The lot remains undeveloped and is the current site of interest for this investigation.

In June 2019, as part of the BRBH project, limited and preliminary investigations were conducted by DP within 5 Skyline Crescent to determine the subsurface conditions affecting the site. The investigation included the excavation of nine test pits to the rear (southern side) of the site sheds, which encountered varying depths of uncontrolled fill overlying natural clay. The results of the 2019 investigation have been included herein.

3. Site Information

3.1 Site Details

Site Address	5 Skyline Crescent, Horningsea Park
Legal Description	Lot 1, Deposited Plan 1266533
Area	Approximately 12,800 m^2
Zoning	WSP - SEPP Western Parkland City
Local Council Area	Liverpool City Council
Current Use	Vacant
Surrounding Uses	North – Industrial East – Vacant & Bringelly Road South – Infrastructure, Bringelly Rd & Glenfield to Leppington Rail Line West – Rural Residential

Figure 1: Site Location

3.2 Site Description

A site walkover was undertaken by a geotechnical engineer on 7 March 2022. The site is an irregularly shaped area covering approximately 12,800 m^2 and is bounded to the north and east by Skyline Crescent, to the south by Bringelly Road and to the west by Stuart Road. Access onto the site is through a gate off the western end of the Skyline Crescent cul-de-sac.

The site is currently vacant. It previously formed part of a rural site and was used as a market garden, then as a stockpile site during the Bringelly Road duplication project, and more recently as a site compound during construction of the BRBH. There is evidence of fill on the site, as well as a surface layer of recycled concrete gravel.

There is also evidence of prior cutting and filling on the site. The land immediately inside the southern and western boundaries has been graded mostly in cut to form a smooth batter that has been mulched and landscaped. The batter falls towards the centre of the site at a typical grade of 6H:1V (approximately 9 degrees) from reduced levels of RL 92 to RL 84, relative to Australian height datum (AHD). The central and northern parts of the site are flatter and fall gently to the north from RL 84 to RL 82.5 to the crest of the roadside batter formed in fill above Skyline Crescent. The Skyline Crescent cul-de-sac pavement is approximately 2 m lower at RL 80.5. Regionally, the site lies on a north-east facing slope near the top of a crest line that is co-aligned with Bringelly Road.

The property is fenced on all sides. A sign has been erected on the southern batter advertising the adjoining Bunnings store and a temporary on-site detention basin is present in the north-eastern corner of the site. The ground surface has a sparse grass cover. A large diameter high pressure gas main cuts through the southern part of the site and is reported to lie between 1 m and 2 m below the lower part of the southern batter.

A review of aerial photographs dating back to 2000, available through the metromap.com.au website, indicates a small, relatively isolated area of greener vegetation is present near the centre of the site in almost all images. The relatively lush vegetation at this location may indicate the presence of a minor, perched groundwater spring.

4. Review of Published Data

4.1 Geology

Reference to the Penrith 1:100 000 Series Geological Sheet indicates that the site is underlain by Bringelly Shale from the Wianamatta Group formation, which typically comprises shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff.

4.2 Soil Landscape

Reference to the Penrith 1:100 000 Series Soils Landscape Sheet indicates that the site is underlain by soils of the erosional Luddenham group. This soil landscape is commonly associated with low to rolling hills overlying the Wianamatta Group shales with local relief of 50 m to 80 m and surface slopes of

between 5% and 20%. Soil types typically include shallow dark podzolic or massive earthy clays on crests, moderately deep red-brown podzolic soils on upper slopes, and moderately deep yellow podzolic soils on lower slopes and along drainage lines. The soils are typically highly erodible, of low permeability, high plasticity and moderate reactivity.

4.3 Acid Sulphate Soils

Reference to the 1:25 000 Acid Sulphate Soils (ASS) Risk map indicates that the site is within an area of no known occurrence of ASS.

4.4 Salinity

The NSW Salinity Potential map for Western Sydney indicates a moderate salinity potential category is relevant for the site and its immediate surrounds.

4.5 Hydrogeology

A search (Water NSW) of nearby groundwater bores within the vicinity did not identify any registered groundwater bores within 1 km of the site. Reference to the Sydney 2 m contour intervals map and site contours indicated on the architectural site plan, indicates that surface water is expected to partly flow across the surface and partly infiltrate into the near-surface soils, collect in the existing onsite detention basin and sheet towards Skyline Crescent. There are no creek receptors within the vicinity of the site.

5. Field Investigation

5.1 Field Work Methods

The field work for the geotechnical investigation was conducted over three days on 7, 10 and 11 March 2022, and included:

- Walkover inspection by a geotechnical engineer.
- Drilling of two boreholes (BH2A and BH3A) using a truck mounted drill rig fitted with solid flight augers and a tungsten carbide (TC) bit. The boreholes were positioned within the southern part of the site at the toe of an existing batter and near to where retaining walls are proposed to heights of up to 8 m. The boreholes were initially drilled to the top of rock (approx.) at depths of between 3 m and 3.5 m to identify the subsurface conditions. Both boreholes were then extended using NMLC diamond core methods to depths of between 8.5 m and 6.6 m, respectively.
- Drilling of a third borehole (BH4) using a bobcat mounted drill rig fitted with solid flight augers and a tungsten carbide (TC) bit. The borehole was positioned within the northern part of the site where the existing fill is deeper. The borehole was drilled to the top of rock (approx.) at a depth of 7 m to identify the subsurface conditions.

- Standard penetration tests (SPT) carried out at regular depth intervals during auger drilling of all three boreholes to assess in situ strength and subsoil consistency.
- Excavation of nine test pits (TP1 to TP7, TP10 and TP11, which replaced a proposed BH1) using a 9.5 tonne excavator fitted with a 900 mm wide toothed bucket. The test pits were excavated to depths of between 1 m and 4.5 m to identify the upper subsoil profiles and to allow more detailed inspection of the existing filling.
- Dynamic cone penetrometer (DCP) testing within each of the test pits to a depth of 1.2 m to assess the in situ consistency of the near-surface soils.
- Sampling of soils to assist with logging and to provide specimens for laboratory testing of soil plasticity, aggressivity, salinity and California bearing ratio (CBR) tests.

The ground surface levels at the test locations were measured relative to AHD using a differential global positioning system (dGPS) receiver, which is generally accurate to within ±0.1 m. Coordinates for each borehole and test pit are reported with reference to Map Grid of Australia MGA94, Zone 56. Coordinates and ground surface levels are recorded on the borehole and test pit log descriptions included in Appendix C. The borehole and test pit locations are shown on Drawing 1, in Appendix B.

5.2 Field Work Results

The subsurface conditions encountered in the geotechnical boreholes and test pits are given in the borehole and test pit log descriptions in Appendix C, together with notes defining classification methods and descriptive terms.

A summary of the typical sequence of subsurface conditions encountered at site is presented below:

Fill:	Orange, red, brown and grey gravelly clay fill, estimated low to medium plasticity, fine to coarse siltstone and sandstone gravels and cobbles, tree and fibrous root inclusions. Foreign materials included traces of brick, tile, plastic, steel (star pickets), asphalt, and boulder-sized concrete pieces. Topsoil materials were noted at the surface of TP6 and TP11 and at the base of the fill in TP2, TP3 and TP10. Recycled concrete gravels are also present at the site's surface. The fill was encountered to depths of between 0.3 m and 6 m at all test locations except at TP6 which was in the deepest area of fill located on the northern side of the site. Generally, the fill was poorly to moderately compacted, of estimated low to medium plasticity and mostly moist. Wet fill was observed in TP3, TP5 and TP7.
Natural (Residual) Clay:	Predominantly stiff to hard, with some firm layers, orange-brown, red-brown, and grey-brown clay and gravelly clay of medium and high plasticity with fine to coarse siltstone and ironstone gravel at all test locations except TP2 and TP4. Natural clays were generally dry to moist and extended to depths of between 1.6 m and 7 m, subject to the overlying fill thickness. Wet clay was encountered in TP10.
Rock:	Very low to medium strength siltstone with some high strength bands, highly to moderately weathered, orange-red-brown and grey, fractured to slightly fractured. Encountered at all test locations except TP2 to TP5 and TP7; over

Low to medium strength interlaminated siltstone and sandstone with some high strength bands, highly to moderately weathered, dark grey, slightly fractured to unbroken. Encountered in the deeper boreholes BH2A and BH3A from depths of 4.2 m and 4.6 m, respectively.

Bedding inclination was generally between 0 and 10 degrees. Defects in both rock profiles included inclined joints at 30 to 90 degrees (mostly 60 to 90 degrees), clay seams of between 3 mm and 40 mm thick, as well as decomposed seams and crushed zones of between 10 mm and 110 mm thick.

Groundwater was not identified in the boreholes during auger drilling, after which the necessary introduction of water into the boreholes to facilitate rock core drilling precluded any further groundwater observations. Perched groundwater seepage was observed during test pitting at TP3 and TP5 (1.9 m depth), TP7 (1.2 m depth) and TP10 (1 m depth) as probable trapped water within localised areas of fill with a higher void content (i.e. poorly compacted fill containing boulders) but also near the top of the natural clay. Seepage may also be associated with leakage of the on-site detention basin, which is probably unlined. It is also noted that TP7 and TP10 lie close to a possible perched groundwater spring, as indicated in historical aerial photographs.

The investigation followed a period of significant, prolonged heavy rainfall. Observations made whilst excavating TP7 and TP10 indicated that seepage flows were generally highest near the interface of the fill and natural clay. Long-term measurement of groundwater levels was beyond the scope of the investigation.

6. Laboratory Testing

Soil samples were collected from selected boreholes and test pits during the field investigation. Representative samples of soil were subjected to laboratory Atterberg limits tests in accordance with AS1289.3.1.2, AS1289.3.2.1 and AS1289.3.3.1, and CBR tests in accordance with AS1289.6.1.1. The test results are presented in Appendix D and are summarised in Table 1.

Table 1: Summary of Laboratory Atterberg Limits and CBR Test Results

TP / BH No.	Depth (m)	Soil Description	LL (%)	PL (%)	PI (%)	CBR (%)	Swell (%)
TP1	1.0 – 1.5	Clay	56	21	35	5	2.0
TP3	0.5 – 1.0	Gravelly Clay Fill	-	-	-	4.0	1.0
TP4	1.0 – 1.5	Gravelly Clay Fill	-	-	-	7	1.0
BH3A	2.5 – 2.95	Clay	55	21	34	-	-

Where: LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index CBR = California bearing ratio

In addition, representative samples were subjected to a suite of chemical tests including texture classification, electrical conductivity, pH, chlorides (Cl) and sulphates (SO_4). The test results are presented in Appendix D and are summarised in Table 2.

Table 2: Summary of Laboratory Chemical Test Results

Sample ID	Depth (m)	$EC_{1:5}$ (dS/m)	Texture Class	ECe (dS/m)	pHw (1:5)	Cl (mg/kg)	SO_4 (mg/kg)	Comments	
								Salinity	Acidity
TP1	0.0 – 0.1	0.07	HC	< 2	8.5	< 10	< 10	NS	St.Alk
TP1	0.4 – 0.5	0.12	MC	< 2	8.7	63	27	NS	St.Alk
TP1	0.9 – 1.0	0.12	HC	< 2	6.7	58	< 10	NS	Neutral
TP1	1.9 – 2.0	0.39	HC	2.3	5.3	210	160	SS	St.Ac
BH2A	0.0 – 0.1	0.22	LMC	< 2	8.9	57	53	NS	St.Alk
BH2A	0.5 – 0.6	0.25	LMC	2.0	9.0	69	62	SS	St.Alk
BH2A	1.0 – 1.1	0.30	MC	2.1	9.0	67	59	SS	St.Alk
BH2A	2.0 – 2.1	0.08	HC	< 2	7.8	34	10	NS	Mi.Alk
TP6	0.9 – 1.0	0.12	-	-	5.8	100	63	-	M.Ac
TP10	1.9 – 2.0	0.11	-	-	7.6	56	< 10	-	Mi.Alk

Where:

$EC_{1:5}$	=	*Electrical Conductivity*	*NS*	=	*Non-saline*
EC_e	=	*Electrical Conductivity corrected for texture*	*SS*	=	*Slightly Saline*
pHw	=	*pH in water*	*St.Ac*	=	*Strongly Acidic*
Cl	=	*Chloride*	*M.Ac*	=	*Moderately Acidic*
SO_4	=	*Sulphate*	*Mi.Alk*	=	*Mildly Alkaline*
dS/m	=	*Deci-Siemens per Metre*	*St.Alk*	=	*Strongly Alkaline*
LMC	=	*Light Medium Clay*	*MC*	=	*Medium Clay*
HC	=	*Heavy Clay*			

7. Proposed Development

The proposed development includes the construction of a new warehouse covering approximately 4,500 m^2, including associated offices, loading docks, car parking and truck access pavements across a total site area of approximately 12,800 m^2. The warehouse will occupy the central part of the site with truck pavements and a loading dock on the northern side, and car parking along the western side. An on-site detention tank is proposed for the north-eastern corner of the site. New site entry pavements will connect with southern side of the Skyline Crescent cul-de-sac. The proposed site layout is shown on the architectural site plan prepared by SBA Architects, Drawing No. 22118 SK02, Rev A, dated February 2022, presented in Appendix B.

The proposed finished floor level for the warehouse is RL 81 (AHD), which requires a bulk earthworks level (BEL) of approximately RL 80.6 on which floor slabs and pavements will be constructed. To achieve the BEL, the site requires excavation to depths ranging between 2 m and 3 m throughout the flatter central and northern areas, increasing within the southern and western batters to 7.5 m at the south-western corner of the building. Design drawings indicate that cuts will be supported by terraced retaining walls set back off the boundary by a few metres. Retaining walls will also extend along the southern side of the building and will also provide support to the existing gas main during construction. The car parking pavements will be higher than the warehouse floor slab at the south-western part of the

site, necessitating the adjoining warehouse wall to act as retaining wall along this part of the building. All other pavement edges will be battered to meet existing ground surface levels.

Footings are likely to include a mixture of pads and piles, subject to rock depths across the site. Floor slabs will be on-grade and independent of building structural loads. External pavements will be of concrete construction. Trenching and the installation of new services will also be required in a range of ground conditions, including controlled fill, natural soils and in situ rock of varying type and strength (i.e. very low to medium, and possibly high strength).

8. Comments

8.1 Geotechnical Model

Based on the results of the field investigation, it is apparent that southern, eastern and western edges of the site contain mostly natural soils overlying in situ siltstone bedrock, with some shallow fill present in the form of landscaped and mulched batters, and minor site regrading.

The flatter, central and northern parts of the site contain uncontrolled fill in progressively increasing thicknesses towards the north, over natural clay and siltstone bedrock. Fill thicknesses in this area range from approximately 1.5 m to 6 m. The fill is somewhat consistent and predominantly comprises gravelly clay that appears, in places, to have been placed and compacted in near-horizontal layers. Elsewhere, layering is less evident and material uniformity decreases. Unsuitable inclusions and trapped groundwater are also present in areas of poorly compacted fill.

Given the need for between 2 m and 7 m of excavation across the site, a significant portion of the uncontrolled fill will be excavated to achieve design BEL. With reference to the borehole and test pits logs, it is estimated that the northern third (a crude approximation) of the site will expose fill at BEL, and that the remaining depth of fill below BEL will vary between approximately 0 m and 3.6 m. This fill will require reworking to form an engineered fill. Reworking will need to include complete stripping, sorting and either off-site disposal (i.e. foreign materials and unsuitable soil) or reuse (i.e. suitable soil) within the general fill volume. The approximate volume of fill to be reworked is in the order of 6,000 m^3 to 9,000 m^3 (subject to verification by survey), which will be reduced slightly by the volume of excavation required for the on-site detention tank.

Laboratory testing on samples of the natural clays on the site confirms its high plasticity and highly reactive nature. The natural clay is typically between 0.8 m and 1.5 m thick and mostly in a stiff to hard condition. Laboratory tests have also indicated relatively low CBR values, further confirming the relatively plastic nature of the clay. The natural clay is likely to be susceptible to shrink and swell ground surface movements and will pose poor trafficability during construction if left exposed. The clay is also likely to be highly erodible.

The underlying siltstone bedrock is initially of very low strength, although this increases to low strength within about 0.6 m of the rock surface, and again to medium strength within about 1 m to 1.5 m of the rock surface. The rock is initially highly fractured, then is typically fractured to slightly fractured below about 1.5 m from the top of rock, however, the degree of fracturing varies. Rock excavation will be required along the southern and western edges of the site to reach BEL but it is unlikely to be exposed throughout the flatter, central and northern parts of the site, except in trench excavations, or similar.

A summary of the depths to the top of each soil and rock profile, including intermediate rock classifications (as per Pells et. al., 1998) are presented in Table 3.

Table 3: Summary of Geotechnical Model

Unit	Material	Depth, m Reduced Level (m AHD) To Top of Each Unit											
		Boreholes			Test Pits								
		2A	3A	4	1	2	3	4	5	6	7	10	11
1	Existing Fill	0.0 83.8	0.0 (83.3)	0.0 (83.0)	0.0 (83.0)	0.0 (82.6)	0.0 (82.6)	0.0 (83.0)	0.0 (83.1)	-	0.0 (83.3)	0.0 (83.6)	0.0 (88.8)
2	Natural Clay	1.7 (82.1)	1.5 (81.8)	6.0 (77.0)	0.8 (82.2)	-	4.3 (78.3)	-	3.6 (79.5)	0.0 (84.7)	1.9 (81.4)	0.8 (82.8)	0.3 (88.5)
3	VL (Class V) Rock	3.0 (80.8)	3.0 (80.3)	7.0 (76.0)	2.3 (80.7)	-	-	-	-	0.8 (83.9)	-	1.6 (82.0)	1.0 (87.8)
4	VL-M (Class IV) Rock	3.6 (80.2)	3.6 (79.7)	-	-	-	-	-	-	-	-	2.2 (81.4)	-
5	M (Class III) Rock	4.3 (79.5)	4.2 (79.1)	-	-	-	-	-	-	-	-	-	-
6	M-H (Class II) Rock[1]	7.4 (76.4)	-	-	-	-	-	-	-	-	-	-	-

Notes: VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength, - = Not Encountered or Not Observed due to discontinuation of borehole / test pit

[1] Further investigation is required to confirm the presence of Class II rock.

Construction on or within the underlying residual clays and shale, siltstone and sandstone bedrock should be relatively straight-forward. The presence of isolated occurrences of groundwater (i.e. trapped within existing fill, or existing on-site detention basin) may pose some difficulty for excavations below this depth, although such seepage is expected to be appropriately managed through normal catch drain methods. Similarly, near-surface groundwater, including the removal of waters from the existing basin, may pose trafficability and material management issues if not properly managed during the bulk earthworks.

Further considerations for site earthworks will need to include the management of soil aggressivity, with respect to on-grade and buried structures (e.g. slabs, pavements, footings and services – refer below).

8.2 Site Excavation

8.2.1 Excavation Conditions

Excavation will be required in uncontrolled fill of variable compaction, natural stiff to hard clay and in situ siltstone bedrock of very low strength through to medium and possibly high strength. Initially, excavation will include stripping of the uncontrolled fill to BEL and then further excavation of uncontrolled fill within the rework area below BEL. Additional excavation will be required in natural clays around the southern, part eastern and western edges of the site, which will then be followed by excavation in mostly very low to low strength rock. Deeper excavations within the existing batters along the southern and westerns sides of the site will encounter medium and possibly high strength rock. Further detailed excavations for footings and service trenches will also be required and these are likely to encounter the full range of soil and rock types.

Excavation of the soil layers (natural or filled) should be readily achieved using conventional earthmoving equipment, such as tracked excavators and scrapers (as appropriate). Subject to the condition of the site at the time of excavation, some trafficability issues are likely to be experienced when stripping or excavating within the vicinity of existing trapped groundwater within the fill and the upper part of the natural clay. Reference should be made to the borehole logs in Appendix C for the initial targeting of seepage affected areas of the site. Further, trafficability may also be problematic when dewatering and desilting the existing basin. For excavation in rock, it is likely that ripping and/or hydraulic rock hammering will be required when excavation intersects rock of medium and high strength.

8.2.2 Disposal of Excavated Material

It should be noted that any off-site disposal of spoil will generally require assessment for re-use or classification in accordance with current *Waste Classification Guidelines* (NSW EPA 2014). As excavation spoil would most likely come from the existing filling layers comprising building rubble, VENM classifications are unlikely unless the spoil is free of foreign materials and existing filling.

8.2.3 Vibration

Noise and vibration will be caused by excavation work in rock, the effects of which can be damaging to adjoining structures and in-ground services. The site essentially vacant with the only structure being the existing advertising sign. This sign is supported on piles presumably socketed into the underlying rock, is estimated to be 10 m to 15 m away from the rock excavation area and is therefore unlikely to be

affected by excavation induced vibrations. As for buried services, an existing 560 mm diameter high pressure (3,500 kPa) steel gas main crosses the southern part of the site and is estimated to be within 5 m of proposed building line. Although most of the rock excavation will be within very low and low strength rock, some excavation in medium strength rock (and possible high strength rock bands) is anticipated within offsets of between 5 m and 10 m from the centreline of the main.

Precautions will be required when excavating close to the gas main. The level of acceptable vibration is dependent on various factors including the type of pipe, its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the pipe and the vibration transmitting medium.

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s peak particle velocity (PPVi). This is generally much lower than the vibration levels required to cause structural damage to buildings and services. The Australian Standard AS2670.2-1990 *Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)* indicates an acceptable day time limit of 8 mm/s PPVi for human comfort. This limit can generally be increased for substantial steel pipes in good condition.

Based on the experience of DP and with reference to AS2670, it is suggested that a maximum PPVi of 20 mm/s (applicable at the top of the pipe) be adopted. This limit must be agreed with and approved by the asset owner (Jemena), or otherwise amended to their satisfaction.

Given the consequences associated with damaging the gas main, all excavation work performed in rock must be accompanied by vibration monitoring that includes direct measurement of excavation induced vibrations at the pipe and on the closest side to the excavation. We recommend a minimum of two to three monitoring points along the main within the length directly adjacent to the excavation area (approx. 120 m). The selection of excavation plant should be based on a vibration trial to confirm that the size of the plant and excavation methods are appropriate.

8.3 Site Preparation

As outlined in Section 8.1, the proposed finished floor level for the new warehouse is set at RL 81, which requires a BEL of RL 80.6. Excavations are therefore required to approximate depths of between 2 m and 7 m with an additional 6,000 m^3 to 9,000 m^3 (or thereabouts) of rework to be undertaken on the remaining existing fill within the central northern third of the site. In addition, the upper 0.3 m of site comprising natural soil and rock will require ripping, moisture conditioning and recompaction to form a uniform building pad and pavement subgrade surface.

It is currently anticipated that proposed structures and pavements within the site will probably be supported by shallow spread footings founding on engineered fill (up to 3.6 m thick), shallow reworked or natural clay of a typical stiff consistency and weathered bedrock within cut areas. The preferred bearing stratum will depend on actual column loads, which have not been advised at this stage.

Adopting the above approach, DP proposes the following site preparation measures:

- Remove all existing vegetation and root affected soils, topsoils, mulch and existing fill from the development footprint and stockpile for reuse or remove from site as per the following requirements.

- Proof roll the exposed surface using a minimum 10 tonne smooth drum roller in non-vibration mode. The surface should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical engineer to detect any soft or heaving areas. Remove any additional unsuitable soil identified during proof rolling.
- Compact the exposed base of any rework area to a minimum dry density ratio of 98%, relative to Standard compaction, maintaining the moisture content of the filling within 2% of Standard OMC.
- Place suitable site materials, or suitable imported filling, within the rework depth in 300 mm maximum thickness layers and compact to a minimum dry density ratio of 98%, relative to Standard compaction, maintaining the moisture content of the filling within 2% of Standard OMC.
- Place sufficient additional layers of filling to achieve design subgrade/foundation level and compact as outlined above. Ensure any reintroduction of non-organic topsoil into the fill is restricted to a maximum blend frequency of one part topsoil to four parts other fill sourced from onsite cuts in natural ground.
- Rip and recompact, or over excavate and replace all exposed natural clay and rock surfaces created by site excavation to a depth of at least 0.3 m to provide a uniform surface that can be reliably trimmed to accommodate design grades and cross falls at the subgrade surface below proposed pavements and floor slabs. This will alleviate the possibility of rainfall seepage being collected in isolated low points within an otherwise uneven rock surface at subgrade level, which could lead to pavement and floor slab deterioration and cracking along pavement joints.

In addition, it is recommended that consideration is given to placing a 0.3 m thick capping of granular fill across the completed site surface to reduce the effects of soil plasticity, site reactivity and low CBR values on floor slab, pavement and footing design. Materials for the capping layer would need to be imported to the site and would preferably include ripped or crushed sandstone, or similar.

Geotechnical inspection and testing of the filling should be carried out in accordance with a Level 1 standard, as defined in AS3798-2007 Guidelines for Earthworks for Commercial and Residential Developments. Site stripping should be assessed by a geotechnical engineer, who should also advise on any specific requirements for material reuse, particularly in relation to sediments removed from the on-site detention basin and reuse of existing fill materials.

The moderate to highly plastic nature of the existing fill and residual clays are such that very poor trafficability conditions should be expected when this material is exposed to wet weather. The use of a minimum 150 mm thick layer of strong, durable crushed rock fill or recycled concrete as a protective running surface may allow all-weather access to the site following wet weather.

8.4 Batter Slopes and Retaining Walls

It is likely that sufficient room is available for the construction of temporary batters along the northern, eastern and western sides of the site, however, the presence of the existing gas main will probably preclude the construction of batters on the southern side. Accordingly, retaining walls likely precede site excavations in this part of the site. Where possible though, during bulk excavation and earthworks on the site, it is recommended that temporary batters of up to 4 m in height do not exceed the grades outlined in Table 4.

Table 4: Recommended Maximum Batter Grades for Exposed Material (up to 4 m high)

Units	Exposed Material	Maximum Temporary Batter Grade (H:V)	Maximum Permanent Batter Grade (H:V)
1	Existing Fill	1.5:1	Not Applicable
2	Engineered Fill & Natural Clay	1:1	2:1
3	VL (Class V) Rock	1:1	2:1
4	VL-M (Class IV) Rock	0.75:1*	1:1*
5	M (Class III) Rock	0.5:1*	1:1*
6	M-H (Class II) Rock[1]	0.5:1*	0.25:1*

*Note: * Subject to geotechnical inspection during construction*

For permanent batters up to 4 m high, a flatter grade of 3H:1V (18 degrees) should be adopted if maintenance access is required (i.e. mowing, or similar). Permanent batters of more than 4 m high are not anticipated for this development.

Retaining walls will reportedly include terraced reinforced blockwork walls along the western side of the warehouse with a contiguous pile wall proposed along the southern side. Retaining walls may be designed on the basis of the parameters outlined in Table 5.

Table 5: Recommended Design Parameters for Retaining Walls

Unit	Material	Unit Weight (kN/m3)	Earth Pressure Coefficient		Effective Cohesion c' (kPa)	Effective Friction Angle (Degrees)
			Active (K_a)	At Rest (K_o)		
1	Existing Fill	20	0.4	0.6	0	20
2	Engineered Fill & Natural Clay	20	0.3	0.5	0	25
3	VL (Class V) Rock	20	0.3	0.5	0	25
4	VL-M (Class IV) Rock	22	0.2	0.25	10	25
5	M (Class III) Rock	24	0.2	0.25	15	30
6	M-H (Class II) Rock[1]	24	0.2	0.25	20	30

Notes: VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength

In addition, a coefficient of passive earth pressure (K_p) equal to 2.5 may be assumed within very stiff to hard clay and well compacted filling, to which a factor of safety must be applied in recognition of the fact that large movements are required to mobilise the full passive resistance. Ultimate passive pressures for rock may be taken as equal to 400 kPa in Unit 4 material and 2000 kPa in Units 5 and 6 materials.

The above parameters do not include any allowance for hydrostatic pressure due to groundwater behind retaining walls, which should be included in the design unless adequate drainage is provided to prevent the build-up of hydrostatic pressures.

The design of batter slopes and retaining walls should account for surcharge loads, including storage of construction materials, adjacent pavements, access roads, buildings or similar. Design should also consider the effects of plant operating above the excavation and/or retaining wall during construction.

8.5 Footings

8.5.1 Bearing Pressures

It is anticipated that footings for the new warehouse will most likely comprise shallow pads founding within the upper 1 m of the new controlled filling (central northern third of the site), natural clays (central part of the site) and weathered bedrock (mostly along the southern and western edges of the site). Alternatively, bored piles founding within the upper 1 m to 2 m of bedrock could be adopted, particularly in areas of deep filling, subject to column loads. The parameters listed in Table 6 are suggested for footing design.

Table 6: Suggested Footing Design Parameters

Unit	Material	End Bearing (kPa)		Shaft Adhesion (kPa)	
		Allowable	Ultimate	Allowable	Ultimate
1	Existing Fill	0	0	0	0
2	Engineered Fill & Natural Clay	150	500	15	25
3	VL (Class V) Rock	200	700	20	40
4	VL-M (Class IV) Rock	1000	3,000	100	150
5	M (Class III) Rock	2500	10,000	150	350
6	M-H (Class II) Rock[1]	3500	20,000	350	600

Notes: The values listed in Table 6 are subject to confirmation during construction.
Values for Unit 4 assume a minimum 0.6 m penetration of the footing into rock.

To confirm the appropriateness of the adopted design footing parameters, it is recommended that all footing excavations are subjected to geotechnical inspection and dynamic cone penetrometer testing (DCP, where applicable) during construction to verify that the listed bearing pressures are available.

Shallow footings founding near excavations (lift wells, pits, service trenches, or similar) must have all loads transferred to below an influence line inclined upwards at 45 degrees commencing from the lowest and closest side of the excavation or trench base. Pad footings can be deepened to accommodate this load transfer or alternatively pile footings may be used.
Local variations in rock strength and depth may occur across the site. All pile or footing excavations in weathered rock should be inspected by a geotechnical engineer or engineering geologist and approved prior to concreting to confirm reduced pressures are not warranted due to extensively weathered or jointed zones.

8.5.2 Settlements

Footings designed in accordance with the parameters listed in Table 6 may undergo elastic settlements in the order of 1% of the footing width. Differential settlements are typically about half of this value.

8.5.3 Site Classification

Although the proposed development will be of an industrial warehouse nature, it is important to note that the results of the Atterberg limits and CBR tests have indicated a high susceptibility of the residual clays to undergo shrink and swell movement as a result of changes in ground moisture contents (i.e. seasonal, or otherwise).

Although the site would be classified as Class P due to the presence of uncontrolled fill, based on the test results and provided the existing fill is reworked to form an engineered fill in accordance with the advice presented herein, the plasticity and thus reactivity of the soils at the site are generally considered representative of Class M (southern part of site) to Class H1 (northern part of site) conditions when assessed in accordance with AS2870-2011. Considering the variations in total soil thickness below the site, it is suggested that footing design is based on Class H1, where relevant. Appropriate consideration of soil plasticity and reactivity should be accounted for in the design of all structures and services.

8.6 Salinity

The NSW Salinity Potential map for Western Sydney indicates a moderate salinity potential category is relevant for the site and its immediate surrounds. The test results obtained for samples subjected to salinity analysis indicate a predominant non-saline to slightly saline class, suggesting that the mapping is generally an overestimation of the salinity conditions.

Soil salinity is assessed with respect to electrical conductivity after conversion of the result to EC_e (electrical conductivity of a saturated extract) by multiplication with a factor dependent on soil texture. Once converted, the EC_e value is compared to the guideline ranges listed within Table 8.

Table 8: Soil Salinity Classification

Class	EC_e (dS/m)	Implication
Non-Saline	<2	Salinity effects mostly negligible
Slightly Saline	2 – 4	Yields of sensitive crops effected
Moderately Saline	4 – 8	Yields of many crops effected
Very Saline	8 – 16	Only tolerant crops yield satisfactorily
Highly Saline	>16	Only a few very tolerant crops yield satisfactorily

During site assessment, samples from the full depth of the soil profile were collected. Eight samples underwent chemical testing in an attempt to 'ground truth' the relevance of the mapped conditions. The results of the testing (Section 6, Table 2) show that non-saline and slightly saline soil conditions are present throughout.

Eight samples equate to approximately one laboratory analyses sample for each 1,600 m^2 of land proposed for development. Two detail soil profiles (i.e. test pits) were used to obtain the eight samples, which equates to one full profile laboratory analysis per 6,400 m^2. This frequency exceeds the minimum testing frequency listed in the *Site Investigations for Urban Salinity* guideline booklet (commonly adopted and published by the Department of Land and Water Conservation [DLWC], 2002). The results, therefore, are considered to be an appropriate representation of the site. In view of the results obtained, a salinity management plan (SMP) is not required for this development.

8.7 Soil Aggressivity

Provided the samples analysed represent the broader soils present at the site, then the soil conditions can be considered as being mostly non-aggressive to buried concrete and steel elements. However, with reference to the laboratory test results listed in Table 2 (Section 6), one sample from BH2A (1.9 m depth) indicated a pH value (5.3) marginally in the mildly aggressive range for concrete. The laboratory test results were compared to the criteria listed within Australian Standard AS2159 (2009).

8.8 Pavements

Subject to earthworks and the final condition of the soils within the upper 1 m of design subgrade level, natural and filled subgrades at this site can be assigned a preliminary design CBR value of 4%, which is equal to the lowest laboratory test result obtained for the existing fill on the site. This value is considered likely to represent the site following bulk earthworks. To maintain this design value, or any other alternative design CBR value, it will be necessary to prepare the subgrade soils into a well compacted condition that is free of significant adverse long-term or differential settlements and/or deflection under service loading. Verification testing should be undertaken during construction to confirm that the design CBR value has been achieved prior to pavement construction.

The pavement designer should consider the following:

- The loads applied to the various pavements over their design life, including normal road vehicle pavements, commercial in-service truck loads and possibly construction machinery loads.
- The magnitude and frequency of load repetitions of the various vehicles using each pavement.
- The need to provide edge constraints to the pavement, particularly along the crest of batters, immediately behind retaining walls and along the edge of landscaped areas.
- The position and grading of subsurface drainage lines, particularly with reference to pavement edges and internal landscaped openings (where relevant).
- Pavement surface gradients and water flow to drainage lines. One-way cross fall pavements may be beneficial, otherwise regularly spaced and centralised drainage collection pits should be installed.
- The backfilling and compaction of service trenches, particularly below heavily loaded pavements.
- The ability of any filled subgrade to carry the load of the pavement.

In addition, a regular and long-term inspection and maintenance programme of the pavement should be adopted by the operator of the pavement. This maintenance program should be primarily aimed at limiting the amount of moisture infiltrating to the subgrade (e.g. inspecting drainage lines and repairing as required, maintaining construction joints and sealing or repairing cracks as they develop).

8.9 Drainage

Surface and subsoil drainage should be incorporated into the pavement and floor slab designs to prevent the ingress of moisture into the pavement and sub-floor working platform layers and any subsequent weakening of the pavement and subgrade layers.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at 5 Skyline Crescent, Horningsea Park in accordance with DP's proposal (Ref: P213088.00.P.001.Rev0, dated 22 February 20221, including subsequent field work scope revisions) and acceptance received from Daniel Galea dated the same day. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of ESR Australia for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

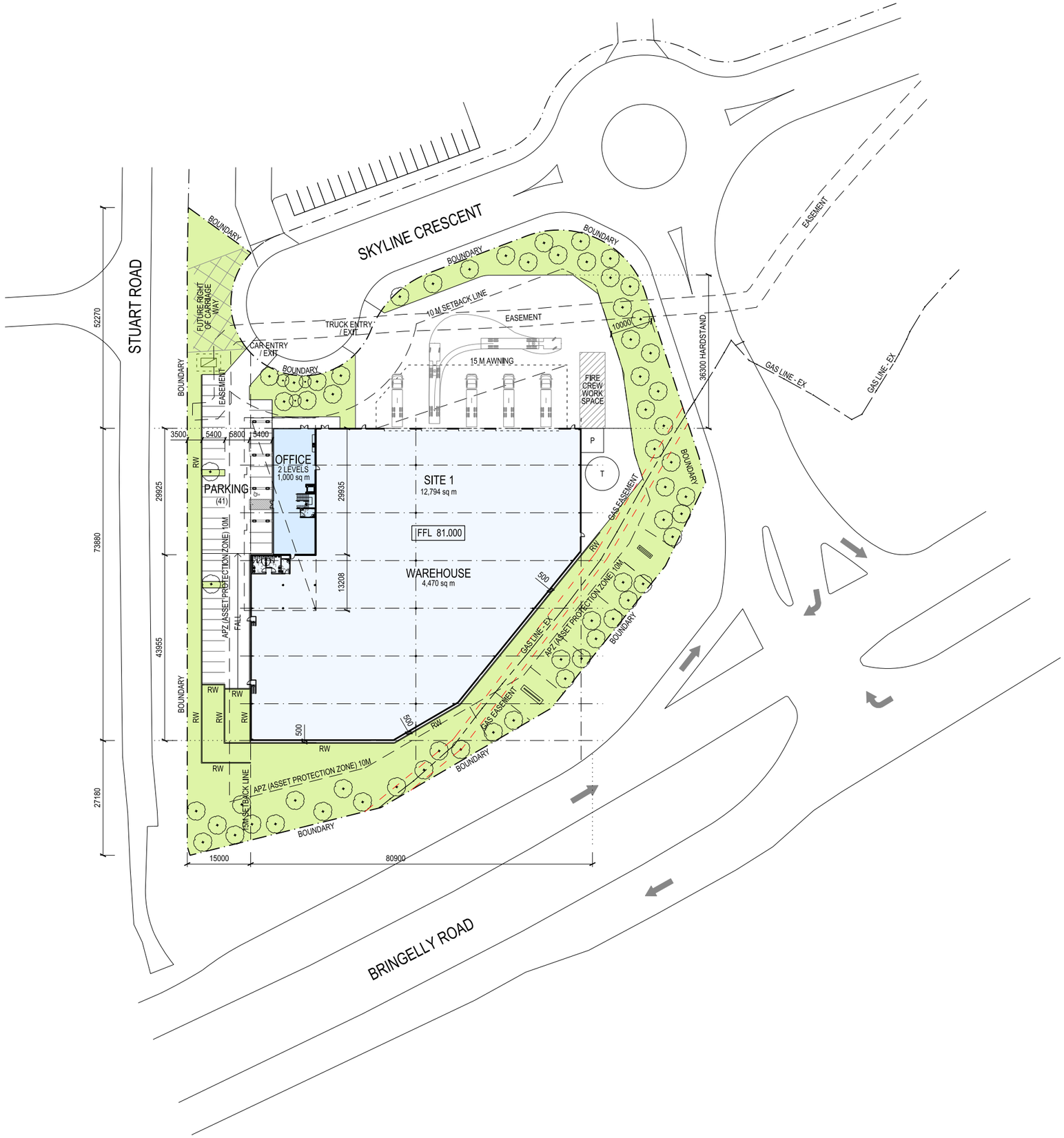
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

Site Inspection

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

Appendix B

Drawings



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ISSUE	REV.	DESCRIPTION	DATE
	A	ISSUED FOR INFORMATION	24.03.2022

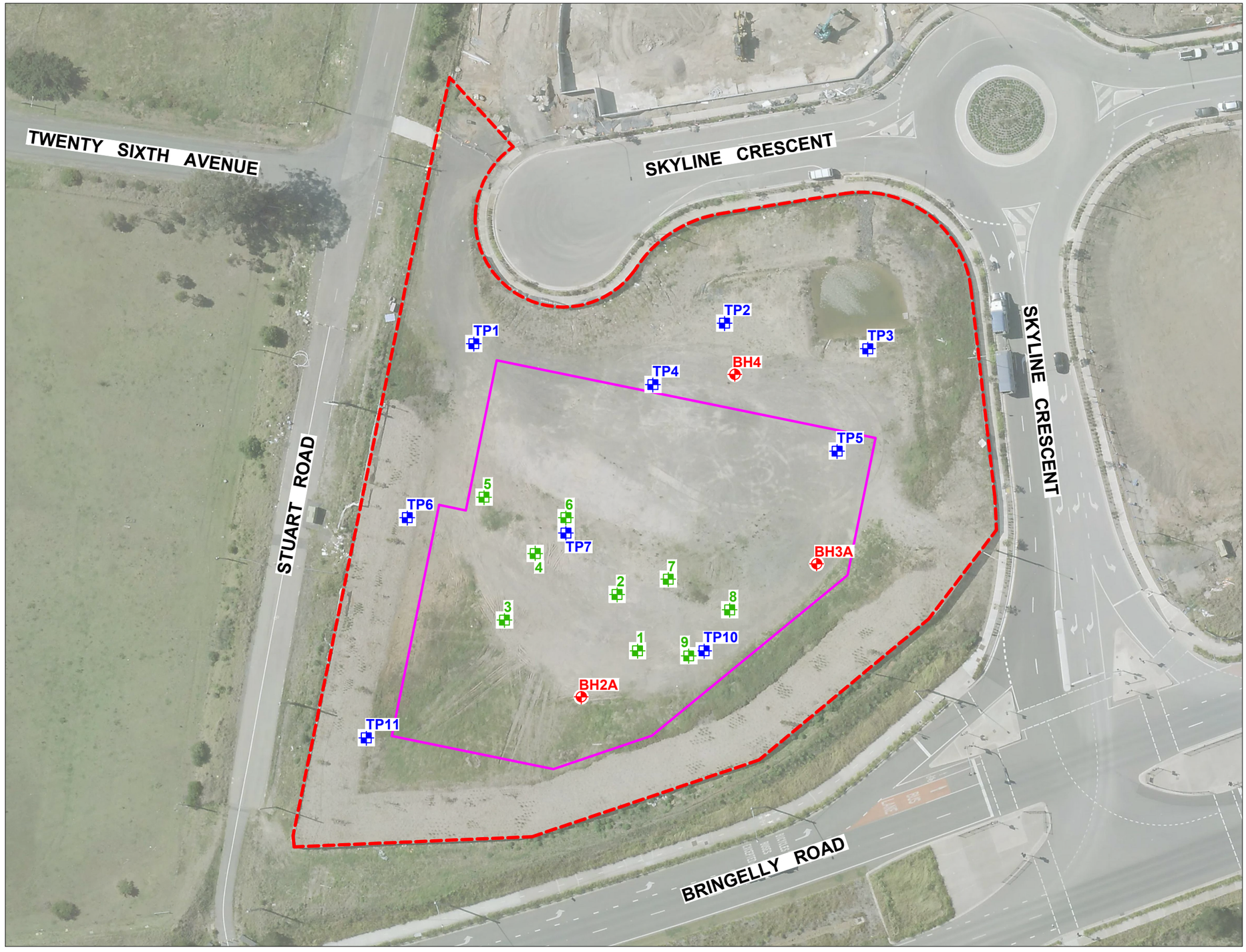
PROPOSED INDUSTRIAL DEVELOPMENT

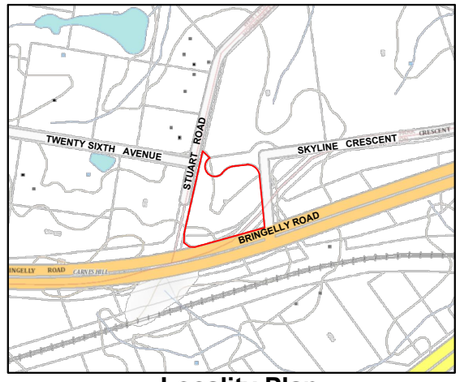
LOT 1 - BRINGELLY ROAD BUSINESS HUB, NSW

NORTH

DRAWING TITLE
SITE PLAN

DATE	SCALE	JOB NO.	DRAWING NO.	
FEB 2022	1:1000 @ A3 1:500 @ A1	22118	SK 02	A





Locality Plan

NOTE:
1: Base image from MetroMap (Dated 27.10.2021)

0 5 10 15 20 30 40 60 80m
1:800 @ A3

LEGEND

- Approximate Site Boundary
- Approximate Proposed Building Outline
- Borehole Location
- Test Pit Location
- Test Pit Location (2019)

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: ESR Australia		TITLE: **Test Location Plan**	PROJECT No: 213088.00
OFFICE: Sydney	DRAWN BY: MG	**Proposed Industrial Development**	DRAWING No: 1
SCALE: 1:800 @ A3	DATE: 30.03.2022	**5 Skyline Crescent, Horningsea Park**	REVISION: 0

Appendix C

Field Work Results

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

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

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

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

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

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

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

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

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	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.
Extremely weathered	XW	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
Highly weathered	HW	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 recognisable. 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.
Moderately weathered	MW	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 recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

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

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

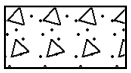
Symbols & Abbreviations

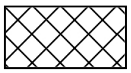
Graphic Symbols for Soil and Rock

General

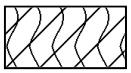

Asphalt

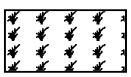

Road base

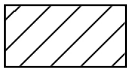

Concrete

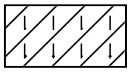

Filling

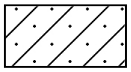
Soils


Topsoil

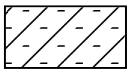

Peat

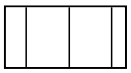

Clay

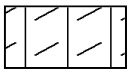

Silty clay

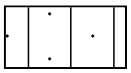

Sandy clay

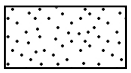

Gravelly clay

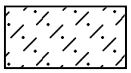

Shaly clay

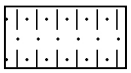

Silt


Clayey silt


Sandy silt

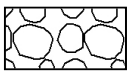

Sand

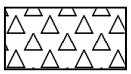

Clayey sand


Silty sand


Gravel

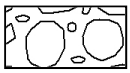

Sandy gravel


Cobbles, boulders

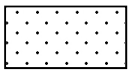

Talus

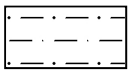
Sedimentary Rocks

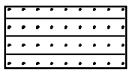

Boulder conglomerate

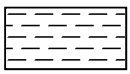

Conglomerate


Conglomeratic sandstone

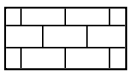

Sandstone


Siltstone

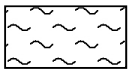

Laminite

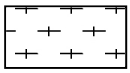

Mudstone, claystone, shale

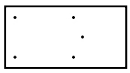

Coal


Limestone

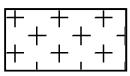
Metamorphic Rocks

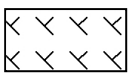

Slate, phyllite, schist

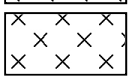

Gneiss

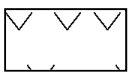

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.8 AHD
EASTING: 299446
NORTHING: 6241140
DIP/AZIMUTH: 90°/--

BORE No: 2A
PROJECT No: 213088.00
DATE: 7/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
83	0	FILL/Gravelly CLAY: low to medium plasticity, brown, with fine to medium sandstone, igneous, terracotta, concrete and tile gravel and fine to medium sand, w>PL							A/E			
	1	Below 0.4m: grey-brown, trace anthropogenics, w~PL							A/E			
									A/E			
									S			5,9,13 N = 22
82	1.7	Below 1.4m: red-brown mottled dark grey, trace fine gravel and rootlets, (possible disturbed residual)										
	2	CLAY CI-CH: medium to high plasticity, orange-brown to red-brown mottled pale grey, trace ironstone gravel, w~PL, firm to stiff, residual						Unless otherwise specified, rock is fractured along rough planar bedding dipping 0°-10° with iron stain and/or clay veneer	A/E			
									A/E*			
81	2.8	Below 2.55m: pale grey mottled red-brown							S			3,6,18 N = 24
	3	CLAY CI: medium plasticity, pale grey mottled red-brown, with very low strength siltstone bands, trace ironstone gravel, hard, rock structure evident (extremely weathered Bringelly Shale)										
	3.65	SILTSTONE: dark grey and pale grey, very low to low strength, highly weathered with extremely weathered bands, highly fractured, Bringelly Shale						3.68-4.20m: B0°-10°(x15), ro, un, cly 2-10mm	C	100	0	
80	4											PL(A) = 0.56
	4.2	SILTSTONE & SANDSTONE: dark grey and red-brown siltstone interlaminated with pale grey, fine to medium grained sandstone, medium strength with medium to high strength iron indurated bands up to 50mm, highly to slightly weathered, fractured to slightly fractured, Bringelly Shale						4.23-4.75m: B0°-10°(x9), ro, un, cly 0-3mm 4.43m: J30°, ro, pl, fe stn 4.44-4.52m: J70°-90°, ro, un, fe stn 4.77-4.95m: J80°-90°, ro, un, fe stn 5.1m: Cs 40mm 5.22-5.55m: B0°-20°(x4), ro, un, fe stn, cly vn 5.57m: Cs 20mm 5.63m: Cz 50mm 5.76m: J70°, ro, pl, fe stn 5.92-6.90m: B0°-10°(x10), ro, un, cly 0-3mm 6.25m: J60°, he, pl, fe stn 6.94m: Ds 110mm 7.09m: Ds 10mm	C	100	10	PL(A) = 0.67
79	5											
78	6											PL(A) = 0.57
77	7											
	7.4	SILTSTONE: dark grey, trace carbonaceous laminations, medium then high strength, fresh, slightly fractured to unbroken, Bringelly Shale						7.14-7.52m: B0°-10°(x9), ro, un, cly 0-3mm 7.17m: Ds 70mm	C	100	100	PL(A) = 0.52
76	8											PL(A) = 2.8
	8.48	Bore discontinued at 8.48m Target depth reached										
75	9											
74												

RIG: Scout 4 **DRILLER:** Ground Test (GM) **LOGGED:** RMM **CASING:** HW to 3.0m, HQ to 3.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 3.0m, NMLC Coring to 8.42m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Field Replicate BD2 taken at 2.5m

SAMPLING & IN SITU TESTING LEGEND

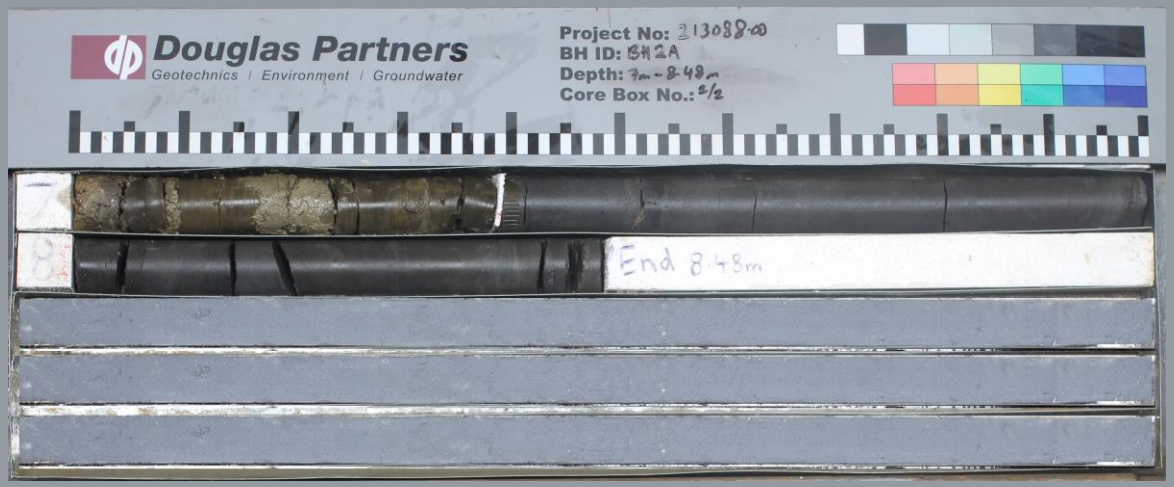
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: 2A PROJECT: HORNINGSEA PARK JANUARY 2022

3 – 7m

BORE: 2A PROJECT: HORNINGSEA PARK JANUARY 2022



7 – 8.48m

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.3 AHD
EASTING: 299492
NORTHING: 6241166
DIP/AZIMUTH: 90°/--

BORE No: 3A
PROJECT No: 213088.00
DATE: 7/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
83	0	FILL/CLAY: low to medium plasticity, brown, with fine to medium sandstone, igneous, terracotta, concrete and tile gravel, and fine to medium sand, w>PL							A/E			
		Below 0.4m: grey-brown, trace anthropogenic (tile, concrete and terracotta)							A/E			
82	1	Below 0.9m: w>PL							A/E*			
									S			3,3,4 N = 7
	1.5	CLAY CI-CH: medium to high plasticity, orange-brown to red-brown mottled pale grey, w~PL, firm to stiff, residual							A/E			
81	2								A/E			
								Unless otherwise specified, rock is fractured along rough planar bedding dipping 0°-10° with iron stain and/or clay veneer				
									S			8,11,23 N = 34
	2.85	CLAY CI: medium plasticity, pale grey mottled red-brown, trace ironstone gravel, hard, rock structure evident, (extremely weathered Bringelly Shale)										
80	3											
	3.5	SILTSTONE: dark grey and red-brown, very low to low strength then low to medium strength, highly weathered then slightly to moderately weathered, highly fractured to fractured, Bringelly Shale						3.81-3.87m: J40°-70°(x3), ro, pl, gravel & cly 10-20mm 3.97m: Ds 40mm 4.04m: J70°, ro, un, fe stn 4.13m: B0°-5°, ro, ir, cln 4.24m: J50°, he, pl/un 4.56m: J45°, he, pl, cly vn 4.61m: J45°, ro, pl, fe stn, cly vn 4.73m: J20°, ro, pl, fe stn, cly vn 5.3m: B0°-5°, ro, ir/un, fe stn 5.47m: J45°, he, pl, fe stn 5.55m: Ds 30mm 5.58-5.90m: J70°-90°, ro, ir, fe stn 5.93m: Cz 80mm 6.05m: J50°, ir, ro, cly vn 6.25-6.35m: B(x2), sm, un, cbs vn				
79	4											PL(A) = 0.44
	4.6	SILTSTONE & SANDSTONE: dark grey and red-brown siltstone interlaminated with pale grey, fine to medium grained sandstone, medium strength with medium to high strength iron indurated bands up to 50mm, slightly to moderately weathered then moderately to highly weathered, fractured to slightly fractured, Bringelly Shale							C	100	52	
78	5											PL(A) = 0.41
	6											
77												PL(A) = 0.67
	6.57	Bore discontinued at 6.57m Target depth reached										
76	7											
75	8											
74	9											

RIG: Scout 4 **DRILLER:** Ground Test (GM) **LOGGED:** RMM **CASING:** HW to 3.5m, HQ to 3.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 3.5m, NMLC Coring to 6.57m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. *Field Replicate BD1 taken at 0.9-1.0m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BORE: 3A **PROJECT: HORNINGSEA PARK** **JANUARY 2022**

3.55 – 6.57m

BOREHOLE LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.0 AHD
EASTING: 299473
NORTHING: 6241203
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 213088.00
DATE: 11/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	VWP Construction Details
83	0	FILL/Gravelly CLAY: medium plasticity, brown-grey and orange-brown, fine to coarse siltstone, ironstone and sandstone gravel and cobbles, w<PL							
82	1								
81	2								
80	3								
79	4								
78	5								
77	6	6.0 CLAY CH: high plasticity, orange-brown and grey, fine siltstone gravel, w<PL, stiff, residual							
76	7	7.0 SILTSTONE: dark grey and brown, highly weathered, Bringelly Shale							
		7.2 Bore discontinued at 7.2m in siltstone.							
75	8								
74	9								

RIG: Bobcat **DRILLER:** Ground Test **LOGGED:** RCB **CASING:** Uncased

TYPE OF BORING: Solid Flight Auger (TC-bit) to 7.2m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Location coordinates are in MGA94 Zone 56. RLs to AHD.

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.0 AHD
EASTING: 299425
NORTHING: 6241209

PIT No: 1
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
83	0.0	FILL/Silty GRAVEL: dark grey, medium, angular to subangular igneous gravel, with asphaltic concrete, cobbles and fine sand, dry, loose		D	0.0				
				E	0.1				
	0.2	FILL/Gravelly CLAY: low to medium plasticity, brown mottled red-brown and orange-grey, fine to medium, angular to subangular siltstone gravel and trace cobbles			0.2				
				D/E	0.4				
					0.5				
	0.8	CLAY CH: high plasticity, orange-brown mottled pale grey, trace root fibres, w<PL, hard, residual			0.9				
82	1			B/D/E	1.0				1
				B					
					1.5				
	1.7	Gravelly CLAY GC: medium plasticity, dark grey mottled orange-brown, fine, angular to subangular siltstone gravel, w<PL, hard, extremely weathered Bringelly Shale			1.9				
81	2			D	2.0				2
	2.3	SILTSTONE: dark grey and orange-brown and red-brown, highly weathered, Bringelly Shale							
	2.5	Pit discontinued at 2.5m Limit of investigation							
80	3								3
79	4								4

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 82.6 AHD
EASTING: 299474
NORTHING: 6241213

PIT No: 2
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
					0.0				5 10 15 20
	0.15	FILL/Sandy GRAVEL: grey, grey-brown and orange-brown, fine sand, fine to medium sandstone, ironstone, siltstone, concrete, tile, brick gravel, loose		D/E	0.1				
		FILL/Gravelly CLAY: low to medium plasticity, brown, orange-brown and pale grey, fine to medium, angular to subangular siltstone, ironstone, sandstone, concrete, asphaltic concrete, brick and tile gravel, with silt, root fibres and siltstone and concrete cobbles, w<PL		B/D/E	0.4 0.5				
82		Below 0.6m: discontinuous band of dark grey ripped siltstone 150mm thick and containing red plastic			0.6				
				B	0.9				
	1			D/E	1.0 1.1				1
81		Between 1.5-2.0m: star picket and concrete boulder sized inclusion							
				D/E	1.9				
	2	Below 2.0m: becoming brown, gravel content reduces to <5%			2.0				2
		At 2.1m: green plastic netting							
80		At 2.5m: wood chips and decomposed roots							
	3	Below 3.0m: increase in pale yellow coarse grained sandstone gravel							3
79				D/E	3.9				
	4				4.0				4
				D/E	4.4				
	4.5	Pit discontinued at 4.5m			4.5				
78		Maximum reach of excavator							

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 82.6 AHD
EASTING: 299502
NORTHING: 6241208

PIT No: 3
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
82	0.0	FILL/Gravelly CLAY: medium plasticity, brown-grey, fine to medium, angular to subangular siltstone, ironstone sandstone gravel, with siltstone cobbles and root fibres, w<PL		D/E	0.0–0.1				
				D/E	0.4–0.5				
				B					
	0.9	FILL/CLAY: high plasticity, orange mottled pale grey and red-brown, with fine, subangular to subrounded sandstone gravel, w~PL		D/E	0.9–1.0				
81	1.1	FILL/Gravelly CLAY: medium plasticity, brown-grey, fine to medium, angular to subangular siltstone, ironstone sandstone gravel, with siltstone cobbles and root fibres, w<PL							
		Below 1.9m: gravel content increases			1.9			▽	
	2	At 2.0m: discontinuous band of ripped siltstone 150mm thick		D/E					
80		At 2.5m: piece of black plastic							
		Below 2.6m: layer of root fibres about 100mm thick, possible old topsoil horizon							
				D/E	2.9–3.0				
79	3								
				D/E	3.9–4.0				
	4								
	4.3	CLAY CH: high plasticity, orange-brown mottled red-brown, with fine, subrounded siltstone gravel, w~PL, firm to stiff, residual		D/E	4.4–4.5				
78	4.5	Pit discontinued at 4.5m Maximum reach of excavator							

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 1.9m

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.0 AHD
EASTING: 299460
NORTHING: 6241201

PIT No: 4
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
83	0.1	FILL/Sandy GRAVEL: grey-brown, fine sand, fine to medium, angular to subrounded sandstone, siltstone, concrete, tile, brick and gravel, with silt and root fibres, loose		D/E	0.0–0.1				
		FILL/Gravelly CLAY: low to medium plasticity, brown and orange-brown, fine to medium, angular to subangular sandstone, siltstone, ironstone, igneous, concrete, tile, brick and asphalt gravel, with silt, root fibres and siltstone cobbles, w<PL		E	0.2–0.3				
		Below 0.5m: gravel content reduces to <5%, trace root fibres		D/E	0.4–0.5				
		Below 0.6m: plastic sheeting		D/E	0.9–1.0				
82	1			B	1.0–1.3				1
				E	1.4–1.5				
				D/E	1.9–2.0				
81	2			E	2.4–2.5				2
				D/E	2.9–3.0				
80	3			D/E	3.9–4.0				3
79	4	At 4.0m: orange PVC conduit		pot HBM					4
	4.5	Pit discontinued at 4.5m Maximum reach of excavator							

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.1 AHD
EASTING: 299496
NORTHING: 6241188

PIT No: 5
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
83	0.2	FILL/Sandy GRAVEL: grey-brown, fine sand, fine to medium, angular to subrounded sandstone, siltstone, concrete, tile, brick and gravel, with silt and root fibres, loose		D/E	0.0–0.1				
		FILL/Gravelly CLAY: low to medium plasticity, grey-brown, fine to medium, angular to subangular siltstone and ironstone gravel, with silt, root fibres and siltstone boulders, w<PL		D/E	0.4–0.5				
82	1			D/E	0.9–1.0				1
	1.9	FILL/Clayey GRAVEL: fine to coarse, angular to subangular siltstone gravel, low to medium plasticity clay, with siltstone cobbles, dense		D/E	1.9–2.0			▽	2
81	2								
	3			D/E	2.9–3.0				3
80	3.6	CLAY CH: high plasticity, pale brown mottled red-brown and pale grey, w<PL, stiff, residual		D/E	3.9–4.0				4
	4								
79	4.0	Pit discontinued at 4.0m Partial test pit collapse due to groundwater ingress							

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 1.9m

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 84.7 AHD
EASTING: 299412
NORTHING: 6241175

PIT No: 6
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
84	0.0	CLAY CH: high plasticity, brown mottled orange-brown, with root fibres and thin layer of mulch on top, w<PL, stiff, residual		D/E	0.0 – 0.1				
	0.3	Gravelly CLAY CI: medium plasticity, pale grey mottled orange-brown, fine to medium, angular siltstone gravel, w<PL, hard, extremely weathered Bringelly Shale		D/E	0.4 – 0.5				
	0.8	SILTSTONE: dark grey and orange-brown, highly weathered, Bringelly Shale		D	0.9				
83	1.0	Pit discontinued at 1.0m Limit of investigation			1.0				
82									
81									
80									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.3 AHD
EASTING: 299443
NORTHING: 6241172

PIT No: 7
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
83	0.1	FILL/Sandy GRAVEL: grey-brown, fine sand, fine to medium, angular to subrounded sandstone, siltstone, concrete, tile, brick and gravel, with silt and root fibres, loose		D/E	0.0–0.1				
		FILL/Gravelly CLAY: medium plasticity, grey-brown, fine to coarse, angular to subangular siltstone and ironstone gravel, with root fibres, concrete boulders (approximately 1m x 0.8m x 0.25m) and siltstone cobbles, w<PL		D/E	0.4–0.5				
	1			B/D/E	0.9–1.0			▽	1
82									
	1.9	Clayey GRAVEL: fine to coarse, angular to subangular siltstone gravel, low to medium plasticity clay, with siltstone cobbles, dense		D/E	1.9–2.0				
81	2								2
				D/E	2.9–3.0				
	3								3
	3.1	Pit discontinued at 3.1m Test pit collpse due to groundwater ingress							
80	4								4
79									

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 1.2m

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 83.6 AHD
EASTING: 299470
NORTHING: 6241149

PIT No: 10
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
83	0.1	FILL/Sandy GRAVEL: grey-brown, fine sand, fine to medium, angular to subrounded sandstone, siltstone, concrete, tile, brick and gravel, with silt and root fibres, loose		D/E	0.0–0.1				
		FILL/Gravelly CLAY: low to medium plasticity, grey-brown, fine to medium, angular to subangular siltstone and ironstone gravel, with silt, root fibres and siltstone boulders, w<PL		D/E	0.4–0.5				
	0.8	Possible old topsoil layer at base of fill							
		CLAY CH: high plasticity, pale brown mottled red-brown and pale grey, w<PL, stiff, residual		D/E	0.9–1.0			▽	
				D/E	1.4–1.5				
82	1.6	SILTSTONE: dark brown-grey, highly to moderately weathered, Bringelly Shale		B/D/E*	1.9–2.0				
				D/E	2.4–2.5				
81	2.5	Pit discontinued at 2.5m Limit of investigation							
80									
79									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: Free groundwater observed at 1.0m

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.
*Field Replicate taken at 1.9-2.0m.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: ESR Australia
PROJECT: Proposed Industrial Development
LOCATION: 5 Skyline Crescent, Horningsea Park

SURFACE LEVEL: 88.8 AHD
EASTING: 299404
NORTHING: 6241132

PIT No: 11
PROJECT No: 213088.00
DATE: 10/3/2022
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
88	0.3	FILL/Gravelly CLAY: medium plasticity, brown mottled dark grey and orange-brown, fine to coarse, angular to subangular siltstone gravel, with root fibres and a thin covering of mulch, w~PL							
		CLAY CH: high plasticity, orange-brown mottled pale grey, with fine to medium siltstone gravel, w<PL, hard, residual							
		Below 0.6m: becoming orange-brown mottled yellow-brown with silt							
87	1.0	SILTSTONE: orange-brown and dark grey, highly weathered, Bringelly Shale							
	1.2	Pit discontinued at 1.2m Limit of investigation							
86									
85									
84									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 9.5t with 900mm tiger tooth bucket

LOGGED: SL

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 56. RLs to AHD.

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
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Appendix D

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Email: mick.gref@douglaspartners.com.au

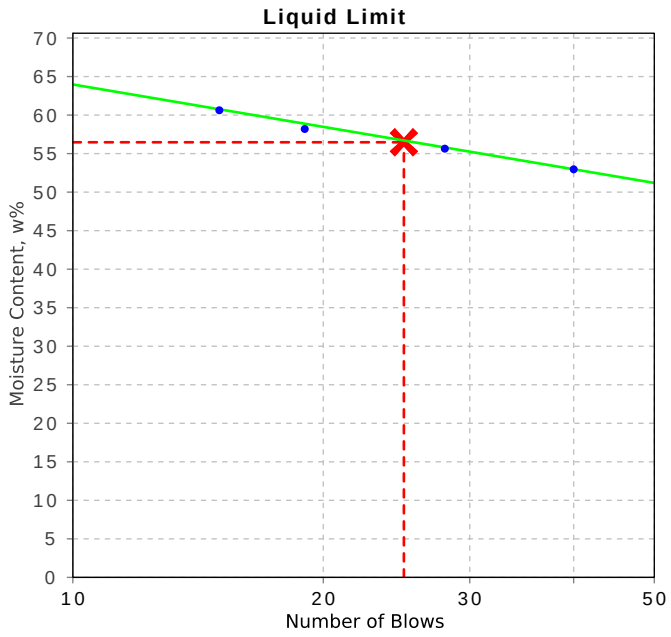
Accredited for compliance with ISO/IEC 17025 - Testing

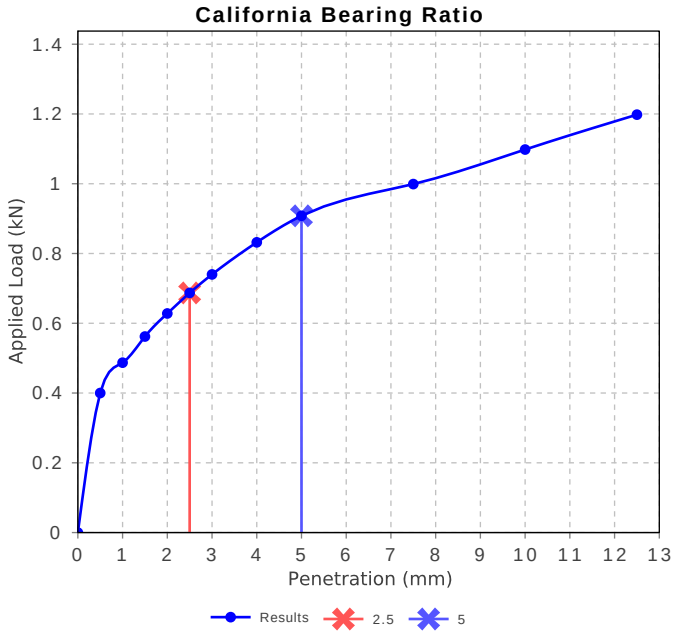
Approved Signatory: Mick Gref
Senior Technician
Laboratory Accreditation Number: 828

Report Number: **213088.00-1**
Issue Number: 1
Date Issued: 29/03/2022
Client: ESR Australia
Level 29, 20 Bond Street, Sydney NSW 2000
Contact: Daniel Galea
Project Number: 213088.00
Project Name: Proposed Industrial Development
Project Location: Skyline Crescent, Horningsea Park NSW
Work Request: 8929
Sample Number: SY-8929A
Date Sampled: 07/03/2022
Dates Tested: 16/03/2022 - 28/03/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP1 (1.0 - 1.5m)**
Material: CLAY: orange-brown mottled pale grey, trace root fibres

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	56		
Plastic Limit (%)	21		
Plasticity Index (%)	**35**		

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.59		
Optimum Moisture Content (%)	22.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	98.0		
Dry Density after Soaking (t/m^3)	1.56		
Field Moisture Content (%)	17.5		
Moisture Content at Placement (%)	21.8		
Moisture Content Top 30mm (%)	25.4		
Moisture Content Rest of Sample (%)	23.8		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	51.4		
Swell (%)	2.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		





Material Test Report

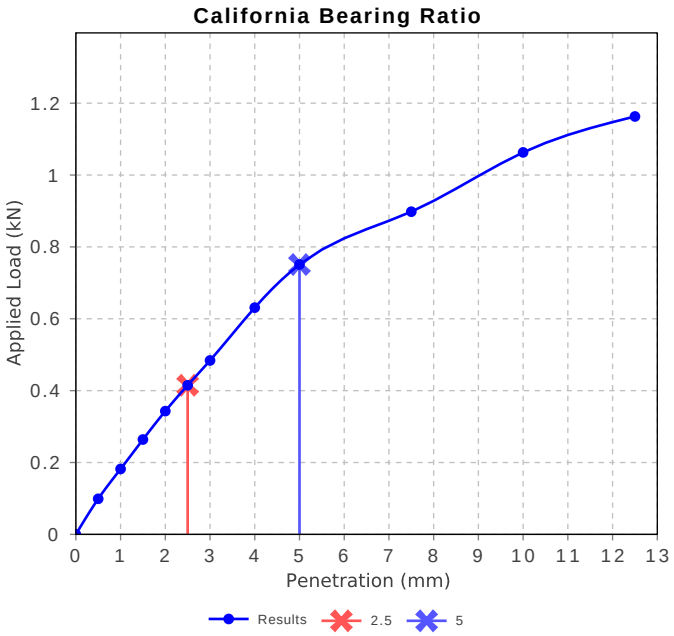
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Email: mick.gref@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Mick Gref
Senior Technician
Laboratory Accreditation Number: 828

Report Number: **213088.00-1**
Issue Number: 1
Date Issued: 29/03/2022
Client: ESR Australia
Level 29, 20 Bond Street, Sydney NSW 2000
Contact: Daniel Galea
Project Number: 213088.00
Project Name: Proposed Industrial Development
Project Location: Skyline Crescent, Horningsea Park NSW
Work Request: 8929
Sample Number: SY-8929B
Date Sampled: 07/03/2022
Dates Tested: 16/03/2022 - 28/03/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP3 (0.5 - 1.0m)**
Material: FILL/Gravelly CLAY: brown-grey and red-brown, subangular to subrounded siltstone, ironstone, sandstone gravel, with siltstone cobbles

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**4.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.89		
Optimum Moisture Content (%)	14.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.87		
Field Moisture Content (%)	16.7		
Moisture Content at Placement (%)	14.7		
Moisture Content Top 30mm (%)	17.6		
Moisture Content Rest of Sample (%)	15.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	50.8		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	3.7		



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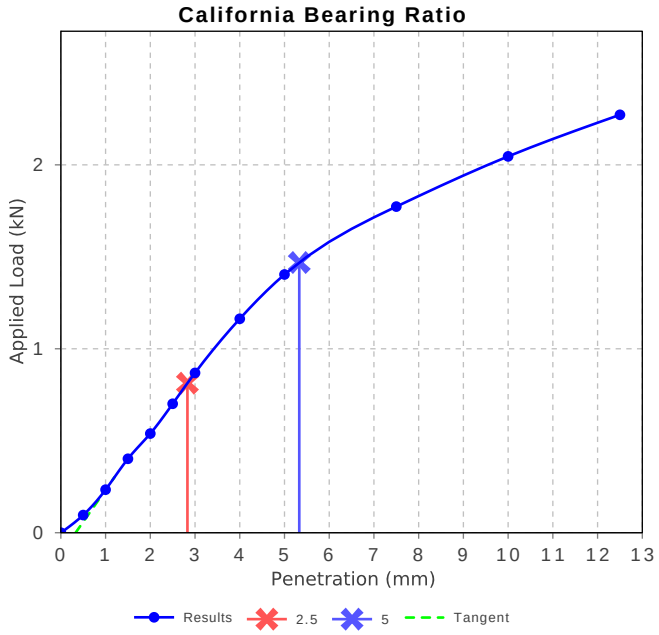
Report Number: **213088.00-1**
Issue Number: 1
Date Issued: 29/03/2022
Client: ESR Australia
Level 29, 20 Bond Street, Sydney NSW 2000
Contact: Daniel Galea
Project Number: 213088.00
Project Name: Proposed Industrial Development
Project Location: Skyline Crescent, Horningsea Park NSW
Work Request: 8929
Sample Number: SY-8929C
Date Sampled: 07/03/2022
Dates Tested: 16/03/2022 - 28/03/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP4 (1.0 - 1.5m)**
Material: FILL/Gravelly CLAY: brown and orange-brown, fine to medium, angular to subangular sandstone, siltstone, ironstone, igneous, concrete, tile, brick and asphalt gravel, with silt, root fibres

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**7**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.93		
Optimum Moisture Content (%)	13.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.90		
Field Moisture Content (%)	12.4		
Moisture Content at Placement (%)	12.9		
Moisture Content Top 30mm (%)	15.4		
Moisture Content Rest of Sample (%)	13.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	70.4		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	18.7		



Material Test Report

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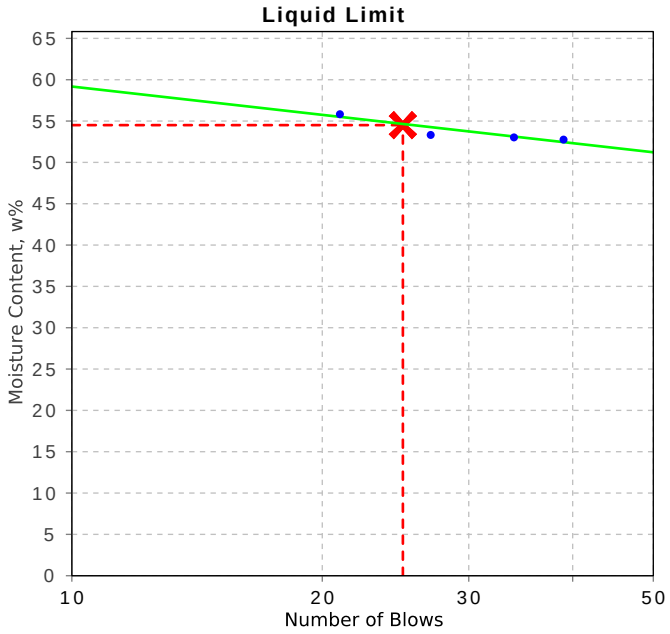
Report Number: **213088.00-1**
Issue Number: 1
Date Issued: 29/03/2022
Client: ESR Australia
Level 29, 20 Bond Street, Sydney NSW 2000
Contact: Daniel Galea
Project Number: 213088.00
Project Name: Proposed Industrial Development
Project Location: Skyline Crescent, Horningsea Park NSW
Work Request: 8929
Sample Number: SY-8929D
Date Sampled: 07/03/2022
Dates Tested: 16/03/2022 - 23/03/2022
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **BH3A (2.5 - 2.95m)**
Material: CLAY: orange-brown to red-brown mottled pale grey, trace gravel

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	55		
Plastic Limit (%)	21		
Plasticity Index (%)	**34**		



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CERTIFICATE OF ANALYSIS 291085

Client Details

Client	Douglas Partners Pty Ltd
Attention	Ray Blinman
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**213088.00, Horningsea Park**
Number of Samples	10 Soil
Date samples received	16/03/2022
Date completed instructions received	16/03/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	23/03/2022
Date of Issue	06/04/2022
Reissue Details	This report replaces R00 due to the addition of Chloride and Sulphate results.

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Results Approved By
Diego Bigolin, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		291085-1	291085-2	291085-3	291085-4	291085-5
Your Reference	UNITS	TP6	TP10	BH2A	BH2A	BH2A
Depth		0.9-1.0	1.9-2.0	0.0-0.1	0.5-0.6	1.0-1.1
Date Sampled		10/03/2022	10/03/2022	07/03/2022	07/03/2022	07/03/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
pH 1:5 soil:water	pH Units	5.8	7.6	8.9	9.0	9.0
Electrical Conductivity 1:5 soil:water	µS/cm	120	110	[NA]	[NA]	[NA]
Chloride, Cl 1:5 soil:water	mg/kg	100	56	57	69	67
Sulphate, SO4 1:5 soil:water	mg/kg	63	<10	53	62	59

Misc Inorg - Soil						
Our Reference		291085-6	291085-7	291085-8	291085-9	291085-10
Your Reference	UNITS	BH2A	TP1	TP1	TP1	TP1
Depth		2.0-2.1	0.0-0.1	0.4-0.5	0.9-1.0	1.9-2.0
Date Sampled		07/03/2022	10/03/2022	10/03/2022	10/03/2022	10/03/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
pH 1:5 soil:water	pH Units	7.8	8.5	8.7	6.7	5.3
Chloride, Cl 1:5 soil:water	mg/kg	34	<10	63	58	210
Sulphate, SO4 1:5 soil:water	mg/kg	10	<10	27	<10	160

Texture and Salinity*						
Our Reference		291085-3	291085-4	291085-5	291085-6	291085-7
Your Reference	UNITS	BH2A	BH2A	BH2A	BH2A	TP1
Depth		0.0-0.1	0.5-0.6	1.0-1.1	2.0-2.1	0.0-0.1
Date Sampled		07/03/2022	07/03/2022	07/03/2022	07/03/2022	10/03/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022	17/03/2022	17/03/2022	17/03/2022
Electrical Conductivity 1:5 soil:water	µS/cm	220	250	300	82	65
Texture Value	-	8.0	8.0	7.0	6.0	6.0
Texture	-	LIGHT MEDIUM CLAY	LIGHT MEDIUM CLAY	MEDIUM CLAY	HEAVY CLAY	HEAVY CLAY
ECe	dS/m	<2	2.0	2.1	<2	<2
Class	-	NON SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	NON SALINE	NON SALINE

Texture and Salinity*				
Our Reference		291085-8	291085-9	291085-10
Your Reference	UNITS	TP1	TP1	TP1
Depth		0.4-0.5	0.9-1.0	1.9-2.0
Date Sampled		10/03/2022	10/03/2022	10/03/2022
Type of sample		Soil	Soil	Soil
Date prepared	-	17/03/2022	17/03/2022	17/03/2022
Date analysed	-	17/03/2022	17/03/2022	17/03/2022
Electrical Conductivity 1:5 soil:water	µS/cm	120	120	390
Texture Value	-	7.0	6.0	6.0
Texture	-	MEDIUM CLAY	HEAVY CLAY	HEAVY CLAY
ECe	dS/m	<2	<2	2.3
Class	-	NON SALINE	NON SALINE	SLIGHTLY SALINE

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-123	Determined using a "Texture by Feel" method.

QUALITY CONTROL: Misc Inorg - Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	291085-2
Date prepared	-			17/03/2022	1	17/03/2022	17/03/2022		17/03/2022	17/03/2022
Date analysed	-			17/03/2022	1	17/03/2022	17/03/2022		17/03/2022	17/03/2022
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.8	5.7	2	99	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	120	130	8	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	100	100	0	101	100
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	63	63	0	100	80

QUALITY CONTROL: Texture and Salinity*					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			17/03/2022	[NT]	[NT]	[NT]	[NT]	17/03/2022	[NT]
Date analysed	-			17/03/2022	[NT]	[NT]	[NT]	[NT]	17/03/2022	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	104	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

pH analyses for samples 291085/3-6 has been performed outside of recommended holding time.