Geotechnical site investigation report

Proposed Bunnings Warehouse, Part Lot 26 DP1244557, 21 Willowbank Avenue, Lithgow NSW

Ref: R13677g
Date: 10/12/2021

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Executive Summary

Background

A Bunnings Warehouse is proposed for Part Lot 26 DP124455, 21 Willowbank Avenue, Lithgow NSW. Site access is proposed from Valley Drive to the north of the proposed development.

The store is Bunnings type SFS which comprises main retail, timber trade sales, outdoor nursery, bagged goods canopy, amenities and associated pavement areas (driveways, arterial road, car parks and truck parks). The total site area is 1.295 hectares.

A geotechnical investigation is required to assist in structural and pavement design for the development.

Scope

Undertake an investigation to describe the soil and geotechnical limitations of the development area to assist in structural and pavement design.

Investigation

Site inspections and subsurface investigations were undertaken on 21 September 2021. Coal has been removed from part of the development site (northern section) and the pit backfilled. The coal in the southern section has yet to be removed and was not assessed in the geotechnical investigation (Figure 1).

The geotechnical properties of the soil on the site were assessed by drilling 7 boreholes (BH1 to BH7) to a depth of up to 5m or drill refusal with a track mounted Geoprobe drill rig and flight auger with TC bit.

Soil conditions were logged for each borehole including approximate fill depth, soil type, colour, depth, moisture, consistency, density, plasticity, rock and groundwater conditions.

Soil samples were collected from selected locations for laboratory analysis of liquid limit, linear shrinkage, pH, electrical conductivity (EC) from proposed buildings areas and California bearing ratio (CBR) in proposed pavement areas. The CBR samples were collected from the existing subgrade (0 to 1000mm) which included fill material.

Cone penetrometer tests (CPT) tests were conducted at representative locations in proposed building areas. Estimated allowable bearing capacity was gauged by soil profile, soil consistency, CPT and resistance to auger drilling with TC bit.

All testing depths undertaken for the assessment were relative to existing ground level on the day of investigation.

Sampling locations are outlined in Figure 1 and Figure 2. The schedule of sampling is presented in Table 1.

The assessment and results are based on conditions, soil profile and soil moisture identified at the borehole locations. Site conditions can vary due to soil strata changes, fluctuations in seasonal factors and soil moisture. The site should be reassessed if surface or subsurface conditions differ from those described in the report.

Conclusions and recommendations

The original mine was underground shafts occurring in the 1990's. Open cut excavations were undertaken in the investigation area in 2018 as part of remediation works and all coal removed. The pit was backfilled, and some density ratio compaction tests conducted but the fill is considered uncontrolled.

The fill at the borehole locations was up to 4.7m but could extend deeper in other areas. The fill was variable including clayey sand and sandy clay with gravel and weathered rock. Some areas of voids and minimal auger recovery was identified at depths greater than 3m in the fill material (borehole BH1 to BH3). Water ingress and wet soil (plastic limit) were detected in the fill material at depths from 2m.

Natural soil was identified in the borehole locations at depths commencing from 3.5m in borehole BH3 to 4.7m in borehole BH4. The natural soil was clayey sand, gravelly sand and weathered rock with very stiff to hard drilling. Drill refusal occurred from 3.8m in BH3 to 5m in BH4 expected to be on very high strength weathered sandstone rock.

The site has a classification of Class P (uncontrolled fill material). The fill material and natural soil analysed had low to moderate liquid limit and linear shrinkage with an estimated maximum surface movement (*Ys*) of 25-30mm.

The fill material had variable consistency ranging from firm to stiff with some areas of voids (minimal auger recovery) from 3m depth. The natural soil below the fill was very stiff to hard consistency with drill refusal occurring on weathered rock.

Footings are recommended to be founded into the weathered rock (drill refusal) which was encountered at depth from 3.8m to 5m. Estimated allowable bearing capacity of the weathered rock is estimated to be 600kPa.

The fill material is not expected to be an excavation or auger limitation. Wet soil and water ingress occurred 2m depths which may be an excavation or pile auger limitation. Drill refusal in natural material occurred from 3.8m to 5m expected to be on very high strength weathered sandstone rock which is an excavation and auger limitation.

The subsoil (fill and natural material) is non-saline and pH in the neutral range (5.7 to 5.9 pH units). Exposure classification for concrete is A1.

The CBR strength of the existing subgrade is moderate with a design CBR of 7%. The existing material is expected to be suitable for subgrade after passing proof rolling and compaction testing.

Mine subsidence records from Subsidence Advisory NSW obtained by email inquiry (October 2021) indicate the area is undermined by the Lithgow Seam. The mapped mine workings are generally to the east and north of the development area with estimated depth of 5-15m. The lot has been assigned *Subsidence Advisory Guideline 7* which means any proposed development would be assessed on merit.

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1. Introduction

A new Bunnings Warehouse is proposed for Part Lot 26 DP1244557, 21 Willowbank Avenue, Lithgow NSW. The development will comprise new buildings and pavements. The proposed access to the development is from Valley Drive.

An assessment of the site is required to determine geotechnical conditions for structural and pavement design options.

2. Objectives

Envirowest Consulting was commissioned by Project Innovations Pty Ltd on behalf of Ceedive to undertake geotechnical investigations for a proposed new Bunnings Warehouse development located at Part Lot 26 DP1244557, 21 Willowbank Avenue, Lithgow NSW.

The investigation includes:

- Summary of surface and subsurface conditions
- Groundwater conditions and potential influences on structures
- Site classification including characteristic surface movement based on AS2870
- Foundation parameters including allowable bearing capacities
- Assessment of acid sulphate soil and soil aggressiveness
- Suitability of subsoil for reuse as fill
- Excavation limitations
- CBR values and recommended pavement parameters
- Mine subsidence information

3. Site location

The new development will be located at Part Lot 26 DP1244557, 21 Willowbank Avenue, Lithgow NSW. The site area is 1.295 hectares. The assessed area was the northern section of the proposed development. The southern section was not able to be accessed.

4. General site description

The proposed development area is zoned B4 – Mixed use under the Lithgow Local Environmental Plan (2014). The northern section of the proposed development area has been excavated and coal removed as part of remedial works. The pit was backfilled. The southern section has yet to be excavated and was not assessed in the geotechnical investigation (Figure 1).

Fill material has been historically placed in the assessed area to backfill the excavated pit.

The area has been assigned *Subsidence Advisory Guideline 7*. Proposed developments will be assessed on merit.

5. Site condition and environment

5.1 Surface cover

Surface cover on the site consisted of mainly scattered weeds.

5.2 Topography

The site occurs on mid slope with southern inclination. The assessed area has been levelled by placement of fill.

5.3 Soils and geology

The site is within the Lithgow Soil Landscape (eSpade accessed October 2021). Natural soils in the area comprise red podzolic soils, yellow podzolic soils and yellow leached earths on upper slopes and well drained areas. Yellow solodic soils occur on lower slopes and in areas of poor drainage.

Boreholes constructed on the site identified fill material up to 4.7m over natural soil of clayey sand, gravelly sand and rock comprising weathered sandstone.

The site is underlain by Illawarra Coal Measures and the Berry Formation with shale, sandstone, siltstone, mudstone, claystone, limestone, coal, torbanite, and conglomerate (eSpade accessed October 2021).

Mine subsidence records from Subsidence Advisory NSW indicate the area is undermined by the Lithgow Seam. The mapped mine workings are generally to the east and north of the development area with estimated depth of 5-15m.

5.4 Water

5.4.1 Surface water

Surface water flows south across the site.

5.4.2 Groundwater

No bores are known to be located on the site. The NSW Office of Water groundwater database identifies four bores within 650m of the site. A summary of bore details is given in the following table.

Groundwater bores within 500m of the site

Bore No.	Date drilled	Location	SWL (m)	Use	Status
GW109125	2008	350m NE	3.5	Monitoring	Active
GW109128	2008	350m NE	3.6	Monitoring	-
GW109126	2008	400m NE	2.5	Monitoring	-
GW109127	2008	500m NE	1.3	Monitoring	-

Water ingress and wet soil (plastic limit) were detected in the fill material during borehole drilling at depths from 2m.

6. Investigation methods

The geotechnical site assessment was undertaken from 21 September 2021. Coal has been removed from the assessment area and the pit backfilled. The site history was investigated, and information collected on historical mining operations.

Seven boreholes (BH1 to BH7) were drilled to a depth of up to 5m or drill refusal with a track mounted Geoprobe drill rig and flight auger with TC bit. Soil conditions were logged for each borehole including approximate fill depth, soil type, colour, depth, moisture, consistency, density and plasticity.

Representative soil samples were collected for laboratory analysis of liquid limit, linear shrinkage, pH, electrical conductivity (EC) and California bearing ratio (CBR). The CBR samples were collected from the existing subgrade (0 to 1000mm) which included fill material.

Cone penetrometer tests (CPT) tests were conducted at representative locations in proposed building areas. Soil consistency, shear strength and estimated allowable bearing capacity were gauged by soil profile, CPT and resistance to auger drilling with TC bit.

All testing depths undertaken for the assessment were relative to existing ground level on the day of investigation. Sampling locations are outlined in Figures 1 and 2. The schedule of sampling is presented in Table 1.

All soil analysis was undertaken at the NATA accredited laboratory of Envirowest Testing Services.

Soil sampling was conducted according to Australian Standard 1726 and site classification in accordance with Australian Standard 2870 by qualified field and laboratory personal. AS2870 is primarily used for residential buildings performance criteria and specific designs for footing systems for foundation conditions commonly found in Australia and to provide guidance on the design of footing systems by engineering principles. AS2870 can be a useful guide for larger commercial structures.

The assessment and results are based on conditions, soil profile and soil moisture identified at the borehole locations. Site conditions can vary due to soil strata changes, fluctuations in seasonal factors and soil moisture. The site should be reassessed if surface or subsurface conditions differ from those described in the report.

Table 1. Sampling locations and tests undertaken

Borehole (Figure 1 and 2)	Proposed location (Figure 2)	GPS Location (Zone 56H)	Tests undertaken	Testing depths (m)	Investigation total depth (m)
BH1	Bagged goods	0235581E 6290896N	Soil properties description CPT Index tests, EC, pH	0 to 4.8 (refusal) 0 to 3.4 (refusal) 0.6	4.8 (refusal)
BH2	Nursery	0235541E 6290867N	Soil properties description Index tests, EC, pH	0 to 4.5 (refusal) 2.8, 4.0	4.5 (refusal)
BH3	Main retail	0235533E 6290833N	Soil properties description CPT Index tests, EC, pH	0 to 3.8 (refusal) 0 to 3.6 (refusal) 1.5	3.8 (refusal)
BH4	Timber trade sales	0235582E 6290821N	Soil properties description	0 to 5.0 (refusal)	5.0 (refusal)
BH5	Arterial road	0235584E 6290912N	Soil properties description CBR	0 to 1.5 0 to 1.0	1.5
BH6	Car park	0235517E 6290821N	Soil properties description CBR	0 to 1.5 0 to 1.0	1.5
BH7	Car park entrance	0235515E 6290861N	Soil properties description CBR	0 to 1.5 0 to 1.0	1.5

EC - electrical conductivity, CPT – cone penetrometer test, CBR – California bearing ratio

7. Results

7.1 Surface condition

Surface cover on the site was generally unmaintained vegetation.

7.2 Site conditions

The lot was vacant on the day of inspection. The assessed area is a backfilled excavation pit.

7.3 Site History

The site mining history of Lithgow lists the Lithgow Valley coal mine occurring on the site. The colliery was operated by the drift system and shafts extend near the eastern and northern end of the site. In 2018 as part of remedial works the upper 3m of soil was excavated and the coal seam layer removed down to sandstone. Photographs of the site during excavations are presented in Figure 3.

The excavated area was backfilled onto sandstone with overburden material and compacted (Appendix 8). Photographs of the backfilled area are presented in Figure 3. A minimum compaction density ratio of 98% was achieved. Insufficient compaction testing was undertaken to classify the fill as controlled.

7.4 Soil profile and subsoil conditions (Appendix 1).

Clay and sandstone fill material has been used to backfill the excavated pit. The fill depth at the borehole locations ranged from 3.5m to 4.7m. Fill depth could extend deeper in other areas. The fill was compacted during backfilling but is considered uncontrolled. The fill material at the borehole locations was variable including sands, clays, gravels with areas of weathered rock and coal fragments.

Some areas of voids and minimal auger recovery was identified at depths greater than 3m in the fill material (borehole BH1 to BH3). Water ingress and wet soil (plastic limit) were detected in the fill material at depths from 2m.

The natural soil at the borehole locations at depths commenced from 3.5m (borehole BH3) to 4.7m (borehole BH4). The natural soil was clayey sand, gravelly sand and weathered rock with very stiff to hard drilling. Drill refusal occurred from 3.8m in BH3 to 5m in BH4 expected to be on very high strength weathered sandstone rock.

7.5 Soil index tests

The soil samples analysed (fill material and natural soil) had low to moderate liquid limit and linear shrinkage (Table 2 and Appendix 2).

Table 2. Soil index test summary

Borehole (Figure 1 and 2)	Sample depth (m)	Liquid limit %	Linear shrinkage %	Soil description
BH1	0.6	30	7.0	FILL, sandy clay, olive brown
BH2	2.8	32	8.0	FILL, sandy clay with gravel, grey
BH2	4.0	33	9.0	CLAYEY SAND, grey (natural soil)
BH3	1.5	31	8.0	FILL, clayey gravelly sand, yellow brown

7.6 Soil aggressiveness

The laboratory results indicate the soil samples collected were non- saline. No obvious signs of salinity were observed on the site surface or within the subsoil. The pH of the soil tested was neutral (5.7 to 5.9 pH units).

Table 3. pH, electrical conductivity analysis results and salinity rating

Borehole (Figure 1 and 2)	Sample depth (m)	Soil type	pH	EC (dS/m)	EC_e (dS/m)	Salinity rating
BH1	0.6	FILL, sandy clay	5.8	0.02	0.15	Non-saline
BH2	2.8	FILL, sandy clay	5.7	0.02	0.15	Non-saline
BH2	4.0	CLAYEY SAND	5.9	0.01	0.23	Non-saline
BH3	1.5	FILL, clayey gravelly sand	5.7	0.02	0.46	Non-saline

EC – Electrical conductivity, EC_e - Electrical conductivity of a saturated extract

7.7 Cone penetrometer tests (CPT)

The CPT results are presented in Table 4. CPT report is presented in Appendix 3.

CPT tests were conducted adjacent to borehole BH1 and BH3 up to 3.6m depth (CPT refusal) to determine the in-situ properties including cone resistance (*qc*), sleeve friction (*fs*), friction ratio (*Rf*), adjusted shear strength (*Cu*) and equivalent SPT N60 value.

Low cone resistance and shear strength was encountered in some layers of fill.

Table 4. Summary of CPT soil properties

Borehole (Figure 1 and 2)	Material	Depth (m)	CPT Data			
			qc (MPa)	*fs* (MPa)	*Cu* (kPa)	*SPT* N60
BH1	FILL, gravelly clayey sand	1.0	16.8	0.21	378	28
BH1	FILL, sandy clay with gravel	2.0	12.6	0.26	283	23
BH1	FILL, gravelly sandy clay	3.0	1.9	0.19	41	6
BH1	FILL, sandy gravel	3.4	7.4	0.10	164	14
BH3	FILL, clayey gravelly sand	1.0	23.9	0.47	536	42
BH3	FILL, clayey gravelly sand	2.0	27.0	0.57	606	48
BH3	FILL, sandy clay / voids	3-3.1	0-0.30	0	0-6	0-2
BH3	Natural – clayey sand	3.6	4.6	0.06	164	9

qc- cone resistance, fs-sleeve friction, Cu – adjusted undrained shear strength using 0.45 reduction factor, SPT – standard penetrometer test equivalent N-value

7.8 California bearing ratio (CBR)

Samples were collected from surface to 1000mm depth for analysis of CBR. The samples were primarily gravelly clay fill material.

The CBR results for the sample collected are moderate ranging from 7% to 8% (Table 5 and Appendix 4).

Table 5. CBR test result

Borehole (Figure 1 and 2)	Sample ID	Sample depth (mm)	Sample description	CBR (%)
BH5	CBR1	0-1000	Gravelly clay fill, grey	8.0
BH6	CBR2	0-1000	Gravelly clay fill, yellow brown	8.0
BH7	CBR3	0-1000	Gravelly clay fill, grey	7.0

7.9 Groundwater

Water ingress and wet soil (plastic limit) were detected in the fill material during borehole drilling at depths from 2m. Groundwater is seasonally perched on the sandstone.

8. Recommendations

8.1 Earthworks

8.1.1 Excavations

The fill material is not expected to be an excavation or auger limitation using a 20-30 tonne excavator. Wet soil and water ingress occurred 2m depths which may be an excavation or pile auger limitation.

Drill refusal in natural soil / weathered rock occurred from 3.8m to 5m. The rock is expected to be very high strength weathered sandstone rock which is an excavation and auger limitation.

8.1.2 Filling

The existing fill material locate at 0 to 4m is suitable to be reused for general filling.

Fill material (reused and imported) shall be compacted in maximum layers of 200mm and moisture content at time of compaction to be 60% - 90% optimum moisture content (OMC). The fill material should not contain rock greater than 40mm diameter.

8.2 Foundations

8.2.1 Soil reactivity

An estimation of design surface movement (Ys) of the natural soil was determined from the shrink swell index (AS1289.7.1.1), soil index tests and soil profile identification as recommended in AS 2870.

The site has a classification of Class P (uncontrolled fill material). The fill material and natural soil analysed had low to moderate liquid limit and linear shrinkage with an estimated maximum surface movement (*Ys*) of 25-30mm.

8.2.2 Exposure classification

Soil saturated extract electrical conductivity (EC_e) was determined to range from 0.15dS/m to 0.46dS/m in the soil samples tested which is in the non-saline range. Soil pH was neutral (5.7 to 5.9 pH units). Exposure classification for concrete is A1.

8.2.4 Footing design parameters

Fill material has been historically applied to the assessed area. The fill at the borehole locations was up to 4.7m but could extend deeper in other areas. The fill was compacted during backfilling but is considered uncontrolled.

The fill material had variable consistency ranging from firm to stiff with some areas of voids (minimal auger recovery) at depths from 3m. The natural soil and weathered rock below the fill were very stiff to hard consistency with drill refusal on rock.

Pile type foundations are recommended to be founded into the weathered rock and rock which was encountered at depths ranging from 3.8m to 5m at the borehole locations.

Allowable bearing capacity and shaft adhesion require the pile foundation to be embedded into natural rock due to potential settlement of the fill material.

Table 6. Soil parameter for engineering design

		Geotechnical design parameters								
Material	**Depth (m)**	**γ kN/m³**	**Cu kPa**	**Ø deg**	**E MPa**	**c kPa**	**Ultimate shaft adhesion kPa**	**Allowable shaft adhesion kPa**	**Ultimate bearing capacity kPa**	**Allowable bearing capacity kPa**
Fill - clayey sand, gravelly sand	1.0	18	>200	25	15	2	-	-	173	200
Fill - gravelly clay, gravelly sand	2.0	29	>200	26	15	2	28	14	280	250
Fill - sandy clay, clayey sand, voids*	3.0	-	0-40	-	-	-	-	-	-	0-75
Natural soil - clayey sand, gravelly sand, weathered rock (refusal)	**3.8 – 5.0**	**21**	**>200**	**32**	**25**	**-**	**135**	**60**	**1350**	**600**

* - Voids and minimal auger recovery encountered at depths from 3m in BH1 to BH3

γ - Bulk unit weight, Cu - undrained shear strength, Ø – soil friction angle, *E* – Young's modulus, *c* – Cohesion

Pile foundations should be designed in accordance with AS 2159 and a geotechnical reduction factor of $\Phi_g = 0.45$ (low to moderate overall risk category and low redundancy). All foundations and piers should be inspected by a suitably qualified person to confirm geotechnical properties.

8.3 Subgrade preparation

Subgrade preparation and fill placement should be in accordance with Australian Standard AS3798 including:

- Uncompacted or loose fill is not suitable for use as subgrade or foundation. Compacted fill will require passing a proof roll using a 12-tonne roller or equivalent prior to use as subgrade. Fill containing large particles (>40mm diameter) is not recommended for subgrade.

- The existing fill on the site is expected to be suitable as subgrade if passing compaction and proof rolling. Soft spots, weak areas or heaving subgrade locations will require excavation and replacement.

- All topsoil, large particles, silty material, wet material, vegetation including tree roots, soft soil, debris and other foreign matter should be removed from the location of the proposed pavement.

- Adjust the in-situ moisture of the subgrade to 60% - 90% optimum moisture content (OMC) at time of compaction.

- The exposed subgrade should be compacted to a minimum 98% of the dry density ratio. The exposed compacted surface should be rolled to detect soft spots.

- Any soft, weak or saturated material should be removed and replaced by suitable fill material and compacted in maximum layers of 200mm, moisture content at time of compaction to be 60% - 90% optimum moisture content (OMC) and at least 98% dry density ratio.

- All service trenches and other excavations should be backfilled with suitable fill material and compacted in maximum layers of 200mm, moisture content at time of compaction to be 60% - 90% optimum moisture content (OMC) and at least 98% dry density ratio.

8.4 Design CBR value

The CBR strength of the existing subgrade is moderate with a design CBR of 7%. The existing material is expected to be suitable for subgrade after passing proof rolling and compaction testing.

8.5 Pavement material

Pavement materials shall be in accordance with Council construction guidelines.

8.6 Surface water and groundwater mitigation

Drainage is recommended to divert surface and groundwater around the buildings and pavement areas. Cut off drains will be required to intercept surface water and groundwater flows from the upslope flows.

8.7 Geotechnical testing

Foundations and pavement layers should be inspected by a suitably qualified person at the time of excavation and placement to confirm accordance with design parameters. The specification, execution and control testing of earthworks and site preparation should be undertaken according to AS3798.

8.8 Mine subsidence

Mine subsidence records from Subsidence Advisory NSW (inquiry obtained in October 2021) indicate the area is undermined by the Lithgow Seam. The mapped mine workings are generally to the east and north of the development area with estimated depth of 5-15m. The lot has been assigned *Subsidence Advisory Guideline 7*. The development will be assessed on merit.

8.9 Additional assessments

Additional assessments are recommended in the southern section of the development area after coal has been excavated and fill reinstated to required ground level.

9. Limitations of the investigation

The engineering logs describe subsurface conditions only at a specific borehole location and inferred boundaries between geotechnical units may vary.

Ground conditions can vary over relatively short distances and it may be necessary to carry out additional investigations for specific excavation and building sites. Once specific proposals are known a geotechnical review should be undertaken and if necessary additional investigations commissioned to provide the level of information required for assessing design parameters. A geotechnical engineer should be engaged to review subsurface condition during construction stages to confirm that subsurface conditions are consistent with design assumptions.

This report has been prepared for the use of the client to achieve the objectives given the client requirements and cost constraints. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

The investigation identifies the actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists who then render an opinion about overall subsurface conditions, the nature and extent of the investigation and its likely impact on the proposed buildings. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no sub surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. It is thus important to understand the limitations of the investigation and recognise that Envirowest Consulting Pty Ltd are not responsible for these limitations.

10. References

AS 2870 Residential *Slabs and Footings - Construction* (Standards Australia: Homebush)

AS 3798 *Guidance on earthworks for commercial and residential buildings* (Standards Australia: Homebush)

AS 1726 (2017) *Geotechnical Site Investigations*

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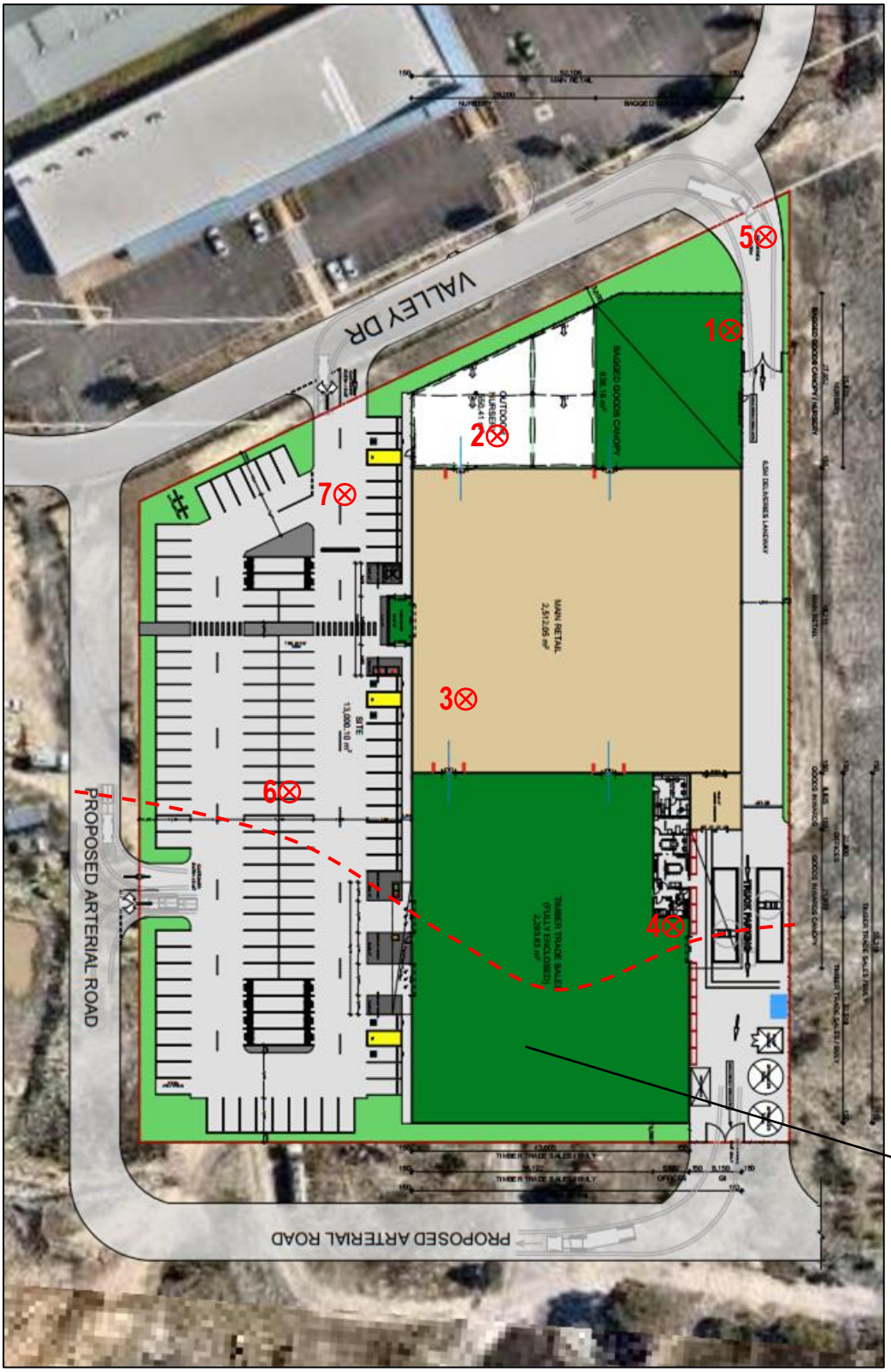
Legend

⊗ Borehole

Approximate Scale 1: 1000

0 10 20 40m

Figure 1. Aerial image (Nearmap 2021) and borehole locations		
Proposed Bunnings Warehouse, Valley Drive, Lithgow NSW		
	Envirowest Consulting Pty Ltd	
Job: R13677g	Drawn by: AR	Date: 14/10/2021



Approximate Scale 1: 1000

0 10 20 40m

Legend

⊗ Borehole location and sampling location

Figure 2. Site plan and sampling locations		
Proposed Bunnings Warehouse, Valley Drive, Lithgow, NSW		
	Envirowest Consulting Pty Ltd	
R13677g	Drawn by: AR from Bunnings supplied plan	Date: 14/10/2021

Figure 3. Photographs

Aerial image during excavations 2018-2019 (supplied by client)

Looking north across the site during excavation 2018-2019 (supplied by client)

Looking east across the site during backfilling 2019 (supplied by client)

Looking east across the site on 21/9/2021

Envirowest Consulting

Borehole No.
BH1
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Appendix 1
Engineering Log - Borehole

Client:	Ceedive	Commenced:	21/09/2021
Project Number:	13677	Completed:	21/09/2021
Location:	Valley Drive, Lithgow NSW	Logged By:	AR
Hole Position:	Bagged goods 235581mE 6290896mN	Checked By:	AR
Drill Model and Mounting:	EVH truck drill rig	Inclination: -90°	RL Surface: Existing surface level
Hole Diameter:	75mm	Operator: EL	Datum: AHD

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Profile Description	Moisture Condition	Consistency Relative Density	Dynamic Cone Penetrometer (DCP) (blows per 10cm) 10 20 30	Structure and Additional Observations
AD/T				D 0.60 m			0		CL	FILL, gravelly clay. dark grey	M	St		0.0m: FIll material to 4.5m
									CL	FILL, gravelly clay, dark yellow brown	M	VSt		
									CI	FILL, sandy clay, olive brown with coarse gravel	M	VSt		
							1		SP	FILL, clayey gravelly sand, grey brown	M	St		
									CI	FILL, sandy clay, yellow brown with coarse gravel	M	St		
							2		CL	FILL, sandy clay, grey brown with coarse gravel	M	St		
									CL	FILL, sandy clay, grey with medium gravel	M (=PL)	St		
							3		CI	FILL, gravelly sandy clay, dark grey with coal fragments, some voids and poor auger recovery	M (=PL)	F		3.0m: Poor auger recovery, some voids
									GP	FILL, sandy gravel, dark grey to grey with sandstone fragments	M (=PL)	St		
							4		SP	GRAVELLY SAND, yellow brown	M	VSt		4.5m: Natural soil
									SP	GRAVELLY SAND and WEATHERED ROCK, yellow brown with weathered sandstone rock fragments	D	H		4.7m: Hard drilling
							5			Hole Terminated at 4.80 m Refusal on weathered sandstone				

Method
AD/T - Auger drillling with tc-bit
AD/V - Auger drilling with v-bit
BH - Backhoe with bucket
E - Excavator
HA - Hand auger

Penetration
Very soft
increasing to
Hard and refusal

Samples and Tests
U - Undisturbed sample
D - Disturbed sample
ES - Environmental sample
SPT - Standard penetrometer test
CBR - California bearing ratio test
DCP - Dynamic cone penetrometer test

Moisture Condition
D - Dry
M - Moist
M=LL - Moist equal to liquid limit
M=PL - Moist equal to plastic limit
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
VSt - Very stiff
H - Hard
Fr - Friable
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Water level
▽ - Water inflow

Structure
qa - Estimated allowable bearing capacity
qs - Estimated shaft adhesion

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Borehole No.
BH2
Page 1 of 1

Engineering Log - Borehole

Client:	Ceedive	Commenced:	21/09/2021
Project Number:	13677	Completed:	21/09/2021
Location:	Valley Drive, Lithgow NSW	Logged By:	AR
Hole Position:	Nursery 235541mE 6290867mN	Checked By:	AR

Drill Model and Mounting:	EVH truck drill rig	Inclination:	-90°	RL Surface:	Existing surface level
Hole Diameter:	75mm	Operator:	EL	Datum:	AHD

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Profile Description	Moisture Condition	Consistency Relative Density	Dynamic Cone Penetrometer (DCP) (blows per 10cm) 10 20 30	Structure and Additional Observations
AD/T									CI	FILL, sandy clay, black	M	F		0.0m: FIll material to 4.0m
									CL	FILL, gravelly clay, grey with coarse gravel	M	F		
									CI	FILL, sandy clay, olive brown with coarse gravel	M	St		
							1		CI	FILL, sandy clay, dark yellow brown with coarse gravel	M	St		
									SP	FILL, clayey gravelly sand, grey brown	M	St		
							2		CI	FILL, sandy clay, grey with coarse gravel	M (=PL)	VSt		
				D 2.80 m					CI	FILL, sandy clay, yellow brown with coarse gravel and coal fragments	M (=PL)	St		
							3		CI	FILL, gravelly sandy clay, dark grey with coal fragments, some voids and poor auger recovery	M (=PL)	F		3.0m: Poor auger recovery, some voids
				D 4.00 m					GP	FILL, sandy gravel, dark grey to grey with sandstone fragments	M (=PL)	St		
							4		SP	GRAVELLY SAND, grey	M	VSt		4.0m: Natural soil
									SP	GRAVELLY SAND and WEATHERED ROCK, grey with weathered sandstone rock fragments	M	H		4.4m: Hard drilling
										Hole Terminated at 4.50 m Refusal on weathered sandstone				
							5							

Method
AD/T - Auger drillling with tc-bit
AD/V - Auger drilling with v-bit
BH - Backhoe with bucket
E - Excavator
HA - Hand auger

Penetration
Very soft
increasing to
Hard and refusal

Samples and Tests
U - Undisturbed sample
D - Disturbed sample
ES - Environmental sample
SPT - Standard penetrometer test
CBR - California bearing ratio test
DCP - Dynamic cone penetrometer test

Moisture Condition
D - Dry
M - Moist
M=LL - Moist equal to liquid limit
M=PL - Moist equal to plastic limit
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
VSt - Very stiff
H - Hard
Fr - Friable
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Water level
▽ - Water inflow

Structure
qa - Estimated allowable bearing capacity
qs - Estimated shaft adhesion

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Borehole No.
BH3
Page 1 of 1

Engineering Log - Borehole

Client:	Ceedive	Commenced:	21/09/2021
Project Number:	13677	Completed:	21/09/2021
Location:	Valley Drive, Lithgow NSW	Logged By:	AR
Hole Position:	Main retail 235533mE 6290833mN	Checked By:	AR

Drill Model and Mounting:	EVH truck drill rig	Inclination:	-90°	RL Surface:	Existing surface level
Hole Diameter:	75mm	Operator:	EL	Datum:	AHD

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Profile Description	Moisture Condition	Consistency Relative Density	Dynamic Cone Penetrometer (DCP) (blows per 10cm) 10 20 30	Structure and Additional Observations
AD/T			▽	D 1.50 m			1		CI	FILL, gravelly sandy clay, dark grey	M	F		0.0m: FIll material to 3.5m
									CI	FILL, sandy clay, dark yellow brown with medium gravel	M	St		
									SP	FILL, clayey gravelly sand, grey brown	M	St		
										Coal fragments				
										Grey with sandstone fragments				
							2			Yellow brown with sandstone fragments				
										Yellow	W			2.0m: Wet soil / water ingress
										Dark yellow brown				
							3		CI	FILL, sandy clay, yellowish grey with coarse gravel	M (=PL)	St		
									CI	FILL, sandy clay, yellow brown with coarse gravel and coal fragments	M (=PL)	F		3.1m: Poor auger recovery, some voids
									SP	GRAVELLY SAND, yellowish grey	M	VSt		3.5m: Natural soil
									SP	GRAVELLY SAND and WEATHERED ROCK, yellowish grey with weathered sandstone rock fragments	M	H		3.6m: Hard drilling
							4			Hole Terminated at 3.80 m Refusal on weathered sandstone				
							5							

Method
AD/T - Auger drillling with tc-bit
AD/V - Auger drilling with v-bit
BH - Backhoe with bucket
E - Excavator
HA - Hand auger

Penetration
Very soft
increasing to
Hard and refusal

Samples and Tests
U - Undisturbed sample
D - Disturbed sample
ES - Environmental sample
SPT - Standard penetrometer test
CBR - California bearing ratio test
DCP - Dynamic cone penetrometer test

Moisture Condition
D - Dry
M - Moist
M=LL - Moist equal to liquid limit
M=PL - Moist equal to plastic limit
W - Wet

Consistency/Relative Density
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S - Soft
F - Firm
VSt - Very stiff
H - Hard
Fr - Friable
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Water level
▽ - Water inflow

Structure
qa - Estimated allowable bearing capacity
qs - Estimated shaft adhesion

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Borehole No.
BH4
Page 1 of 1

Engineering Log - Borehole

Client:	Ceedive	Commenced:	21/09/2021
Project Number:	13677	Completed:	21/09/2021
Location:	Valley Drive, Lithgow NSW	Logged By:	AR
Hole Position:	Timber trade sales 235582mE 6290821mN	Checked By:	AR

Drill Model and Mounting:	EVH truck drill rig	Inclination:	-90°	RL Surface:	Existing surface level
Hole Diameter:	75mm	Operator:	EL	Datum:	AHD

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Profile Description	Moisture Condition	Consistency Relative Density	Dynamic Cone Penetrometer (DCP) (blows per 10cm) 10 20 30	Structure and Additional Observations
AD/T			▽				1		CI	FILL, gravelly sandy clay, dark grey to dark yellow brown	M	F		0.0m: Fill material to 4.7m
									CI	FILL, sandy clay, dark yellow brown with medium gravel Grey brown with coarse gravel	M	St		
							2		SP	FILL, clayey gravelly sand, yellow brown with medium gravel Grey Brown Grey	M	St		
							3		SC	FILL, clayey sand, yellow brown with sandstone fragments	M (=PL)	St		
							4		GP	FILL, sandy gravel, yellowish grey with sandstone fragments	W	St		4.0m: Wet soil / water ingress
									SP	GRAVELLY SAND, yellowish grey	M	VSt		4.7m: Natural soil
							5		SP	GRAVELLY SAND and WEATHERED ROCK, yellowish grey with weathered sandstone rock fragments Hole Terminated at 5.00 m Refusal on weathered sandstone	M	H		4.9m: Hard drilling

Method
AD/T - Auger drillling with tc-bit
AD/V - Auger drilling with v-bit
BH - Backhoe with bucket
E - Excavator
HA - Hand auger

Penetration
Very soft
increasing to
Hard and refusal

Samples and Tests
U - Undisturbed sample
D - Disturbed sample
ES - Environmental sample
SPT - Standard penetrometer test
CBR - California bearing ratio test
DCP - Dynamic cone penetrometer test

Moisture Condition
D - Dry
M - Moist
M=LL - Moist equal to liquid limit
M=PL - Moist equal to plastic limit
W - Wet

Consistency/Relative Density
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S - Soft
F - Firm
VSt - Very stiff
H - Hard
Fr - Friable
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Water level
▽ - Water inflow

Structure
qa - Estimated allowable bearing capacity
qs - Estimated shaft adhesion

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Borehole No.
BH5
Page 1 of 1

Engineering Log - Borehole

Client:	Ceedive	Commenced:	21/09/2021
Project Number:	13677	Completed:	21/09/2021
Location:	Valley Drive, Lithgow NSW	Logged By:	AR
Hole Position:	Arterial road 235584mE 6290912mN	Checked By:	AR

Drill Model and Mounting:	EVH truck drill rig	Inclination:	-90°	RL Surface:	Existing surface level
Hole Diameter:	75mm	Operator:	EL	Datum:	AHD

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Profile Description	Moisture Condition	Consistency Relative Density	Dynamic Cone Penetrometer (DCP) (blows per 10cm) 10 20 30	Structure and Additional Observations
AD/T				1 CBR 0.00-1.00 m			0		CL	FILL, gravelly clay. dark grey	M	F		
									CL	FILL, gravelly clay, dark yellow brown	M	St		
									CI	FILL, sandy clay, brown with coarse gravel	M	St		
							1		SP	FILL, clayey gravelly sand, grey brown	M	St		
									CL	FILL, sandy clay, grey brown with coarse gravel	M	St		
							2			Hole Terminated at 2.00 m Target depth				
							3							
							4							
							5							

Method
AD/T - Auger drillling with tc-bit
AD/V - Auger drilling with v-bit
BH - Backhoe with bucket
E - Excavator
HA - Hand auger

Penetration
Very soft
increasing to
Hard and refusal

Samples and Tests
U - Undisturbed sample
D - Disturbed sample
ES - Environmental sample
SPT - Standard penetrometer test
CBR - California bearing ratio test
DCP - Dynamic cone penetrometer test

Moisture Condition
D - Dry
M - Moist
M=LL - Moist equal to liquid limit
M=PL - Moist equal to plastic limit
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
VSt - Very stiff
H - Hard
Fr - Friable
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Water level
▽ - Water inflow

Structure
qa - Estimated allowable bearing capacity
qs - Estimated shaft adhesion

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Borehole No.
BH6
Page 1 of 1

Engineering Log - Borehole

Client:	Ceedive	Commenced:	21/09/2021
Project Number:	13677	Completed:	21/09/2021
Location:	Valley Drive, Lithgow NSW	Logged By:	AR
Hole Position:	Car park 235517mE 6290821mN	Checked By:	AR

Drill Model and Mounting:	EVH truck drill rig	Inclination:	-90°	RL Surface:	Existing surface level
Hole Diameter:	75mm	Operator:	EL	Datum:	AHD

Drilling Information								***Soil Description***				***Observations***
Method	Penetration	Support	Water	Samples Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Profile Description	Moisture Condition	Consistency Relative Density	Dynamic Cone Penetrometer (DCP) (blows per 10cm) 10 20 30	Structure and Additional Observations
AD/T				1 CBR 0.00-1.00 m			0		CI	FILL, gravelly sandy clay, dark yellow brown	M	F		
									CI	FILL, sandy clay, yellow brown with medium gravel	M	St		
							1		SP	FILL, clayey gravelly sand, yellow brown with medium gravel	M	St		
							2			Hole Terminated at 2.00 m Target depth				
							3							
							4							
							5							

Method
AD/T - Auger drillling with tc-bit
AD/V - Auger drilling with v-bit
BH - Backhoe with bucket
E - Excavator
HA - Hand auger

Penetration
Very soft
increasing to
Hard and refusal

Samples and Tests
U - Undisturbed sample
D - Disturbed sample
ES - Environmental sample
SPT - Standard penetrometer test
CBR - California bearing ratio test
DCP - Dynamic cone penetrometer test

Moisture Condition
D - Dry
M - Moist
M=LL - Moist equal to liquid limit
M=PL - Moist equal to plastic limit
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
VSt - Very stiff
H - Hard
Fr - Friable
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Water level
▽ - Water inflow

Structure
qa - Estimated allowable bearing capacity
qs - Estimated shaft adhesion

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Borehole No.
BH7
Page 1 of 1

Engineering Log - Borehole

Client:	Ceedive	Commenced:	21/09/2021
Project Number:	13677	Completed:	21/09/2021
Location:	Valley Drive, Lithgow NSW	Logged By:	AR
Hole Position:	Car park entrance 235515mE 6290861mN	Checked By:	AR
Drill Model and Mounting:	EVH truck drill rig	Inclination: -90°	RL Surface: Existing surface level
Hole Diameter:	75mm	Operator: EL	Datum: AHD

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Profile Description	Moisture Condition	Consistency Relative Density	Dynamic Cone Penetrometer (DCP) (blows per 10cm) 10 20 30	Structure and Additional Observations
AD/T				1 CBR 0.00-1.00 m			0		CI	FILL, gravelly sandy clay, grey with medium gravel	M	St		
									CI	FILL, sandy clay, dark yellow brown with medium gravel	M	St		
							1		SP	FILL, clayey gravelly sand, grey brown with coarse gravel	M	St		
							2			Hole Terminated at 2.00 m Target depth				
							3							
							4							
							5							

Method
AD/T - Auger drillling with tc-bit
AD/V - Auger drilling with v-bit
BH - Backhoe with bucket
E - Excavator
HA - Hand auger

Penetration
Very soft
increasing to
Hard and refusal

Samples and Tests
U - Undisturbed sample
D - Disturbed sample
ES - Environmental sample
SPT - Standard penetrometer test
CBR - California bearing ratio test
DCP - Dynamic cone penetrometer test

Moisture Condition
D - Dry
M - Moist
M=LL - Moist equal to liquid limit
M=PL - Moist equal to plastic limit
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
VSt - Very stiff
H - Hard
Fr - Friable
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Water level
▽ - Water inflow

Structure
qa - Estimated allowable bearing capacity
qs - Estimated shaft adhesion

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Environmental
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Asbestos
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Rec 51002 Soil Index Properties - Test Report

Client: Ceedive

Report no: LR13677g page 1 of 1

Address: c/- Project Innovations Pty Ltd
Unit 11, 26-30 Linda Street
Hornsby NSW 2077

Site location: Part Lot 26, 21 Willowbank Avenue
Lithgow NSW

Borehole		BH1	BH2	BH2	BH3
Depth (mm)		600	2800	4000	1500
	Methods				
Liquid Limit (%)	AS 1289.3.1.2	30	32	33	31
Plastic limit (%)	AS 1289.3.2.1	-	-	-	-
Plasticity index (%)	AS 1289.3.3.1	-	-	-	-
Linear shrinkage (%)	AS 1289.3.4.1	7.0	8.0	9.0	8.0
Characteristics (curling or crumbling)		curling	curling	curling	curling
Field Moisture (%)	AS 1289.2.1.1	-	-	-	-
I_{SS}	AS 1289.7.1.1	-	-	-	-
USCS*	AS 1726	CL	CL	SC	SC
Description*	AS 1726	SANDY CLAY (FILL)	SANDY CLAY (FILL)	CLAYEY SAND	CLAYEY SAND (FILL)
Colour*	AS 1726	Olive brown	Grey	Grey	Yellow brown

Undisturbed samples

Inert inclusions in specimen	-	%					
Soil crumbling during shrinkage affecting mass	-	Yes	-	No			
Extent of cracking of sample	-	Major	-	Minor	-	Nil	

Disturbed samples

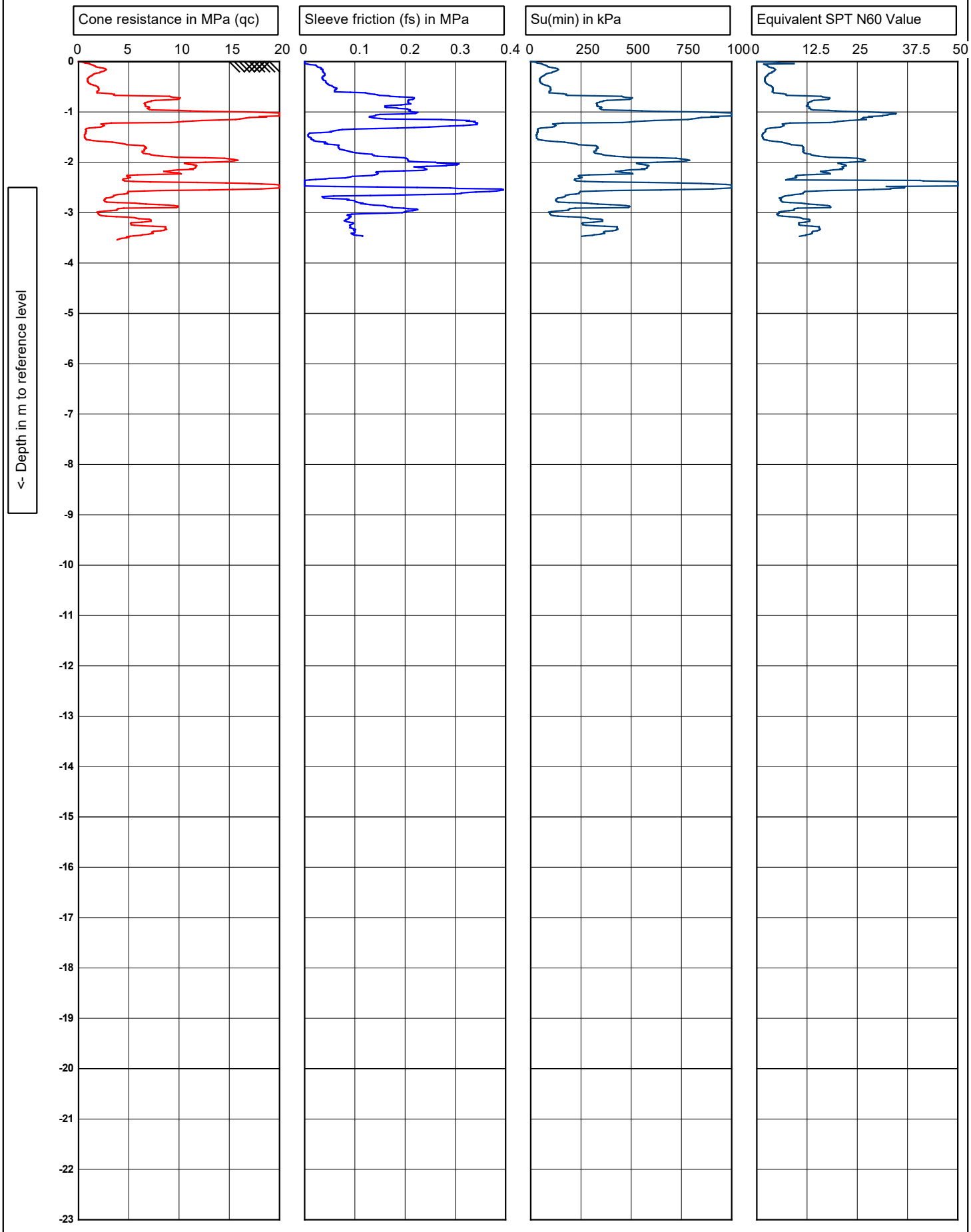
Sample preparation:	-drying	-	Air	x	Oven	-	Natural state
	-sieving	-	Wet			x	Dry
	-material	-	Pass 2.36mm			x	Pass 425 µm
Linear shrinkage:	-mould	x	251 mm			-	125 mm
Liquid Limit:	-method	x	One Point			-	Four Point

Samples tested as received
*Not a NATA accredited test

G. Madafiglio

Authorised signatory
Date: 18/10/2021

NATA
Accredited for compliance with
ISO/IEC 17025- **testing**
Accred. No. 15372



CPT-OFFICE

u2
225 cm²
15 cm²

Test according ISO 22476-1

G.L. : **0 NAP**

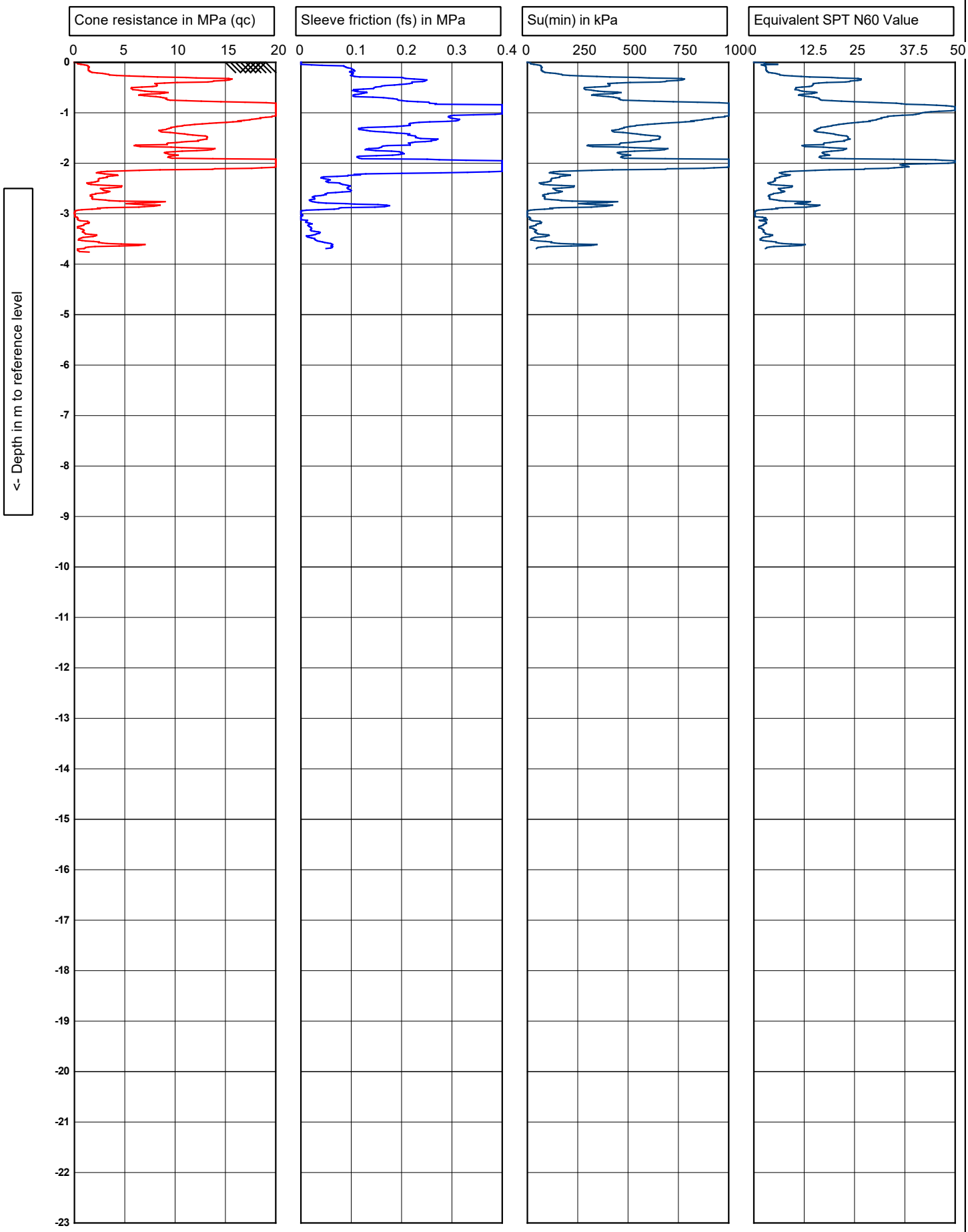
W.L. : **0**

Project : **EC**

Location : **BH1**

Position :

Pre drill :	**0**
Date :	**21/09/2021**
Cone no. :	**DP15-CFPTxy.70127**
Project no. :	**13677**
CPT no. :	**BH1** **1/1**



CPT-OFFICE

r u2
L 225 cm²
15 cm²

Test according ISO 22476-1

G.L. : **0 NAP**

W.L. : **0**

Project : **EC**

Location : **BH3**

Position :

Pre drill : **0**

Date : **21/09/2021**

Cone no. : **DP15-CFPTxy.70127**

Project no. : **13677**

CPT no. : **BH3b** **1/1**

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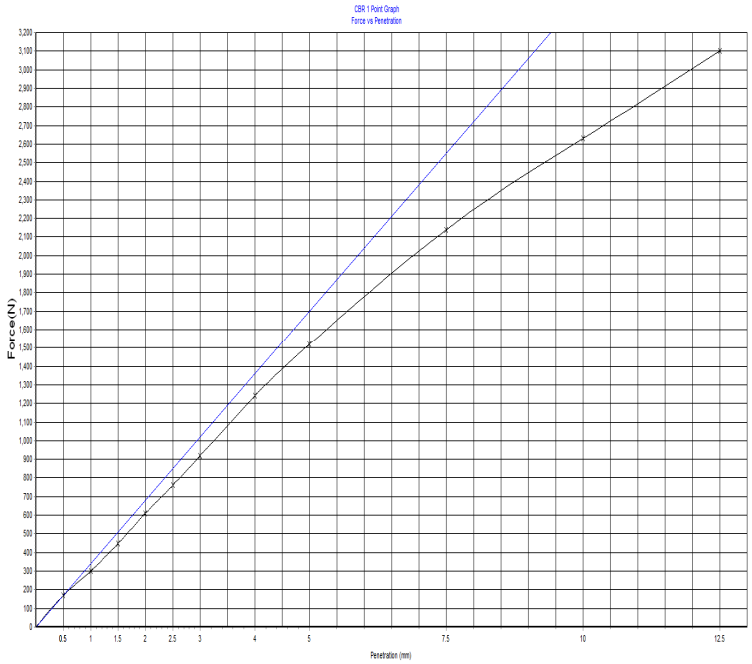
Environmental Geotechnical Asbestos Services

California Bearing Ratio Report (1 Point)

Client :	**Ceedive Pty Ltd**	Report Number:	**LR13677cbr.1**
Address :	**Po Box 379, Lithgow, NSW, 2790**	Report Date :	**6/10/2021**
Project Number :	**13677**	Order Number :	
Project Name :	**Proposed New Bunnings**	Test Method :	**T117**
Location:	**Valley Drive , Lithgow**	**Page 1 of 3**	

Sample Number :	S21-562	SAMPLE LOCATION
Date Sampled :	21/09/2021	Borehole: CBR1
Date Tested :	5/10/2021	Depth: 0-1000mm
Sampled By :	Andrew Ruming	Location:
Sampling Method :	T105	Desc: Subgrade
Material Source :		Lot Number :
Material Type :		Test Number : 2109-501
Remarks :		#REF!

Moisture Method :	T120
Maximum Dry Density (t/m³) :	1.85
Optimum Moisture Content (%) :	12.2
Compactive Effort :	Standard
Nominated Percentage of MDD :	100
Nominated Percentage of OMC :	100
Achieved Percentage of MDD :	102
Achieved Percentage of OMC :	98.0
Dry Density Before Soak (t/m³) :	1.879
Dry Density After Soak (t/m³) :	1.88
Moisture Content Before Soak (%) :	12.0
Moisture Content After Soak (%) :	
Density Ratio After Soak (%) :	102
Field Moisture Content (%) :	11.7
Top Moisture Content - After Penetration (%) :	14.4
Total Moisture Content - After Penetration (%) :	
Soak Condition :	Soaked
Soak Period (days) :	4
Swell (%) :	0.0



CBR Surcharge (kg) :	4.5	CBR 2.5mm (%) :	6
Oversize (%) :	3	CBR 5.0mm (%) :	**8**
Oversize Material Replaced (%) :	Excluded	**CBR Value (%) :**	**8**

Site Selection :	Client Selected
Soil Description :	Gravelly clay, grey

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing

APPROVED SIGNATORY

T. Beasley

Terry Beasley - Laboratory Manager
NATA Accreditation Number : 15372

Document Code RF41-5

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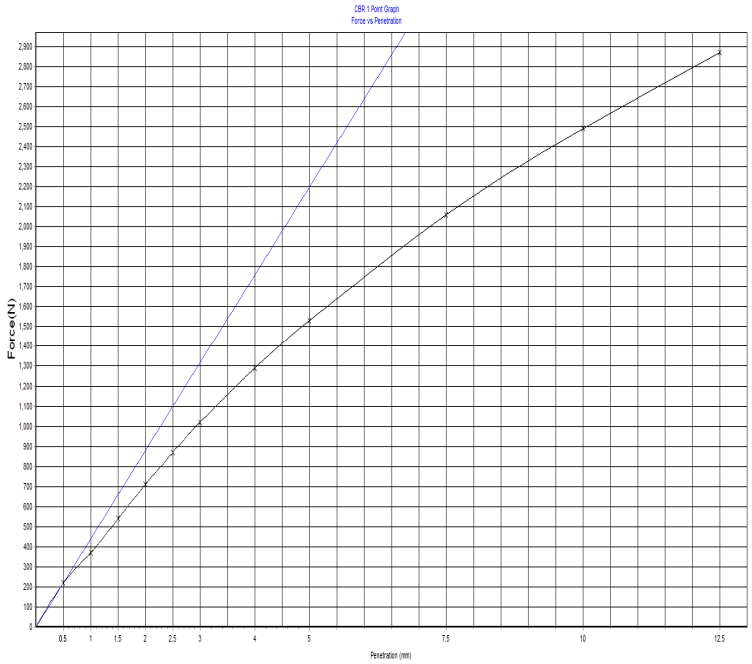
Environmental Geotechnical Asbestos Services

California Bearing Ratio Report (1 Point)

Client :	**Ceedive Pty Ltd**	Report Number:	**LR13677cbr.1**
Address :	**Po Box 379, Lithgow, NSW, 2790**	Report Date :	**6/10/2021**
Project Number :	**13677**	Order Number :	
Project Name :	**Proposed New Bunnings**	Test Method :	**T117**
Location:	**Valley Drive , Lithgow**	**Page 2 of 3**	

Sample Number :	S21-563	SAMPLE LOCATION
Date Sampled :	21/09/2021	Borehole: CBR2
Date Tested :	5/10/2021	Depth: 0-1000mm
Sampled By :	Luke Niven	Location:
Sampling Method :	T105	Desc: Subgrade
Material Source :		Lot Number :
Material Type :		Test Number : 2109-502
Remarks :		

Moisture Method :	T120
Maximum Dry Density (t/m³) :	1.864
Optimum Moisture Content (%) :	12.8
Compactive Effort :	Standard
Nominated Percentage of MDD :	100
Nominated Percentage of OMC :	100
Achieved Percentage of MDD :	100
Achieved Percentage of OMC :	101.0
Dry Density Before Soak (t/m³) :	1.861
Dry Density After Soak (t/m³) :	1.87
Moisture Content Before Soak (%) :	12.9
Moisture Content After Soak (%) :	
Density Ratio After Soak (%) :	100
Field Moisture Content (%) :	11.1
Top Moisture Content - After Penetration (%) :	15.8
Total Moisture Content - After Penetration (%) :	
Soak Condition :	Soaked
Soak Period (days) :	4
Swell (%) :	-0.5



CBR Surcharge (kg) :	4.5	CBR 2.5mm (%) :	7
Oversize (%) :		CBR 5.0mm (%) :	**8**
Oversize Material Replaced (%) :		**CBR Value (%) :**	**8**

Site Selection :	Client Selected
Soil Description :	Gravelly clay, yellow brown

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Terry Beasley - Laboratory Manager
NATA Accreditation Number :
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California Bearing Ratio Report (1 Point)

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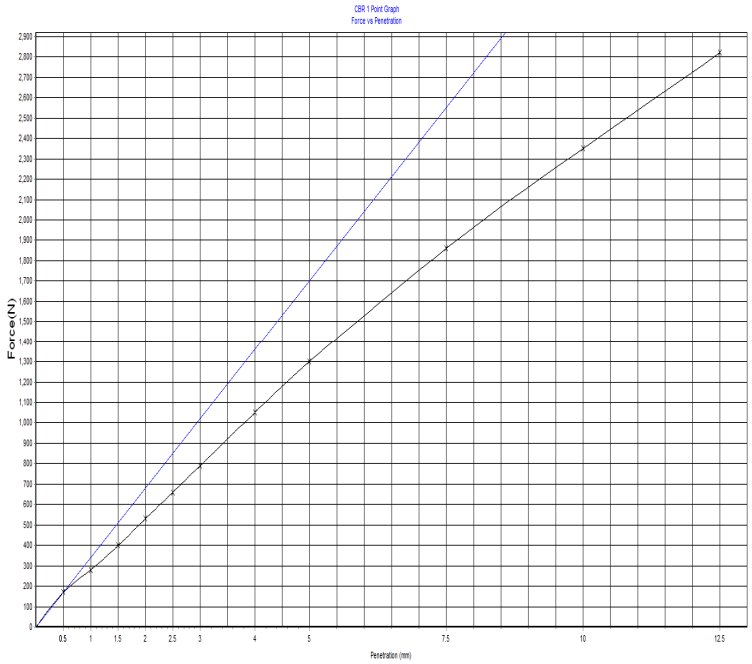
Address :	**Po Box 379, Lithgow, NSW, 2790**	Report Date :	**6/10/2021**
Project Number :	**13677**	Order Number :	
Project Name :	**Proposed New Bunnings**	Test Method :	**T117**
Location:	**Valley Drive , Lithgow**	**Page 3 of 3**	

Sample Number :	S21-564	SAMPLE LOCATION
Date Sampled :	21/09/2021	Borehole: CBR3
Date Tested :	5/10/2021	Depth: 0-1000mm
Sampled By :	Luke Niven	Location:
Sampling Method :	T105	Desc: Subgrade
Material Source :		Lot Number :
Material Type :		Test Number : 2109-503
Remarks :		#REF!

Moisture Method :	T120
Maximum Dry Density (t/m³) :	1.933
Optimum Moisture Content (%) :	11.3
Compactive Effort :	Standard
Nominated Percentage of MDD :	100
Nominated Percentage of OMC :	100
Achieved Percentage of MDD :	100
Achieved Percentage of OMC :	104.0
Dry Density Before Soak (t/m³) :	1.942
Dry Density After Soak (t/m³) :	2.188
Moisture Content Before Soak (%) :	11.7
Moisture Content After Soak (%) :	
Density Ratio After Soak (%) :	113
Field Moisture Content (%) :	10.7
Top Moisture Content - After Penetration (%) :	13.4
Total Moisture Content - After Penetration (%) :	
Soak Condition :	Soaked
Soak Period (days) :	4
Swell (%) :	0.0



CBR Surcharge (kg) :	4.5	CBR 2.5mm (%) :	5
Oversize (%) :		CBR 5.0mm (%) :	**7**
Oversize Material Replaced (%) :		**CBR Value (%) :**	**7**

Site Selection :	Client Selected
Soil Description :	Gravelly clay, grey

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Appendix 5 Aggressive soils, extract from Australian Standards, *AS 2870*

Exposure classification for concrete in saline soils

Saturated extract electrical conductivity (EC_e), *dS/m*	Exposure classification
<4	A1
4-8	A2
8-16	B1
>16	B2

Notes:

1. Guidance on concrete in saline soils can be found in CCAA T56
2. Exposure classifications are from AS 3600
3. The currently accepted method of determining the salinity level of the soil is by measuring the extract electrical conductivity (*EC*) of a soil and water mixture in deciSiemens per metre (dS/m) and using conversion factors that allow for the soil texture, to determine the saturated extract electrical conductivity (EC_e)
4. The division between a non-saline and saline soil is generally regarded as an EC_e value of 4dS/m, therefore no increase in the minimum concrete strength is required below this value

Exposure classification for concrete in sulphate soils

Exposure conditions			Exposure classification	
Sulphates (expressed as SO_4)*		pH	Soil conditions A**	Soil conditions B†
In soil (ppm)	In groundwater (ppm)			
<5,000	<1,000	>5.5	A2	A1
5,000-10,000	1,000-3,000	4.5-5.5	B1	A2
10,000-20,000	3,000-10,000	4-4.5	B2	B1
>20,000	>10,000	<4	C2	B2

* Approximately 100ppm SO_4 = 80ppm SO_3

** Soil conditions A – high permeability soils (e.g. sands and gravels) that are in groundwater

† Soil conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater

Minimum design characteristic strength (f_c') and curing requirements for concrete

Exposure classification	Minimum f_c' MPa	Minimum initial curing requirement
A1	20	Cure continuously for at least 3 days
A2	25	
B1	32	Cure continuously for at least 7 days
B2	40	
C1	≥50	
C2	≥50	

Minimum reinforcement cover for concrete

Exposure classification	Minimum cover in saline soils * mm	Minimum cover in sulfate soils ** (mm)
A1	See Clause 5.3.2	40
A2	45	50
B1	50	60
B2	55	65
C1	†	70
C2	†	85

* Where a damp-proofing membrane is installed, the minimum reinforcement cover in saline soils may be reduced to 30mm.

** Where a damp-proofing membrane is installed, the minimum reinforcement cover in sulfate soils may be reduced by 10mm.

† Saline soils have a maximum exposure classification of B2 as per Table 5.1.

Appendix 6. Important information about the report

Background
The intention of the Australian Standard 2870, Residential slabs and footings, is to provide guidance in the design of slabs and footings of residential building on commonly encountered foundations. The standard is also considered to provide useful guidance for commercial and industrial buildings. This involves (1) site classification, (2) structural design and construction and (3) site maintenance after construction. The classification assessment in this report is the first step in providing a footing system for a building, which will have a low risk of inadequate performance (Appendix B AS2870). Even significant cracking to widths of over 3 mm usually presents only aesthetic rather than structural problems. Some minor problems should be expected during settlement or in periods of drought.

Classification
AS2870 establishes a classification system whereby reactive sites (unaffected by filling) are designated slightly, moderately, highly or extremely reactive based on the range of ground surface movements anticipated and which are likely to have a less than 5% chance of being exceeded in the design life of the structure. Where the foundation conditions at a site need to consider aspects in addition to, or other than soil reactivity, the site is classified P.

It is neither possible nor economical to design for the extreme conditions that could occur in the foundation if a site is not properly maintained. The recommended foundation maintenance is described below. Some minor cracking and movement will occur in a significant proportion of houses, especially on reactive clays.

The method of subsurface investigation has been described in the attached report and it usually involves one or more boreholes or test pits in each lot. It may also involve the inspection of exposures in road cuttings and trenches. In making the assessment there is a risk that variations which may occur between tests or exposure locations may not be detected. The number of test pit locations undertaken is a professional estimate to provide a description of the general soil profile at the site. No subsurface investigation, no matter how comprehensive, can reveal all details and anomalies. Small local variations such as deep topsoil, fill associated with local grubbing of tree stumps and previous trenches or pits may be undetected. If subsoil conditions encountered during the footing excavation are different from those described in the report, reclassification may be necessary. The site should be reassessed and may require revision of the classification and footing design.

Most sites are not level and often require cutting and filling to provide a level platform for construction. AS2870 specifies the classification should be revised if (a) the depth of the cut exceeds 0.5m, or (b) the depth of compacted fill exceeds 0.4 m for clay or 0.8 m for sand.

Foundation maintenance
All soils are affected by water. Silts are weakened by water and some sands can settle if heavily watered, but most problems arise on clay foundations. Clays swell and shrink due to changes in moisture. Sands, silts and clays should be protected from becoming extremely wet. Sites classified as M, H or E shall be maintained at essentially stable moisture conditions and extremes of wetting and drying prevented. This requires attention to the following:

(a) Drainage of the site. The site shall be graded and drained so that water cannot pond against or near the house. The ground immediately adjacent to the house shall be graded to a uniform fall of 50mm minimum away from the house over the first metre. The sub floor space for houses with suspended floors shall be graded or drained to prevent ponding, where this may affect the performance of the footing system. The site drainage requirement shall be maintained for the economic life of the building.
(b) Limitation on gardens. The buildings shall not interfere with the drainage requirements or the sub floor ventilation and weep hole drainage systems. Garden beds adjacent to the house should be avoided. Care should be taken to avoid over watering of gardens close to the house footings.
c) Restrictions on trees and shrubs. Planting of trees and shrubs should be avoided near the foundations of a house on reactive sites as they can cause damage, even at substantial distances, due to the drying of the clay. To reduce, but not eliminate the possibility of damage, trees should be restricted to a distance of 1 times the mature tree height for Class H and M, and 1.5 times mature tree height for Class E. Where groups of trees are involved, distances should be increased. Removal of trees from the site can also cause similar problems.
(d) Repair of leaks. Leaks in plumbing, including storm water and sewage should be repaired promptly.

Class P sites
The presence of fill, compressible soils at depth or slope may influence footing performance and these need to be considered in foundation design.

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Hilf Density Ratio Report

Client :	**Kemdar Pty Ltd**	Report Number:	**LR11164.1**
Address :	**15 Laidley Street, Lithgow, NSW, 2790**	Report Date :	**1/08/2019**
Project Name :	**Valley Drive Commercial**	Order Number :	
Project Number :	**11164**	Test Method :	**AS1289.5.7.1 & 5.8.1**
Location:	**Valley Drive , Lithgow**	**Page 1 of 1**	

Sample Number :	S19-568	S19-569	S19-570	S19-571
Test Number :	3007-101	3007-102	3007-103	3007-104
Sampling Method :	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)
Date Sampled :	30/07/2019	30/07/2019	30/07/2019	30/07/2019
Date Tested :	31/07/2019	31/07/2019	31/07/2019	31/07/2019
Time Sampled :	1.20 pm	1.30 pm	1.40 pm	1.50 pm
Material Type :				
Lot Number :				
Sample Location :	General Location: Building Pad Sampling Location: S/E corner Lift: 1 Description: Fill	General Location: Building Pad Sampling Location: N/E corner Lift: 1 Description: Fill	General Location: Building Pad Sampling Location: Centre Lift: 1 Description: Fill	General Location: Building Pad Sampling Location: N/W corner Lift: 1 Description: Fill
Test Depth (mm) :	300	300	300	300
Layer Depth (mm) :				
Maximum Size (mm) :	19	19	19	19
Oversize Wet (%) :	0	0	0	0
Oversize Dry (%) :				
Oversize Density (t/m³) :				
Field Moisture Content (%) :	9.9	7.8	9.5	11.0
Hilf MDR Number :	S19-568	S19-569	S19-570	S19-571
Hilf MDR Method :	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1
Compactive Effort :	Standard	Standard	Standard	Standard
Moisture Method :	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1
Moisture Ratio (%) :	82.6	61.7	79.8	88.4
Field Wet Density (t/m³) :	2.07	2.09	2.05	2.09
Optimum Moisture Content (%) :	12.0	12.6	11.9	12.4
Moisture Variation :	2% dryer	5% dryer	2.5% dryer	1.5% dryer
Peak Converted Wet Density (t/m³) :	2.07	2.01	2.09	2.09
Hilf Density Ratio (%) :	**100.0**	**104.5**	**98.0**	**100.0**
Minimum Specification :				
Moisture Specification :				
Site Selection :	Random	Random	Random	Random
Soil Description :	Calyey sand, yellow brown	Clayey sand, yellow brown	Clayey sand, yellow brown	Clayey sand, yellow brown
Remarks :	-			

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Hilf Density Ratio Report

Client :	**Kemdar Pty Ltd**	Report Number:	**LR11164.2**
Address :	**15 Laidley Street, Lithgow, NSW, 2790**	Report Date :	**8/08/2019**
Project Name :	**Valley Drive Commercial**	Order Number :	
Project Number :	**11164**	Test Method :	**AS1289.5.7.1 & 5.8.1**
Location:	**Valley Drive , Lithgow**	**Page 1 of 3**	

Sample Number :	S19-581	S19-582	S19-583	S19-584
Test Number :	0208-1	0208-2	0208-3	0508-1
Sampling Method :	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)
Date Sampled :	2/08/2019	2/08/2019	2/08/2019	5/08/2019
Date Tested :	2/08/2019	2/08/2019	2/08/2019	5/08/2019
Time Sampled :	12.30	12.40	12.50	14.20
Material Type :				
Lot Number :				
Sample Location :	General Location: Building pad Sampling Location: North west Lift: 2 Description: Fill	General Location: Building pad Sampling Location: Centre Lift: 2 Description: Fill	General Location: Building pad Sampling Location: North east Lift: 2 Description: Fill	General Location: Building pad Sampling Location: North east Lift: 3 Description: Fill
Test Depth (mm) :	300	300	300	300
Layer Depth (mm) :				
Maximum Size (mm) :	19	19	19	19
Oversize Wet (%) :	0	0	0	0
Oversize Dry (%) :				
Oversize Density (t/m³) :				
Field Moisture Content (%) :	16.5	14.2	23.8	9.0
Hilf MDR Number :	S19-581	S19-582	S19-583	S19-584
Hilf MDR Method :	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1
Compactive Effort :	Standard	Standard	Standard	Standard
Moisture Method :	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1
Moisture Ratio (%) :	75.5	79.5	79.0	76.8
Field Wet Density (t/m³) :	2.01	2.10	1.82	2.07
Optimum Moisture Content (%) :	21.9	17.8	30.1	11.7
Moisture Variation :	5% dryer	3.5% dryer	6% dryer	3% dryer
Peak Converted Wet Density (t/m³) :	1.89	2.09	1.74	2.06
Hilf Density Ratio (%) :	**106.0**	**100.5**	**104.5**	**100.0**
Minimum Specification :				
Moisture Specification :				
Site Selection :	Random	Random	Random	Random
Soil Description :	Clayey Sand, yellow brown	Clayey Sand, yellow brown	Clayey Sand, yellow brown	Clayey Sand, yellow brown
Remarks :	-			

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Client :	**Kemdar Pty Ltd**	Report Number:	**LR11164.2**
Address :	**15 Laidley Street, Lithgow, NSW, 2790**	Report Date :	**8/08/2019**
Project Name :	**Valley Drive Commercial**	Order Number :	
Project Number :	**11164**	Test Method :	**AS1289.5.7.1 & 5.8.1**
Location:	**Valley Drive , Lithgow**	**Page 2 of 3**	

Sample Number :	S19-585	S19-586	S19-587	S19-588
Test Number :	0508-2	0508-3	0708-1	0708-2
Sampling Method :	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)
Date Sampled :	5/08/2019	5/08/2019	7/08/2019	7/08/2019
Date Tested :	5/08/2019	5/08/2019	7/08/2019	7/08/2019
Time Sampled :	14.30	14.40	10.40	10.50
Material Type :				
Lot Number :				
Sample Location :	General Location: Building pad Sampling Location: Centre Lift: 3 Description: Fill	General Location: Building pad Sampling Location: South west Lift: 3 Description: Fill	General Location: Building pad Sampling Location: North east Lift: 4 Description: Fill	General Location: Building pad Sampling Location: Centre Lift: 4 Description: Fill
Test Depth (mm) :	300	300	300	300
Layer Depth (mm) :				
Maximum Size (mm) :	19	19	19	19
Oversize Wet (%) :	0	0	0	0
Oversize Dry (%) :				
Oversize Density (t/m³) :				
Field Moisture Content (%) :	9.5	8.8	10.5	9.7
Hilf MDR Number :	S19-585	S19-586	S19-587	S19-588
Hilf MDR Method :	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1
Compactive Effort :	Standard	Standard	Standard	Standard
Moisture Method :	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1
Moisture Ratio (%) :	80.4	73.6	83.4	82.3
Field Wet Density (t/m³) :	2.09	2.04	2.18	2.13
Optimum Moisture Content (%) :	11.8	12.0	12.6	11.8
Moisture Variation :	2.5% dryer	3% dryer	2% dryer	2% dryer
Peak Converted Wet Density (t/m³) :	2.02	2.04	2.04	2.03
Hilf Density Ratio (%) :	**103.5**	**100.0**	**107.0**	**105.0**
Minimum Specification :				
Moisture Specification :				
Site Selection :	Random	Random	Random	Random
Soil Description :	Clayey Sand, yellow brown	Clayey Sand, yellow brown	Clayey Sand, yellow brown	Clayey Sand, yellow brown
Remarks :	-			

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Project Name :	**Valley Drive Commercial**	Order Number :	
Project Number :	**11164**	Test Method :	**AS1289.5.7.1 & 5.8.1**
Location:	**Valley Drive , Lithgow**	**Page 3 of 3**	

Sample Number :	S19-589	S19-590		
Test Number :	0708-3	0708-4		
Sampling Method :	AS 1289.1.2.1 (clause 6.4)	AS 1289.1.2.1 (clause 6.4)		
Date Sampled :	7/08/2019	7/08/2019		
Date Tested :	7/08/2019	7/08/2019		
Time Sampled :	10.55	11.00		
Material Type :				
Lot Number :				
Sample Location :	General Location: Building pad Sampling Location: South west Lift: 4 Description: Fill	General Location: Building pad Sampling Location: South east Lift: 4 Description: Fill		
Test Depth (mm) :	300	300		
Layer Depth (mm) :				
Maximum Size (mm) :	19	19		
Oversize Wet (%) :	0	0		
Oversize Dry (%) :				
Oversize Density (t/m³) :				
Field Moisture Content (%) :	9.7	9.9		
Hilf MDR Number :	S19-589	S19-590		
Hilf MDR Method :	AS1289.5.7.1	AS1289.5.7.1		
Compactive Effort :	Standard	Standard		
Moisture Method :	AS1289.2.1.1	AS1289.2.1.1		
Moisture Ratio (%) :	80.1	81.8		
Field Wet Density (t/m³) :	2.19	2.16		
Optimum Moisture Content (%) :	12.1	12.1		
Moisture Variation :	2.5% dryer	2% dryer		
Peak Converted Wet Density (t/m³) :	2.03	2.04		
Hilf Density Ratio (%) :	**108.0**	**106.0**		
Minimum Specification :				
Moisture Specification :				
Site Selection :	Random	Random		
Soil Description :	Clayey Sand, yellow brown	Clayey Sand, yellow brown		
Remarks :	-			

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Hilf Density Ratio Report

Client :	**Kemdar Pty Ltd**	Report Number:	**LR11164.3/1**
Address :	**15 Laidley Street, Lithgow, NSW, 2790**	Report Date :	**19/08/2019**
Project Name :	**Valley Drive Commercial**	Order Number :	
Project Number :	**11164**	Test Method :	**AS1289.5.7.1 & 5.8.1**
Location:	**Valley Drive , Lithgow**	**Page 1 of 2**	

Sample Number :	S19-592	S19-593	S19-594	S19-595
Test Number :	0908-1	0908-2	0908-3	0908-4
Sampling Method :	AS 1289.1.2.1 (clause 6.2)	AS 1289.1.2.1 (clause 6.2)	AS 1289.1.2.1 (clause 6.2)	AS 1289.1.2.1 (clause 6.2)
Date Sampled :	9/08/2019	9/08/2019	9/08/2019	9/08/2019
Date Tested :	9/08/2019	9/08/2019	9/08/2019	9/08/2019
Time Sampled :	9:30	9:40	9:50	10:00
Material Type :				
Lot Number :				
Sample Location :	General Location: Building pad Sampling Location: South east Lift: 5 Description: Fill	General Location: Building pad Sampling Location: North east Lift: 5 Description: Fill	General Location: Building pad Sampling Location: North west Lift: 5 Description: Fill	General Location: Building pad Sampling Location: South west Lift: 5 Description: Fill
Test Depth (mm) :	300	300	300	300
Layer Depth (mm) :				
Maximum Size (mm) :	19	19	19	19
Oversize Wet (%) :	0	0	0	0
Oversize Dry (%) :				
Oversize Density (t/m³) :				
Field Moisture Content (%) :	10.3	9.8	10.1	10.6
Hilf MDR Number :	S19-592	S19-593	S19-594	S19-595
Hilf MDR Method :	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1
Compactive Effort :	Standard	Standard	Standard	Standard
Moisture Method :	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1
Moisture Ratio (%) :	89.5	92.7	82.9	83.5
Field Wet Density (t/m³) :	2.16	2.12	2.17	2.16
Optimum Moisture Content (%) :	11.5	10.6	12.2	12.7
Moisture Variation :	1% dryer	1% dryer	2% dryer	2% dryer
Peak Converted Wet Density (t/m³) :	2.06	2.10	2.03	2.05
Hilf Density Ratio (%) :	**105.0**	**101.5**	**107.0**	**105.0**
Minimum Specification :				
Moisture Specification :				
Site Selection :	Random	Random	Random	Random
Soil Description :	Clayey sand, yellow brown	Clayey sand, yellow brown	Clayey sand, yellow brown	Clayey sand, yellow brown
Remarks :	-			

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Greg Madafiglio - Manager
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Hilf Density Ratio Report

Client :	**Kemdar Pty Ltd**	Report Number:	**LR11164.3/1**
Address :	**15 Laidley Street, Lithgow, NSW, 2790**	Report Date :	**19/08/2019**
Project Name :	**Valley Drive Commercial**	Order Number :	
Project Number :	**11164**	Test Method :	**AS1289.5.7.1 & 5.8.1**
Location:	**Valley Drive , Lithgow**	**Page 2 of 2**	

Sample Number :	S19-605	S19-606	S19-607	
Test Number :	1508-1	1508-2	1508-3	
Sampling Method :	AS 1289.1.2.1 (clause 6.2)	AS 1289.1.2.1 (clause 6.2)	AS 1289.1.2.1 (clause 6.2)	
Date Sampled :	15/08/2019	15/08/2019	15/08/2019	
Date Tested :	15/08/2019	15/08/2019	15/08/2019	
Time Sampled :	9:30	9:40	9:50	
Material Type :				
Lot Number :				
Sample Location :	General Location: Valley Drive Commercial Sampling Location: North west Lift: 6 Description: Fill	General Location: Valley Drive Commercial Sampling Location: West side Lift: 6 Description: Fill	General Location: Valley Drive Commercial Sampling Location: South West Lift: 6 Description: Fill	
Test Depth (mm) :	300	300	300	
Layer Depth (mm) :				
Maximum Size (mm) :	19	19	19	
Oversize Wet (%) :	0	0	0	
Oversize Dry (%) :				
Oversize Density (t/m³) :				
Field Moisture Content (%) :	10.8	10.8	10.1	
Hilf MDR Number :	S19-605	S19-606	S19-607	
Hilf MDR Method :	AS1289.5.7.1	AS1289.5.7.1	AS1289.5.7.1	
Compactive Effort :	Standard	Standard	Standard	
Moisture Method :	AS1289.2.1.1	AS1289.2.1.1	AS1289.2.1.1	
Moisture Ratio (%) :	85.2	89.9	85.0	
Field Wet Density (t/m³) :	2.09	2.09	2.10	
Optimum Moisture Content (%) :	12.7	12.0	11.9	
Moisture Variation :	2% dryer	1% dryer	2% dryer	
Peak Converted Wet Density (t/m³) :	2.04	2.06	2.05	
Hilf Density Ratio (%) :	**102.5**	**101.0**	**103.0**	
Minimum Specification :				
Moisture Specification :				
Site Selection :	Random	Random	Random	
Soil Description :	Clayey sand, yellow brown	Clayey sand, yellow brown	Clayey sand, yellow brown	
Remarks :	-			

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