Willow Tree Waste Management Facility

Landfill Expansion Masterplan

Liverpool Plains Shire Council

13 September 2021

GHD Pty Ltd | ABN 39 008 488 373

Suite C Level 1, 307 Peel Street

Tamworth, New South Wales 2340, Australia

T +61 2 49799900 | **F** +61 2 49799900 | **E** tamworthmail@ghd.com | **ghd.com**

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	S. Kentwell, A. Patapanian	C. Nivison-Smith		J. Roworth		13/09/2021

Contents

Table index

Figure index

Appendices

1. Introduction

1.1 Background

In 2018, Liverpool Plains Shire Council (Council) developed a 10-year strategy for the ongoing management of waste within their region (MRA, 2018). Landfilling forms an essential part of this strategy, along with the waste avoidance and reduction, increased recycling, and diversion of waste from landfill. The waste management strategy proposes to rationalise the landfilling operations across the region by establishing the Willow Tree Management Facility (WMF) (the site) as the primary landfill, servicing Council's Local Government Area (LGA) via an expansion of this existing landfill site with the existing lot boundary.

Council has engaged GHD Pty Ltd (GHD) to develop a masterplan for the site including a concept design for the landfill expansion.

1.2 Purpose

The purpose of this report is to document the site masterplan and concept design for the landfill expansion.

1.3 Scope of works

Specifically, the scope of works included:

- Review of site setting and masterplan inputs.
- Development of a facility arrangement and design basis for the landfill expansion, including relevant regulatory requirements and a review of options for cell geometry and lining/capping materials.
- Preliminary 3D modelling for the development of landfill airspace estimates for cell.
- Preliminary cost estimation for the landfill expansion.
- Identification of supplementary assessments and investigations required for the subsequent phases of the project.
- Provision of this report alongside preparation of concept design drawings to support preliminary cost estimates for the expansion.

1.4 Limitations

This report has been prepared by GHD for Liverpool Plains Shire Council and may only be used and relied on by Liverpool Plains Shire Council for the purpose agreed between GHD and Liverpool Plains Shire Council as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Liverpool Plains Shire Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has prepared this report on the basis of information provided by Liverpool Plains Shire Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared the preliminary cost estimate set out in Section 8 of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD and described throughout this report.

The Cost Estimate has been prepared for the purpose of supporting feasibility assessment of the landfill expansion and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

2. Site setting

2.1 Site location and surrounds

A summary of key site location details is provided in Table 2.1. The site locality and surrounding lands is shown in Figure 2.1.

Table 2.1 Site information summary

Item	Details
Address	Merriwa Road, Willow Tree, NSW, 2339
Land title	Lot 213, DP 1173230
Site land owner	Liverpool Plains Shire Council
Land zoning	SP1: Special Activities RU1: Primary Production
Overview of site location and surrounds	The site is surrounded by rural land with the Willow Tree township located 2 km northeast of the site. A privately run gravel quarry (Willow Tree Gravel Quarry) is located adjacent to the landfill site.

Figure 2.1 Site location (source: Google Earth)

2.2 Site history

Limited information is available on the history of the site. Based on site observations and discussions with Council, it is understood that the northern portion of the site was previously used for quarrying. The southern end of this portion has since been utilised for landfilling. Various crushed rock stockpiles are still present from these previous quarrying activities.

The southern portion of the site is predominately undisturbed, with the exception of access roads established across this area.

2.3 Topography and hydrology

A roughly north-south trending ridge forms a central portion with an unsealed access track along it. The northern part of this ridge has been removed by quarrying such that the high point is now near the central western area of the site. The land slopes away from this high point in all directions.

The northern portion of the site has been modified by quarrying and landfilling whereas the southern portion is largely undisturbed. The northern portion generally drains towards a number of ponds that are central to this area and were likely formed during the quarrying activities. The southern and eastern portions sheet flow away in all directions from the high point, with an intermittent waterbody present in the southwestern corner of the site.

2.4 Soils and geology

2.4.1 Geological setting

Reference to the NSW Seamless Geology dataset (accessed via MinView) indicates the site is situated on lower Triassic age Banks Wall Sandstone [Tnrb] as shown in Figure 2.2.

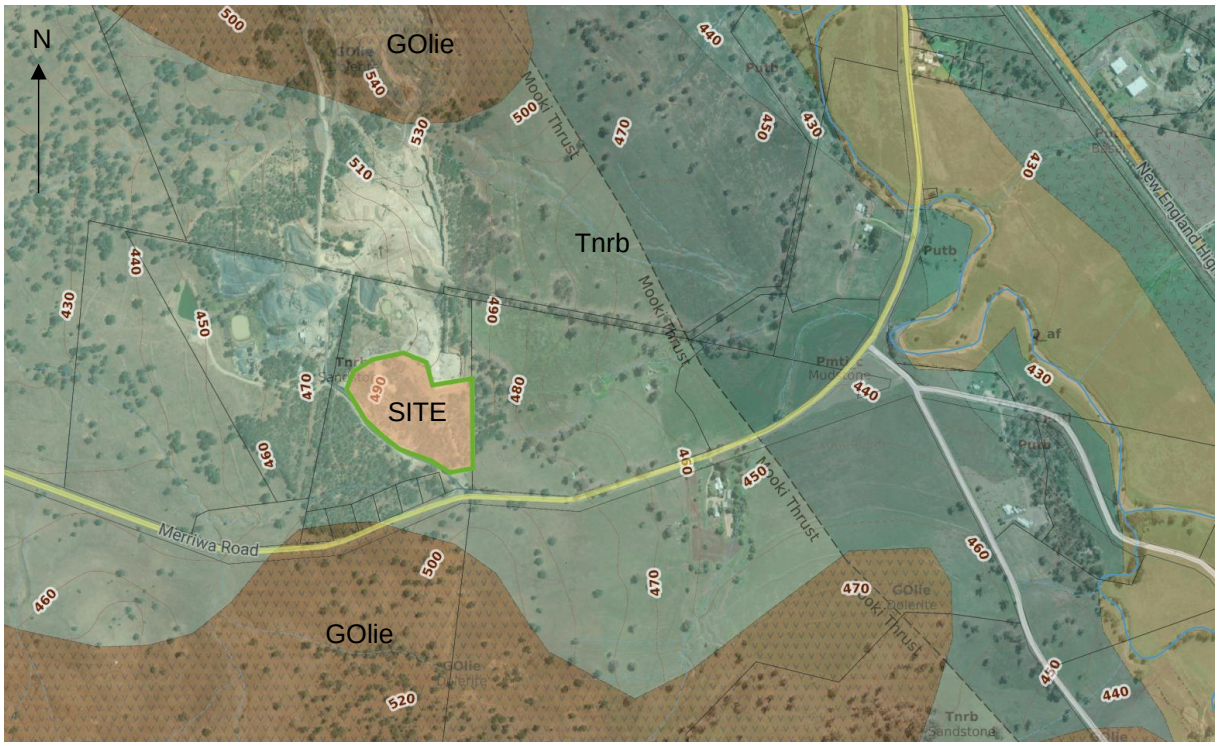


Figure 2.2 Geological setting

The superseded 1:250,000 scale Geological Series Sheet for Tamworth indicates that the site is situated on the Digby Conglomerate of the Narrabeen Group [Rrd].

As observed from bedrock outcrops on the site, this unit has bedding generally dipping toward a bearing of about 190° to 230° at 12° to 18° dip. The local lithology was observed to comprise conglomerate, pebbly sandstone and sandstone beds.

The Mooki thrust fault is located about 500 m to the north-east and dolerite capped hills, mapped as Liverpool East Basalt [GOlie], are about 1 km to the north of the site and south of Merriwa Road.

Willow Tree Gravel Quarry adjacent to the site quarries both the Liverpool East Basalt and Banks Wall Sandstone units to produce a variety of road and rail construction materials.

2.4.2 Soil landscape

Reference to the 1:100,000 scale Soil Landscapes of the Murrurundi map indicate that the site has a Ferrosol and Kandosol soil landscape. The soil landscape is characterised by undulating to rolling low hills with slopes ranging 5-15%. Slopes are typically 375-625 m long with elevation ranging from 400-460 m. Total relief is less than 50 m and a local relief of less than 30 m with minor to moderate erosion hazards. The typical soil profile consists of fine sandy loam to silt loam, overlying a loamy clay to clay.

2.5 Hydrogeology

Limited information is available on the hydrogeological conditions at the site. A review of nearby registered groundwater monitoring bores suggests groundwater levels significantly below the existing surface level.

2.6 Climate

Climate data for the site was obtained from the Bureau of Meteorology and is presented in Table 2.2 and Figure 2.3. Precipitation and temperature data was sourced from Murrurundi Gap AWS (Station no. 061392), located 11.8 km away from Willow Tree, NSW. Evaporation data was sourced from Lostock Dam (Station no. 061288), located 105 km away from the site.

Table 2.2 Climate statistics

Time period	Mean monthly rainfall (mm) (Murrurundi Gap AWS, no. 061392)	Mean monthly maximum temperature (ºC) (Murrurundi Gap AWS, no. 061392)	Mean monthly minimum temperature (ºC) (Murrurundi Gap AWS, no. 061392)	Mean monthly[1] evaporation (mm) Lostock Dam, no. 061288)
January	65.9	28.6	16.7	189.1
February	71.9	27.2	15.8	142.8
March	79.3	24.4	14.2	124.0
April	33.9	20.9	11.2	96.0
May	35.4	16.7	8.2	77.5
June	66.4	13	6	66.0
July	46.6	12.6	4.9	77.5
August	38.5	14.6	5.7	103.5
September	43.5	18.4	8.6	138.0
October	52.6	21.8	11	167.4
November	78.6	24.7	13.2	174.0
December	85.3	26.7	14.9	207.7
Annual (total for rainfall/evaporation and average for temperature)	707.3	20.8	10.9	1,569.5

[1] Calculated by multiplying daily rainfall by the number of days in that month, 28 days used for February.

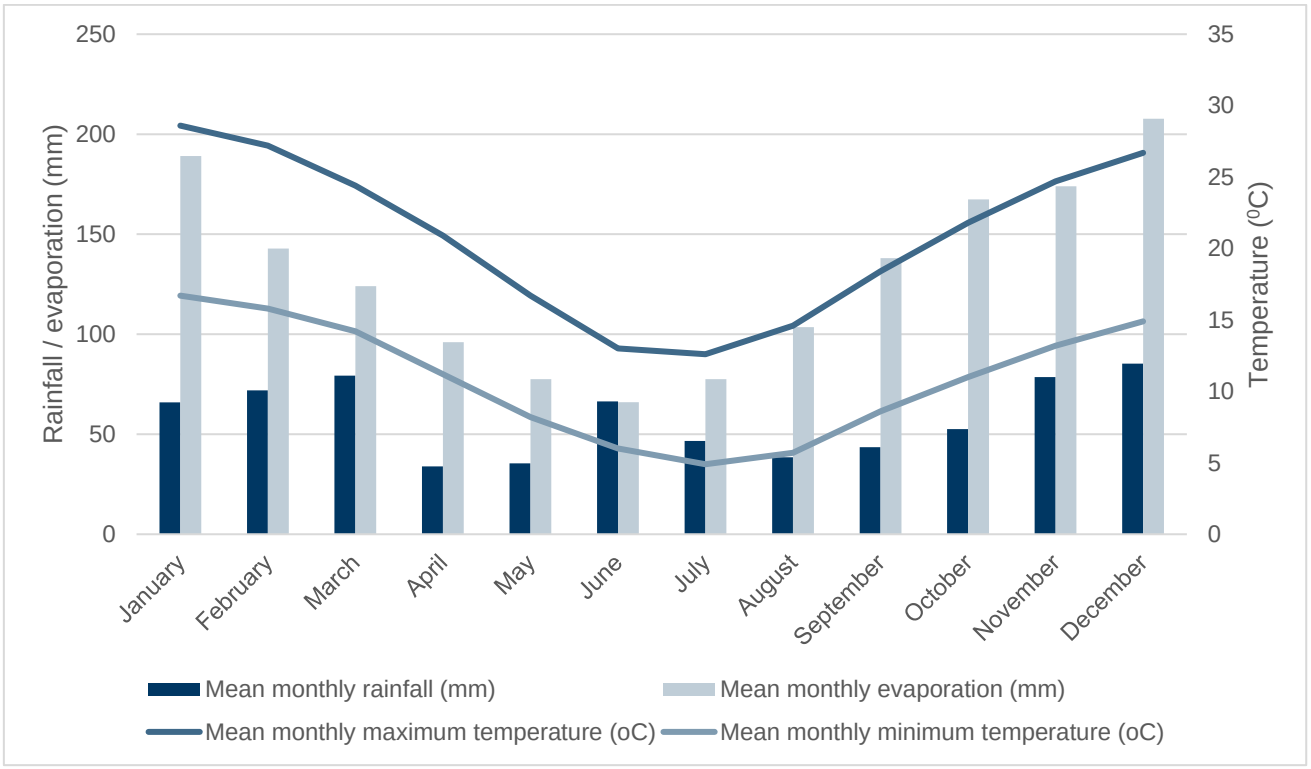


Figure 2.3 Climate statistics

The data shown above indicates the following:

- Mean monthly maximum and minimum temperatures are lowest during winter months (June to August) and highest during the summer months (December to February).
- Mean monthly rainfall varies across the year with the lowest during autumn and spring (April-May and July-October) and highest during summer and early autumn months (November-March).
- Estimated monthly evaporation is lowest during the late autumn and early winter months (May-July) and highest during late spring and summer months (September-February).
- Estimated monthly evaporation exceeds mean monthly rainfall for all months except for June and estimated annual evaporation exceeds the estimated annual rainfall.

3. Masterplan inputs

3.1 General

A number of initial assessment and investigation works have been completed to inform the masterplan and these are summarised below.

3.2 Site suitability

An initial desktop review was completed by GHD to assess the suitability of the site for expansion of the landfill, with consideration to the principals and procedures outlined in the EIS Guideline – Landfilling (NSW Department of Urban Affairs and Planning[2], 1996). This is documented in GHD (2021) and the review concluded that the expansion of landfill operations at the site appears feasible with no severe constraints identified. However, a number of items were identified for further consideration in the next phases of the project. Where relevant, these have been considered as part of this masterplan.

3.3 Survey

Council provided a topographic survey of the works area, completed by Bath Steward Associates (Dwg. Ref. 20096), dated 14 May 2020. This survey has been relied upon for the masterplan and design works, and the associated preliminary cost estimate.

3.4 Geotechnical conditions

3.4.1 General

GHD completed an initial geotechnical investigation in the southern undisturbed areas to obtain a better understanding of the site geology and geotechnical conditions. The report is contained in Appendix C and findings relevant to the masterplan are summarised below. Test pit locations for this investigation are shown in Figure 3.1.

[2] Currently the NSW Department of Urban Affairs and Planning

Figure 3.1 Test pit locations (source: GHD (2021a))

3.4.2 Excavation conditions

The 13.5 tonne excavator and pendulum auger used in the field investigation met with practical refusal on numerous occasions. In TP02 and TP04 this was due to waste debris binding up around the auger. An excavator with general purpose bucket would have been able to excavate through this material.

In the remainder of conditions, practical refusal was due to very slow progress of the auger through less weathered and stronger conglomerate and sandstone. Where previous stripping of surficial weathered material had occurred such as at TP05, TP06 and TP16 refusal was reached at less than 0.3 m depth. In other locations, refusal was reached when rock strength increased below a shallow weathered profile.

Excavation with a small to medium sized tracked excavator and bucket is likely to meet with similar slow progress in these materials. The use of hydraulic hammers to increase excavation progress is not expected to be effective as the sandstone and conglomerate bedding is expected to be thick. Large excavators of at least 20 to 30 tonne with buckets and suitable teeth are expected to be more effective but progress could still be very slow in high strength materials that are generally expected below the limit of the test pit investigation.

The excavation method employed by Willow Tree Gravel in these same materials is blasting. Excavation of the former quarry also appears to have been by blasting.

Excavation for a landfill cell is expected to be well beyond the limit of the geotechnical investigation. However, a good indication of conditions below this is available from the former quarry and Willow Tree Gravel Quarry where blasting is used. The blasting plans and experience of Willow Tree Gravel in excavating these materials would provide a valuable guide to excavation of rock to create a landfill cell.

3.4.3 Excavated material characteristics and re-use

The characteristics of the material as excavated is a function of the excavation method. In the case of the field investigation, a pendulum auger with new tungsten carbide teeth that are designed to roll and hence 'self-sharpen'. The effect was generally to grind through the material and it was only in the more thinly bedded sandstone that pieces of rock were recovered. Point Load Index testing could only be undertaken on these samples.

Excavation with a bucket, ripper or by blasting would produce material with larger pieces of rock. This can be seen in the below photo from the Willow Tree Gravel Quarry (Figure 3.2).

To produce a similar material to that created by auger drilling, crushing of oversized material from ripping or blasting would be needed. For very low and low strength materials, use of a grid roller on thinly spread material is likely to be effective in reducing oversize proportions. However, the effectiveness of this technique should be confirmed with a field trial, particularly for breakup of medium strength rock which is expected to comprise a significant proportion of the excavated material.

Figure 3.2 Willow Tree Gravel Quarry highwall

Re-use functions of the excavated soil and rock for use in landfill operations will depend on how the material is excavated and blended. Based on the observed auger excavated material and products of Willow Tree Gravel from the same rock units the following material uses are expected to be achievable:

– Daily cover.
– Intermediate cover.
– Internal access roads and hardstands.

The use of site won material in landfill cell liners would be restricted to protection layers for geosynthetics or liner foundation material. The material is expected to be too permeable to provide the function of a clay liner by itself and require significant processing of the harder rock for use in any drainage layers.

For capping materials, the site won material could provide a useful component but by itself is expected to be too permeable to provide the function of a clay capping.

3.5 Waste types and quantities

Council's Waste Management Strategy (MRA, 2018) includes estimates for waste generation for the region, which have been used to inform this masterplan and are summarised in Figure 3.3.

In 2013/14, Council received approximately 5,000 tonnes of waste through its rural landfills, major landfills and transfer stations, of which 1,800 tonnes was recycled and the remainder sent to landfill for disposal.

Waste generation has been projected for Council using:

– The rate of population growth in Council.
– The rate of growth of consumption in the Extended Regulated Area[3].

These projections estimate that waste generated in Council in Financial Year 2017 (1 July 2016 – 30 June 2017) was 5,751 tonnes per annum and will reach 9,427 tonnes per annum by FY27.

MRA (2018) noted limitations to this estimate, specifically the data for FY12 to FY14 (which comprises the basis of the projections):

– Was collected by visual inspection, incurring a large margin of error.
– Was measured at the three major landfills, and therefore is exclusive of the four rural landfills.

It was also noted that the impact of the NSW Government's Container Deposit Scheme (CDS) for drink containers was not included in this projection as the impacts are difficult to predict and are likely to lie within the margin of error for this analysis.

[3] The extended Regulated Area (ERA) is comprised of the Hunter, Illawarra and Central Coast regions. While Council is not located within the ERA, the quality of waste and resource recovery data for Council required the use of the next best available regional data.

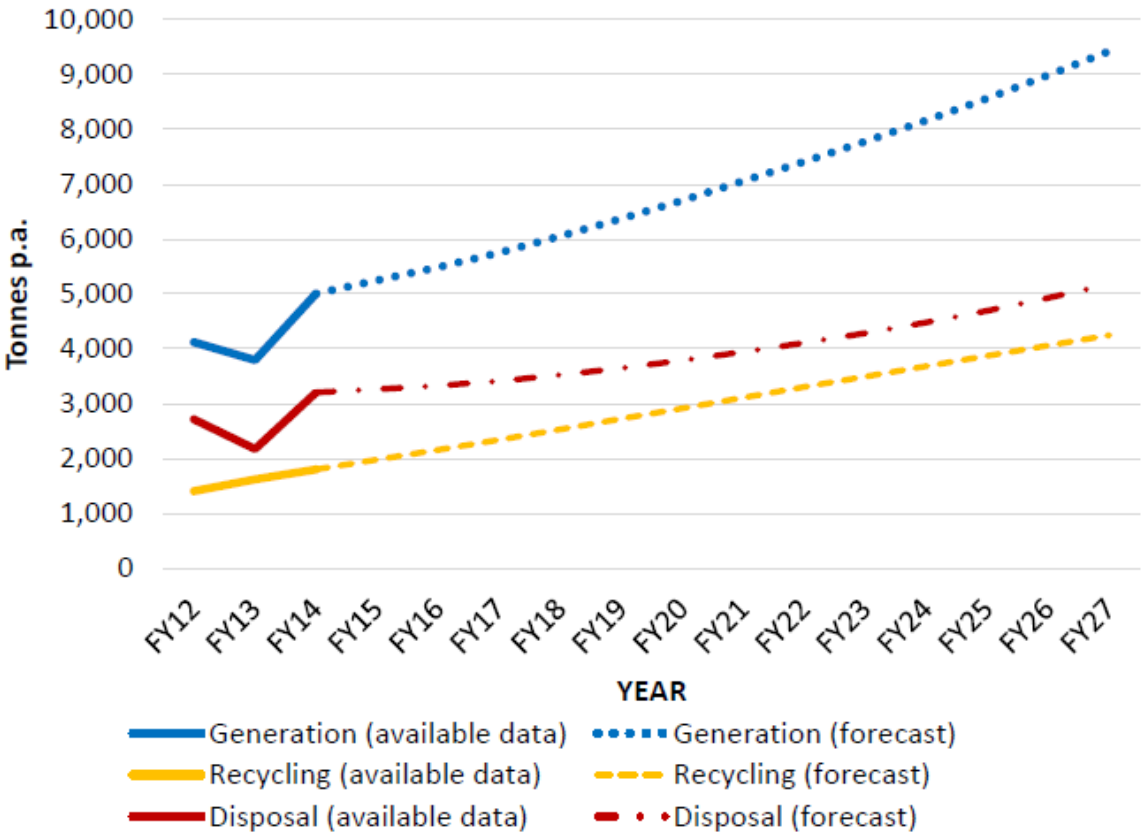


Figure 3.3 Council waste generation, recycling and disposal forecast (FY12-FY27) (source: MRA (2018))

3.6 Future land use

GHD understands that no specific future land use has been nominated at present. For the purposes of the concept design and masterplan, it is assumed that the future land use of the site will be restricted open space, with potential to retain infrastructure as part of a future waste transfer station operation.

4. Facility arrangement

4.1 Functional layout

The traffic and facility layout were conceptually arranged such that the domestic customers can conduct their activities in a single traffic loop, and commercial vehicles can conduct their activities with safe delineation. It allows site users to drive-by and stop at the individual drop-off facilities, and to park their vehicles in designated areas where required. A domestic vehicle traffic route has been adopted to maximise waste diversion and recycling prior to domestic access to waste drop-off areas for landfilling.

Provision has also been made for sufficient parking space for site personnel, with safe access to the office and amenities buildings.

4.2 Facility allocation

Table 4.1 summarises the landfill facilities that were allowed for as part of the masterplan alongside the new landfill cells and supporting infrastructure. These facilities are primarily to support the operational staff and domestic customers at the site. The area allocated for these facilities were based on previous experience with similar sized landfill sites and can be refined as part of the subsequent phases of the project, should the project be deemed feasible.

Table 4.1 Landfill facilities basis summary

Facility	Summary of basis
Weighbridge	Located at site entrance, dual weighbridge preferred.
Site office and amenities	Located near site entrance including parking for 3-5 staff.
Resource recovery area	General area for resource recovery, may include a community recycling centre, and drop-off locations for domestic customers for tyres, concrete, steel, green waste, bulky wastes, etc.
Small vehicles transfer station	Area for waste disposal by domestic customers, for transfer by the site operator or collections contractor to the landfill cells.

4.3 Access

Access arrangements comprise of the following, in line with the proposed functional layout:

– Access from the Merriwa Road via formalisation of the existing access track running through the site for both domestic and commercial vehicles.
– Combined access to the weighbridge for domestic and commercial vehicles, followed by delineation of these vehicles to separate routes.
– Access road for domestic vehicles to the resource recovery areas (to promote resource recovery in the first instance), followed by access to the small vehicles transfer station for residual waste disposal, and then access to the site exit route.
– Access road for commercial vehicles directly to the landfill cells, and then access to the site exit route. Safety measures to be implemented where commercial vehicles re-join and share domestic vehicle routes. Additional access for commercial vehicles to the small vehicles transfer station for waste transfer to the landfill cells.

5. Landfill cell design basis

5.1 General

The concept design basis for the new landfill cells for the expansion is summarised below. Sketches for the preferred option (refer Section 9) are presented in Appendix A.

5.2 Cell extent

The cell extent will maximise the available site area whilst allowing sufficient area for site operational facilities, resource recovery areas and supporting infrastructure such as roads and ponds.

Two areas were considered for the new landfill cells:

1. Former quarry area: This comprises of the northern portion of the site which was previously used for quarrying activities. The cell extent in this area would be generally bounded by the quarry walls with sufficient area retained for access as well as surface water and leachate ponds.
2. Undeveloped area: This comprises of the undisturbed central to the southern portion of the site, bounded:
    - To the north and east by the former quarry area, the access track running through the site and the existing landfilled areas.
    - To the south and west by the access road to the Willow Tree Gravel Quarry.

An additional undeveloped area on the western side access road to the Willow Tree Gravel Quarry may potentially be used for landfilling, however was not considered given the overall airspace requirements for the project and potential issues with the intermittent waterbody present in this area.

5.3 Existing landfilled areas

Based on site observations and intrusive investigations undertaken as part of GHD (2021a) and the site survey area aerial, the existing landfilled areas include:

– An active landfilling mound central to the former quarry area.
– A linear mound of waste parallel to the western side of the central access track.
– Deeper buried waste encountered in test pits TP1, TP2, TP4, TP7 and TP17.

Given the central location of these existing landfill areas, they present a challenge to the future lined landfill cells to achieve a continuous lined area and maximise the potential landfilling airspace. A number of options were identified to address this issue as summarised in Table 5.1 These have been considered as part of the concept design and associated airspace and cost estimates described in this report. Further investigations will be required to refine the extent of the existing landfilled areas and subsequently determine the extent of the new landfill cells.

Table 5.1 Options for existing landfilled areas

Option	Benefits/constraints
Offset the new landfill cells from the existing landfilled areas, capping and rehabilitating the existing landfilled areas separate to the landfill expansion.	– No additional measures required to address legacy landfilling issues as part of the expansion. – Significantly reduction in landfill airspace due to offset.
Install a landfill liner over the existing landfilled areas (with additional measures to control differential settlement, i.e. piggyback lining).	– Maximise landfill airspace for the expansion. – Costs associated with piggyback lining.
Progressively relocate existing landfilled waste into the lined cells constructed as part of the expansion.	– Maximise landfill airspace for the expansion. – Costs associated with waste relocation.

5.4 Cell excavation and stockpiling

For both areas considered for the new landfill cells, excavation will be limited to a minimum, primarily establish a suitable grading along the landfill base for construction and operation. This is due to the following:

– For the undeveloped area, based on the subsurface conditions encountered during GHD (2021a), excavation may be significantly hampered by the subsurface rock materials.
– The conditions are likely to be similar in the former quarry area and excavation issues potentially exacerbated by this quarrying (which would have retained harder rock material in place). However, it is noted that a fill platform appears to have been established in the northwestern corner of this area which may potentially be removed as part of the excavation works where possible and this should be investigated further as part of the subsequent phases of the project, if deemed feasible.

It is anticipated that the excavated materials will be segregated during cell construction for future reuse, including topsoil for capping, soil materials for cover and capping, and rock material for processing and reuse in access road construction. Given the limited excavation quantities expected, the excavated material will be progressively stockpiled in unused landfill areas, interim covered areas and/or capped areas as the landfilling progresses. It is assumed the same stockpiling process can be used for the cover material sourced from the Willow Tree Gravel Quarry and that it will be progressively provided to suit landfilling operations.

5.5 Cell grading

The base of the cells will be graded in accordance with the requirements of the NSW EPA Landfill Guidelines, 1% longitudinally along the cells, with 3% grades in the transverse direction. Sidewalls in the undeveloped area will be no greater than 1V:3H based on a review of geotechnical conditions (refer Section 3.4) and to provide a stable surface for lining. Sidewalls in the in the former quarry area will be steeper to align with previous quarrying works.

5.6 Liner profile

5.6.1 Basal liner

Basal liner options

Basal liner options were developed consistent with NSW EPA's Environmental Guidelines: Solid Waste Landfills (2016). These options include:

– A low permeability natural soil liner profile consisting of compacted clay overlain with a leachate collection layer – single sealing layer required based on expected waste quantities.
– A low permeability geosynthetic capping profile consisting of geosynthetic clay liner (GCL) and high density polyethylene (HDPE) geomembrane overlain with a leachate collection layer – composite sealing layer required where GCL is used as an alternative to clay.

Each of the proposed options is considered potentially suitable for meeting the design objectives of the works. The options are described in further detail in Table 5.2.

Table 5.2 Proposed basal liner profiles (top to bottom)

Layer	Option 1	Option 2
Leachate collection layer	Separation geotextile	Separation geotextile
	300 mm thick drainage aggregate with PE leachate collection pipework	300 mm thick drainage aggregate with PE leachate collection pipework
	Separation geotextile	Protection geotextile
Sealing layer	1,000 mm thick compacted clay	HDPE geomembrane
		Geosynthetic clay liner
Subgrade	Prepared existing surface with min. 200 mm thick surface ripped, moisture conditioned and re-compacted	Prepared existing surface with min. 200 mm thick surface ripped, moisture conditioned and re-compacted

Basal liner options assessment

GHD conducted a comparative assessment of the proposed basal liner options (considering feedback from Council on material availability), summarised in Table 5.3.

Table 5.3 Comparative basal liner options assessment

Option	Comparative cost[4]	NSW EPA compliance	Airspace consumption	Constructability	Material availability
1	\$70-120 / m^2	Yes	Relatively 1 m thicker than Option 2	– Earthen materials can be installed using typical civil construction methods – Clay installation requires specific focus on moisture control	– Suitable clay can be challenging to procure due to permeability requirements
2	\$80-100 / m^2	Yes	Relatively 1 m thinner than Option 1	– Geosynthetics installed by a specialist, GCL requires wet weather management during installation	– Geosynthetics in stock or manufactured as required (6 weeks lead time)

Basal liner recommendations

Based on our assessment, Option 2 was adopted based on the following:

– Option 1 is highly dependent on clay procurement, and based on Council feedback on our local experience, this is likely to be challenging and result in a comparative cost on the high end of our estimate.
– Option 2 provides the additional benefit of generating additional airspace compared to Option 1, offset any potential additional costs.

5.6.2 Sidewall liner

For the undeveloped area, the sidewall liner profile options and recommendations were consistent with the basal liner options discussed in Section 5.6.1, with a drainage geocomposite used for the leachate collection layer due to the grading of these areas.

For the former quarry area, further inspections/investigations will be required to confirm the suitably of the current quarry faces for lining to be undertaken as part of the subsequent phases of the project, if deemed feasible. For the purposes of this phase of the project, a conservative lining approach has been assumed with an earthen layer installed to allow lining to occur. Future investigations may identify a steep wall lining approach can be adopted (if possible and cost effective).

[4] Represent direct costs only and are not intended to represent likely project budgets or expected contract costs. The advice has been provided for comparison purposes only.

It is proposed that the sidewall liner be constructed using a ‘shingle’ approach, where the vertical component of the liner is incrementally constructed in parallel with waste placement lifts. Each adjoining vertical liner segment connects to the one below it to form a continuous hydraulic barrier. The shingle approach is repeated until the sidewall liner reaches the desired height.

The sidewall liner profile was developed generally consistent with NSW EPA’s Environmental Guidelines: Solid Waste Landfills (2016), and consists of (from top to bottom):

– Sacrificial / Slip plane geotextile (if required)
– Protection geotextile
– HDPE geomembrane
– Min 2 m thick earthen berm offset from the existing rock face

Due to the steep nature of the sidewalls, it was proposed that a leachate collection layer is not required for the sidewall liner profile, to be justified as part of the detailed design. A similar approach has been recently approved at other quarry landfill sites in NSW.

5.7 Groundwater management

The need for groundwater management measures will be assessed as part of the subsequent phases of the project, if deemed feasible. For the concept design, it was understood that the base of the cell will be significantly above the groundwater table and as such no specific measures will be considered for groundwater management as part of the concept design.

5.8 Surface water management

Incoming clean surface water flowing from surrounding terrain will be diverted around the landfill expansion area via diversion drains/banks.

Where possible, rainfall falling onto the footprint of the landfill cell would be prevented from coming into contact with waste via the application of soil (or other inert) cover materials. Sediment laden water would be opportunistically collected and/or diverted to the existing pond for treatment.

A nominal allowance was made for a sediment pond based on high level staging of the landfill operations with reference to the Blue Book Volume 2B. The final pond size will be refined as part of the subsequent phases of the project, if deemed feasible.

5.9 Leachate management

5.9.1 Overview

Leachate collected in the landfill cells will be pumped to a new leachate pond. Based on the climatic data presented in Section 2.6, leachate disposal via evaporation from this pond is feasible and would be implemented. The need for emergency leachate disposal measures (such as irrigation and off-site tankering during or immediately after high rainfall events) will be assessed as part of the subsequent phases of the project, if deemed feasible.

The leachate pond was sized based on high level staging of the landfill operations with consideration to the default rainfall infiltration percentages provided in NSW EPA’s Environmental Guidelines: Solid Waste Landfills (2016). The final pond size will be refined as part of the subsequent phases of the project, if deemed feasible.

5.9.2 Leachate pond liner profile

The leachate pond will be lined to a similar standard as the new landfill cells (refer Section 5.6). Given potential issues with ongoing confinement, it is recommended that a clay sealing layer is utilised, noting the potential supply issues with this material.

The proposed pond liner profile consists of (from top to bottom):

– 1000 mm thick compacted clay.
– Prepared existing surface with min. 200 mm thick surface ripped, moisture conditioned and re-compacted.

5.10 Landfill gas management

Landfill gas management will be addressed during operation of the cell and not specifically as part of the concept design of the cell which is industry practice.

5.11 Cover material

The limited excavation proposed for the new landfill cells will require cover material to be recovered from a separate source. Council has conducted initial discussions with the Willow Tree Gravel Quarry to utilise overburden material from their operations as cover material. It is assumed this process can provide suitable cover material for the life of the landfill.

As previously identified, a fill platform appears to have been established in the northwestern corner of the former quarry area which may potentially be removed as part of the excavation works and reused as cover material. This should be investigated further as part of the subsequent phases of the project, if deemed feasible.

5.12 Final landform and staging

The final landform will be assumed to contain maximum 1V:5H slopes with a minimum of 5% batters. As there is no specified future land use at present (refer Section 3.6), the design sought to maximise landfill capacity across the expansion area.

Staging will be subject to ongoing access, leachate management and surface water management. In general, each landfill cell in the expansion area was designed to last approximately 5 years.

5.13 Final capping profile

5.13.1 Capping options

Capping options were developed consistent with NSW EPA's Environmental Guidelines: Solid Waste Landfills (2016). These options include:

– A low permeability natural soil capping profile consisting of compacted clay overlain with subsoil/topsoil and revegetation.
– A low permeability geosynthetic capping profile consisting of linear low-density polyethylene (LLDPE) geomembrane or coated GCL overlain with subsoil/topsoil and revegetation.
– An evapotranspiration (ET) capping profile consisting of suitable subsoil overlain with topsoil and revegetation.

Each of the proposed options is considered potentially suitable for meeting the design objectives of the works. The options are described in further detail in Table 5.4.

Table 5.4 Proposed capping profiles (top to bottom)

Layer	Option 1	Option 2	Option 3
Revegetation layer	Shallow rooted grass species	Shallow rooted grass species	To be confirmed based on phytocap modelling, however likely to comprise: – Design specific shrubs and planting – 200 mm thick topsoil layer – 1,300 mm thick subsoil layer (min.)
	200 mm thick topsoil layer	200 mm thick topsoil layer	
	800 mm thick subsoil layer	800 mm thick subsoil layer	
Subsoil drainage layer / capillary break layer	-	Drainage geocomposite	Drainage geocomposite (if required)
Sealing layer	600 mm thick compacted clay	LLDPE geomembrane	-
Gas drainage layer	To be confirmed based on landfill gas modelling	To be confirmed based on landfill gas modelling	To be confirmed based on landfill gas modelling
Seal bearing layer	300 mm thick existing interim cover layer	300 mm thick existing interim cover layer	300 mm thick existing interim cover layer

5.13.2 Capping options assessment

GHD conducted a comparative assessment of the proposed basal liner options (considering feedback from Council on material availability), summarised in Table 5.5.

Table 5.5 Comparative cap options assessment

ID	Comparative cost[5]	NSW EPA compliance	Infiltration rates / leachate generation	Constructability	Material availability
1	\$50-90 / m^2	Yes	Low (5% of average annual rainfall)	– Earthen materials can be installed using typical civil construction methods – Clay installation requires specific focus on moisture control	– Earthen materials will need to be imported – Suitable clay can be challenging to procure due to permeability requirements
2	\$60-80 / m^2	Likely yes, however it will require justification for alternative sealing layer	Very low (<1% of average annual rainfall)	– Earthen materials can be installed using typical civil construction methods – Geosynthetics installed by a specialist, usually not significantly impacted by rain	– Earthen materials will need to be imported – Geosynthetics in stock or manufactured as required (6 weeks lead time)
3	\$40-80 / m^2 (note: considers whether capillary break layer may or may not be required)	Potentially yes, however further modelling and justification required (including a field trial)	Low (5% of average annual rainfall)	– Earthen materials can be installed using typical civil construction methods, with a greater focus on minimising compaction – Specialist landscaping contractors may be required for installation and maintenance of revegetation – Geosynthetics (if required) installed by a specialist, usually not significantly impacted by rain	– Earthen materials will need to be imported – Assessment of likely available materials will need to be considered for site specific modelling prior to procurement – Geosynthetics in stock or manufactured as required (6 weeks lead time)

[5] Represent direct costs only and are not intended to represent likely project budgets or expected contract costs. The advice has been provided for comparison purposes only.

5.13.3 Capping recommendations

Based on our assessment, Option 2 or 3 was adopted based on the following:

– Option 1 is highly dependent on clay procurement, and based on Council feedback on our local experience, this is likely to be challenging and result in a comparative cost on the high end of our estimate.
– Option 2 provides the highest comparative confidence for material procurement and supply and will also provide the most significant reduction in rainfall infiltration and leachate generation. Based on our previous experience, it is very likely to be approved as an alternative capping profile by the NSW EPA.
– Option 3 requires site-specific modelling and a field trial that can take 3-5 years. This option is potentially favourable but contingent on time available for trialling and suitable material being available.

5.14 Access

Access arrangements comprises the following:

– Formalisation of the existing access track running through the site for commercial vehicle access to the landfill cells.
– Access tracks running around the perimeter of the landfill cells, sediment pond and leachate pond.
– Temporary access during landfilling into each landfill cell as they progress.

6. Safety in design

As part of the concept design, safety in design risk identification was undertaken, with a comprehensive assessment to be undertaken as part of the future stages of the project, if deemed feasible.

The risk identification process indicated the following potential safety issues:

– Rockfall from quarry faces.
– Construction on steep slopes, including ongoing stability and working from heights.
– Leachate generation/exposure.
– Landfill gas generation/exposure.
– Noise and dust generation/exposure.
– Placement and compaction of materials on batter slopes.
– Movement of construction machinery.

7. Preliminary landfill airspace estimates

7.1 General

Landfill airspace estimates were completed with respect to the various design options above, to support the preliminary cost estimates and decision making for the feasibility of the landfill expansion.

Specifically, the landfill airspace estimates are based upon:

– The options for new landfill cell areas presented in Section 5.2.
– The options for managing existing landfilled areas presented in Section 5.3.
– The preferred basal liner and sidewall liner options presented in Section 5.6.
– The preferred capping profile options presented in Section 5.13.

Landfill life calculations were based on the following assumptions:

– Waste disposal estimates described in MRA (2018) and summarised in Section 3.5, assuming a 2022 start date.
– A landfill compaction rate of 0.8 t/m^3 is achieved.

The estimates do not include additional airspace that may be generated via removal of the fill platform in the former quarry area, as discussed in Section 5.4.

7.2 Preliminary estimates

Preliminary landfill airspace estimates and landfilling life estimates are provided in Appendix B and summarised in Table 7.1 and Table 7.2.

Based on the preliminary estimates:

– Offsetting from the existing landfilled areas results in a reduction of landfilling airspace for both areas, however it is significant for the former quarry area given the central location of this waste which compromises the final landform arrangement.
– The former quarry area produces significantly more airspace that the undeveloped area due to the former quarrying providing additional depth for landfilling.

Table 7.1 Preliminary landfill airspace estimates – former quarry area

Item	Option		
	Offset from existing landfilled areas	**Piggyback liner over existing landfilled areas**	**Relocate existing landfilled areas**
Total void (m^3)	175,000	325,000	325,000
Liner volume (m^3)	20,900	38,200	33,200
Capping volume (m^3)	30,000	35,000	35,000
Landfill airspace (m^3)	124,100	251,800	256,800
Landfilling life (yrs) (with annual growth)	19	32	32

Table 7.2 Preliminary landfill airspace estimates – undeveloped area

Item	Option		
	Offset from existing landfilled areas	Piggyback liner over existing landfilled areas	Relocate existing landfilled areas
Total void (m^3)	80,000	100,000	100,000
Liner volume (m^3)	4,500	8,500	6,000
Capping volume (m^3)	20,000	25,000	25,000
Landfill airspace (m^3)	55,500	66,500	69,000
Landfilling life (yrs) (with annual growth)	10	11	12

8. Preliminary cost estimates

8.1 General

Preliminary capital cost estimates were prepared for the landfill expansion options outlined in Section 7, for the purposes of supporting feasibility assessment of the proposed landfill expansion.

Specifically, the landfill airspace estimates are based upon:

– The basis of the landfill airspace estimates described in Section 7.
– Assumed quantity of waste to be relocated (if required).
– Assumed cost for procurement of cover material, assuming it is primarily sourced from Willow Tree Gravel Quarry at a competitive rate.
– Only very limited excavation will be required where possible to establish a suitable grading along the landfill base for construction and operation (subject to the outcomes of additional site investigations).
– The quarry sidewalls will not require any significant improvement works as part of the sidewall liner installation (subject to the outcomes of additional site investigations).
– Nominal allowances for supporting landfill facilities (including weighbridge, site office and amenities, resource recovery area, and small vehicles transfer station) informed by the landfilled waste projections in Council's Waste Management Strategy (MRA, 2018).
– Council will undertake any construction supervision (e.g. superintendency) using existing Council staff or via a separate budget.
– Construction quality assurance has been allowed for specific landfill cell infrastructure (cell lining and leachate management systems).

The estimates exclude:

– Any additional airspace that may be generated via removal of the fill platform in the former quarry area, as discussed in Section 5.4.
– Operational costs, including but not limited to:
    - General landfill operation (including staff, plant and equipment).
    - Purchase and application of cover materials.
    - Management and maintenance of environmental management infrastructure (including sediment ponds, leachate ponds, etc.).
    - Ongoing environmental monitoring and reporting.
– Any costs associated with the existing landfilled areas (including capping and/or relocation).

8.2 Cost estimates

The preliminary capital cost estimates are provided in Appendix B and summarised in Table 8.1 and Table 8.2. Note these estimates consider the cost of utilising the entire new landfill cell areas, and Council may limit overall area used based on airspace requirements and budget.

Based on the preliminary estimates:

– In general, relocation of the existing landfilled areas appears to be the most cost effective option for both areas when considering cost per airspace generated due to the significant airspace lost through offsetting and the high cost of piggyback lining.
– The former quarry area is significantly more cost effective than the undeveloped area when considering cost per airspace generated due to the former quarrying providing additional depth for landfilling.

Table 8.1 Preliminary capital cost estimates – former quarry area

Item	Option		
	Offset from existing landfilled areas	Piggyback liner over existing landfilled areas	Relocate existing landfilled areas
Preliminary capital cost estimate (ex GST)	$8,250,000.00	$10,170,000.00	$10,330,000.00
Capital cost vs. landfill airspace generated (ex GST)	$66/m^3	$40/m^3	$40/m^3

Table 8.2 Preliminary capital cost estimates – undeveloped area

Item	Option		
	Offset from existing landfilled areas	Piggyback liner over existing landfilled areas	Relocate existing landfilled areas
Preliminary capital cost estimate (ex GST)	$5,950,000.00	$7,100,000.00	$7,210,000.00
Capital cost vs. landfill airspace generated (ex GST)	$107/m^3	$107/m^3	$104/m^3

9. Preferred option and initial staging

Based on the preliminary landfill airspace estimates outlined in Section 7 and the preliminary cost estimates outlined in Section 8, development of new landfill cells in the former quarry area was deemed as the preferred option, with existing waste in this area either relocated or lined over to maximise landfill airspace.

A preliminary capital cost estimate was prepared for the initial stage of this preferred option to establish an initial landfill cell, as summarised in Table 9.1. The estimate was developed using the same basis as described in Section 8.1, with the following additions:

– The initial landfill cell would be located in the former quarry area and initially offset from the existing landfilled waste areas.
– The construction works encompass initial landfill cell construction to provide 10 years of landfilling life for the site, based on landfilled waste projections in Council's Waste Management Strategy (MRA, 2018).
– The construction works encompass bulk earthworks for the entire initial landfill cell area, with two stages of lining works to provide two 5-year landfill cell stages.
– The construction works include supporting infrastructure as described in GHD (2021), with relevant reductions in magnitude based on the initial landfill cell size.
– The construction works do not include final capping works, assuming this will be covered as part of future works.

Table 9.1 Preliminary capital cost estimate – initial stage in former quarry area

ID	Item	Cost estimate (ex GST)
01	Site investigations and updates to concept design	$150,000
02	Environmental assessment and planning approval	$130,000
03	Detailed design (including construction phase support)	$100,000
04	Bulk earthworks	$200,000
05	Cell lining and leachate collection system	$1,600,000
06	Supporting landfill infrastructure (including surface water management, leachate management, landfill gas management and access)	$500,000
07	Supporting landfill facilities (including weighbridge, site office and amenities, resource recovery area, and small vehicles transfer station)	$400,000
	Total	**$3,080,000**

10. Supplementary assessments and investigations

The masterplan provides a basis for the feasibility assessment for the new landfill cell. The masterplan outlines a number of items that should be considered when assessing the feasibility of this project, including a number of supplementary assessments and investigations that should be considered in the next phases of the project.

The cost and potential outcomes of these assessments and investigations should be factored into the feasibility assessment and progressed as part of the planning approval and detailed design phases if the project is deemed feasible. These include:

– Geotechnical assessment of quarry walls in the former quarry area to inform sidewall liner strategy in this area.
– Geotechnical assessment of the fill platform in the former quarry area to determine if it should be removed or retained, and potential reuse of this material for cover and capping.
– Site investigation to refine quantities of existing landfilled waste (such as via geophysical survey) to inform selection of strategy to address this issue as part of cell construction.
– Procurement discussions and cost confirmation for cover material supply from Willow Tree Gravel Quarry.

11. References

GHD (2021). Willow Tree Waste Management Facility – Review of Site Suitability for Landfill Expansion.

GHD (2021a) Willow Tree Waste Management Facility - Geotechnical Investigation for Landfill Expansion.

Landcom. (2004). Managing Urban Stormwater: Soils and Construction.

MRA Consulting Group (2018). Waste Management Strategy.

NSW Department of Environment and Climate Change (2008). Managing Urban Stormwater, Soils and Construction, Volume 2B Waste Landfills.

NSW EPA (2016). Environmental Guidelines: Solid Waste Landfills.

Appendices

Appendix A

Concept Design Drawings

LIVERPOOL PLAINS SHIRE COUNCIL
WILLOW TREE WASTE MANAGEMENT FACILITY
LANDFILL EXTENSION CONCEPT DESIGN
12534581

LOCALITY PLAN
SCALE NTS

DRAWING LIST

DRG No.	DRAWING TITLE
12534581-C001	COVER SHEET, LOCALITY PLAN AND DRAWING LIST
12534581-C002	EXISTING SITE PLAN
12534581-C003	CELL ARRANGEMENT PLAN
12534581-C004	FINAL LANDFORM PLAN
12534581-C005	CONCEPT STAGING PLAN
12534581-C006	TYPICAL SECTIONS AND DETAILS

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	INITIAL ISSUE		LP			

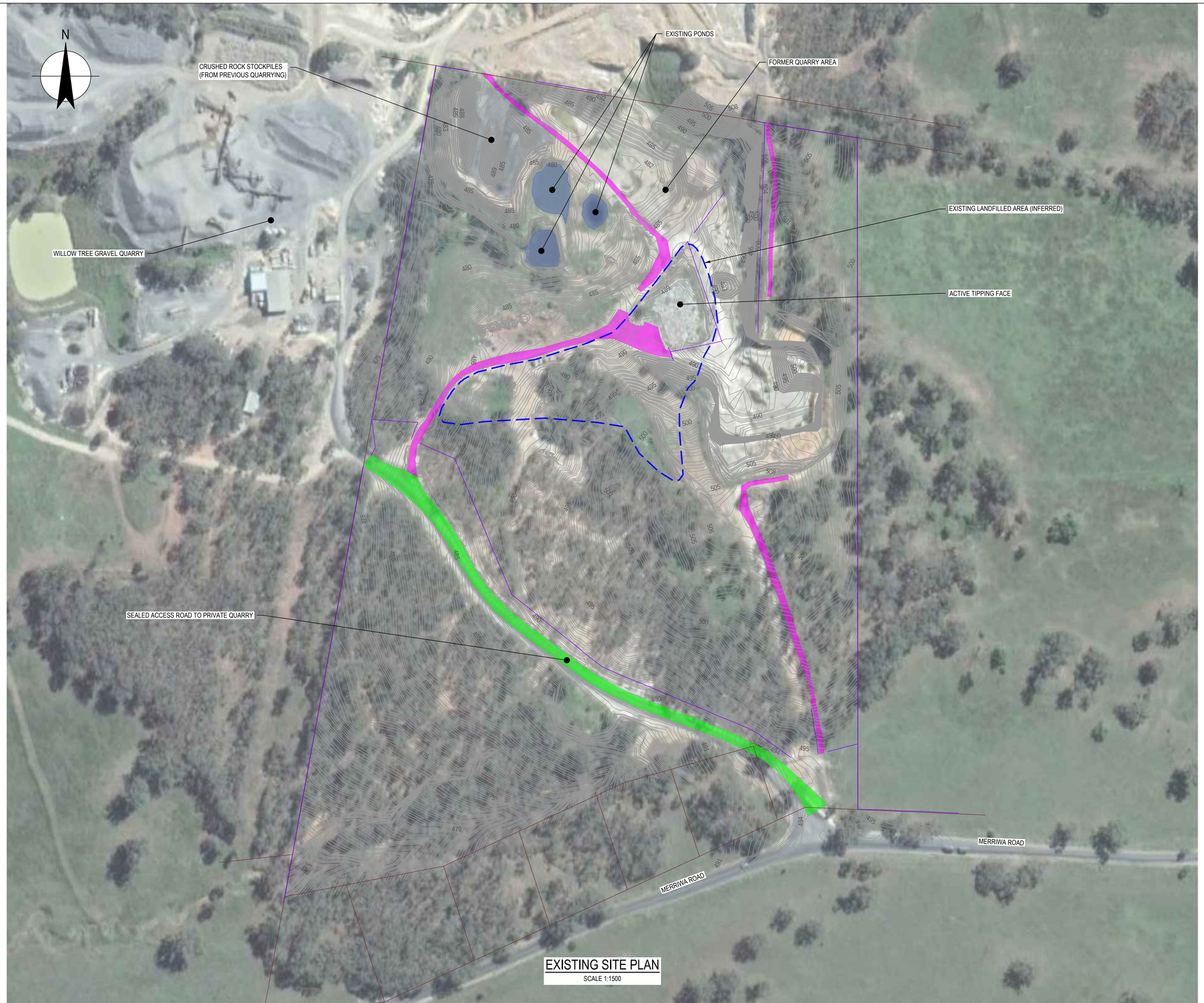
Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com

DO NOT SCALE

Drawn	L. POSADAS	Designer	C. N-SMITH
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	NOT TO SCALE	This Drawing must not be used for Construction unless signed as Approved	

Client	LIVERPOOL PLAINS SHIRE COUNCIL
Project	WILLOW TREE WASTE MANAGEMENT FACILITY
Title	LANDFILL EXTENSION CONCEPT DESIGN COVER SHEET, LOCALITY PLAN AND DRAWING LIST
Original Size	A1
Drawing No:	12534581-C001
Rev:	A

Plot Date: 30 July 2021 - 12:46 PM Plotted by: Laurence Gae Posadas Cad File No: \\ghdnet\ghd\PH\Cebu\Projects\21\12534581\CADD\Drawings\12534581-C001.dwg



LEGEND

- EXISTING CONTOURS m A.H.D
- CADASTRE
- FENCE LINE
- SEALED ROAD
- UNSEALED ROAD
- EXISTING PONDS

NOTES:

1. CONTOURS AND CADASTRE TAKEN FROM BATH STEWART ASSOCIATES SURVEY DATED 14/05/20. REF. 20096.
2. INFERRED WASTE FOOTPRINT BASED ON SITE AERIAL, SITE INSPECTIONS AND GEOTECHNICAL INVESTIGATION (GHD, 2020).
3. ALL LOCATIONS ARE APPROXIMATE.

EXISTING SITE PLAN

SCALE 1:1500

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	INITIAL ISSUE		LP			

0 20 40 60m

SCALE 1:1500 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com

DO NOT SCALE

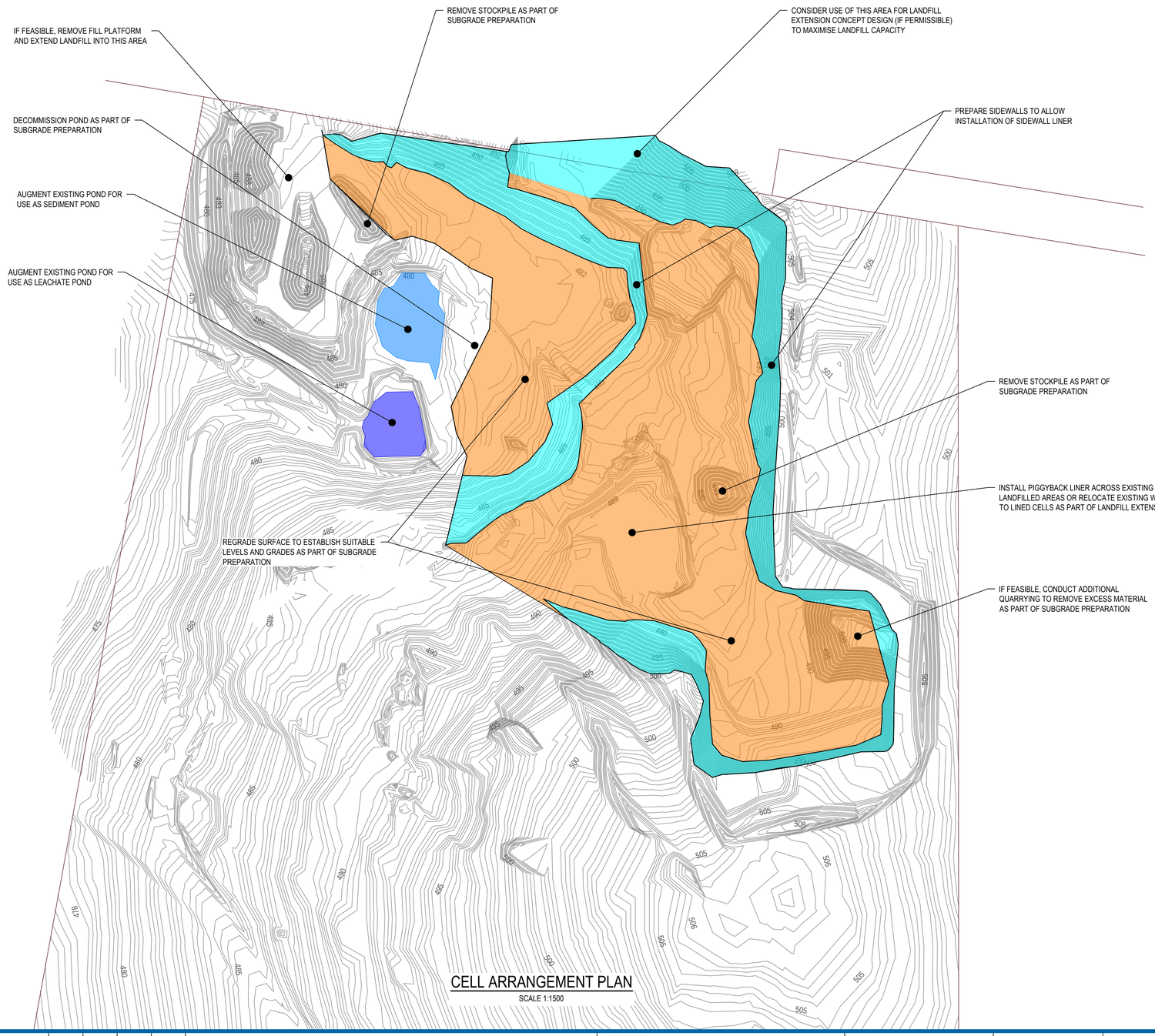
Drawn	L. POSADAS	Designer	C. N-SMITH
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	1:1500	This Drawing must not be used for Construction unless signed as Approved	

Client: LIVERPOOL PLAINS SHIRE COUNCIL
Project: WILLOW TREE WASTE MANAGEMENT FACILITY
Title: LANDFILL EXTENSION CONCEPT DESIGN
EXISTING SITE PLAN

Original Size A1 | Drawing No: 12534581-C002 | Rev: A

Plot Date: 30 July 2021 - 12:46 PM Plotted by: Laurence Gae Posadas Cad File No: \\ghdnet\ghd\PH\Cebu\Projects\21\12534581\CADD\Drawings\12534581-C002.dwg

N



CELL ARRANGEMENT PLAN

SCALE 1:1500

LEGEND

- EXISTING CONTOURS m A.H.D
- CADASTRE
- BASAL LINER
- SIDEWALL LINER
- SURFACE WATER POND
- LEACHATE POND

NOTES:

1. SURFACE WATER DIVERSION MEASURES AROUND LANDFILL CELL NOT SHOWN, TO BE CONFIRMED IN DETAILED DESIGN.
2. FINAL EXTENT OF LINER AREAS AND GEOMETRY TO BE CONFIRMED IN DETAILED DESIGN BASED ON FINAL LANDFORM, ROCKWALL STABILITY AND LINER PROFILES.
3. ALL LOCATIONS ARE APPROXIMATE.

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	INITIAL ISSUE		LP			

0 20 40 60m

SCALE 1:1500 AT ORIGINAL SIZE

GHD

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com

DO NOT SCALE

Drawn	L. POSADAS	Designer	C. N-SMITH
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	1:1500	This Drawing must not be used for Construction unless signed as Approved	

Client LIVERPOOL PLAINS SHIRE COUNCIL
Project WILLOW TREE WASTE MANAGEMENT FACILITY
Title LANDFILL EXTENSION CONCEPT DESIGN
CELL ARRANGEMENT PLAN

Original Size A1 **Drawing No: 12534581-C003** **Rev: A**

Plot Date: 30 July 2021 - 1:11 PM Plotted by: Laurence Gae Posadas Cad File No: \\ghdnet\ghd\PH\Cebu\Projects\21\12534581\CADD\Drawings\12534581-C003.dwg

N

LEGEND

- 500 — EXISTING CONTOURS m A.H.D
- 500 — FINAL LANDFORM DESIGN CONTOURS
- CADASTRE
- SURFACE WATER POND
- LEACHATE POND

FINAL LANDFORM PLAN

SCALE 1:1500

NOTES:

1. SURFACE WATER DIVERSION MEASURES AROUND LANDFORM AND COLLECTION MEASURES ON LANDFORM SURFACE NOT SHOWN, TO BE CONFIRMED IN DETAILED DESIGN.
2. ALL LOCATIONS ARE APPROXIMATE.

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	INITIAL ISSUE		LP			

0 20 40 60m

SCALE 1:1500 AT ORIGINAL SIZE

GHD

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com

DO NOT SCALE

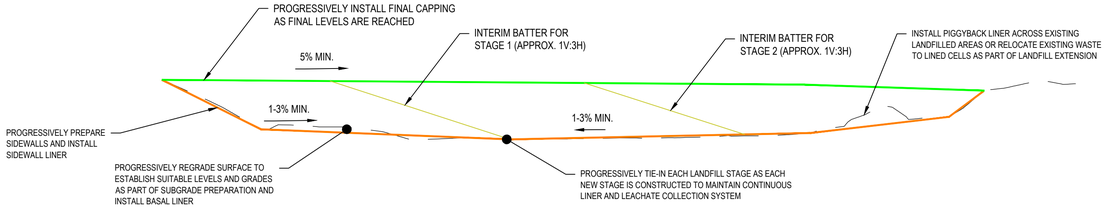
Drawn	L. POSADAS	Designer	C. N-SMITH
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	1:1500	This Drawing must not be used for Construction unless signed as Approved	

Client LIVERPOOL PLAINS SHIRE COUNCIL
Project WILLOW TREE WASTE MANAGEMENT FACILITY
Title LANDFILL EXTENSION CONCEPT DESIGN
FINAL LANDFORM PLAN

Original Size **A1** Drawing No: **12534581-C004** Rev: **A**

Plot Date: 30 July 2021 - 12:47 PM Plotted by: Laurence Gae Posadas Cad File No: \\ghdnet\ghd\PH\Cebu\Projects\21\12534581\CADD\Drawings\12534581-C004.dwg

N



A - SECTION

NOT TO SCALE

CONCEPT STAGING PLAN

SCALE 1:1500

LEGEND

- EXISTING CONTOURS m A.H.D
- FINAL LANDFORM DESIGN CONTOURS
- CADASTRE
- SURFACE WATER POND
- LEACHATE POND

NOTES:

1. SURFACE WATER DIVERSION MEASURES AROUND LANDFORM AND COLLECTION MEASURES ON LANDFORM SURFACE NOT SHOWN, TO BE CONFIRMED IN DETAILED DESIGN.
2. INTERIM WASTE BATTERS TO BE ESTABLISHED AT 1V:3H AT STAGE INTERFACE LOCATIONS.
3. ALL LOCATIONS ARE APPROXIMATE.

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
B	ADDITIONAL SECTION		LP			
A	INITIAL ISSUE		LP			

GHD

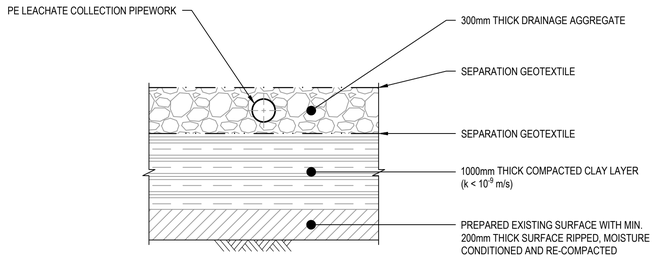
Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com

Drawn	L. POSADAS	Designer	C. N-SMITH
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client: LIVERPOOL PLAINS SHIRE COUNCIL
Project: WILLOW TREE WASTE MANAGEMENT FACILITY
Title: LANDFILL EXTENSION CONCEPT DESIGN
CONCEPT STAGING PLAN

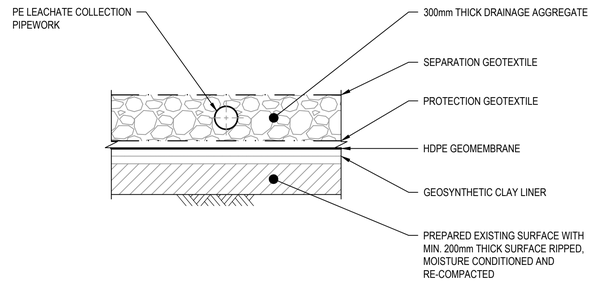
Original Size: A1
Drawing No: 12534581-C005
Rev: B

Plot Date: 2 August 2021 - 4:30 PM
Plotted by: Laurence Gae Posadas
Cad File No: \\ghdnet\ghd\PH\Cebu\Projects\21\12534581\CADD\Drawings\12534581-C005.dwg



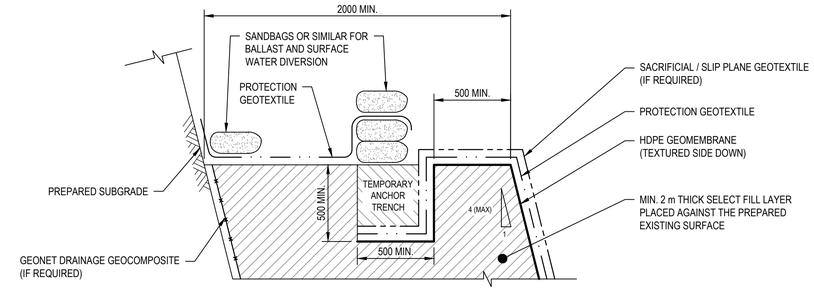
BASAL LINER OPTION 1

1A DETAIL
SCALE 1 : 20



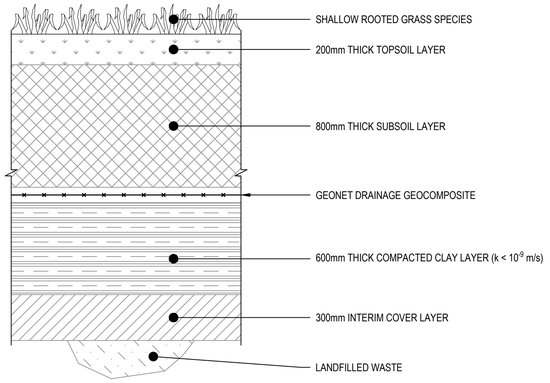
BASAL LINER OPTION 2

1B DETAIL
SCALE 1 : 20



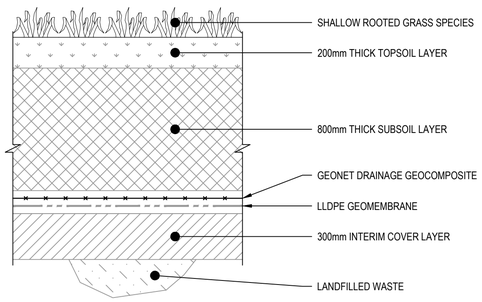
SIDEWALL LINER

2 DETAIL
SCALE 1 : 20



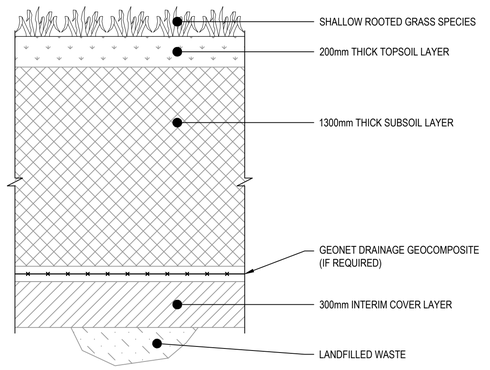
CAPPING PROFILE OPTION 1

3A DETAIL
SCALE 1 : 20



CAPPING PROFILE OPTION 2

3B DETAIL
SCALE 1 : 20



CAPPING PROFILE OPTION 3 (REFER NOTE 1)

3C DETAIL
SCALE 1 : 20

NOTE:

1. FINAL PROFILE TO BE CONFIRMED BASED ON SITE SPECIFIC PHYTOCAP MODELLING, IF PURSUED.

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	INITIAL ISSUE		LP			

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com

DO NOT SCALE

Drawn	L. POSADAS	Designer	C. N-SMITH
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	1:20	This Drawing must not be used for Construction unless signed as Approved	

Client LIVERPOOL PLAINS SHIRE COUNCIL
Project WILLOW TREE WASTE MANAGEMENT FACILITY
Title LANDFILL EXTENSION CONCEPT DESIGN
TYPICAL SECTIONS AND DETAILS

Original Size **A1** Drawing No: **12534581-C006** Rev: **A**

Plot Date: 30 July 2021 - 12:48 PM Plotted by: Laurence Gae Posadas Cad File No: \\ghdnet\ghd\PH\Cebu\Projects\21\12534581\CADD\Drawings\12534581-C006.dwg

Appendix B

Preliminary Landfill Airspace and Cost Estimates

Preliminary Landfill Airspace Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Landfill Airspace Estimates

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

ID	Description	Quantity	Unit			Reference and notes
	UNDEVELOPED AREA - OFFSET					
	Void space	80,000	m3			Estimate
	Liner volume	4,500	m3			
	Capping volume	20,000	m3			
	Landfilling airspace	55,500	m3			
	Cover material required	8,325	m3			15% usage rate
	UNDEVELOPED AREA - PIGGYBACK					
	Void space	100,000	m3			Estimate
	Liner volume	8,500	m3			
	Capping volume	25,000	m3			
	Landfilling airspace	66,500	m3			
	Cover material required	9,975	m3			15% usage rate
	UNDEVELOPED AREA - RELOCATE					
	Void space	100,000	m3			Estimate
	Liner volume	6,000	m3			
	Capping volume	25,000	m3			
	Landfilling airspace	69,000	m3			
	Cover material required	10,350	m3			15% usage rate
	FORMER QUARRY AREA - OFFSET					
	Void space	175,000	m3			Estimate
	Liner volume	20,900	m3			
	Capping volume	30,000	m3			
	Landfilling airspace	124,100	m3			
	Cover material required	18,615	m3			15% usage rate
	FORMER QUARRY AREA - PIGGYBACK					
	Void space	325,000	m3			Estimate
	Liner volume	38,200	m3			

Preliminary Landfill Airspace Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Landfill Airspace Estimates

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Capping volume	35,000	m3			
	Landfilling airspace	251,800	m3			
	Cover material required	37,770	m3			15% usage rate
	FORMER QUARRY AREA - RELOCATE					
	Void space	325,000	m3			Estimate
	Liner volume	33,200	m3			
	Capping volume	35,000	m3			
	Landfilling airspace	256,800	m3			
	Cover material required	38,520	m3			15% usage rate

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

ID	Description	Quantity	Unit	Rate ($/unit)	Total ($)	Reference and notes
	PRELIMINARIES					
	Design and planning approvals				**$380,000.00**	Initial
	Detailed design	1	item	$100,000.00	$100,000.00	Estimate
	Site investigations	1	item	$150,000.00	$150,000.00	Estimate
	Planning approval	1	item	$130,000.00	$130,000.00	Estimate
	CONSTRUCTION WORKS					
	UNDEVELOPED AREA - OFFSET				**$4,165,775.00**	
	Bulk earthworks				**$391,000.00**	Staged
	Clearing and grubbing	20,000	m2	$2.00	$40,000.00	
	Bulk earthworks	20,000	m3	$15.00	$300,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (0%)	1	item	-	$0.00	Minimal for bulk earthworks
	Indirects - Contractor (15%)	1	item	-	$51,000.00	Increased rate due to staged excavation
	Basal liner profile				**$1,415,000.00**	Staged
	Surface preparation	15,000	m2	$2.00	$30,000.00	
	Supply and install GCL	15,000	m2	$15.00	$225,000.00	
	Supply and install HDPE geomembrane	15,000	m2	$15.00	$225,000.00	
	Supply and install protection geotextile	15,000	m2	$10.00	$150,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	4,500	m3	$100.00	$450,000.00	
	Supply and install separation geotextile	15,000	m2	$5.00	$75,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$87,000.00	Increased quantity due to staged lining
	Indirects - Contractor (15%)	1	item	-	$173,000.00	Increased quantity due to staged lining
	Sidewall liner profile				**$307,000.00**	Staged
	Surface preparation	5,000	m2	$2.00	$10,000.00	
	Supply and install GCL	5,000	m2	$15.00	$75,000.00	
	Supply and install LLDPE geomembrane	5,000	m2	$15.00	$75,000.00	
	Supply and install geonet drainage composite	5,000	m2	$18.00	$90,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$19,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$38,000.00	Increased rate due to staged lining
	Cover material				**$224,775.00**	
	Procure and stockpile cover material	8,325	m3	$27.00	$224,775.00	Assumed
	Capping profile				**$1,828,000.00**	Staged
	Seal bearing surface preparation	20,000	m2	$27.00	$540,000.00	
	Supply and install geonet drainage geocomposite	-	m2	$18.00	$0.00	Assume LFG underdrainage not required
	Supply and install LLDPE geomembrane or coated GCL	20,000	m2	$15.00	$300,000.00	

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Supply and install 800 mm thick subsoil layer	16,000	m3	$27.00	$432,000.00	
	Supply and install 200 mm thick topsoil layer	4,000	m3	$45.00	$180,000.00	
	Revegetation	20,000	m2	$2.00	$40,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$112,000.00	Increased rate due to staged capping
	Indirects - Contractor (15%)	1	item	-	$224,000.00	Increased rate due to staged capping
	UNDEVELOPED AREA - PIGGYBACK				**$5,313,825.00**	
	Bulk earthworks				**$489,000.00**	Staged
	Clearing and grubbing	25,000	m2	$2.00	$50,000.00	
	Bulk earthworks	25,000	m3	$15.00	$375,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (0%)	1	item	-	$0.00	Minimal for bulk earthworks
	Indirects - Contractor (15%)	1	item	-	$64,000.00	Increased rate due to staged excavation
	Basal liner profile				**$1,415,000.00**	Staged
	Surface preparation	15,000	m2	$2.00	$30,000.00	
	Supply and install GCL	15,000	m2	$15.00	$225,000.00	
	Supply and install HDPE geomembrane	15,000	m2	$15.00	$225,000.00	
	Supply and install protection geotextile	15,000	m2	$10.00	$150,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	4,500	m3	$100.00	$450,000.00	
	Supply and install separation geotextile	15,000	m2	$5.00	$75,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$87,000.00	Increased quantity due to staged lining
	Indirects - Contractor (15%)	1	item	-	$173,000.00	Increased quantity due to staged lining
	Sidewall liner profile				**$307,000.00**	Staged
	Surface preparation	5,000	m2	$2.00	$10,000.00	
	Supply and install GCL	5,000	m2	$15.00	$75,000.00	
	Supply and install LLDPE geomembrane	5,000	m2	$15.00	$75,000.00	
	Supply and install geonet drainage composite	5,000	m2	$18.00	$90,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$19,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$38,000.00	Increased rate due to staged lining
	Piggyback liner profile				**$548,500.00**	Staged
	Surface preparation	5,000	m2	$2.00	$10,000.00	
	Supply and install geogrid	5,000	m2	$15.00	$75,000.00	
	Supply and install 500 mm thick settlement control layer	2,500	m3	$15.00	$37,500.00	
	Supply and install GCL	5,000	m2	$15.00	$75,000.00	
	Supply and install LLDPE geomembrane	5,000	m2	$15.00	$75,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	1,500	m3	$100.00	$150,000.00	
	Supply and install separation geotextile	5,000	m2	$5.00	$25,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Indirects - CQA (7.5%)	1	item	-	$34,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$67,000.00	Increased rate due to staged lining
	Cover material				**$269,325.00**	
	Procure and stockpile cover material	9,975	m3	$27.00	$269,325.00	Assumed
	Capping profile				**$2,285,000.00**	Staged
	Seal bearing surface preparation	25,000	m2	$27.00	$675,000.00	
	Supply and install geonet drainage geocomposite	-	m2	$18.00	$0.00	Assume LFG underdrainage not required
	Supply and install LLDPE geomembrane or coated GCL	25,000	m2	$15.00	$375,000.00	
	Supply and install 800 mm thick subsoil layer	20,000	m3	$27.00	$540,000.00	
	Supply and install 200 mm thick topsoil layer	5,000	m3	$45.00	$225,000.00	
	Revegetation	25,000	m2	$2.00	$50,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$140,000.00	Increased rate due to staged capping
	Indirects - Contractor (15%)	1	item	-	$280,000.00	Increased rate due to staged capping
	UNDEVELOPED AREA - RELOCATE				**$5,419,450.00**	
	Bulk earthworks				**$661,000.00**	Staged
	Clearing and grubbing	25,000	m2	$2.00	$50,000.00	
	Bulk earthworks	25,000	m3	$15.00	$375,000.00	
	Waste relocation	5,000	m3	$30.00	$150,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (0%)	1	item	-	$0.00	Minimal for bulk earthworks
	Indirects - Contractor (15%)	1	item	-	$86,000.00	Increased rate due to staged excavation
	Basal liner profile				**$1,887,000.00**	Staged
	Surface preparation	20,000	m2	$2.00	$40,000.00	
	Supply and install GCL	20,000	m2	$15.00	$300,000.00	
	Supply and install HDPE geomembrane	20,000	m2	$15.00	$300,000.00	
	Supply and install protection geotextile	20,000	m2	$10.00	$200,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	6,000	m3	$100.00	$600,000.00	
	Supply and install separation geotextile	20,000	m2	$5.00	$100,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$116,000.00	Increased quantity due to staged lining
	Indirects - Contractor (15%)	1	item	-	$231,000.00	Increased quantity due to staged lining
	Sidewall liner profile				**$307,000.00**	Staged
	Surface preparation	5,000	m2	$2.00	$10,000.00	
	Supply and install GCL	5,000	m2	$15.00	$75,000.00	
	Supply and install LLDPE geomembrane	5,000	m2	$15.00	$75,000.00	
	Supply and install geonet drainage composite	5,000	m2	$18.00	$90,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$19,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$38,000.00	Increased rate due to staged lining

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Cover material				**$279,450.00**	
	Procure and stockpile cover material	10,350	m3	$27.00	$279,450.00	Assumed
	Capping profile				**$2,285,000.00**	Staged
	Seal bearing surface preparation	25,000	m2	$27.00	$675,000.00	
	Supply and install geonet drainage geocomposite	-	m2	$18.00	$0.00	Assume LFG underdrainage not required
	Supply and install LLDPE geomembrane or coated GCL	25,000	m2	$15.00	$375,000.00	
	Supply and install 800 mm thick subsoil layer	20,000	m3	$27.00	$540,000.00	
	Supply and install 200 mm thick topsoil layer	5,000	m3	$45.00	$225,000.00	
	Revegetation	25,000	m2	$2.00	$50,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$140,000.00	Increased rate due to staged capping
	Indirects - Contractor (15%)	1	item	-	$280,000.00	Increased rate due to staged capping
	FORMER QUARRY AREA - OFFSET				**$6,462,605.00**	
	Bulk earthworks				**$328,000.00**	Staged
	Clearing and grubbing	30,000	m2	$2.00	$60,000.00	
	Bulk earthworks	15,000	m3	$15.00	$225,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (0%)	1	item	-	$0.00	Minimal for bulk earthworks
	Indirects - Contractor (15%)	1	item	-	$43,000.00	Increased rate due to staged excavation
	Basal liner profile				**$2,170,000.00**	Staged
	Surface preparation	23,000	m2	$2.00	$46,000.00	
	Supply and install GCL	23,000	m2	$15.00	$345,000.00	
	Supply and install HDPE geomembrane	23,000	m2	$15.00	$345,000.00	
	Supply and install protection geotextile	23,000	m2	$10.00	$230,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	6,900	m3	$100.00	$690,000.00	
	Supply and install separation geotextile	23,000	m2	$5.00	$115,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$133,000.00	Increased quantity due to staged lining
	Indirects - Contractor (15%)	1	item	-	$266,000.00	Increased quantity due to staged lining
	Sidewall liner profile				**$720,000.00**	Staged
	Supply and install earthen fill	14,000	m3	$27.00	$378,000.00	
	Supply and install LLDPE geomembrane	7,000	m2	$15.00	$105,000.00	
	Supply and install protection geotextile	7,000	m2	$10.00	$70,000.00	
	Supply and install sacrificial / slip plane geotextile	7,000	m2	$5.00	$35,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$44,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$88,000.00	Increased rate due to staged lining
	Cover material				**$502,605.00**	
	Procure and stockpile cover material	18,615	m3	$27.00	$502,605.00	Assumed

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Capping profile				**$2,742,000.00**	Staged
	Seal bearing surface preparation	30,000	m2	$27.00	$810,000.00	
	Supply and install geonet drainage geocomposite	-	m2	$18.00	$0.00	Assume LFG underdrainage not required
	Supply and install LLDPE geomembrane or coated GCL	30,000	m2	$15.00	$450,000.00	
	Supply and install 800 mm thick subsoil layer	24,000	m3	$27.00	$648,000.00	
	Supply and install 200 mm thick topsoil layer	6,000	m3	$45.00	$270,000.00	
	Revegetation	30,000	m2	$2.00	$60,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$168,000.00	Increased rate due to staged capping
	Indirects - Contractor (15%)	1	item	-	$336,000.00	Increased rate due to staged capping
	FORMER QUARRY AREA - PIGGYBACK				**$8,378,290.00**	
	Bulk earthworks				**$404,500.00**	Staged
	Clearing and grubbing	37,000	m2	$2.00	$74,000.00	
	Bulk earthworks	18,500	m3	$15.00	$277,500.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (0%)	1	item	-	$0.00	Minimal for bulk earthworks
	Indirects - Contractor (15%)	1	item	-	$53,000.00	Increased rate due to staged excavation
	Basal liner profile				**$1,321,000.00**	Staged
	Surface preparation	14,000	m2	$2.00	$28,000.00	
	Supply and install GCL	14,000	m2	$15.00	$210,000.00	
	Supply and install HDPE geomembrane	14,000	m2	$15.00	$210,000.00	
	Supply and install protection geotextile	14,000	m2	$10.00	$140,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	4,200	m3	$100.00	$420,000.00	
	Supply and install separation geotextile	14,000	m2	$5.00	$70,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$81,000.00	Increased quantity due to staged lining
	Indirects - Contractor (15%)	1	item	-	$162,000.00	Increased quantity due to staged lining
	Sidewall liner profile				**$1,338,000.00**	Staged
	Supply and install earthen fill	26,000	m3	$27.00	$702,000.00	
	Supply and install LLDPE geomembrane	13,000	m2	$15.00	$195,000.00	
	Supply and install protection geotextile	13,000	m2	$10.00	$130,000.00	
	Supply and install sacrificial / slip plane geotextile	13,000	m2	$5.00	$65,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$82,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$164,000.00	Increased rate due to staged lining
	Piggyback liner profile				**$1,096,000.00**	Staged
	Surface preparation	10,000	m2	$2.00	$20,000.00	
	Supply and install geogrid	10,000	m2	$15.00	$150,000.00	
	Supply and install 500 mm thick settlement control layer	5,000	m3	$15.00	$75,000.00	
	Supply and install GCL	10,000	m2	$15.00	$150,000.00	

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Supply and install LLDPE geomembrane	10,000	m2	$15.00	$150,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	3,000	m3	$100.00	$300,000.00	
	Supply and install separation geotextile	10,000	m2	$5.00	$50,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$67,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$134,000.00	Increased rate due to staged lining
	Cover material				**$1,019,790.00**	
	Procure and stockpile cover material	37,770	m3	$27.00	$1,019,790.00	Assumed
	Capping profile				**$3,199,000.00**	Staged
	Seal bearing surface preparation	35,000	m2	$27.00	$945,000.00	
	Supply and install geonet drainage geocomposite	-	m2	$18.00	$0.00	Assume LFG underdrainage not required
	Supply and install LLDPE geomembrane or coated GCL	35,000	m2	$15.00	$525,000.00	
	Supply and install 800 mm thick subsoil layer	28,000	m3	$27.00	$756,000.00	
	Supply and install 200 mm thick topsoil layer	7,000	m3	$45.00	$315,000.00	
	Revegetation	35,000	m2	$2.00	$70,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$196,000.00	Increased rate due to staged capping
	Indirects - Contractor (15%)	1	item	-	$392,000.00	Increased rate due to staged capping
	FORMER QUARRY AREA - RELOCATE				**$8,543,540.00**	
	Bulk earthworks				**$702,500.00**	Staged
	Clearing and grubbing	37,000	m2	$2.00	$74,000.00	
	Bulk earthworks	18,500	m3	$15.00	$277,500.00	
	Waste relocation	10,000	m3	$30.00	$300,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (0%)	1	item	-	$0.00	Minimal for bulk earthworks
	Indirects - Contractor (15%)	1	item	-	$51,000.00	Increased rate due to staged excavation
	Basal liner profile				**$2,264,000.00**	Staged
	Surface preparation	24,000	m2	$2.00	$48,000.00	
	Supply and install GCL	24,000	m2	$15.00	$360,000.00	
	Supply and install HDPE geomembrane	24,000	m2	$15.00	$360,000.00	
	Supply and install protection geotextile	24,000	m2	$10.00	$240,000.00	
	Supply and install 300 mm thick drainage aggregate with PE leachate collection pipework	7,200	m3	$100.00	$720,000.00	
	Supply and install separation geotextile	24,000	m2	$5.00	$120,000.00	
	Indirects - Superintendent (0%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$139,000.00	Increased quantity due to staged lining
	Indirects - Contractor (15%)	1	item	-	$277,000.00	Increased quantity due to staged lining
	Sidewall liner profile				**$1,338,000.00**	Staged
	Supply and install earthen fill	26,000	m3	$27.00	$702,000.00	
	Supply and install LLDPE geomembrane	13,000	m2	$15.00	$195,000.00	

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Supply and install protection geotextile	13,000	m2	$10.00	$130,000.00	
	Supply and install sacrificial / slip plane geotextile	13,000	m2	$5.00	$65,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$82,000.00	Increased rate due to staged lining
	Indirects - Contractor (15%)	1	item	-	$164,000.00	Increased rate due to staged lining
	Cover material				**$1,040,040.00**	
	Procure and stockpile cover material	38,520	m3	$27.00	$1,040,040.00	Assumed
	Capping profile				**$3,199,000.00**	Staged
	Seal bearing surface preparation	35,000	m2	$27.00	$945,000.00	
	Supply and install geonet drainage geocomposite	-	m2	$18.00	$0.00	Assume LFG underdrainage not required
	Supply and install LLDPE geomembrane or coated GCL	35,000	m2	$15.00	$525,000.00	
	Supply and install 800 mm thick subsoil layer	28,000	m3	$27.00	$756,000.00	
	Supply and install 200 mm thick topsoil layer	7,000	m3	$45.00	$315,000.00	
	Revegetation	35,000	m2	$2.00	$70,000.00	
	Indirects - Superintendent (7.5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$196,000.00	Increased rate due to staged capping
	Indirects - Contractor (15%)	1	item	-	$392,000.00	Increased rate due to staged capping
	OTHER ITEMS				**$1,407,000.00**	
	Groundwater management				**$0.00**	Staged
	N/A	1	Item	-	$0.00	Assume not required based on existing information
	Leachate management				**$303,000.00**	Initial
	Leachate pond	1	item	$200,000.00	$200,000.00	
	Riser pipework	1	item	$5,000.00	$5,000.00	
	Supply and install pipework/connect to leachate dam	100	m	$90.00	$9,000.00	
	Pump and instrumentation	1	item	$50,000.00	$50,000.00	
	Indirects - Superintendent (5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (5%)	1	item	-	$13,000.00	
	Indirects - Contractor (10%)	1	item	-	$26,000.00	
	Surface water management				**$144,000.00**	Staged
	Construct diversion and collection berms/drains	1	item	$25,000.00	$25,000.00	
	Sediment pond/s	1	item	$100,000.00	$100,000.00	
	Indirects - Superintendent (5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$0.00	Minimal for bulk earthworks
	Indirects - Contractor (15%)	1	item	-	$19,000.00	
	Landfill gas management				**$230,000.00**	Staged
	Gas collection bores and manifolds	1	Item	$100,000.00	$100,000.00	Nominal based on cell dimensions
	Landfill gas flare	1	Item	$100,000.00	$100,000.00	Nominal based on cell dimensions
	Indirects - Superintendent (5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$0.00	N/A
	Indirects - Contractor (15%)	1	item	-	$30,000.00	

Preliminary Capital Cost Estimates

Client: Liverpool Plains Shire Council
Project: Willow Tree WMF - Landfill Expansion
Subject: Preliminary Capital Cost Estimate - All Items

Project Number: 12434581
Prepared by: S Kentwell
Checked by: C Nivison-Smith

Revision: B
Date of issue: 13-Sep-21

	Access				**$345,000.00**	Staged
	Road construction and upgrades	1	item	$300,000.00	$300,000.00	
	Indirects - Superintendent (5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (7.5%)	1	item	-	$0.00	N/A
	Indirects - Contractor (15%)	1	item	-	$45,000.00	
	Other facilities				**$385,000.00**	Initial
	Weighbridge	1	item	$100,000.00	$100,000.00	
	Site office and amenities	1	item	$50,000.00	$50,000.00	
	Resource recovery area	1	item	$50,000.00	$50,000.00	
	Small vehicles transfer station	1	item	$150,000.00	$150,000.00	
	Indirects - Superintendent (5%)	1	item	-	$0.00	Assume Council uses internal staff
	Indirects - CQA (5%)	1	item	-	$0.00	N/A
	Indirects - Contractor (10%)	1	item	-	$35,000.00	

Appendix C

Willow Tree WMF – Geotechnical Investigation for Landfill Expansion (GHD, 2020)

Liverpool Plains Shire Council

Willow Tree Waste Management Facility

Geotechnical investigation for landfill expansion

February 2021

Table of contents

Table index

Image index

Appendices

1. Introduction

1.1 Background

In 2018, Liverpool Plains Shire Council (Council) developed a 10-year strategy for the ongoing management of waste within their region (MRA, 2018). Landfilling forms an essential part of this strategy, along with the waste avoidance and reduction, increased recycling, and diversion of waste from landfill. The waste management strategy proposes to rationalise the landfilling operations across the region by establishing the Willow Tree Management Facility (WMF) (the site) as the primary landfill, servicing Council's Local Government Area (LGA), via an expansion of this existing landfill site with the existing lot boundary.

Council engaged GHD Pty Ltd (GHD) to complete a geotechnical investigation of a portion of the proposed expansion site on Lot 213 DP1173230 as shown in the image below.

Image 1 Location of investigated site on Lot 213

1.2 Purpose

The purpose of the investigation was to develop a greater understanding of the geology in the landfill expansion area to support future design work, including information on the geotechnical properties of the existing materials for potential reuse as part of the construction, operation and closure.

1.3 Scope

The scope of work was developed by Council in consultation with GHD and set out our proposal to dated 25 November 2020 (GHD Ref. 12532265-51047-3). The following was completed:

- Preparation of a Job Safety and Environmental Analysis (JSEA) covering the tasks undertaken by GHD on site.
- Geotechnical logging of 24 pendulum auger test pits at locations nominated by Council.
- Geotechnical observations of site surface conditions, including the adjacent quarry.
- Laboratory testing of selected samples.
- Preparation of this report.

A geotechnical desktop study of the site was also completed by GHD and reported to Council in the draft geotechnical investigation brief. The findings of this desktop study are also reported herein for completeness.

This report must be read in conjunction with the General Notes included in Appendix A.

1.4 Limitations

This report: has been prepared by GHD for Liverpool Plains Shire Council and may only be used and relied on by Liverpool Plains Shire Council for the purpose agreed between GHD and the Liverpool Plains Shire Council as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Liverpool Plains Shire Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared. Specifically, this Report does not take into account the effects, implications and consequences of or responses to COVID-19, which is a highly dynamic situation and rapidly changing. These effects, implications, consequences of and responses to COVID-19 may have a material effect on the opinions, conclusions, recommendations, assumptions, qualifications and limitations in this Report, and the entire Report must be re-examined and revisited in light of COVID-19. Where this Report is relied on or used without obtaining this further advice from GHD, to the maximum extent permitted by law, GHD disclaims all liability and responsibility to any person in connection with, arising from or in respect of this Report whether such liability arises in contract, tort (including negligence) or under statute.

GHD has prepared this report on the basis of information provided by Liverpool Plains Shire Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Methodology

2.1 Desktop study

The desktop study included review of published geology maps, soil landscape maps, recent aerial photographs and MinView spatial database.

The findings are presented in Section 3.

2.2 Fieldwork

A subsurface investigation was undertaken on the 3 and 4 December 2020 and comprised excavation of 24 test pits ranging from 0.1 to 1.9 m depth arranged on a 50 m by 50 m grid by Council.

The test pit locations were surveyed and pegged by Council. The locations are shown in Figure 1 in Appendix B. This figure was prepared using a survey CAD file provided by Council that was created by Bath Stewart Associates (Dwg. Ref. 20096, dated 14 May 2020). The pegged locations of TP4, TP5 and TP6 were unreachable by the excavator and were moved to the nearest practicable location. The locations shown in Figure 1 show this change.

The test pits were excavated using a 600 mm diameter pendulum auger mounted on a 13.5 tonne Kobelco excavator provided by Soil Conservation Services.

The test pitting was supervised on a full time basis by a suitably qualified geotechnical engineer from GHD who was responsible for locating the test pits, logging the encountered strata and collecting representative samples for laboratory testing. The logging was carried out in accordance with Australia Standard, AS1726-2017.

Following logging and sampling the test pits were backfilled with excavated material by a smaller excavator provided by Soil Conservation Services.

The test pit log sheets and photographs are contained in Appendix C. These should be read in conjunction with the attached Standard Sheets (in Appendix A), which explain the symbols used in their preparation and the limitations of the logging procedures.

Observations of site conditions within and around the site were also made as part of the fieldwork. This included such surface features as rock outcrops, bedding, joints, topography and areas of waste. Features of note were photographed and located using a handheld GPS and the site survey plan provided by Council.

2.3 Laboratory testing

Selected samples recovered from the test pits were submitted to GHD's NATA accredited laboratory in Artarmon for materials testing. The following laboratory testing was undertaken:

- Atterberg Limits (3 tests)
- Particle size distribution (10 tests)
- Point Load Index – lump (5 tests)

The laboratory report sheets are contained in Appendix D. Test results are presented and discussed in Section 4.

3. Site description and surface observations

3.1 Geological setting

Reference to the NSW Seamless Geology dataset (accessed via MinView) indicates the site is situated on lower Triassic age Banks Wall Sandstone [Tnrb] as shown in the below image.

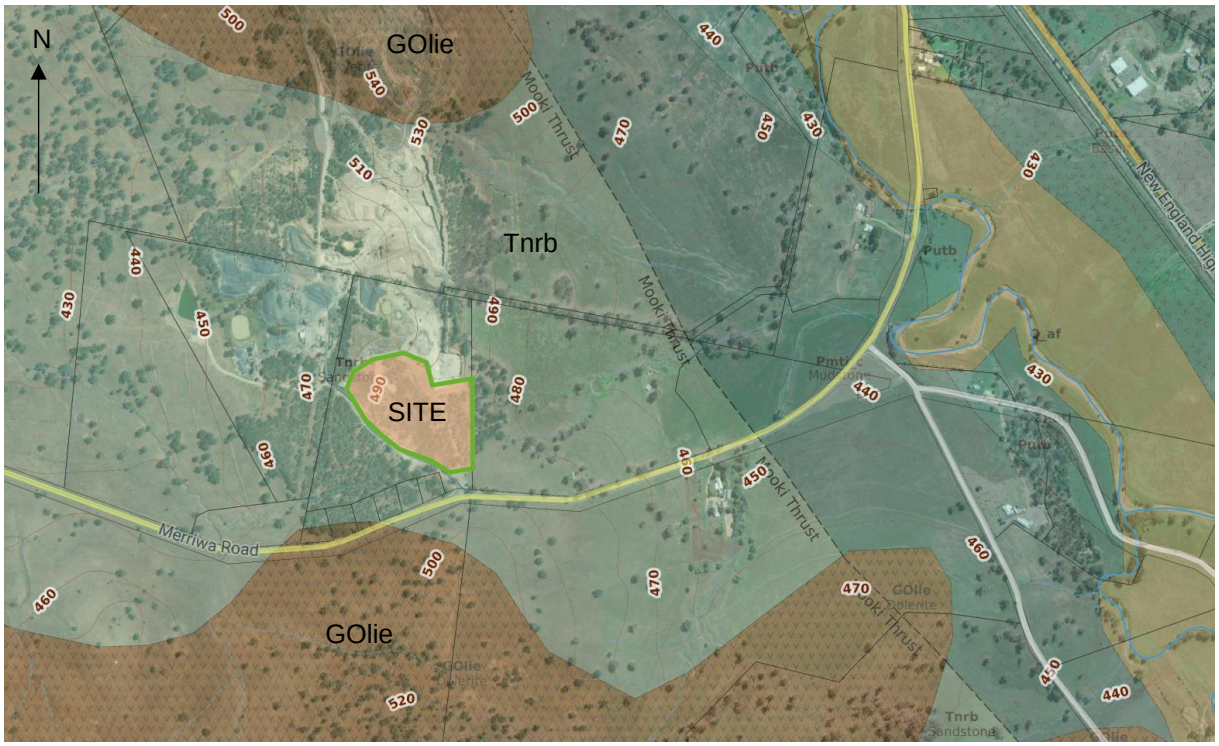


Image 2 Site location and geological setting

The superseded 1:250,000 scale Geological Series Sheet for Tamworth indicates that the site is situated on the Digby Conglomerate of the Narrabeen Group [Rrd].

As observed from bedrock outcrops on the site, this unit has bedding generally dipping toward a bearing of about 190° to 230° at 12° to 18° dip. The local lithology was observed to comprise conglomerate, pebbly sandstone and sandstone beds.

The Mooki thrust fault is located about 500 m to the north-east and dolerite capped hills, mapped as Liverpool East Basalt [GOlie], are about 1 km to the north of the site and south of Merriwa Road.

Willow Tree Gravel quarries both the Liverpool East Basalt and Banks Wall Sandstone units to produce a variety of road and rail construction materials.

3.2 Soil landscape

Reference to the 1:100,000 scale Soil Landscapes of the Murrurundi map indicate that the site has a Ferrosol and Kandosol soil landscape. The soil landscape is characterised by undulating to rolling low hills with slopes ranging 5-15%. Slopes are typically 375-625 m long with elevation ranging from 400-460 m. Total relief is less than 50 m and a local relief of less than 30 m with minor to moderate erosion hazards. The typical soil profile consists of fine sandy loam to silt loam, overlying a loamy clay to clay.

3.3 Topography and areas of disturbance

The site topography is shown by the contours on Figure 1 in Appendix B.

A roughly north-south trending ridge forms a central portion with an unsealed access track along it. The northern part of this ridge has been removed by quarrying such that the high point is now near TP14 and TP15. The land slopes away from this high point in all directions.

The northern and western area has been modified by quarrying and waste emplacement whereas the southern and eastern areas are largely undisturbed. While the ad-hoc waste placement in this area appears shallow and sporadic, notable exceptions are:

- A linear mound of waste parallel to the unsealed track.
- Deeper buried waste encountered in test pits TP1, TP2, TP4, TP7 and TP17 as discussed in Section 5.

These areas and features are shown approximately in the below image.

Image 3 Areas of surface disturbance

3.4 Rock exposures

Exposures of conglomerate, sandstone and pebbly sandstone are common throughout the investigated site and particularly beside the unsealed access track and at the former quarry. These and other areas of noted rock exposures are shown in the below image together with observations of bedding and joint (JT) dip and dip direction.

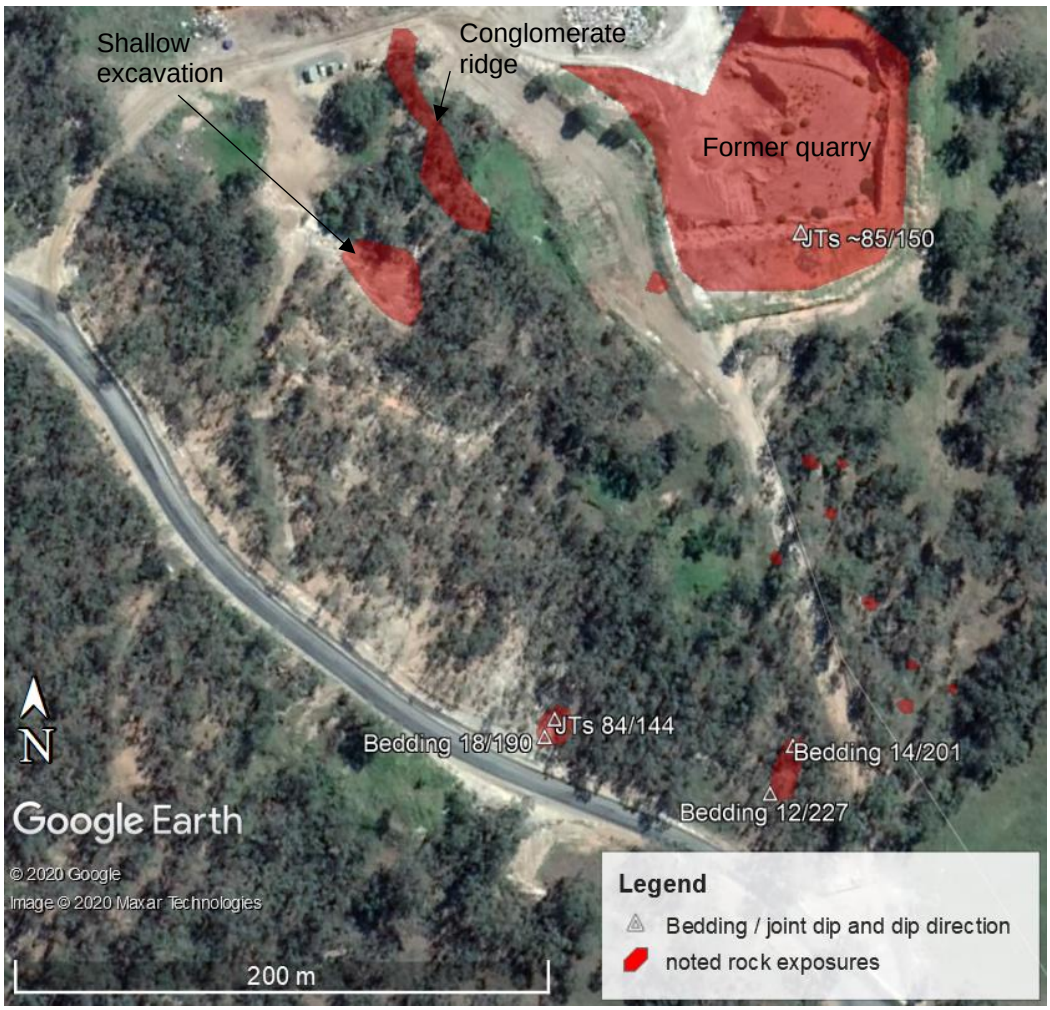


Image 4 Noted rock exposures and bedding / joint observations

The below series of photographs show the following notable features, the locations of which are shown in the above image.

- Shallow excavation in sandstone at TP08
- Conglomerate ridge near TP03
- Former quarry below TP05
- Bedding and joints in sandstone along the roadside

Image 5 Shallow excavation in sandstone at TP08

Image 6 Conglomerate ridge – looking north from TP03

Image 7 Conglomerate ridge – looking south on main block

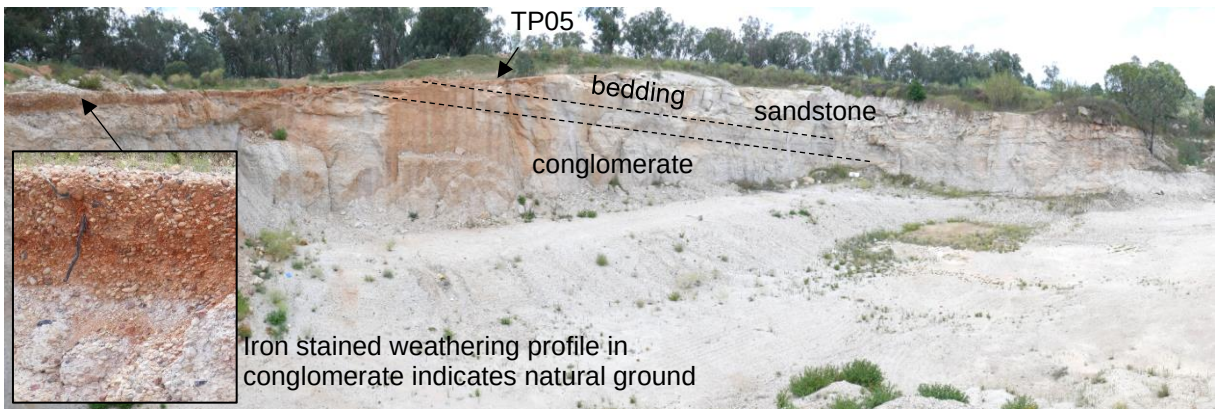


Image 8 Former quarry panorama

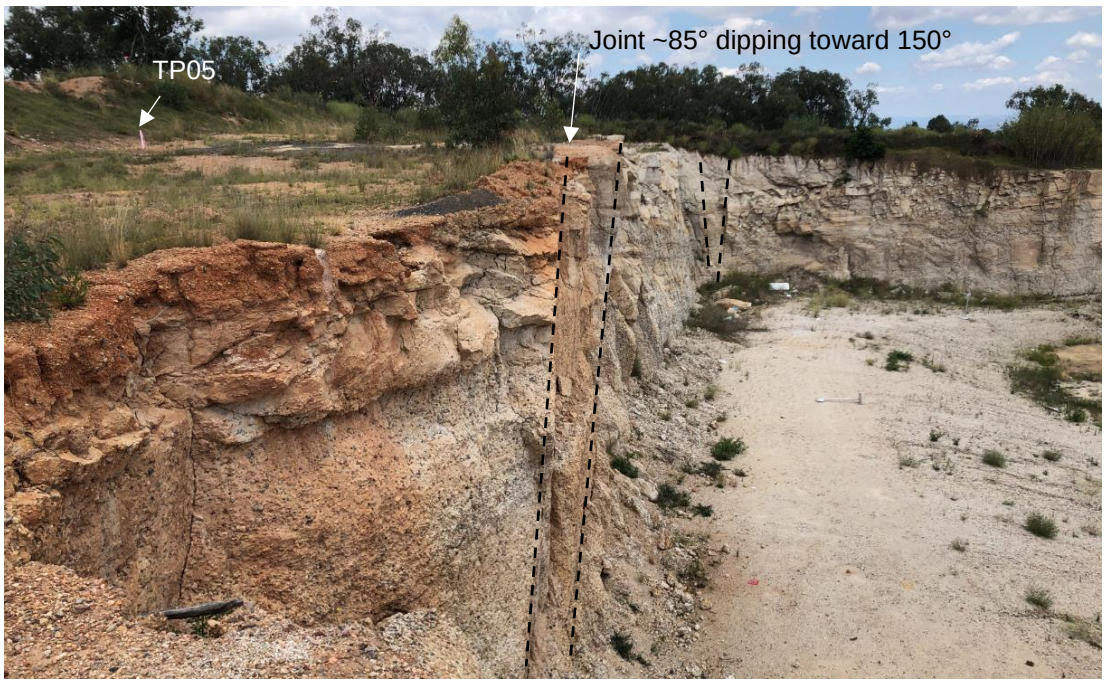


Image 9 Former quarry jointing

Image 10 Bedding and joints in sandstone along roadside

4. Laboratory test results

The laboratory results are summarised in the following tables. Test reports are in Appendix D.

Table 4-1 Particle size distribution test results

Sample location	Sample depth (m)	Material description (from laboratory)	Percent by dry weight		
			Gravel	Sand	Fines
TP1	1.5-1.8	(CL) CLAY with sand trace gravel [1A]	13	28	59
TP9	0.2-0.5	(GP) GRAVEL with clay and sand [1A]	61	27	12
TP10	0.0-0.3	(SC) Clayey Gravelly SAND [1B]	34	40	26
TP13	1.0-1.5	(CL) Sandy CLAY with gravel [1A]	22	39	39
TP15	0.5-1.1	(GM/SM) Silty SANDY GRAVEL [1A]	46	40	14
TP18	0.5-1.0	(GC/SC) Clayey SANDY GRAVEL [1A]	43	41	16
TP21	1.0-1.7	(CL) Sandy CLAY with gravel [2A]	19	39	42
TP22	0.5-1.2	(CL) Sandy CLAY with gravel [2A]	17	33	50
TP23	0.5-1.3	(SC/GC) Clayey GRAVELLY SAND [1A]	40	44	16
TP24	0.5-1.5	(SC) Clayey SAND with gravel [1A]	29	49	22

1A. Sample from conglomerate / pebbly sandstone. 1B. Sample from residual conglomerate / pebbly sandstone.

2A. Sample from sandstone

As explained on the Standard Sheets in Appendix A, material with 35% or more fines is classified as a fine grained (CLAY or SILT depending on behaviour of the fine grained portion). For example, the sample from TP13 is CLAY despite having 61% combined sand and gravel.

The results of the particle size distribution tests show the tested samples are poorly sorted mixtures of gravel, sand and fines (clay and silt sized material).

With reference to the distribution charts included with the test reports in Appendix D, samples from sandstone tend to have significantly higher proportions of fines and less gravel compared to samples from conglomerate. An exception is the sample from TP01 which has a very high proportion of fines despite being from conglomerate / pebbly sandstone.

Table 4-2 Atterberg Limits Results

Sample location	Sample depth (m)	Material description (from laboratory)	% of sample passing 425 µm	Atterberg Limits			WPI
				LL (%)	PL (%)	PI	
TP10	0.0-0.3	(SP) Clayey gravelly SAND	44	35	17	18	792
TP21	1.0-1.7	(CL) Sandy CLAY with gravel	70	24	15	9	630
TP22	0.5-1.2	(CL) Sandy CLAY with gravel	77	31	17	14	1078

Where LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index

* Atterberg tests are performed on the portion of sample that is less than 425 µm

The Atterberg Limit results confirm the logging of the tested material as low plasticity clay (CL).

Weighted Plasticity Index values for these samples has been calculated based on the percentage of material finer than 425 µm as follows.

Weighted Plasticity Index (WPI) = PI x % passing 425 µm sieve

5. Subsurface investigation findings

General descriptions of the encountered subsurface conditions are provided below. This section should be read in conjunction with the test pit logs in Appendix C for a detailed description of the subsurface conditions encountered at each test location.

The three cross-sections presented on Figure 2 in Appendix B provide an interpretation of the subsurface conditions encountered based on the observed bedding dip and dip direction.

The following Table 5-1 presents a summary of the test pit locations and termination depths.

Table 5-1 Test pit summary – depth of encountered materials (m)

Test Pit	Fill / Waste	Conglomerate / Pebbly Sandstone		Sandstone (moderately to highly weathered)	LoE
		Residual	Extremely Weathered		
TP1	0 - 0.5	0.5 – 1.2	1.2 – 1.9	n.e.	1.9
TP2	0 - 0.5	n.e.	n.e.	n.e.	0.5
TP3	n.e.	0.05 - 0.6	n.e.	n.e.	0.6
TP4	0 - 0.6	n.e.	n.e.	n.e.	0.6
TP5	n.e.	n.e.	n.e.	0 - 0.3	0.3
TP6	n.e.	n.e.	n.e.	0 - 0.1	0.1
TP7	0 - 0.3	n.e.	0.3 – 1.0	n.e.	1.0
TP8	n.e.	n.e.	n.e.	0 – 0.6	0.6
TP9	n.e.	n.e.	0 – 0.9	n.e.	0.9
TP10	n.e.	0 - 0.3	0.3 – 1.1	n.e.	1.1
TP11	0 – 0.15	0.15 – 0.3	0.3 – 0.7	from 0.7	0.7
TP12	n.e.	0 - 0.3	0.3 – 1.1	n.e.	1.1
TP13	n.e.	n.e.	0.05 – 1.5	1.5 – 1.6	1.6
TP14	0 - 0.5	n.e.	0.5 – 1.2	n.e.	1.2
TP15	n.e.	n.e.	0.05 – 1.1 (slightly weathered from 0.9)	n.e.	1.1
TP16	n.e.	n.e.	0 – 0.2 (slightly weathered)	n.e.	0.2
TP17	0 – 1.2	n.e.	n.e.	1.2 – 1.3 (extremely weathered)	1.3
TP18	n.e.	n.e.	0.05 – 1.8	n.e.	1.8
TP19	n.e.	0 – 0.4	0.4 – 0.8	n.e.	0.8
TP20	n.e.	0 – 0.2	0.2 – 0.7	n.e.	0.7
TP21	n.e.	n.e.	0 – 0.45	0.45 – 1.8	1.8
TP22	n.e.	n.e.	1.2 – 1.3 (highly to moderately weathered)	0.1 – 1.2 (extremely weathered)	1.3
TP23	n.e.	n.e.	0.0 – 1.3	n.e.	1.3
TP24	n.e.	n.e.	0 – 1.6	1.6 – 1.8	1.8

n.e. = not encountered; LoE = limit of excavation

In general terms the subsurface conditions encountered comprised thickly bedded weathered conglomerate / pebbly sandstone and thinner sandstone beds. In some areas these materials were overlain by residual red-brown soils (derived from conglomerate) and in other areas by fill or waste debris.

Conglomerate / pebbly sandstone was more commonly encountered and was typically extremely weathered and of very low strength. In TP15 and TP16 there was noticeably less weathered conglomerate judged to be of medium strength. The conglomerate / pebbly sandstone was typical recovered from the auger as poorly sorted mixtures of rounded gravel, sand and fines of low plasticity.

Sandstone was often encountered at the ground surface or below a conglomerate bed and was of medium strength, frequently resulting in practical refusal of the auger. In TP21 the sandstone was more thinly bedded and so could be excavated with the auger. In TP17 and TP22 the sandstone was extremely weathered, thinly bedded and of very low strength. The sandstone was typical recovered from the auger as low plasticity Sandy CLAY with gravel.

Waste debris from or near ground surface (uncovered or with very thin covering) was encountered at TP01, TP04, TP07 and TP17. Often this waste was mixed with soil. At TP01 and TP02 a more deliberate soil cover of about 0.3 m thickness over the waste was apparent.

The maximum thickness of waste encountered (excluding cover thickness at TP01 and TP02) was in TP17 (1.2 m over sandstone). Second thickest was in TP04 (0.6 m to the limit of excavation). These occurrences are likely to be linked with the waste encountered in TP07 and associated with the linear ‘waste mound’ discussed in Section 3.3.

No groundwater was observed in the test pits.

6. Discussion

6.1 Excavation conditions

The 13.5 tonne excavator and pendulum auger met with practical refusal on numerous occasions. In TP02 and TP04 this was due to waste debris binding up around the auger. An excavator with general purpose bucket would have been able to excavated through this material.

In the remainder of conditions, practical refusal was due to very slow progress of the auger through less weathered and stronger conglomerate and sandstone. Where previous stripping of surficial weathered material had occurred such as at TP05, TP06 and TP16 refusal was reached at less than 0.3 m depth. In other locations, refusal was reached when rock strength increased below a shallow weathered profile.

Excavation with a small to medium sized tracked excavator and bucket is likely to meet with similar slow progress in these materials. The use of hydraulic hammers to increase excavation progress is not expected to be effective as the sandstone and conglomerate bedding is expected to be thick. Large excavators of at least 20 to 30 tonne with buckets and suitable teeth are expected to be more effective but progress could still be very slow in high strength materials that are generally expected below the limit of the test pit investigation.

The excavation method employed by Willow Tree Gravel in these same materials is blasting. Excavation of the former quarry also appears to have been by blasting.

Excavation for a landfill cell is expected to be well beyond the limit of our investigation. However, a good indication of conditions below this is available from the former quarry and Willow Tree Gravel quarry where blasting is used. The blasting plans and experience of Willow Tree Gravel in excavating these materials would provide a valuable guide to excavation of rock to create a landfill cell.

6.2 Excavated material characteristics and re-use

The characteristics of the material as excavated is a function of the excavation method. In this case a pendulum auger with new tungsten carbide teeth that are designed to roll and hence ‘self-sharpen’. The effect was generally to grind through the material and it was only in the more thinly bedded sandstone that pieces of rock were recovered. Point Load Index testing could only be undertaken on these samples.

Excavation with a bucket, ripper or by blasting would produce material with larger pieces of rock. This can be seen in the below photo from the Willow Tree Gravel quarry.

To produce a similar material to that created by auger drilling, crushing of oversized material from ripping or blasting would be needed. For very low and low strength materials, use of a grid roller on thinly spread material is likely to be effective in reducing oversize proportions. However, the effectiveness of this technique should be confirmed with a field trial, particularly for breakup of medium strength rock which is expected to comprise a significant proportion of the excavated material.

Image 11 Willow Tree Gravel quarry highwall

Re-use functions of the excavated soil and rock for use in landfill operations will depend on how the material is excavated and blended. Based on the observed auger excavated material and products of Willow Tree Gravel from the same rock units the following material uses are expected to be achievable:

- Daily cover
- Intermediate cover
- Internal access roads and hardstands

The use of site won material in landfill cell liners would be restricted to protection layers for geosynthetics or liner foundation material. The material is expected to be too permeable to provide the function of a clay liner by itself and require significant processing of the harder rock for use in any drainage layers.

For capping materials, the site won material could provide a useful component but by itself is expected to be too permeable to provide the function of a clay capping.

6.3 Further investigation work recommendations

The scope of further geotechnical investigations should take into consideration the proposed landfill cell design and required volumes and specifications for various materials to be won from the excavation. Based on our preliminary understanding of the proposed landfill and the results of this investigation, we recommend the following be considered:

- Diamond cored boreholes and rock laboratory testing to assess rock strength and lithology and hence allow estimates of different rock unit volumes to be excavated.
- Consultation with Willow Tree Gravel on blasting, crushing and screening.
- Depending on proposed excavation methods and material handling: field trial with a large excavator (20 to 30 tonne) with grid rolling to breakup oversize.
- Additional laboratory testing of excavated and processed material to compare properties with specifications for various material functions.

Appendices

Appendix A – General Notes and standard sheets

GENERAL NOTES

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

The report contains the results of a geotechnical investigation or study conducted for a specific purpose and client. The results may not be used or relied on by other parties, or used for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the report are excluded unless they are expressly stated to apply in the report.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water depths presented on the test hole logs are the depths of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater depth may differ from this recorded depth depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this depth could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities such as a change is ground surface level. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate surveys, instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in ground conditions do occur in the natural environment, particularly between discrete test hole locations or available observation sites. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural processes.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to GHD for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

Ref: DS5.5.1 Issue 0 Date: 05/10/2018

SOIL DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

Soil is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical Site Investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines soil as particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking. Classification of the soil is undertaken following description.

SOIL DESCRIPTION

The soil description includes a) Composition, b) Condition, c) Structure, d) Origin and e) Additional observations. 'FILL', 'TOPSOIL' or a 'MIXTURE OF SOIL AND COBBLES / BOULDERS' (with dominant fraction first) is denoted at the start of a soil description where applicable.

a) Soil Composition (soil name, colour, plasticity or particle characteristics, secondary and then minor components)

Soil Name: A soil is termed a *coarse grained soil* where the dry mass of sand and gravel particles exceeds 65% of the total. Soils with more than 35% fines (silt or clay particles) are termed *fine grained soils*. The soil name is made up of the primary soil component (in BLOCK letters), prefixed by applicable secondary component qualifiers. Minor components are applied as a qualifiers to the soil name (using the words 'with' or 'trace').

Particles are differentiated on the basis of size. 'Boulders' and 'cobbles' are outside the soil particle range, though their presence (and proportions) is noted. While individual particles may be designated as silt or clay based on grain size, fine grained soils are characterised as silt or clay based on tactile behaviour or Atterberg Limits, and not the relative composition of silt or clay sized particles.

Colour: The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Roughly equally proportioned colours are prefixed by (spotted, mottled, streaked etc.). Colour is described in its moist condition, though both wet and dry colours may also be provided if appropriate.

Plasticity: Fine grained soils are designated within standard ranges of plasticity based on tactile assessment or laboratory assessment of the Liquid Limit.

Particle Characteristics: The particle shape, particle distribution and particle size range within a coarse grained soil is described using standard terms. Particle composition may be described using rock or mineral names, with specific terms for carbonate soils.

Secondary and Minor Components: The primary soil is described and modified by secondary and minor components, with assessed ranges as tabulated.

Carbonate Soils: Carbonate content can be assessed by use of dilute '10%' HCl solution. Resulting clear sustained effervescence is interpreted as a *Carbonate soil* (approximately >50% carbonate), while weak or sporadic effervescence indicates *Calcareous soil* (< 50% carbonate). No effervescence is interpreted as a non-calcareous soil.

Organic and Peat Soils: Where identified, organic content is noted. *Organic soil* (2% to 25% organic matter) is usually identified by colour (usually dark grey/black) and odour (i.e. 'mouldy' or hydrogen sulphide odour). *Peat* (>25% organic matter) is identified by a spongy feel and fibrous texture. Peat soils' decomposition may be described as '*fibrous*' (little / no decomposition), '*pseudo-fibrous*' (moderate decomposition) or '*amorphous*' (full decomposition).

Fraction	Components		Particle Size (mm)
Oversize	BOULDERS		> 200
	COBBLES		63 - 200
Coarse grained soil particles	GRAVEL	Coarse	19 - 63
		Medium	6.7 -19
		Fine	2.36 - 6.7
	SAND	Coarse	0.6 - 2.36
		Medium	0.21 - 0.6
		Fine	0.075 - 0.21
Fine grained soil particles	SILT		0.002 - 0.075
	CLAY		< 0.002

Plasticity Terms (Fine Grained Soils)		Laboratory Liquid Limit Range
Silt	**Clay**	
N/A	N/A	(Non Plastic)
Low Plasticity	*Low Plasticity*	≤ 35%
	Medium Plasticity	> 35% and ≤ 50%
High Plasticity	*High Plasticity*	> 50%

Particle Distribution Terms (Coarse Grained Soils)	
Well graded	good representation of all particle sizes
Poorly graded	one or more intermediate sizes poorly represented
Gap graded	one or more intermediate sizes absent
Uniform	essentially of one size

Particle Shape Terms (Coarse Grained Soils)		
Rounded	*Sub-angular*	*Flaky or Platy*
Sub-rounded	*Angular*	*Elongated*

Secondary and Minor Components for Coarse Grained Soils			
Fines (%)	**Modifier** (as applicable)	**Accessory coarse (%)**	**Modifier** (as applicable)
≤ 5	*'trace silt / clay'*	≤ 15	*'trace sand / gravel'*
> 5, ≤ 12	*'with clay / silt'*	> 15, ≤ 30	*'with sand / gravel'*
> 12	*prefix 'silty / clayey'*	> 30	*prefix 'gravelly / sandy'*

Secondary and Minor Components for Fine Grained Soils	
% Coarse	**Modifier** (as applicable)
≤ 15	add *"trace sand / gravel"*
> 15, ≤ 30	add *"with sand / gravel"*
> 30	prefix soil *"sandy / gravelly"*

Ref: DS6.5.1.1 Rev 0 Date: 2/03/2018

SOIL DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

b) Soil Condition (moisture, relative density or consistency)

Moisture: Fine grained soils are described relative to plastic or liquid limits, while coarse grained soils are assessed based on appearance and feel. The observation of seepage or free water is noted on the test hole logs.

Moisture - Coarse Grained Soils

Term		Tactile Properties
Dry	*('D')*	Non-cohesive, free running
Moist	*('M')*	Feels cool, darkened colour, tends to stick together
Wet	*('W')*	Feels cool, darkened colour, tends to stick together, free water forms when handling

Moisture - Fine Grained Soils

Term		Tactile Properties
Moist, dry of plastic limit	*('w < PL')*	Hard and friable or powdery
Moist, near plastic limit	*('w ≈ PL')*	Can be moulded
Moist, wet of plastic limit	*('w > PL')*	Weakened, free water forms on hands with handling
Wet, near liquid limit	*('w ≈ LL')*	Highly weakened, tends to flow when tapped
Wet, wet of liquid limit	*('w > LL')*	Liquid consistency, soil flows

Relative Density (Non Cohesive Soils): The Density Index is inherently difficult to assess by visual or tactile means, and is normally assessed by penetration testing (e.g. SPT, DCP, PSP or CPT) with published correlations. Assessment may be affected by moisture and *in situ* stress conditions. Density Index assessment may be refined by combination of *in situ* density testing and laboratory reference maximum and minimum density ranges.

Consistency (Cohesive Soils): May be assessed by direct measurement (shear vane, CPT etc.), or approximate tactile correlations. Cohesive soils include fine grained soils, and coarse grained soils with sufficient fine grained components to induce cohesive behaviour. A 'design shear strength' must consider the mode of testing, the *in situ* moisture content and potential for variations of moisture which may affect the shear strength.

Relative Density (Non-Cohesive Soils)

Term and (Symbol)		Density Index (%)
Very Loose	*(VL)*	≤ 15
Loose	*(L)*	> 15 and ≤ 35
Medium Dense	*(MD)*	> 35 and ≤ 65
Dense	*(D)*	> 65 and ≤ 85
Very Dense	*(VD)*	> 85

Consistency assessment can be influenced by moisture variation.

Consistency (Cohesive Soils)

Term and (Symbol)		Tactile Properties	Undrained Shear Strength
Very Soft	*(VS)*	Extrudes between fingers when squeezed	< 12 kPa
Soft	*(S)*	Can be moulded by light finger pressure	12 - 25 kPa
Firm	*(F)*	Can be moulded by strong finger pressure	25 - 50 kPa
Stiff	*(St)*	Cannot be moulded by fingers	50 - 100 kPa
Very Stiff	*(VSt)*	Can be indented by thumb nail	100 - 200 kPa
Hard	*(H)*	Can be indented with difficulty by thumb nail	> 200 kPa
Friable	*(Fr)*	Easily crumbled or broken into small pieces by hand	-

c) Structure (zoning, defects, cementing)

Zoning: The *in situ* zoning is described using the terms below. *'Intermixed'* may be used for an irregular arrangement.

'layer' (a continuous zone across the exposed sample)

'lens' (a discontinuous layer with lenticular shape)

'pocket' (an irregular inclusion of different material).

'interbedded' or *"interlaminated"* (alternating soil types)

Defects: Described using terms below, with dimension orientation and spacing described where practical.

'parting' (an open or closed surface or crack sub parallel to layering with little / no tensile strength - open or closed)

'fissure' (as per a parting, though not parallel or sub parallel to layering – may include desiccation cracks)

'sheared seam' (zone of sub parallel near planar closely spaced intersecting smooth or slickensided fissures dividing the mass into lenticular or wedge shaped blocks)

'sheared surface' (a near planar, curved or undulating smooth, polished or slickensided surface, indicative of displacement)

'softened zone' (in clayey soils, usually adjacent to a defect with associated higher moisture content)

'tube' (tubular cavity, singly or one of a large number, often formed from root holes, animal burrows or tunnel erosion)

'tube cast' (an infilled tube – infill may vary from uncemented through to cemented or have rock properties)

'infilled seam' (sheet like soil body cutting through the soil mass, formed by infilling of open defects)

Cementation: Soils may be cemented by various substances (e.g. iron oxides and hydroxides, silica, calcium carbonate, gypsum), and the cementing agent shall be identified if practical. Cemented soils are described as:

'weakly cemented'	easily disaggregated by hand in air or water
'moderately cemented'	effort required to disaggregate the soil by hand in air or water

Materials extending beyond '*moderately cemented*' are encompassed within the rock strength range. Where consistent cementation throughout a soil mass is identified as a duricrust, it is described in accordance with duricrust rock descriptors. Where alternate descriptors of cementation development are applied for consistency with regional practices or geology, or client requirements, these are outlined separately.

Ref: DS6.5.1.1 Rev 0 Date: 2/03/2018

SOIL DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

d) Origin

An interpretation is provided based on observations of landform, geology and fabric, and may further include assignment of a stratigraphic unit. The use of terms 'possibly' or 'probably' indicates a higher degree of uncertainty regarding the assessed origin or stratigraphic unit. Typical origin descriptors include:

Residual	Formed directly from in situ weathering with no visible structure or fabric of the parent soil or rock.
Extremely weathered	Formed directly from in situ weathering, with remnant and/or fabric from the parent rock.
Alluvial	Deposited by streams and rivers (may be applied more generically as transported by water).
Estuarine	Deposited in coastal estuaries, including sediments from inflowing rivers, streams, and tidal currents.
Marine	Deposited in a marine environment.
Lacustrine	Deposited in freshwater lakes.
Aeolian	Transported by wind.
Colluvial and Slopewash	Soil and rock debris transported down slopes by gravity (with or without assistance of water). Colluvium is typically applied to thicker / localised deposits, and slopewash for thinner / widespread deposits.
TOPSOIL	Surficial soil, typically with high levels of organic material. Topsoils buried by other transported soils are termed *'remnant topsoil'*. Tree roots within otherwise unaltered soil does not characterise topsoil.
FILL	Any material which has been placed by anthropogenic processes (i.e. human activity).

e) Additional Observations

Additional observations may be included to supplement the soil description. Additional observations may consist of notations relating to soil characteristics (odour, contamination, colour changes with time), inferred geology (with delineation of soil horizons or geological time scale) or notes on sampling and testing application (including the reliability, recovery, representativeness, or condition of samples or test conditions and limitations). If the material is assessed to be not representative, terms such as 'poor recovery', 'non-intact', 'recovered as' or 'probably' are applied.

SOIL CLASSIFICATION

Classification allocates the material within distinct soil groups assigned a two character Group Symbol:

Coarse Grained Soils (sand and gravel: more than 65% of soil coarser than 0.075 mm)

Major Division	Group Symbol	Soil Group
GRAVEL (more than half of the coarse fraction is > 2.36 mm)	GW	GRAVEL, well graded
	GP	GRAVEL, poorly graded
	GM	Silty GRAVEL
	GC	Clayey GRAVEL
SAND (more than half of the coarse fraction is < 2.36 mm)	SW	SAND, well graded
	SP	SAND, poorly graded
	SM	Silty SAND
	SC	Clayey SAND

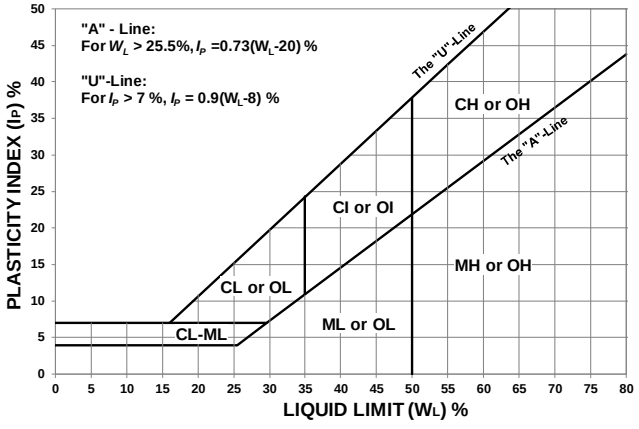
Fine Grained Soils (silt and clay: more than 35% of soil finer than 0.075 mm)

Major division	Group Symbol	Soil Group
SILT and CLAY (low to medium plasticity)	ML	SILT, low plasticity
	CL	CLAY, low plasticity
	CI	CLAY, medium plasticity
	OL	Organic SILT
SILT and CLAY (high plasticity)	MH	SILT, high plasticity
	CH	CLAY, high plasticity
	OH	Organic CLAY / SILT
Highly Organic	Pt	PEAT

Coarse grained soils with fines contents between 5% and 12% are provided a dual classification comprising the two group symbols separated by a dash, e.g. for a poorly graded gravel with between 5% and 12% silt fines (poorly graded 'GRAVEL with silt'), the classification is GP-GM.

For the purpose of classification, *poorly graded, uniform,* or *gap graded* soils are all designated as poorly graded. Soils that are dominated by boulders or cobbles are described separately and are not classified.

Classification is routinely undertaken based on tactile assessment with the soil description. Refinement of soil classification may be applied using laboratory assessment, including particle size distribution and Atterberg Limits. Atterberg Limits testing is applied to the sample portion finer than 0.425 mm. Fine grained soil components are assessed on the basis of regions defined within the Modified Casagrande Chart.



ROCK DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

Rock is described in general accordance with Australian Standard AS 1726-2017 (Geotechnical site investigations) in terms of visual and tactile properties, with potential refinement by laboratory testing. AS 1726 defines rock as any aggregate of minerals and/or organic materials that cannot be disaggregated by hand in air or water without prior soaking. The rock description and classification distinguishes between rock material, defects, structure and rock mass.

ROCK DESCRIPTION AND CLASSIFICATION

a) Description of rock material (rock name, grain size and type, colour, texture and fabric, inclusions or minor components, moisture content and durability)

Rock Name: Simple rock names are used to provide a reasonable engineering description rather than a precise geological classification. The rock name is chosen on the basis of origin, with common types summarised below. Additional, non-exhaustive, terminology is included in AS 1726. Rock names not described within AS 1726 may be adopted, with geological characteristics typically noted within accompanying text.

<table>
<tr><th rowspan="2">Grain Size (mm)</th><th colspan="4">Sedimentary</th><th colspan="2">Metamorphic</th><th colspan="3">Igneous</th></tr>
<tr><th colspan="2">Clastic or Detrital</th><th colspan="2">Carbonate</th><th rowspan="2">Pyroclastic</th><th rowspan="2">Foliated</th><th rowspan="2">Non-Foliated</th><th rowspan="2">Felsic</th><th rowspan="2">↔</th><th rowspan="2">Mafic</th></tr>
<tr><th colspan="2"></th><th>Low Porosity</th><th>Porous</th></tr>
<tr><td>>2.0</td><td colspan="2">CONGLOMERATE
(rounded grains in a finer matrix)

BRECCIA
(angular or irregular fragments in a finer matrix)</td><td rowspan="4">LIMESTONE
(Predominantly $CaCO_3$)

or

DOLOMITE
(Predominantly $CaMgCO_3$)</td><td>CALCIRUDITE</td><td>AGGLOMERATE
(rounded grains in a finer matrix)

VOLCANIC BRECCIA
(angular fragments in a finer matrix)</td><td>GNEISS</td><td>MARBLE
(carbonate)

QUARTZITE</td><td>GRANITE</td><td>DIORITE</td><td>GABBRO</td></tr>
<tr><td>2.0-0.06</td><td colspan="2">SANDSTONE</td><td>CALCARENITE</td><td>TUFF</td><td>SCHIST</td><td rowspan="3">SERPENTINITE

HORNFELS</td><td>MICRO-GRANITE</td><td>MICRO-DIORITE</td><td>DOLERITE</td></tr>
<tr><td>0.06-0.002</td><td rowspan="2">MUDSTONE
(silt and clay)</td><td>SILTSTONE
(mostly silt)</td><td>CALCISILTITE</td><td rowspan="2">Fine grained TUFF</td><td rowspan="2">PHYLLITE or SLATE</td><td rowspan="2">RHYOLITE</td><td rowspan="2">ANDESITE</td><td rowspan="2">BASALT</td></tr>
<tr><td><0.002</td><td>CLAYSTONE
(mostly clay)</td><td>CALCILUTITE</td></tr>
</table>

Reproduced with modification from Tables 15, 16 and 17, Clause 6.2.3.1, AS 1726-2017, Geotechnical site investigations.

Grain size: For rocks with predominantly sand sized grains the dominant or average grain size is described as follows:

Rock type	Coarse grained	Medium grained	Fine grained
Sedimentary rocks	Mainly 0.6 mm to 2 mm	Mainly 0.2 mm to 0.6 mm	Mainly 0.06 mm (just visible) to 0.2 mm
Igneous and metamorphic rocks	Mainly >2 mm	Mainly 0.06 mm to 2 mm	Mainly <0.6 mm (just visible)

Colour assists in rock identification and interpolation. Rock colour is generally described in a *"moist"* condition, using simple terms (e.g. grey, brown, etc.) and modified as necessary by *"pale"*, *"dark"*, or *"mottled"*. Borderline colours may be described as a combination of these colours (e.g. red-brown).

Texture refers to the arrangement of, or the relationship between, the component grains or crystals (e.g. porphyritic, crystalline or amorphous).

Fabric refers to visible grain arrangement along a preferential orientation or a layering. Fabric may be noted as *"indistinct"* (little effect on strength) or *"distinct"* (rock breaks more easily parallel to the fabric). Common terms include *"massive"* or *"flow banding"* (igneous), *"foliation"* or *"cleavage"* (metamorphic). Sedimentary layering is described as *"bedding"* or (where thickness < 20 mm) *"lamination"*. The typical orientation, spacing or thickness of these structural features can be described directly in millimetres and metres. Further quantification of bedding thickness applied by GHD is as follows:

Bedding Term	Thickness
Very thickly bedded	>2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 to 200 mm
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	<6 mm

Features, Inclusions and Minor Components are typically only described when those features could influence the engineering behaviour of the rock. Described features may include: gas bubbles in igneous rocks; veins of quartz, calcite or other minerals; pyrite crystals and nodules or bands of ironstone or carbonate; cross bedding in sandstone; clast or matrix support in conglomerates and breccia.

Moisture content may be described by the feel and appearance of the rock, as follows: *"dry"* (looks and feels dry), *"moist"* (feels cool, darkened in colour, but no water is visible on the surface), or *"wet"* (feels cool, darkened in colour, water film or droplets visible on the surface). The moisture content of rock cored with water may not represent in situ conditions.

Durability of rock samples is noted where there is an observed tendency of samples to crack, breakdown in water or otherwise deteriorate with exposure.

ROCK DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

b) Classification of the rock material condition (strength, weathering and/or alteration)

Estimated Strength refers to the rock material and not the rock mass. The strength is defined in terms of uniaxial compressive strength (UCS), though is typically estimated by either tactile assessment or Point Load Strength Index ($Is_{(50)}$) (measured perpendicular to planar anisotropy). A correlation between $Is_{(50)}$ and UCS is adopted for classification, though is not intended for design purposes without appropriate supporting assessment. A field guide follows:

Term and (Symbol)		UCS (MPa)	$Is_{(50)}$ (MPa)	Field Guide
Very Low	*(VL)*	0.6 – 2	0.03 - 0.1	Material crumbles under firm blows with sharp end of geological pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm thick can be broken by finger pressure.
Low	*(L)*	2 - 6	0.1 - 0.3	Easily scored with knife; indentations 1 to 3 mm show in the specimen with firm blows of a geological pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	*(M)*	6 - 20	0.3 - 1.0	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
High	*(H)*	20 - 60	1 - 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a geological pick with a single firm blow; rock rings under hammer.
Very High	*(VH)*	60 - 200	3 -10	Hand specimen breaks with geological pick after more than one blow; rock rings under hammer.
Extremely High	*(EH)*	>200	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Based on Table 19, Clause 6.2.4.1, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Material with strength less than *"very low"* is described using soil characteristics, with the presence of an original rock texture or fabric noted if relevant.

Weathering and Alteration: The process of weathering involves physical and chemical changes to the rock resulting from exposure near the earth's surface. A subjective scale for weathering is applied as follows:

Weathering Term and (Symbol)		Description
Residual Soil	*(RS)*	Material has 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 has weathered to such an extent that it has soil properties. Mass structure, 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)*	Rock shows no sign of decomposition of individual minerals or colour changes.

Modified based on Table 20, Clause 6.2.4.2, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Where physical and chemical changes to the rock are caused by hot gases or liquids at depth, the process is called alteration. Unlike weathering, the distribution of altered material may occur at any depth and show no relationship to topography. Where alteration minerals are identified the terms *"extremely altered" (XA)*, *"highly altered" (HA)*, *"moderately altered" (MA)* and *"slightly altered" (SA)* can be used to describe the physical and chemical changes described above.

ROCK DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

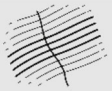
c) Description of defects (defect type, orientation, roughness and shape, coatings and composition of seams, spacing, length, openness and thickness, block shape)

Defects often control the overall engineering behaviour of a rock mass. AS 1726 defines a defect as “a discontinuity, fracture, break or void in the material or materials across which there is little or no tensile strength”. Describing the type, character and distribution of natural defects is an essential part of the description of many rock masses.

Commonly described characteristics of defects within a rock mass include type, orientation, roughness and shape, coatings and composition of seams, aperture, persistence, spacing and block shape.

The degree of detail required for defect descriptions depends on project requirements. All defects judged of engineering significance for the site and project are described individually. Where appropriate, generalised descriptions for less significant, or multiple similar, defects can be provided for delineated parts of rock core or exposures. A general description of delineated defect sets is provided when sufficient orientation data is available.

Defect Type is described using the terms summarised below. On core logs, only natural defects across which the core is discontinuous are described (i.e. inferred artificial fractures such as drill breaks are excluded). Incipient defects are described using the relevant texture or fabric terms. Healed defects (those that have been re-cemented by minerals such as chlorite or calcite) are described using the prefix “healed” (e.g. healed joint).

Type and (Symbol)		Description	Diagram
Parting	(Pt)	A surface or crack across which the rock has little or no tensile strength. Parallel or sub-parallel to layering (e.g. bedding) or a planar anisotropy in the rock material (e.g. cleavage). May be open or closed.	
Joint	(Jt)	A surface or crack with no apparent shear displacement and across which the rock has little or no tensile strength, but which is not parallel or subparallel to layering or to planar anisotropy in the rock material. May be open or closed.	
Sheared Surface	(SS)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement.	
Sheared Zone	(SZ)	Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Sheared Seam	(SSm)	Seam of soil material with roughly parallel almost planar boundaries, composed of soil materials with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks.	
Crushed Seam	(CSm)	Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties.	
Infilled Seam	(ISm)	Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1 mm thick may be described as a veneer or coating on a joint surface.	
Extremely Weathered Seam	(WSm)	Seam of soil material, often with gradational boundaries. Formed by weathering of the rock material in place.	

Modified based on Table 22, Clause 6.2.5.2, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Defect Orientation is recorded as the “dip” (maximum angle of the mean plane, measured from horizontal) and the “dip direction” (azimuth of the dip, measured clockwise from true north). Dip and dip direction is expressed in degrees, with two-digit and three-digit numbers respectively, separated by a slash (e.g. 45/090). For vertical boreholes, the defect dip is measured as the acute angle from horizontal. Rock core extracted from vertical boreholes is generally not oriented, so the dip direction cannot be directly measured. For non-oriented inclined boreholes, a defect “alpha” (α) angle is measured as the acute angle from the core axis. For vertical and non-oriented inclined boreholes, the dip direction can sometimes be estimated from the relationship of the defect to a well-defined site structure such as fabric. For oriented inclined boreholes, the measurement of the defect orientation is carried out and recorded in a form suited to the particular device being used and later processed to report true dip and dip direction.

ROCK DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

Roughness and Shape of the defect surface combine to have significant influence on shear strength. Standard descriptions and abbreviations include:

Roughness and (Symbol)		Description
Very Rough	(VR)	Many large surface irregularities (amplitude generally more than 1 mm). Feels like, or coarser than very coarse sand paper.
Rough	(Rf)	Many small surface irregularities (amplitude generally less than 1 mm). Feels like fine to coarse sand paper.
Smooth	(So)	Smooth to touch. Few or no surface irregularities.
Polished	(Pol)	Shiny smooth surface.
Slickensided	(Slk)	Grooved or striated surface, usually polished.

Shape and (Symbol)		Description
Planar	(Pln	The defect does not vary in orientation.
Curved	(Cu)	The defect has a gradual change in orientation.
Undulating	(Un)	The defect has a wavy surface.
Stepped	(St)	The defect has one or more well defined steps.
Irregular	(Ir)	The defect has many sharp changes of orientation.

Although the surface roughness of defects can be described at small (10-100 mm) scales of observation, the overall shape of the defect surface can usually be observed only at medium (0.1-1 m) and large (>1 m) scale.

Where it is necessary to assess the shear strength of a defect, observations are generally made at multiple scales. Surface roughness may also be characterised by using the joint roughness coefficient (JRC) profiles established by Barton and Choubey (1977). Where large-scale observations are possible, further measurement of defect "waviness" (angle of the asperities relative to the overall dip angle of the plane) is made.

Coatings and Composition of Seams: Many defects have surface coatings, which can affect their shear strength. Standard descriptions include:

Coating and (Symbol)		Description
Clean	(Cn)	No visible coating.
Stained	(Sn)	No visible coating but surfaces are discoloured.
Veneer	(Ve)	A visible coating of soil or mineral substance, but too thin to be measured may be patchy.
Coating	(Co)	A visible coating up to 1 mm thick. Soil material greater than 1 mm thick is described using defect terms (e.g. infilled seam). Rock material greater than 1 mm thick is described as a vein (Vn).

Common Minerals and (Symbol)	
Clay	(CLAY)
Calcite	(Ca)
Carbonaceous	(X)
Chlorite	(Kt)
Iron Oxide	(Fe)
Micaceous	(Mi)
Manganese	(Mn)
Pyrite	(Py)
Quartz	(Qz)

The composition of seams are described using soil description terms as given on the SOIL DESCRIPTION AND CLASSIFICATION Standard Sheet. Where possible the mineralogy of coatings is identified. Common mineral coatings include:

Aperture: Defects across which there is little or no tensile strength can be either *"open"* (*Op*) or *"closed"* (*Cl*). For rock core, the width of the "open" defect is measured whilst still in the core barrel splits. The descriptor *"tight"* (*Ti*) can only apply to healed or incipient defects (i.e. veins, foliation, etc.).

Persistence and Spacing of defects is described directly in millimetres and metres. If the measurement of defect persistence is limited by the extent of the exposure, the end conditions are noted (i.e. 0, 1 or 2 defect ends observed). The spacing between defects of similar orientation (i.e. within a specific defect set) is recorded when possible.

The frequency of defects within rock core can be measured as either: the spacing between successive defects; or the "Fracture Index", which is the number of defects per metre of core.

Spacing Term	Thickness
Very wide	>2 m
Wide	0.6 to 2 m
Medium	0.2 to 0.6 m
Closely	60 to 200 mm
Very closely	20 to 60 mm
Extremely closely	6 to 20 mm

Block Shape: Where it is considered significant, block shape can be described using the subjective terms as follows:

Block Shape	Description
Polyhedral	Irregular discontinuities without arrangement into distinct sets, and of small persistence.
Tabular	One dominant set of parallel discontinuities, for example bedding planes, with other non-continuous joints; thickness of blocks much less than length or width.
Prismatic	Two dominant sets of discontinuities, approximately orthogonal and parallel, with a third irregular set; thickness of blocks much less than length or width.
Equidimensional	Three dominant sets of discontinuities, approximately orthogonal, with occasional irregular joints, giving equidimensional blocks.
Rhomboidal	Three (or more) dominant, mutually oblique, sets of joints giving oblique-shaped, equidimensional blocks.
Columnar	Several, usually more than three sets of continuous, parallel joints usually crossed by irregular joints; lengths much greater than other dimensions.

Modified based on Table 23, Clause 6.2.5.7, AS 1726-2017, Geotechnical site investigations. Refer to source document for further detail.

Ref: DS6.5.2.1 Issue 2.0 Date: 01/08/2019

ROCK DESCRIPTION AND CLASSIFICATION

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

d) Interpreted stratigraphic unit

Stratigraphic units may be interpreted and reported, in accordance with The Australian Stratigraphic Units Database (ASUD). The terms *"possibly"* or *"probably"* indicate increased uncertainty in this interpretation.

e) Geological structure

After describing the rock material and defects, an interpretation of the nature and configuration of rock mass defects may be presented in logs, charts, 2D sections and 3D models (e.g. dipping strata, folds, unconformities, weathering profiles, defect sets, geological faults, etc.).

PARAMETERS RELATED TO CORE DRILLING

Drill Depth and Core Loss: Drilling intervals are shown on GHD Core Log Sheets by depth increments and horizontal marker lines.

"Core loss", or its inverse "total core recovery" (TCR), is measured as a percentage of the core run. If the location of the core loss is known, or strongly suspected, it is shown in a region of the column bounded by dashed horizontal lines. If unknown, core loss is assigned to the bottom of a core run.

Rock Quality Designation (RQD), described by Deere et al. (1989), may be recorded on GHD Core Log Sheets.

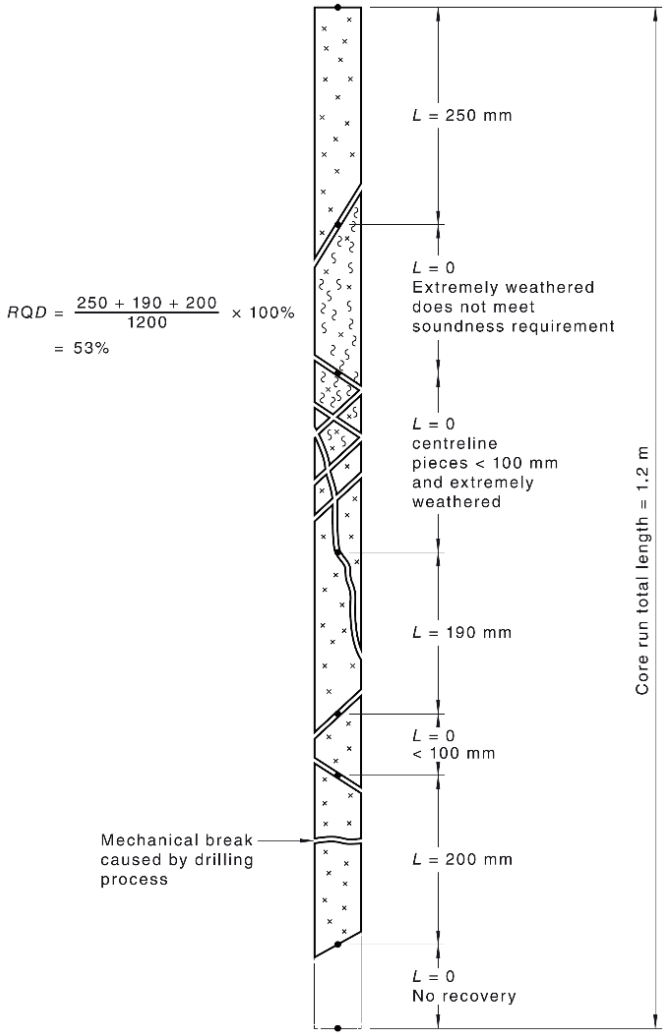
For certain projects, such as tunnelling or underground mining investigations, rock mass ratings or classifications can be required as part of the design process. The RQD forms a component of these rock mass ratings and provides a quantitative estimate of rock mass quality from rock core logs.

The rock core must be "N" sized (nominally 50 mm) or greater for derivation of RQD. The RQD is expressed as a percentage of intact rock core (excluding residual soil and extremely weathered rock) greater than 100 mm in length over the total selected core length.

Deere et al. (1989) recommends measuring lengths of core along the centreline, as shown right.

RQD is expressed as:

$$RQD = \frac{\sum Length\ of\ sound\ core\ pieces > 100\ mm\ in\ length}{Length\ of\ core\ run}\ x\ 100\%$$



RQD measurement procedure
(reproduced from Figure 13, Clause 6.2.9.4, AS 1726-2017, Geotechnical site investigations)

ROCK MASS CLASSIFICATION

Rock mass classification schemes may be used to represent the engineering characteristics of a rock mass. A large variety of classification schemes have been developed by various authors, ranging from simple to complex. All of the schemes are limited in their application and many rock mass classification systems assume that the rock mass is isotropic, which is rarely the case.

References

STANDARDS AUSTRALIA (2017). AS 1726-2017. GEOTECHNICAL SITE INVESTIGATIONS.
BARTON, N. AND CHOUBEY, V. (1977). THE SHEAR STRENGTH OF ROCK JOINTS IN THEORY AND PRACTICE. ROCK MECHANICS 10, 1-54. SPRINGER.
DEERE, D.U. AND DEERE, D.W. (1989). ROCK QUALITY DESIGNATION (RQD) AFTER TWENTY YEARS. CONTRACT REPORT GL-89-1. ARMY CORPS OF ENGINEERS. WASHINGTON DC, 1989.

GLOSSARY OF SYMBOLS

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

This standard sheet should be read in conjunction with all test hole log sheets and any idealised geological sections prepared for the investigation report.

GENERAL

Symbol	Description	Symbol	Description
D	Disturbed Sample	R	Rising Head Permeability Test
B	Bulk Sample	F	Falling Head Permeability Test
U(50)	Undisturbed Sampled (suffixed by sample size or tube diameter in mm if applicable)	PBT	Plate Bearing Test
CS	Core Sample (suffixed by diameter in mm)		Water Inflow (make)
ES	Soil sample for environmental sampling		Water Outflow (loss)
PID	Photoionisation Detector		Temporary Water Level
SPT	Standard Penetration Test (with blows per 0.15m)		Final Water Level
N	SPT Value		Point Load Test (axial)
HB/HW	SPT Hammer Bouncing/Hammer Weight		Point Load Test (diametric)
PP/HP	Pocket/Hand Penetrometer (suffixed by value kPa)	PL	Point Load (kPa)
PK	Packer Test (kPa)	IMP	Impression Device Test
PZ	Piezometer Installation	PM	Pressuremeter Test
SV/VS	Shear Vane Test (suffixed by value in kPa)		

SOIL SYMBOLS

Main Components				Minor Components			
	SAND		FILL		sandy		vegetation, roots
	GRAVEL		SILT		gravelly		silty
	CLAY		TOPSOIL		clayey	*Note: Natural soils are generally a combination of constituents, e.g. sandy CLAY*	

ROCK SYMBOLS

Sedimentary						Igneous			
	SANDSTONE		SILTSTONE		CONGLOMERATE		GRANITIC ROCK		IGNEOUS DYKE
	CLAYSTONE		SHALE		COAL		BASALTIC ROCK		

Note: Additional rock symbols may be allocated for a particular project

NATURAL DEFECTS *(Coding)*

Defect Type		Orientation					
Jt	Joint	For vertical non-oriented core ... “Dip” angle (eg. 5°) measured relative to horizontal.					
Pt	Parting	For inclined non-oriented core ... “Angle” measured relative to core axis.					
SS	Sheared Surface	For inclined oriented core ... “Dip” angle and “Dip Direction” angle (eg. 45°/225° mag.).					
WSm	Weathered Seam	**Orientation (con’t)**		**Roughness**		**Coating**	
SSm	Sheared Seam	VT	Vertical	Pol	Polished	Cn	Clean
CSm	Crushed Seam	HZ or 0°	Horizontal	So	Smooth	Sn	Stained
ISm	Infilled Seam	d / °	Degrees	Rf	Rough	Ve	Veneer
SZ	Sheared Zone			VR	Very Rough	Co	Coating
VN	Vein			Slk	Slickensided		
Shape				**Infilling / Common Materials**			
Pln	Planar	St	Stepped	CLAY	Clay	Mi	Micaceous
Cu	Curved	Ir	Irregular	Ca	Calcite	Mn	Manganese
Un	Undulating	Dis	Discontinuous	X	Carbonaceous	Py	Pyrite
Others				Kt	Chlorite	Qz	Quartz
OP	Open	CL	Closed	Ti	Tight	Fe	Iron Oxide	MU	Unidentified Mineral

Ref: DS6.5.3 Rev 1 Date : 25/09/2019

LABORATORY TESTING

GHD
Specialist Services in Geotechnical Engineering, Geology, Field/Laboratory Testing and Hydrogeology
www.ghd.com/Geotechnical

GENERAL

Samples extracted during the fieldwork stage of a site investigation may be “disturbed” or “undisturbed” (as generally indicated on the test hole logs) depending upon the nature and purpose of the sample as well as the method of extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results, which must of necessity, reflect the effects of such disturbance.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site variability of soil strata, future changes in moisture and other conditions and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory test results provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and project in hand.

TESTING

Laboratory testing is normally carried out in accordance with Australian Standard AS 1289 as amended, or in NSW, Roads and Maritime Services (RMS) standards when specified. The routine Australian Standard tests are as follows:

Moisture Content	AS1289 2.1.1	
Liquid Limit	AS1289 3.1.1	collectively known as Atterberg Limits
Plastic Limit	AS1289 3.2.1	
Plasticity Index	AS1289 3.3.1	
Linear Shrinkage	AS1289 3.4.1	
Particle Density	AS1289 3.5.1	
Particle Size Distribution	AS1289 3.6.1, 3.6.2 and 3.6.3	
Emerson Class Number	AS1289 3.8.1	collectively, Dispersive Classification
Percent Dispersion	AS1289 3.8.2	
Pinhole Dispersion Classification	AS1289 3.8.3	
Hole Erosion (HE)	GHD Method	
No Erosion Filter (NEF)	GHD Method	
Organic Matter	AS1289 4.1.1	
Sulphate Content	AS1289 4.2.1	
pH Value	AS1289 4.3.1	
Resistivity	AS1289 4.4.1	
Standard Compaction	AS1289 5.1.1	
Modified Compaction	AS1289 5.2.1	
Dry Density Ratio	AS1289 5.4.1	
Minimum Density	AS1289 5.5.1	
Density Index	AS1289 5.6.1	
California Bearing Ratio	AS1289 6.1.1 and 6.1.2	
Shear Box	AS1289 6.2.2	
Undrained Triaxial Shear	AS1289 6.4.1 and 6.4.2	
One Dimensional Consolidation	AS1289 6.6.1	
Permeability Testing	AS1289 6.7.1, 6.7.2 and 6.7.3	

Where tests are used which are not covered by appropriate standard procedures, details are given in the report.

LABORATORIES

Our Australian laboratories are NATA accredited to AS ISO / IEC17025 for the listed tests.

The oedometer, triaxial and shear box equipment are fully automated for continuous operation using computer controlled data acquisition, processing and plotting systems.

Ref: DS5.5.2 Issue 0 Date: 05/10/2018

Appendix B – Figures

LEGEND

- 500 — EXISTING CONTOURS m A.H.D
- CADASTRE
- TEST PIT LOCATIONS

NOTE:

1. CONTOURS AND CADASTRE TAKEN FROM BATH STEWART ASSOCIATES SURVEY DATED 14/05/20. REF. 20096.

0 25 50 75m
SCALE 1:2500 AT ORIGINAL SIZE

N

GHD

LIVERPOOL PLAINS SHIRE COUNCIL
WILLOW TREE WASTE MANAGEMENT FACILITY

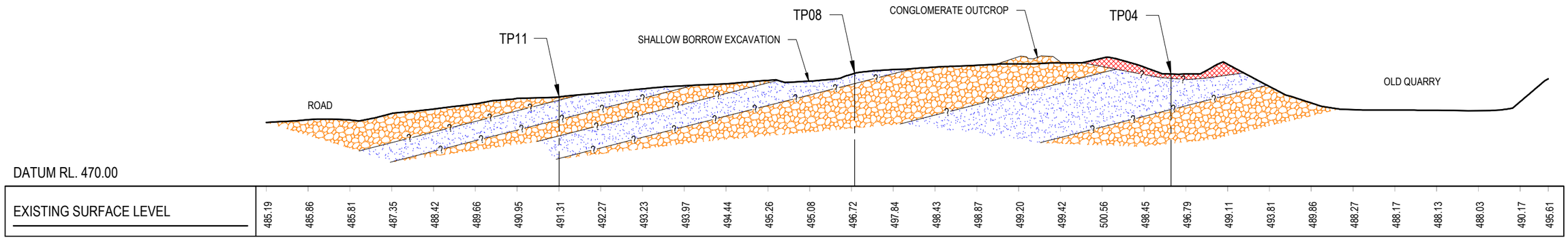
GEOTECHNICAL INVESTIGATION PLAN

Job Number 12534581
Revision A
Date DEC 2020

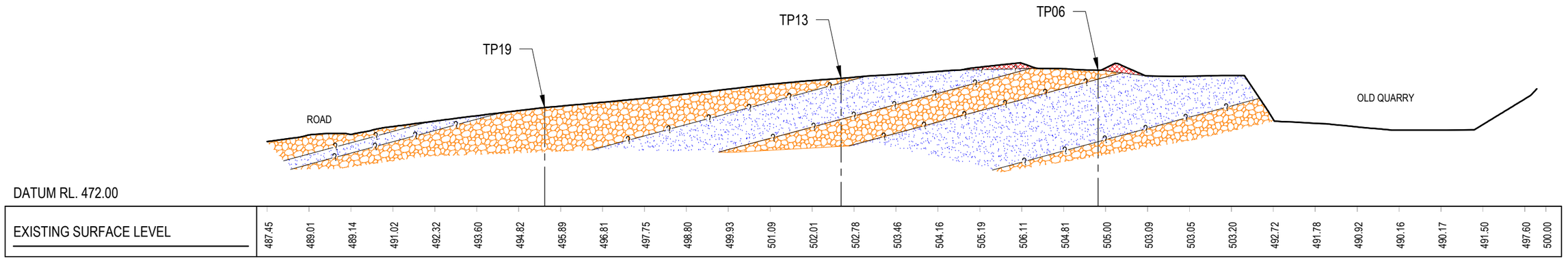
Figure 01

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

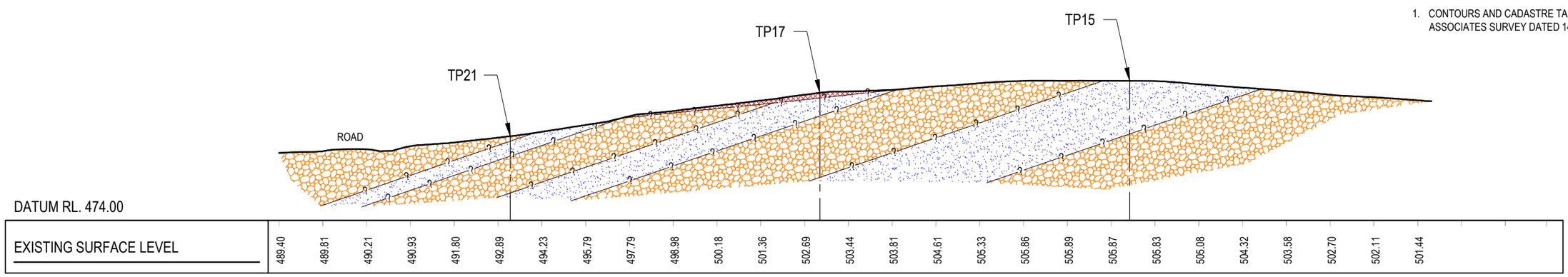
Plot Date: 18 December 2020 - 11:25 PM Plotted by: Laurence Gae Posadas
Cad File No: C:\Users\lcposadas\Desktop\Working - LPSC - Willow Tree Regional Landfill Facility\12534581-FIG01.dwg



A SECTION
FIG01 SCALE 1:1000V 1:1000H



B SECTION
FIG01 SCALE 1:1000V 1:1000H



C SECTION
FIG01 SCALE 1:1000V 1:1000H

NOTE:

1. CONTOURS AND CADASTRE TAKEN FROM BATH STEWART ASSOCIATES SURVEY DATED 14/05/20. REF. 20096.

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE

CONGLOMERATE AND PEBBLY SANDSTONE
SANDSTONE AND PEBBLY SANDSTONE BEDS
FILL/WASTE

GHD

LIVERPOOL PLAINS SHIRE COUNCIL
WILLOW TREE WASTE MANAGEMENT FACILITY

Job Number 12534581
Revision A
Date DEC 2020

GEOTECHNICAL INVESTIGATION SECTIONS Figure 02

Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

Plot Date: 18 December 2020 - 11:24 PM Plotted by: Laurence Gae Posadas
Cad File No: C:\Users\lcposadas\Desktop\Working - LPSC - Willow Tree Regional Landfill Facility\12534581-FIG02.dwg

Appendix C – Test Pit Logs and Photographs

BOREHOLE LOG SHEET

Client :	Liverpool Plains Shire Council
Project :	Willow Tree Waste Management Facility
Location :	Merriwa Road, Willow Tree, NSW

HOLE No. TP01

SHEET 1 OF 1

Position : Refer to test location plan | **Surface RL:** 485.2m AHD | **Angle from Horiz. :** 90° | **Processed :** HAL

Rig Type : Kobelco Excavator SK135SR Auger | **Contractor :** | **Driller :** | **Checked :** SJM

Date Started : 4/12/2020 | **Date Completed :** 4/12/2020 | **Logged by :** S. Mackenzie | **Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
			Nil				-	[FILL]: Sandy GRAVEL: fine to coarse, brown, with waste, plastic, metal, rubber hose, roots.	D	-	Appears loose.
					0.30		-	[FILL]: Gravelly CLAY: red brown, with sand, metal pieces, roots.	M	-	Appears well compacted.
1					0.50		GC	Clayey GRAVEL: fine to coarse, with sand, red brown (residual).	M	VD	
				D	1.20		-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey, with iron staining, very low strength, extremely weathered sandstone interbedding? (excavates as CLAY with sand, trace gravel (CL)). 1.8m, becoming higher strength.	-	-	
2					1.90			End of borehole at 1.90 metres. Practical Refusal			
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP02

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 488.8m AHD **Angle from Horiz. :** 90° **Processed :** HAL

Rig Type : Kobelco Excavator SK55SRTracker **Contractor :** **Driller :** **Checked :** SJM

Date Started : 3/12/2020 **Date Completed :** 3/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations Note: * indicates signatures on original issue of log or last revision of log
			Nil		0.30		-	[FILL]: GRAVEL: fine to coarse, rounded, red brown, with sand, trace fines.	D	-	Appears well compacted.
					0.50		-	[FILL]: REFUSE WASTE: sheet metal/corrugated iron? or thinner.	D	-	
1								End of borehole at 0.50 metres. Auger binding up on rubbish not able to turn. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **12534581**

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

Client : Liverpool Plains Shire Council		**HOLE No. TP03**	
Project : Willow Tree Waste Management Facility			
Location : Merriwa Road, Willow Tree, NSW		**SHEET 1 OF 1**	
Position : Refer to test location plan	**Surface RL:** 493.3m AHD	**Angle from Horiz. :** 90°	**Processed :** HAL
Rig Type : Kobelco Excavator SK135SR Auger	**Contractor :**	**Driller :**	**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie	**Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations
					0.05		-	[TOPSOIL]: leaf litter.	-	-	
			Nil	B	0.60		-	CONGLOMERATE/PEBBLY SANDSTONE: medium to coarse, orange brown, very low strength, extremely weathered (excavates as Clayey Sandy GRAVEL, medium to coarse).	-	-	
								End of borehole at 0.60 metres. Practical Refusal			
1											
2											
3											

Description key: [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP04

SHEET 1 OF 1

Position : Refer to test location plan | **Surface RL:** 497.0m AHD | **Angle from Horiz. :** 90° | **Processed :** HAL

Rig Type : Kobelco Excavator SK85CR-3 Mounted Auger | **Contractor :** | **Driller :** | **Checked :** SJM

Date Started : 4/12/2020 | **Date Completed :** 4/12/2020 | **Logged by :** S. Mackenzie | **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Note: * indicates signatures on original issue of log or last revision of log Comments/ Observations
			Nil		0.60		-	[FILL]: WASTE: bricks, bottles, metal, slag, wire. ~0.1m, soil cover also containing waste.	D	-	Appears poorly compacted
1								End of borehole at 0.60 metres. Auger binding up in waste. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council		**HOLE No. TP05**	
Project : Willow Tree Waste Management Facility			
Location : Merriwa Road, Willow Tree, NSW		**SHEET 1 OF 1**	
Position : Refer to test location plan	**Surface RL:** 504.0m AHD	**Angle from Horiz. :** 90°	**Processed :** HAL
Rig Type : Kobelco Excavator SK135SR Auger	**Contractor :**	**Driller :**	**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie	**Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations
			Nil	D	0.30		-	SANDSTONE: medium grained, orange brown, medium strength, highly weathered.	-	-	
								End of borehole at 0.30 metres. Practical Refusal			
1											
2											
3											

Description column heading: [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP06

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 504.0m AHD **Angle from Horiz. :** 90° **Processed :** HAL

Rig Type : Kobelco Excavator SK150LC-7 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 3/12/2020 **Date Completed :** 3/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
			Nil		0.10	. . . . .	-	SANDSTONE: fine to coarse grained, pale grey with red brown iron staining, with fine to medium pebbles, medium to high strength, moderately weathered. End of borehole at 0.10 metres. Practical Refusal	-	-	
1											
2											
3											

Note: * indicates signatures on original issue of log or last revision of log

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP07

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 502.0m AHD **Angle from Horiz. :** 90° **Processed :** HAL

Rig Type : Kobelco Excavator SK55SRX-3 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 3/12/2020 **Date Completed :** 3/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
							-	[FILL]: Sandy GRAVEL: dark brown to brown mottled, with roots, wire rope, metal parts.	D	-	Appears loose.
					0.30		-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey, low strength, extremely to moderately weathered (excavates as Sandy GRAVEL, fine to medium, with fines).	-	-	
			Nil					0.9m, becoming stronger (harder drilling resistance).			
1					1.00			End of borehole at 1.00 metres. Practical Refusal			
2											
3											

Note: * indicates signatures on original issue of log or last revision of log

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **12534581**

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council
Project : Willow Tree Waste Management Facility
Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP08

SHEET 1 OF 1

Position : Refer to test location plan	**Surface RL:** 497.0m AHD	**Angle from Horiz. :** 90°	**Processed :** HAL
Rig Type : Kobelco Excavator SK135SR Mounting:	**Contractor :**	**Driller :**	**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie	**Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	**Description** [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	**Comments/ Observations**
			Nil	D (cobble)	0.60		-	SANDSTONE: fine grained, pale brown with iron staining bedded at ~40-100mm thickness, medium strength, moderately weathered (excavates as sandstone cobbles and gravel).	-	-	
1								End of borehole at 0.60 metres. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council
Project : Willow Tree Waste Management Facility
Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP09

SHEET 1 OF 1

Position : Refer to test location plan	**Surface RL:** 490.4m AHD	**Angle from Horiz. :** 90°	**Processed :** AJET
Rig Type : Kobelco Excavator SK135SR Auger	**Contractor :**	**Driller :**	**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie	**Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description: [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
			Nil	D	0.90		-	CONGLOMERATE: fine to medium, pale grey and red brown iron stained, very low strength, extremely weathered (excavates as GRAVEL with fines and sand (GP).	-	-	
1								End of borehole at 0.90 metres. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP10

SHEET 1 OF 1

Position : Refer to test location plan	**Surface RL:** 485.6m AHD	**Angle from Horiz. :** 90°		**Processed :** AJET
Rig Type : Kobelco Excavator SK55SRTracker	**Contractor :**	**Driller :**		**Checked :** SJM
Date Started : 4/12/2020	**Date Completed :** 4/12/2020	**Logged by :** S. Mackenzie		**Date:** 18/12/2020

DRILLING					MATERIAL						Note: * indicates signatures on original issue of log or last revision of log
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
				D			SC	Clayey Gravelly SAND: red brown, fine to medium, with roots (residual).	D	VD	
					0.30		-	CONGLOMERATE: fine to medium, pale grey with red brown iron staining, very low strength, extremely weathered (excavates as Sandy GRAVEL, fine to medium, with fines, with roots).	-	-	
1			Nil					1.0m, becoming higher strength, increased drilling resistance and larger clasts.			
					1.10			End of borehole at 1.10 metres. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

Client : Liverpool Plains Shire Council		**HOLE No. TP11**	
Project : Willow Tree Waste Management Facility			
Location : Merriwa Road, Willow Tree, NSW		**SHEET 1 OF 1**	
Position : Refer to test location plan	**Surface RL:** 491.3m AHD	**Angle from Horiz. :** 90°	**Processed :** AJET
Rig Type : Kobelco Excavator SK135SR Auger	**Contractor :**	**Driller :**	**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie	**Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description	Moisture Condition	Consistency / Density Index	Comments/ Observations
					0.15		-	[FILL]: CRUSHED ROCK: medium grained, dark grey.	D	-	Appears loose
			Nil		0.30		GC	Clayey Sandy GRAVEL: fine to medium, red brown (residual).	D	VD	
					0.70		-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey with iron staining, very low strength, extremely weathered (excavates as Sandy GRAVEL, with fines). 0.7m, becoming higher strength off white SANDSTONE in base.	-	-	
								End of borehole at 0.70 metres. Practical Refusal			
1											
2											
3											

Description: [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **12534581**

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council
Project : Willow Tree Waste Management Facility
Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP12

Position : Refer to test location plan	**Surface RL:** 497.2m AHD	**Angle from Horiz. :** 90°	**Processed :** AJET
Rig Type : Kobelco Excavator SK135SR Auger	**Contractor :**	**Driller :**	**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie	**Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
			Nil				GC	Clayey Sandy GRAVEL: fine to medium, red brown (residual).	D	VD	
					0.30		-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey with red brown iron staining, extremely weathered, very low strength (excavates as Sandy GRAVEL, with fines).	-	-	
1								1.0m, becoming harder, low to medium strength.			
					1.10			End of borehole at 1.10 metres.			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP13

SHEET 1 OF 1

Position : Refer to test location plan	**Surface RL:** 502.5m AHD	**Angle from Horiz. :** 90°		**Processed :** AJET
Rig Type : Kobelco Excavator SK55SR-7 Mounted Auger	**Contractor :**	**Driller :**		**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie		**Date:** 18/12/2020

DRILLING					MATERIAL						Note: * indicates signatures on original issue of log or last revision of log
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
1			Nil	B	0.05		-	[TOPSOIL]: Leaf litter.	D	-	Consistently hard drilling resistance.
							-	CONGLOMERATE PEBBLY/SANDSTONE: fine to medium, pale grey with red brown iron staining, very low strength, extremely weathered (excavates as Sandy CLAY with gravel (CL).	-	-	
					1.50		-	SANDSTONE: fine grained, orange brown, medium strength, highly weathered.	-	-	
					1.60			End of borehole at 1.60 metres. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council
Project : Willow Tree Waste Management Facility
Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP14

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 506.0m AHD **Angle from Horiz. :** 90° **Processed :** AJET
Rig Type : Kobelco Excavator SK85CR-3 **Contractor :** **Driller :** **Checked :** SJM
Date Started : 3/12/2020 **Date Completed :** 3/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations Note: * indicates signatures on original issue of log or last revision of log
1			Nil	D	0.50		-	[FILL]: Gravelly SAND: brown and dark brown mottled, with fines, with roots and minor organics.	M	-	Appears well compacted.
					1.20		-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey with red brown iron staining, very low strength, extremely weathered (excavates as Clayey Sandy GRAVEL). 1.1m, becomes low to medium strength.	-	-	Becoming harder drilling at 1.1m.
2								End of borehole at 1.20 metres. Practical Refusal			
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **12534581**

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP15

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 506.2m AHD **Angle from Horiz. :** 90° **Processed :** AJET

Rig Type : Kobelco Excavator SK55SRX-3 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 3/12/2020 **Date Completed :** 3/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
					0.05		-	[TOPSOIL]: Leaf litter.	D	-	
			Nil	B			-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey with red brown iron staining, very low strength, extremely weathered (excavates as Silty Sandy GRAVEL, fine to medium (GM/SM).	-	-	
1					0.90		-	CONGLOMERATE: fine to medium, pale grey, medium strength, slightly weathered.	-	-	Harder drilling from 0.9m.
					1.10			End of borehole at 1.10 metres. Practical Refusal			
2											
3											

Note: * indicates signatures on original issue of log or last revision of log

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council
Project : Willow Tree Waste Management Facility
Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP16

Position : Refer to test location plan	**Surface RL:** 504.3m AHD	**Angle from Horiz. :** 90°	**Processed :** AJET
Rig Type : Kobelco Excavator SK135SR Auger	**Contractor :**	**Driller :**	**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie	**Date:** 18/12/2020

Note: * indicates signatures on original issue of log or last revision of log

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	**Description** [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	**Comments/ Observations**
			Nil		0.20		-	CONGLOMERATE: fine to medium, pale grey, medium strength, slightly weathered (excavates as GRAVEL with sand and fines).	-	-	
								End of borehole at 0.20 metres. Practical Refusal			
1											
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP17

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 503.1m AHD **Angle from Horiz. :** 90° **Processed :** AJET

Rig Type : Kobelco Excavator SK85CR-7 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 4/12/2020 **Date Completed :** 4/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations Note: * indicates signatures on original issue of log or last revision of log
1			Nil		1.20		-	[FILL]: WASTE: metal bike frame, bed frame, glass bottles (dated 1962), insulated wire, bricks, plastic, with topsoil spread throughout.	D	-	Appears loose
					1.30		-	SANDSTONE: fine grained, pale grey, very low strength, extremely weathered.	-	-	
2								End of borehole at 1.30 metres. Waste collapsing & binding up auger			
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP18

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 500.0m AHD **Angle from Horiz. :** 90° **Processed :** AJET

Rig Type : Kobelco Excavator SK55SR-7 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 4/12/2020 **Date Completed :** 4/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						Note: * indicates signatures on original issue of log or last revision of log
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
1			Nil	B	0.05		-	[TOPSOIL]: leaf litter.	M	-	Consistent drilling.
							-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, some coarse clasts, pale grey ironstained red brown, very low to low strength, extremely weathered (excavates as Clayey Sandy GRAVEL, fine to medium (GC).	-	-	
					1.80						
2								End of borehole at 1.80 metres. Near max reach			
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP19

SHEET 1 OF 1

Position : Refer to test location plan	**Surface RL:** 495.5m AHD	**Angle from Horiz. :** 90°		**Processed :** AJET
Rig Type : Kobelco Excavator SK55SRT Mounted Auger	**Contractor :**	**Driller :**		**Checked :** SJM
Date Started : 3/12/2020	**Date Completed :** 3/12/2020	**Logged by :** S. Mackenzie		**Date:** 18/12/2020

DRILLING					MATERIAL						Note: * indicates signatures on original issue of log or last revision of log
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
			Nil		0.40		GC	Sandy Clayey GRAVEL: fine to medium, red brown (residual).	D	VD	
					0.80		-	CONGLOMERATE: fine to medium, pale grey with iron staining, very low strength, extremely weathered, with roots and fines (excavates as Sandy GRAVEL, fine to medium, with fines). 0.7m, becoming stronger.	-	-	
								End of borehole at 0.80 metres. Practical Refusal			
1											
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP20

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 490.1m AHD **Angle from Horiz. :** 90° **Processed :** AJET

Rig Type : Kobelco Excavator SK55SRX-7 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 3/12/2020 **Date Completed :** 3/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
							GC	Sandy Clayey GRAVEL: fine to medium, red brown (residual).	D	VD	
			Nil		0.20		-	CONGLOMERATE: fine to medium, pale grey with iron staining, very low strength, extremely weathered (excavates as Sandy GRAVEL, with fines). 0.6m, becoming low to medium strength and pale grey.	-	-	
					0.70			End of borehole at 0.70 metres. Practical Refusal			
1											
2											
3											

Note: * indicates signatures on original issue of log or last revision of log

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **12534581**

BOREHOLE LOG SHEET

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP21

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 493.2m AHD **Angle from Horiz. :** 90° **Processed :** HAL

Rig Type : Kobelco Excavator SK55SRX-3 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 4/12/2020 **Date Completed :** 4/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations Note: * indicates signatures on original issue of log or last revision of log
1			Nil	D (rock) B	0.45		-	CONGLOMERATE: fine to medium, pale grey to red brown, very low strength, extremely weathered (excavates at Sandy GRAVEL, fine to medium, with fines).	-	-	
					1.80		-	SANDSTONE: fine grained, grey to dark grey, bedded 5-10mm thick, medium strength, moderately weathered (excavates as Sandy CLAY with gravel (CL). 1.8m, becoming stronger.	-	-	
2								End of borehole at 1.80 metres. Slow progress near maximum reach			
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **12534581**

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP22

SHEET 1 OF 1

Position : Refer to test location plan	**Surface RL:** 497.6m AHD	**Angle from Horiz. :** 90°		**Processed :** HAL
Rig Type : Kobelco Excavator SK85CR-3	**Contractor :** Mitchell Auger	**Driller :**		**Checked :** SJM
Date Started : 4/12/2020	**Date Completed :** 4/12/2020	**Logged by :** S. Mackenzie		**Date:** 18/12/2020

DRILLING					MATERIAL					
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Note: * indicates signatures on original issue of log or last revision of log Comments/ Observations
					0.10		-	[TOPSOIL]: leaf litter, 100mm.	-	-	
							-	SANDSTONE: fine grained, red brown, thinly bedded, with roots, very low strength, extremely weathered (excavates as Sandy CLAY, low plasticity with gravel (CL).	-	-	
1			Nil	B				0.5m, pale grey with red brown iron stained.			
					1.20		-	CONGLOMERATE: fine to coarse, up to 100mm clasts of quartz, pale grey and red brown, low to medium strength, highly to moderately weathered.	-	-	
					1.30			End of borehole at 1.30 metres. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP23

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 500.5m AHD **Angle from Horiz. :** 90° **Processed :** HAL

Rig Type : Kobelco Excavator SK55SRX-3 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 3/12/2020 **Date Completed :** 3/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

DRILLING					MATERIAL						Note: * indicates signatures on original issue of log or last revision of log
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations
1			Nil	B	1.30		-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey with red brown iron staining, very low strength, extremely weathered (excavates as Clayey Gravelly SAND (SC).	-	-	Consistently slow progress.
2								End of borehole at 1.30 metres. Practical Refusal			
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 12534581

BOREHOLE LOG SHEET

GEO_BOREHOLE_AS1726 2017 12534581 WILLOW TREE.GPJ GHD_GEO_TEMPLATE 2.00.GDT 22/12/20

Client : Liverpool Plains Shire Council

Project : Willow Tree Waste Management Facility

Location : Merriwa Road, Willow Tree, NSW

HOLE No. TP24

SHEET 1 OF 1

Position : Refer to test location plan **Surface RL:** 495.3m AHD **Angle from Horiz. :** 90° **Processed :** HAL

Rig Type : Kobelco Excavator SK55SR-7 **Contractor :** **Driller :** **Checked :** SJM

Date Started : 4/12/2020 **Date Completed :** 4/12/2020 **Logged by :** S. Mackenzie **Date:** 18/12/2020

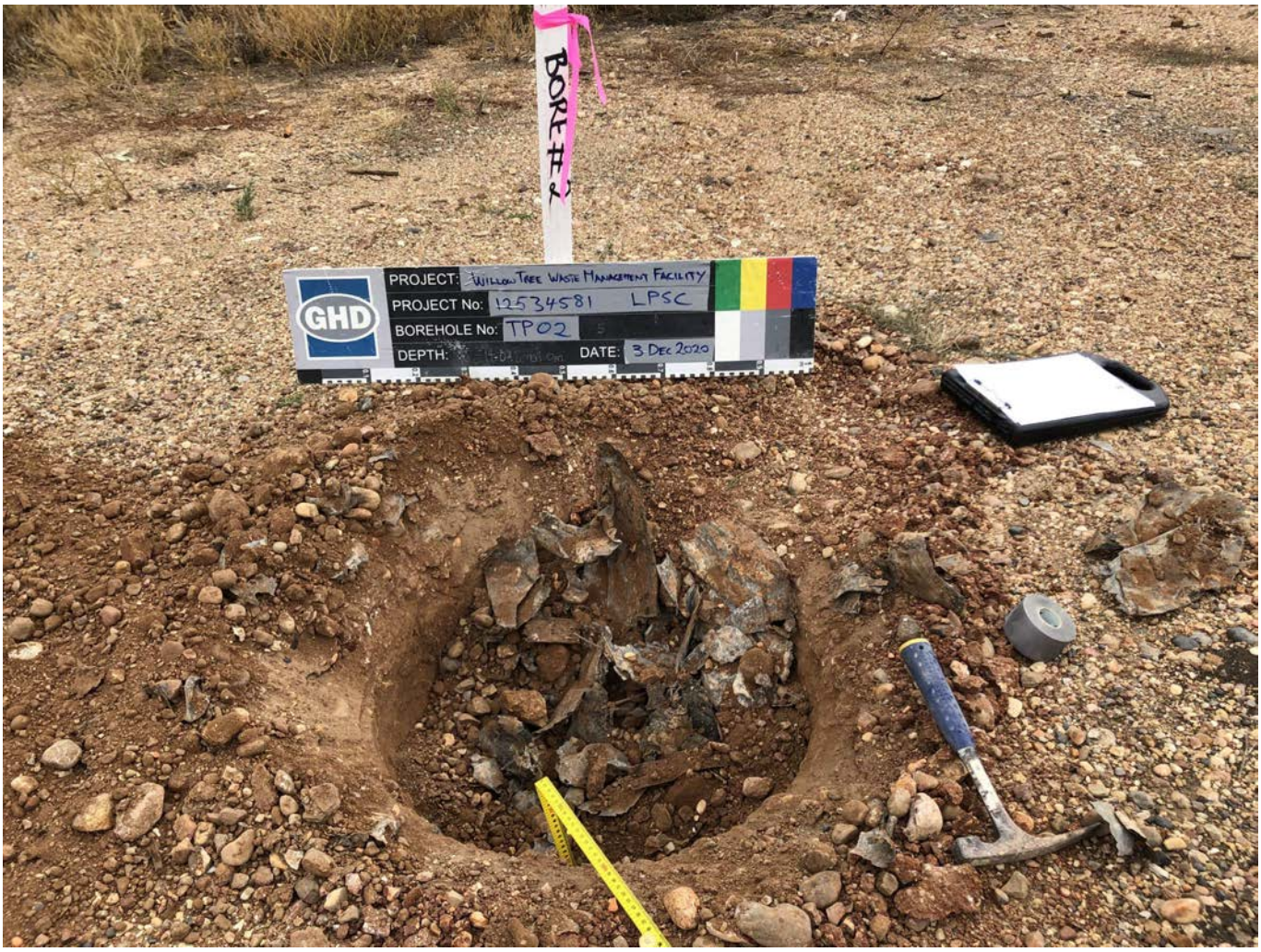
DRILLING					MATERIAL						
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth metres	Graphic Log	USC Symbol	Description [COBBLES/BOULDERS/FILL/TOPSOIL] then SOIL NAME: plasticity / primary particle characteristics, colour, secondary and minor components, zoning (origin) and ROCK NAME: grain size, colour, fabric / texture, inclusions or minor components, durability, strength, weathering / alteration, defects	Moisture Condition	Consistency / Density Index	Comments/ Observations Note: * indicates signatures on original issue of log or last revision of log
1			Nil	B			-	CONGLOMERATE/PEBBLY SANDSTONE: fine to medium, pale grey, with red brown iron staining, very low strength, extremely weathered (excavates as Clayey SAND with gravel (SC).	-	-	20mm leaf litter.
					1.60		-	SANDSTONE: fine to medium grained, grey brown, low strength, moderately to highly weathered.	-	-	
					1.80			End of borehole at 1.80 metres. Practical Refusal			
2											
3											

See standard sheets for details of abbreviations & basis of descriptions

GHD
Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle 2300 Australia
T: +61 2 4979 9999 F: +61 2 4979 9988 E: ntlmail@ghd.com
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. **12534581**

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020	
	CHECKED: S Mackenzie	DATE: 18/12/2020	
	SCALE: Not To Scale		A4
	PROJECT No: 12534581	FIGURE No: TP01 1/1	



Liverpool Plains Shire Council
Willow Tree Waste Management Facility
Merriwa Road, Willow Tree NSW
TP Photographs

DRAWN	H Warr	DATE	18/12/2020
CHECKED	S Mackenzie	DATE	18/12/2020
SCALE	Not To Scale		A4
PROJECT No	12534581	FIGURE No	TP02 1/1

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP03 1/1

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN H Warr	DATE 18/12/2020	
	CHECKED S Mackenzie	DATE 18/12/2020	
	SCALE Not To Scale		A4
	PROJECT No 12534581	FIGURE No TP04 1/1	

Liverpool Plains Shire Council
Willow Tree Waste Management Facility
Merriwa Road, Willow Tree NSW
TP Photographs

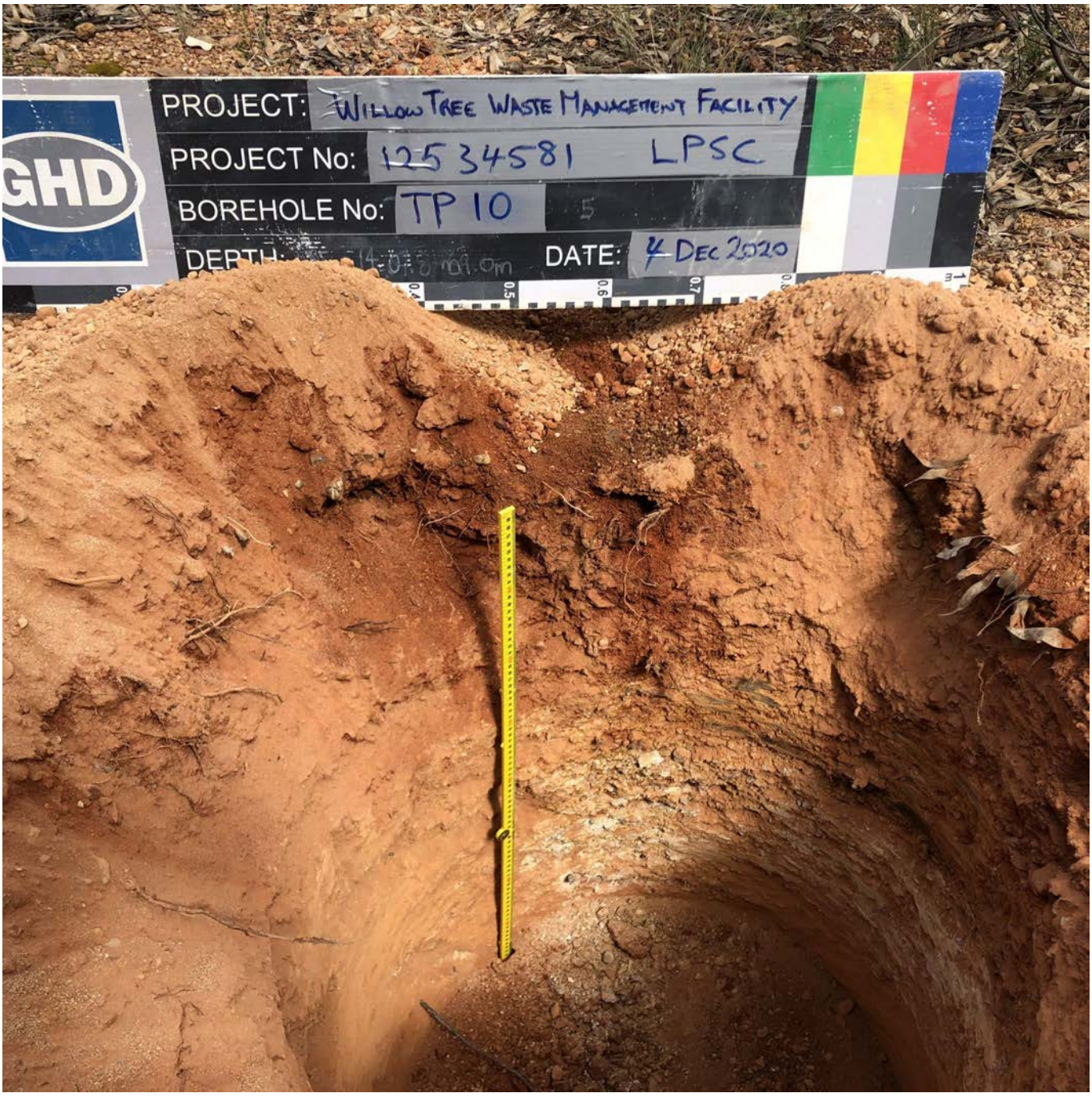
DRAWN	H Warr	DATE	18/12/2020
CHECKED	S Mackenzie	DATE	18/12/2020
SCALE	Not To Scale		A4
PROJECT No	12534581	FIGURE No	TP05 1/1

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP06 1/1

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP07 1/1

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020	
	CHECKED: S Mackenzie	DATE: 18/12/2020	
	SCALE: Not To Scale		A4
	PROJECT No: 12534581	FIGURE No: TP08 1/1	

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP09 1/1



GHD_GEO_LIBRARY 2.00.GLB GrfcTbl DG PHOTO TEST PIT PHOTO 1 PER PAGE 12534581 WILLOW TREE.GPJ <<DrawingFile>> 19/12/2020 00:19 10.02.00.04

	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP10 1/1

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN H Warr	DATE 18/12/2020	
	CHECKED S Mackenzie	DATE 18/12/2020	
	SCALE Not To Scale		A4
	PROJECT No 12534581	FIGURE No TP11 1/1	

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020	
	CHECKED: S Mackenzie	DATE: 18/12/2020	
	SCALE: Not To Scale		A4
	PROJECT No: 12534581	FIGURE No: TP12 1/1	

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP13 1/1

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020	
	CHECKED: S Mackenzie	DATE: 18/12/2020	
	SCALE: Not To Scale		A4
	PROJECT No: 12534581	FIGURE No: TP14 1/1	

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP15 1/1

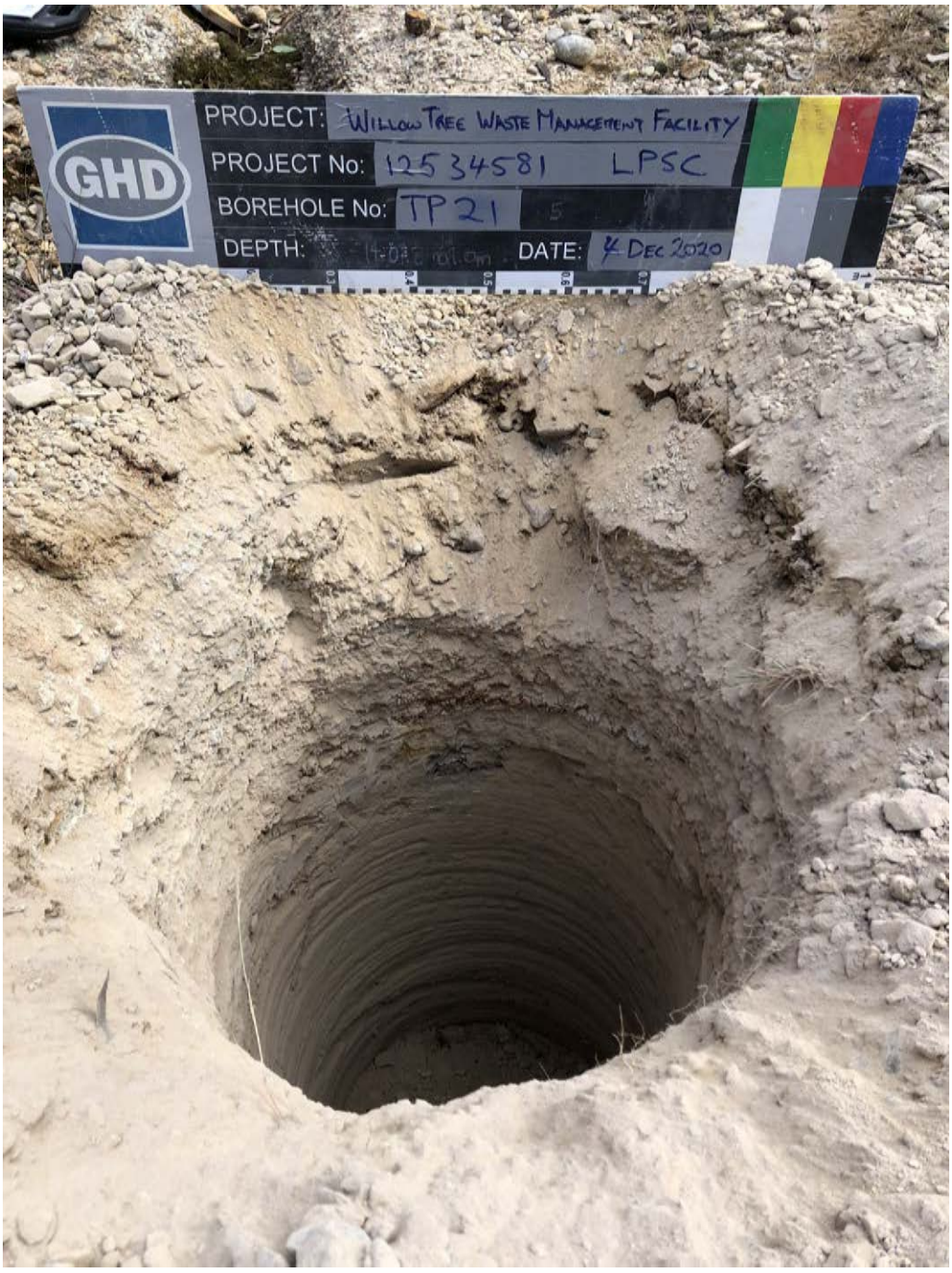
	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP16 1/1

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN H Warr	DATE 18/12/2020	
	CHECKED S Mackenzie	DATE 18/12/2020	
	SCALE Not To Scale		A4
	PROJECT No 12534581	FIGURE No TP17 1/1	

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP18 1/1

	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP19 1/1

Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020	
	CHECKED: S Mackenzie	DATE: 18/12/2020	
	SCALE: Not To Scale		A4
	PROJECT No: 12534581	FIGURE No: TP20 1/1	



Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN H Warr	DATE 18/12/2020	
	CHECKED S Mackenzie	DATE 18/12/2020	
	SCALE Not To Scale		A4
	PROJECT No 12534581	FIGURE No TP21 1/1	

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP22 1/1

GHD	Liverpool Plains Shire Council Willow Tree Waste Management Facility Merriwa Road, Willow Tree NSW TP Photographs	DRAWN: H Warr	DATE: 18/12/2020
		CHECKED: S Mackenzie	DATE: 18/12/2020
		SCALE: Not To Scale	A4
		PROJECT No: 12534581	FIGURE No: TP23 1/1

Liverpool Plains Shire Council
Willow Tree Waste Management Facility
Merriwa Road, Willow Tree NSW
TP Photographs

DRAWN	H Warr	DATE	18/12/2020
CHECKED	S Mackenzie	DATE	18/12/2020
SCALE	Not To Scale		A4
PROJECT No	12534581	FIGURE No	TP24 1/1

Appendix D – Laboratory Test Reports

Sydney Laboratory
Unit 5 / 43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax: (02) 9462 4710

Report No: SYD2002784
Issue No: 1

Point Load Strength Index - Report

Client:	Liverpool Plains Shire Council
Project:	Willow Tree Waste Management Facility
Location:	Merriwa Road, Willow Tree
Job No.:	12534581
Borehole / Sample No.:	See below
Test Method:	AS4133.4.1

Accredited for compliance with ISO / IEC 17025 - Testing
Laboratory Accreditation No. 679

Authorised Signatory: D.Brooke

Date of issue : 16/12/20

Test Results

Depth (m)	Test Type (D,A,I)	Dimensions				Results				Sample Description		
		D (mm)	L (mm)	W (mm)	De (mm)	Load, P (kN)	Failure Mode (1,2,3..)	Is (MPa)	Is_{50} (MPa)	Rock Type	Structure	Moisture
TP5												
0.0 - 0.3	I	82.1	56.2	92.3	98.2	2.35	3	0.24	**0.33**	SS	MA	Moist
	I	60.1	54.2	83.0	79.7	1.66	3	0.26	**0.32**	SS	MA	Moist
TP8												
0.0 - 0.6	I	74.1	36.3	75.5	84.4	2.87	3	0.40	**0.51**	SS	MA	Moist
TP21												
0.5 - 1.8	I	36.5	56.4	95.4	66.6	2.4	3	0.54	**0.62**	SS	MA	Moist
	I	50.5	34.8	90.5	76.3	2.94	3	0.51	**0.61**	SS	MA	Moist

Comments (if applicable):

MOISTURE
(W) Wet
(M) Moist
(D) Dry
(AD) As Drilled
(AR) As Received

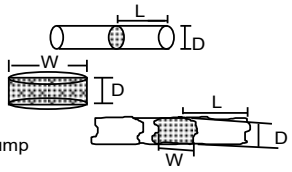
ROCK TYPE
(SS) Sandstone
(ST) Siltstone
(SH) Shale
(G) Granitic
(MSS) Meta Sandtone
(MST) Meta Siltstone

STRUCTRUE
(MA) Massive
(BE) Bedded
(IB) Interbedded
(LA) Laminated
(CR) Crystalline

FAILURE MODE
1 = Fracture through fabric oblique to bedding
2 = Fracture along bedding
3 = Fracture through rock mass
4 = Fracture influenced by pre-existing:
(J) Joint plane, (M) Microfracture, (F) Foliation, (V) Vein
5 = Partial fracture or chip (Invalid result)

TEST TYPES

D = Diametral — L > 0.5 D
A = Axial — 0.6W < D < W
I = Irregular Lump — 0.6W < D < W



Time Since Sampling = - Days
Storage:
☐ CORE BOX ☒ UNDER COVER
☒ WRAPPED ☐ OPEN AIR
☐ UNWRAPPED ☐ UNKNOWN

Sampled By: GHD
Date Sampled: not known
Tested By: GC
Date Tested: 14/12/20

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002751
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

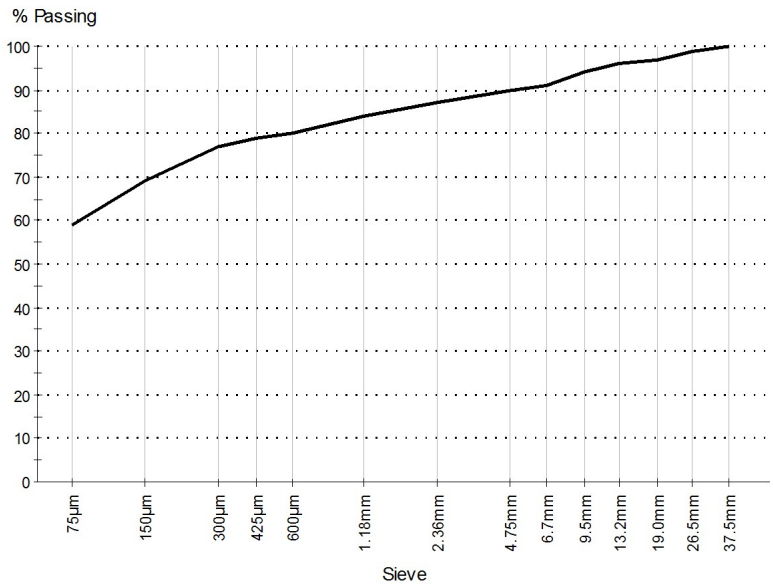
GHD Sample No	SYD20-0515-01
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP1
Depth (m)	1.5 - 1.8
Soil Description	CLAY with sand trace gravel light grey

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

AS 1289.3.6.1



Drying by: Oven
Date Tested: 8/12/2020

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	97	
13.2mm	96	
9.5mm	94	
6.7mm	91	
4.75mm	90	
2.36mm	87	
1.18mm	84	
600µm	80	
425µm	79	
300µm	77	
150µm	69	
75µm	59	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002752
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

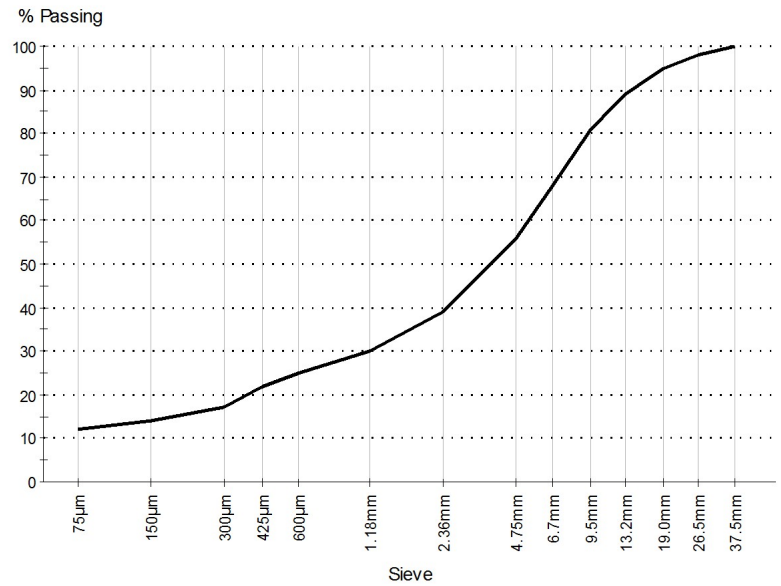
GHD Sample No	SYD20-0515-04
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP9
Depth (m)	0.2 - 0.5
Soil Description	GRAVEL with clay & sand light red brown

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

AS 1289.3.6.1



Date Tested:

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	98	
19.0mm	95	
13.2mm	89	
9.5mm	81	
6.7mm	68	
4.75mm	56	
2.36mm	39	
1.18mm	30	
600µm	25	
425µm	22	
300µm	17	
150µm	14	
75µm	12	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002753
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

GHD Sample No	SYD20-0515-05
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP10
Depth (m)	0.0 - 0.3
Soil Description	Clayey gravelly SAND red brown

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
	AS 1289.3.4.1		
Linear Shrinkage (%)		Not Tested	
Mould Length (mm)			
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	35	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	18	

Particle Size Distribution

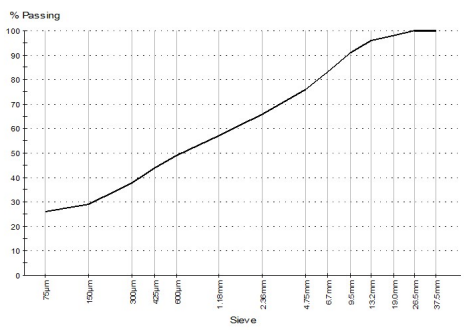
Method: AS 1289.3.6.1

Date Tested:

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	100	
19.0mm	98	
13.2mm	96	
9.5mm	91	
6.7mm	83	
4.75mm	76	
2.36mm	66	
1.18mm	57	
600µm	49	
425µm	44	
300µm	38	
150µm	29	
75µm	26	

Chart



Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002754
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

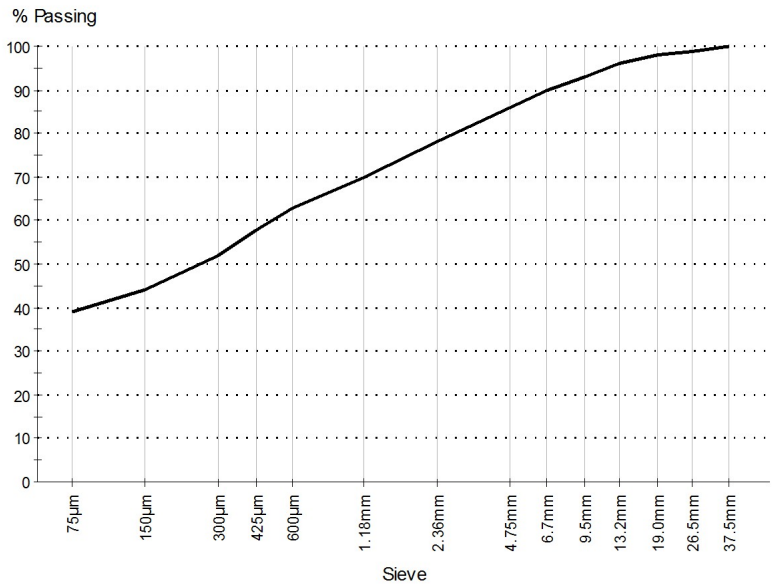
GHD Sample No	SYD20-0515-06
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP13
Depth (m)	1.0 - 1.5
Soil Description	Sandy CLAY with gravel

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

AS 1289.3.6.1



Drying by: Oven
Date Tested: 8/12/2020

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	98	
13.2mm	96	
9.5mm	93	
6.7mm	90	
4.75mm	86	
2.36mm	78	
1.18mm	70	
600µm	63	
425µm	58	
300µm	52	
150µm	44	
75µm	39	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002755
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

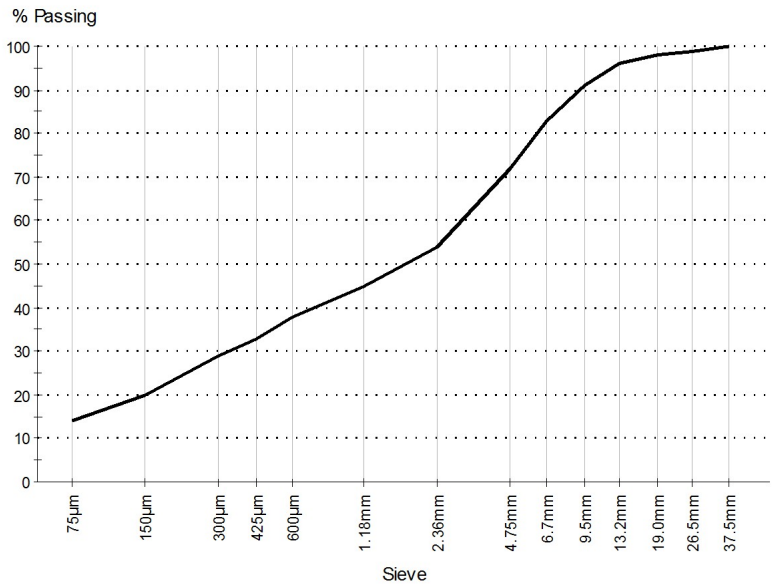
GHD Sample No	SYD20-0515-07
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP15
Depth (m)	0.5 - 1.1
Soil Description	Silty SANDY GRAVEL

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

AS 1289.3.6.1



Date Tested:

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	98	
13.2mm	96	
9.5mm	91	
6.7mm	83	
4.75mm	72	
2.36mm	54	
1.18mm	45	
600µm	38	
425µm	33	
300µm	29	
150µm	20	
75µm	14	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002756
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

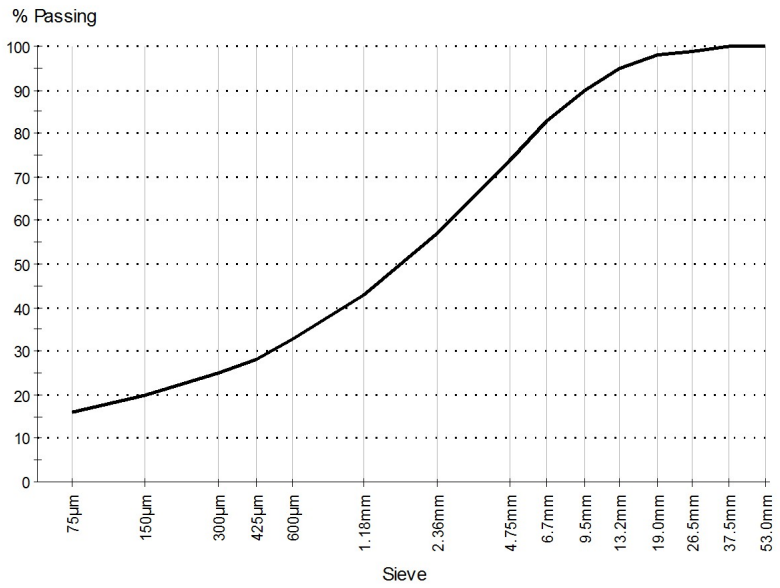
GHD Sample No	SYD20-0515-08
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP18
Depth (m)	0.5 - 1.0
Soil Description	Clayey SANDY GRAVEL

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

AS 1289.3.6.1



Date Tested: 8/12/2020

Note: Sample Washed

Sieve Size	% Passing	Limits
53.0mm	100	
37.5mm	100	
26.5mm	99	
19.0mm	98	
13.2mm	95	
9.5mm	90	
6.7mm	83	
4.75mm	74	
2.36mm	57	
1.18mm	43	
600µm	33	
425µm	28	
300µm	25	
150µm	20	
75µm	16	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002758
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

GHD Sample No	SYD20-0515-10
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP21
Depth (m)	1.0 - 1.7
Soil Description	Sandy CLAY with gravel light grey brown

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
	AS 1289.3.4.1		
Linear Shrinkage (%)		Not Tested	
Mould Length (mm)			
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	24	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	15	
Plasticity Index (%)	AS 1289.3.3.1	9	

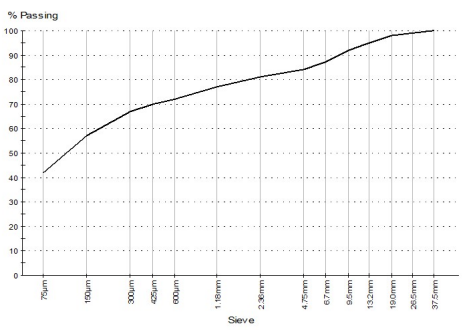
Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 8/12/2020

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	98	
13.2mm	95	
9.5mm	92	
6.7mm	87	
4.75mm	84	
2.36mm	81	
1.18mm	77	
600µm	72	
425µm	70	
300µm	67	
150µm	57	
75µm	42	

Chart



Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002757
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

GHD Sample No	SYD20-0515-11
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP22
Depth (m)	0.5 - 1.2
Soil Description	Sandy CLAY with gravel light red brown

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
	AS 1289.3.4.1		
Linear Shrinkage (%)		Not Tested	
Mould Length (mm)			
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	31	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	14	
Date Tested		11/12/2020	

Particle Size Distribution

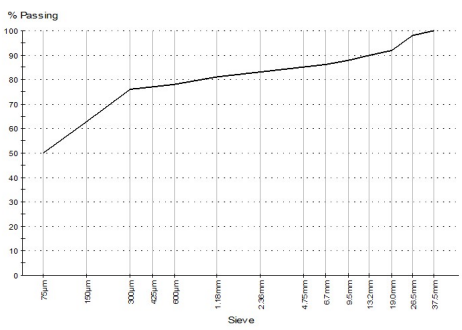
Method: AS 1289.3.6.1

Date Tested:

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	98	
19.0mm	92	
13.2mm	90	
9.5mm	88	
6.7mm	86	
4.75mm	85	
2.36mm	83	
1.18mm	81	
600µm	78	
425µm	77	
300µm	76	
150µm	63	
75µm	50	

Chart



Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002759
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

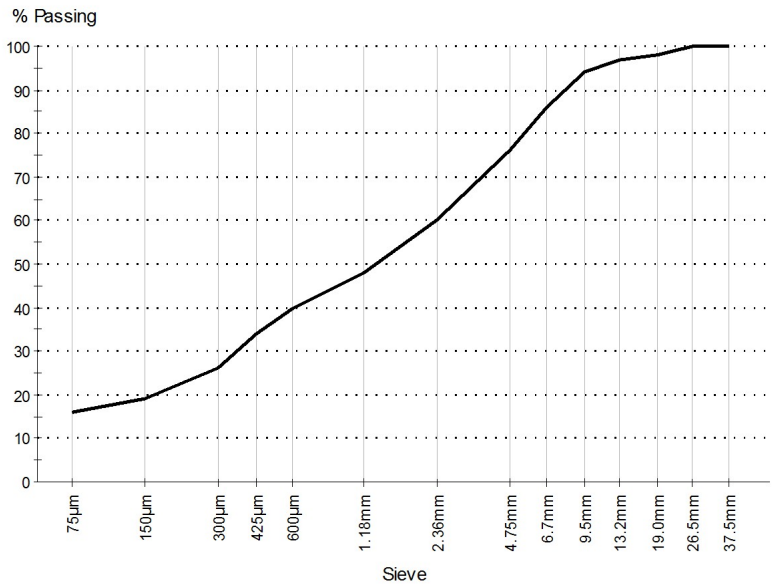
GHD Sample No	SYD20-0515-12
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP23
Depth (m)	0.5 - 1.3
Soil Description	Clayey GRAVELLY SAND

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

AS 1289.3.6.1



Date Tested:

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	100	
19.0mm	98	
13.2mm	97	
9.5mm	94	
6.7mm	86	
4.75mm	76	
2.36mm	60	
1.18mm	48	
600µm	40	
425µm	34	
300µm	26	
150µm	19	
75µm	16	

Comments

N/A

Sydney Laboratory
Unit 5/43 Herbert St
Artarmon NSW 2064
email: artarmon@ghd.com.au
web: www.ghd.com.au/ghdgeotechnics
Tel: (02) 9462 4860
Fax:(02) 9462 4710

Material Test Report

Report No: SYD2002760
Issue No: 1

Client: Liverpool Plains Shire Council

Project: 12534581

Accredited for compliance with ISO / IEC 17025 - Testing

NATA Accreditation No: 679

Approved Signatory: D.P Brooke

Date of Issue: 15/12/2020

Sample Details

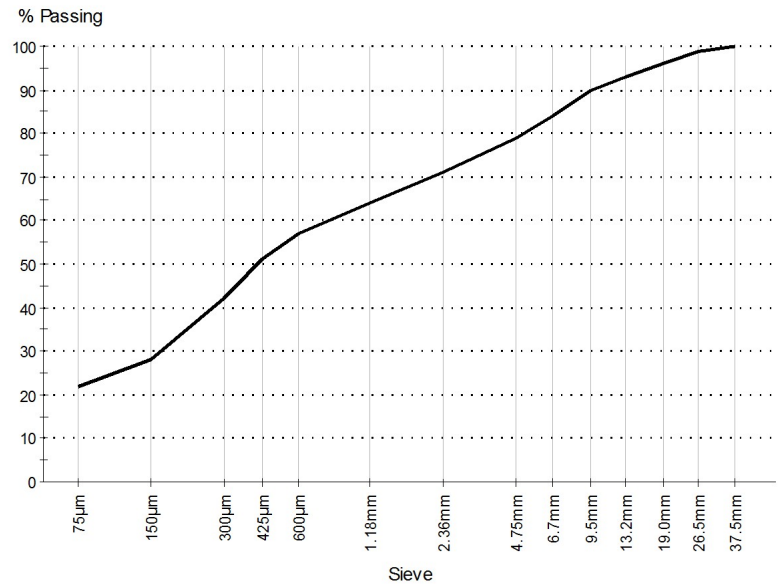
GHD Sample No	SYD20-0515-13
Sampled By	Sampled by GHD
Location	Willow Tree Waste Management Facility
Client Location	Merriwa Road, Willow Tree
BH / TP No.	TP24
Depth (m)	0.5 - 1.5
Soil Description	Clayey SAND with gravel

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

AS 1289.3.6.1



Date Tested:

Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	96	
13.2mm	93	
9.5mm	90	
6.7mm	84	
4.75mm	79	
2.36mm	71	
1.18mm	64	
600µm	57	
425µm	51	
300µm	42	
150µm	28	
75µm	22	

Comments

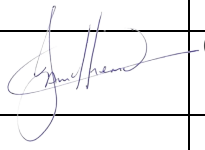
N/A

GHD

Level 3, GHD Tower
24 Honeysuckle Drive
NEWCASTLE NSW 2300
T: 61 2 4979 9999 F: 61 2 9475 0725 E: ntlmail@ghd.com

12534581-42698-22/https://projectsportal.ghd.com/sites/pp01_01/lpscwillowtreeregion/ProjectDocs/12534581-REP_Willow Tree geotechnical investigation.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S Mackenzie	Chris Nivison-Smith		J McPherson		23/12/2020
1	S Mackenzie	Chris Nivison-Smith		J McPherson		02/02/2020

www.ghd.com

ghd.com

The Power of Commitment