



Memorandum

15 February 2017

To	Luke Moloney		
Copy to	Sue Hassett		
From	Adrian Roberts	Tel	+61 2 9239 7307
Subject	Crookwell Landfill - Detailed Design - Stage 1 - Design Basis Memorandum	Job no.	2125974

DRAFT FOR DISCUSSION

1 Introduction

This Design Basis Memorandum (DBM) present the basis of design, including preliminary safety in design (SiD) assessment, for the detailed design of the Stage 1 landfill re-development works (Stage 1 works) at the Crookwell Landfill (the site) for Upper Lachlan Shire Council (Council).

2 Purpose

The purpose of this DBM is to document the design basis for the Stage 1 works, as outlined in GHD's proposal entitled *Proposal for Crookwell Landfill Detailed Design Works – Stage 1 dated November 2016*.

3 Reliance

The following information has been relied upon in preparing this DBM:

- CMPS&F Pty Ltd (1998), Landfill Environmental Management Plan for Crookwell Waste Depot dated March 1998
- Egis Consulting Australia (1999), Report on Hydrological Investigation of The Crookwell Landfill dated July 1999
- GHD (2017a), Draft Crookwell Landfill Gas Risk Assessment dated February 2017
- GHD (2017b), Aggregate/Soil Test Reports for Sample 1, 3 and 5
- GHD (2016a), Proposal for Crookwell Landfill Detailed Design Works – Stage 1 dated November 2016
- GHD (2016b), Crookwell Landfill Leachate Management Plan dated October 2016
- GHD (2016c), Crookwell Landfill Surface Water Management Plan dated October 2016
- GHD (2016d), Crookwell Landfill Preliminary Staging Plans dated July 2016
- GHD (2015a), Crookwell Landfill Stormwater Management & Conceptual Drainage Design dated September 2015



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- GHD (2015b), Feasibility Study Crookwell Landfill dated June 2015
- LandTeam (2017), Crookwell Waste Management Site Survey dated 27 January 2017
- NSW Department of Environment & Climate Change (2008), Managing Urban Stormwater, Soil and Construction: Volume 2B Waste Landfills
- NSW EPA (2016), Environmental Guidelines: Solid Waste Landfills, Second Edition dated April 2016 (Landfill Guidelines)
- NSW EPA (2015), Environmental Protection Licence (EPL) No. 6054 dated August 2015

4 Project understanding

A feasibility study was undertaken by GHD in 2015 in response to Condition U1 of the site's EPL (at that time, condition since removed from site EPL). Condition U1 required completion of a landfill capacity investigation for the site, as part of a Pollution Reduction Program (PRP). This assessment presented various options for the site's final landform. Council selected the following option for the site's future operations:

Option 3 – Filling with maximised footprint area, as per the PRP suggestion and in general accordance with the existing site Landfill Environmental Management Plan (approximately 34 - 44 years of capacity remaining)

The assessment also identified a series of essential works to remediate the site. These works included:

- Remediation of existing over-steepened batter on the eastern and western site boundary. This would involve trimming of the existing landfill toe and capping works; and
- Formalisation of water management at the site, including formalisation of leachate dam and stormwater infrastructure.

Following completion of the Feasibility Study, Council retained GHD to prepare a number of management plans for the site (leachate, stormwater, landfill gas and staging / filling plan). Following the preparation of these management plans, Council retained GHD to prepare detailed design documentation for the Stage 1 Works as follows:

- Detailed design of a lined landfill cell (Cell 1) inclusive of liner system and leachate collection and conveyance system
- Detailed design of surface water drains inclusive of sediment and erosion control measures
- Detailed design of a sedimentation pond
- Detailed design of waste batter re-profiling including estimation of quantities of waste to be re-located
- Decommissioning method for existing stormwater pipe
- Detailed design of perimeter leachate drain and associated extraction points
- Detailed design of a leachate dam



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- Detailed design of landfill cap
- Detailed design of landfill gas collection system

5 Environmental setting

5.1 Regional topography

The site is situated on the western flank of the Crookwell River valley, approximately 2 km south west of Crookwell, and 2.5 km west of the river. The current elevation of the site ranges between approximately 990 mAHD and 1000 mAHD.

5.2 Geology

The site is understood to be located within the Taralga soil landscape, which consists of plateaux or valleys of gently undulating to undulating rises. The Taralga soil landscape is understood to be associated with weathering of basalt plateaux. Typically, soils in this landscape consist of Kraznozems and Xanthozems on crests, Chocolate soils on sideslopes and Prarie soils on footslopes.

GHD understands that the site is underlain by sediments of an undifferentiated sequence of Ordovician age. The sediments are of an intermediate-deep marine origin, which have undergone low-grade metamorphism. These rocks consist of black and grey slate and phyllite with greyish to olive, muddy, fine to medium quartzose sandstone. The sandstone frequently exhibits graded bedding and may be classed as a subgrey wacke. The sequence is of an unknown thickness.

Furthermore, it is understood that:

- The Crookwell area is characterised by the presence of basalt and dolerite extrusive igneous rocks that are also found in the central Lachlan valley
- That the area around the site is a zone of intense deformation comprised of isoclinally folded and cleaved material, frequently turned over with small scale folds

Available site specific information suggests that the soils at the site are variable in composition and consist of a mixture of clay, gravel, silt, sand and peat (location dependent). Furthermore, this information suggests that these soils are variable in thickness (between approximately 0 and 1 m thick) and are underlain by weathered slate/phyllite bedrock (which become more competent/stronger with depth).

Soil samples were collected by GHD on 29 November 2016 and subjected to selected testing at GHD's geotechnical laboratory in Artarmon, NSW. The laboratory results of the tested soil samples are summarised in Table 1 below. Full testing results are provided in Attachment A.



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Table 1 Site soil testing results

Test	Sample 1	Sample 5	Sample 3	GHD Target
Emerson Class Number	4	4	4	>3
Particle Size Distribution (% Passing)				
2.36 mm (Gravel)	92	86	94	N/A
75 µm (Sand)	72	69	77	
Permeability (m/s)	1 x 10 ⁻⁹	7 x 10 ⁻¹⁰	1 x 10 ⁻⁹	≤ 1 x 10 ⁻⁸
Plasticity Index	20	13	20	≥ 10
Liquid Limit (%)	44	47	47	≤ 50
Moisture Content (%)	26.1	25.8	26.5	N/A
Standard compaction moisture				N/A

5.3 Hydrogeology

Standing water level data obtained from groundwater monitoring bores at or within the site boundary by GHD on 29 November 2016 are summarised in Table 2 below. The location of these groundwater monitoring bores are shown on Sketch SK010 contained in Attachment B.



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Table 2 Summary of groundwater level monitoring data (from 29/11/2016)

Well	Casing upstand above ground level (m)	Depth to water (mbtoc) ⁽¹⁾	Base of well (mbtoc) ⁽¹⁾	Depth to water below ground level (mbgl) ⁽²⁾	Screen depth (mbtoc) ⁽¹⁾
MW1 ³	0.71	0.09	9.1 ⁽⁴⁾	-0.62 (i.e. above prevailing ground level)	7
MW2	0.56	2.2	10.26	1.64	5.5
MW4D	0.70	0.51	7.68	-0.19 (i.e. above prevailing ground level)	7
MW4S	0.62	1.7	1.63	1.08	0.2

The data in Table 2 indicates that the groundwater table at or within the site boundary varies between being above the prevailing ground levels to up to 1.64 m below the prevailing ground levels at the groundwater monitoring bores. It is noted that these groundwater levels may not indicate typical long-term groundwater levels around the site and could be indicative of recent heavy and persistent rainfall during 2016 or penetration of a confined aquifer by certain wells (for example MW1 and MW4D).

GHD understands that a previous investigation undertaken at the site (CPMS&F, 1998) identified two water bearing zones underneath the site as follows:

- The first water bearing zone was a shallow, impermanent zone located in the soil profile. At that time, this system was only present in permeable soils (approximately 2 to 3 m thick) and was regarded as a type of perched aquifer. The groundwater encountered during this investigation was located between 0.3 and 1.8 metres below the prevailing ground level and was considered to possibly be perched on ironstone bands located within the soil horizon
- The second and more significant water bearing zone was thought to be located in a fractured rock aquifer representing the bedrock beneath the soil profile at a much greater depth than the first water bearing zone. At that time, it was thought that this groundwater was transported through the rock mass via interconnected fractures and joints towards the east of the site in the direction of the Crookwell River (in accordance with the prevailing local topography)

¹ metres below top of casing

² metres below ground level

³ Base of well information obtained on 8 August 2016



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- There are two groundwater wells within 600 m of the site ⁽⁵⁾. These wells (GW703578 and GW703579) are located to the site's north. These wells showed several water bearing zones at the time of monitoring, all in excess of 36 metres depth below the prevailing ground levels
- The *1:2,000,000 Groundwater in New South Wales, Assessment of Pollution Risk Map (1987)* indicates that the investigation area is likely to be underlain by fractured rocks/all pre-Permian rocks, mainly igneous and metamorphic rocks, which transmit water through an inter-connected network of joints and partings. It was classified as having moderate potential for groundwater movement and a low salinity rendering it suitable for stock, domestic and some irrigation purposes (i.e. 0 - 1000 mg/L)

5.4 Hydrology

No formalised stormwater infrastructure is currently in place to collect and direct stormwater generated on-site. As such, stormwater generated on the site's eastern part currently flows in accordance with the prevailing topography (i.e. eastwards) towards the informal leachate / stormwater depression located on the site's eastern boundary. From here, this stormwater subsequently flows off-site via an intermittent watercourse towards the Crookwell River.

Stormwater generated on the site's western part currently flows in accordance with the prevailing topography, around the toe of the waste mass and towards the site's south-eastern boundary. From here, this stormwater subsequently flows off-site into an off-site dam.

Further details on existing stormwater management at the site is provided in later sections of this document.

5.5 Climate

The climate at the site is summarised in Table 3 below, which contains weather data available from the Crookwell Post Office Bureau of Meteorology (BOM) weather monitoring station (No. 070025) and Goulburn TAFE Bureau of Meteorology (BOM) weather monitoring station (No. 070263). The Crookwell post office and Goulburn TAFE BOM stations are approximately 3.5 km northeast and 40 km southeast of the site respectively.

⁵ <http://allwaterdata.water.nsw.gov.au/water.stm> accessed during March 2016



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Table 3 Summary of average monthly climatic conditions for Crookwell⁶

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	26.5	25.9	23.6	18.4	13.9	10.3	9.5	11.0	14.7	18.3	21.4	25.0	18.2
Mean minimum temperature (°C)	10.7	10.7	8.8	5.0	2.3	0.6	-0.4	0.3	2.1	4.6	6.7	9.0	5.0
Mean monthly rainfall (mm)	69.7	54.1	57.8	58.3	66.4	89.8	84.9	89.2	75.4	76.8	65.2	66.3	858.6
Mean daily evaporation ⁽⁷⁾ (mm)	6.3	5.2	4	2.5	1.6	1.1	1.2	1.9	2.8	3.9	5	6.1	3.5
Mean monthly evaporation ⁽⁸⁾ (mm)	195.3	146.9	124	75	49.6	33	37.2	58.9	84	120.9	150	189.1	1263.9

From the data in Table 3, it can be seen that:

- Mean monthly rainfall is variable throughout the year, with rainfall being highest during June to August and lowest during February to April
- Mean monthly evaporation is lowest during the months of May to August and highest during the months of November to February
- The annual mean monthly evaporation (1263.9 mm) far exceeds the annual mean rainfall (858.6 mm)
- Mean monthly evaporation exceeds mean monthly rainfall between September and April
- Mean monthly rainfall exceeds mean monthly evaporation between May and August

6 Existing site layout and operations

6.1 Survey

Waste disposal operations have disturbed the original natural topography, which is believed to have comprised gently sloping land falling towards the middle of the site and eastwards towards the Crookwell River.

⁶ Data for mean maximum temperature, mean minimum temperatures and mean monthly rainfall obtained from Crookwell Post Office BOM station, accessed 06 December 2016 (1916 to 1975 data for mean maximum and minimum temperatures, 1883 to 2016 data for mean monthly rainfall).

⁷ 1968 to 2016 data for evaporation obtained from Goulburn TAFE BOM station, accessed 6 December 2016. This data was used as the Crookwell Post Office BOM station does not record evaporation data.

⁸ Mean daily evaporation multiplied by days in month



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The surface created by the waste disposal operations varies in shape and slope. A slope analysis previously undertaken by GHD (GHD, 2015a) identified that large parts of the eastern and western batters were over steepened and exceeded slopes of 1(V):3(H). It is understood that Council has recently undertaken works to reduce the steepness of these slopes in some areas to 1(V): 4(V) to provide batters that are stable in the long term and capable of supporting a landfill cap.

It is noted that GHD has recently developed staging plans for the reshaping and future filling of the site (GHD, 2015b).

The site's most recent detailed survey was undertaken by LandTeam on 27 January 2017.

6.2 Site infrastructure

The following infrastructure exists on site:

- Site office
- General equipment shed
- Recyclables materials shed
- Water tank
- Underground Telstra utilities services ⁽⁹⁾

Further details of the site's existing infrastructure can be found in the GHD site visit memorandum provided in Attachment C.

6.3 Extent of existing landfilled waste

As mentioned in Section 6.1, GHD undertook a slope analysis of the site as part of the feasibility study (GHD, 2015b). At that time, GHD also estimated that the existing waste footprint was approximately 3.5 ha in area

It is understood that some waste deposition had previously occurred outside the northern boundary of the site in the adjacent road reserve. The northern batter has since been reshaped by Council. In addition, a new area of landfilling has recently been established in the north western part of the site. Excavation works to a depth of approximately 5 m was undertaken by Council in this new area of landfilling. An asbestos pit and a historical animal carcasses disposal trench is situated to the south of the landfilled areas.

6.4 Adjacent road reserves

GHD understand that:

- The road reserve located adjacent to the northern boundary of the site is located inside the site fenceline. This road reserve is currently used for 4WD access to the adjacent properties. Waste has previously been placed within this road reserve. Council is currently considering acquisition of

⁹ Based on a Dial-Before-You-Dig search undertaken on 17 March 2016



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this road reserve. The in-situ waste may not need to be removed if Council acquires this land.
FOR DISCUSSION

- The road reserve located adjacent to the eastern boundary of the site is located outside the site fenceline. Council is currently considering acquisition of this road reserve. FOR DISCUSSION
- The road reserves are to be included within the site extents for the design works. FOR DISCUSSION.

The limitation on the infrastructure which can be established within the road reserves due to zoning restrictions has not been investigated by GHD. Council to advise.

6.5 Waste acceptance and predicted waste growth

Detailed records of the waste types and quantities landfilled at the site are not available for all years of operation. However, data is available for 5 recent financial years⁽¹⁰⁾. This data is summarised in Table 4.

Table 4 Annual waste quantities (FYE 2011 to FYE 2015)

Financial Year Ending (FYE)	Waste quantities (tonnes)			Total received (tonnes)	Materials transported offsite for recovery (tonnes)	Total waste landfilled (tonnes)
	MSW	C&I	C&D			
2010 / 11	2,649	26	285	2,960	77	2,882
2011 / 12	2,375	27	362	3,116	68	3,048
2012 / 13	2,621	27	325	2,972	242	2,730
2013 / 14	2,725	28	283	3,036	233	2,803
2014 / 15	2,975	28	94	3,097	217	2,880
Average	2,669	27	270	3,036	167	2,869

Table 4 identifies that:

- The majority of waste deposited at the site (at least in recent years) has been MSW, with only relatively minor quantities of C&I and C&D wastes deposited
- The quantities of deposited waste have been relatively stable (as least in recent years) below 3,000 tonnes per annum

¹⁰ It is noted that the site does not have a weighbridge, so these quantities are based on vehicle counts.



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6.6 Environmental controls and performance

6.6.1 Surface water

There are limited environmental controls for managing surface water at the site. These are discussed below.

Off-site run-on

There is a large bund along the north-western boundary of the site, parallel to Grabben Gullen Road. The bund is vegetated with grass and large trees. There is also a grassed channel in the crest of the bund, which collects surface water from Grabben Gullen Road and conveys it to the informal leachate/stormwater depression located on the site's eastern boundary.

The precise size of the grassed channel located at the crest of the bund is unknown.

On-site flows

No formalised stormwater infrastructure is currently in place to collect and direct stormwater generated on-site. As such, stormwater generated on the site's eastern part currently flows in accordance with the prevailing topography (i.e. eastwards) towards the informal leachate/stormwater depression located on the site's eastern boundary. From here, this stormwater subsequently flows off-site via an intermittent watercourse towards the Crookwell River.

Erosion and sediment control

Currently the informal leachate/surface water pond is used as a quasi-sedimentation pond by Council. A diversion bund/embankment is located along the western part of the site's south-western boundary. This acts to help direct surface water towards the leachate/surface water pond located on the site's eastern boundary.

6.6.2 Leachate

There are limited environmental controls for managing leachate at the site. At present, the site is unlined and has no engineered leachate collection and conveyance systems. It is noted that no areas of the site have yet been final capped. Additionally, there are no formal leachate storage or disposal measures currently utilised at the site. A pipe through the waste mass channels water to the informal leachate/surface water pond is used for evaporation of leachate/surface water. The effectiveness of which is unknown.

6.6.3 Landfill gas

There are limited environmental controls for managing landfill gas at the site. These controls include the following:

- The application of cover material
- The use of site buildings / structures with air voids beneath them (e.g. the site office)
- The maintenance of a specific operational protection buffer distance around the landfill

It is understood that no formal landfill gas extraction and/or collection system is currently installed at the site.



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GHD undertook one round of landfill gas monitoring for surface emissions and building accumulation at the site on 29 November 2016. The findings of that monitoring round were as follows:

Surface emission monitoring

- No exceedances of the nominated assessment criteria for surface emissions (500 ppm of methane) were detected
- The highest detected methane concentration was 8.5 ppm (i.e. very low)

Building accumulation monitoring

- No exceedances of the nominated assessment criteria for building accumulation (10 000 ppm of methane) were detected
- The highest detected methane concentration was 1.9 ppm

6.6.4 Groundwater

There are limited environmental controls for managing groundwater at the site. Groundwater is monitored via a series of groundwater monitoring wells located both on and off site.

Recent excavation works undertaken by Council have exposed natural soil materials and suggest that groundwater movement is not significant.

6.6.5 Management plans

The following management plans are associated with the site:

- Surface water management plan
- Leachate management plan
- Landfill gas risk assessment and landfill gas management plan (in progress)

6.7 Existing vegetation

As per the site visit memorandum (refer Attachment C), it is understood that a large portion of the site and the waste mass, especially the eastern batters and the location of the future sediment and leachate ponds are covered with vegetation.

Council to confirm that removal of existing vegetation within the site boundary is approved and if there are any trees which must be retained.

7 Basis of design and proposed approach

7.1 Regulatory requirements

Environment Protection Licence

The EPL (No. 6054) outlines the requirements for the site. The relevant EPL requirements to be considered as part of this DBM are contained in Table 5.



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Table 5 EPL requirements

EPL Condition Number	Condition Text
O6.2	The leachate barrier system and leachate collection system must be installed on each surface within the premises to be used for the disposal of waste. This condition does not apply to any surface used for the emplacement of waste before 1 July 2000
O6.3	Surface drainage must be diverted away from any area where waste is being or has been landfilled
O6.4	The licensee must ensure that the amount of landfill space used is minimised
O6.6	The licensee must ensure that the landfill cells are capped progressively when the level of waste reaches final heights

7.2 Opportunities

- Concept design layouts have been completed and verbally accepted by the NSW EPA
- Recent excavation works has generated natural soil materials which can be reused on site. Recent geotechnical testing suggests that this material is likely to be suitable for various uses on-site.
- The construction of a new sediment pond on the southern area of the site would provide additional material to use for rehabilitation works. Design of the pond should consider maximising pond capacity and excavated materials to be recovered for site reuse.
- An area at the west of the site has been regraded with on-site soil materials. This allows for potential relocation of on-site infrastructure (green waste stockpiling and processing).
- Council contractors, who have a good working relationship with Council, are likely to be engaged by Council to undertake general earthworks.
- The potential acquisition of the adjacent road reserves to the north and east of the site would
 - Increase the area of the mandated landfill buffer zone that is in Council's control
 - Potentially allow waste in the road reserve to the site's north to remain where it is and be capped over
 - Provide land for vehicular access along the site's northern and eastern boundaries
 - Provide land for the installation of groundwater and landfill gas monitoring bores
 - Provide land for a tree buffer between the site and adjacent land owners
 - Provide land for surface water drains

7.3 Constraints

- Potential confined aquifer lying beneath site and uncertain depth. For discussion.



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- Neighbour to the north of the site requires access in the north east corner of the site. As such, sufficient space between the toe of the northern landfill batter and the lot boundary to the north of the site is required.
- Current leachate dam is full as a result of a wet winter weather and active pumping from new landfill cell. Temporary leachate management control measures may be required during cell and pond construction.
- Excavated soil material has been stockpiled over the central section of the landfill. This may require relocation to allow the Stage 1 works to be undertaken.
- Existing landfill batters are quite steep and heavily vegetated. Areas and drains around the toe of the landfill were observed to have some standing water.
- The existing batter on the eastern side of the site is steep and close to the current site boundary.
- There are trees around the perimeter of the site. Some or all of these may need to be removed to allow the Stage 1 works to be completed.
- Current on-site waste processing and storage operations and infrastructure need to be relocated to allow for construction of new lined landfill cell.
- The recently constructed landfill cell is located within the previous concept cell design area. An appropriate offset between the recently constructed and new lined cell will need to be identified.
- Uncertainty in relation to the actual location of special waste pits (animal carcasses and asbestos) around the site

7.4 Safety in Design

A preliminary safety in design review was undertaken to consider issues that could lead to or cause hazards during the life of the works to be undertaken, including design, construction, commissioning and operation. The issues and risks identified are documented in the preliminary safety in design register contained in Attachment D.

7.5 Landfill cell

7.5.1 Earthworks

The following excavation works and subgrade levels are proposed:

- Cell 1 will be designed to fall at 1% generally falling to the west, with the low point located on the south west corner of the cell.
- All Cell 1 walls to be 1:3 (V:H) unless otherwise noted
- An internal bund will be located at the western extent of the cell to provide containment of the Stage 1 waste and a location for termination of the liner system
- An offset from the recently constructed landfill cell will need to be developed.



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Footprint modifications

The Stage 1 works require modification to the eastern (and possibly the northern – for discussion) batter of the landfill to allow for the construction of required infrastructure to the south east of the landfill. In consideration of the eastern batter, GHD notes the following:

- The Eastern waste batter needs to be trimmed to grades of approximately 1:4 (V:H)
- 'Hard' waste (e.g. fridges and pallets) stockpiled on the northern area of the landfill will need to be relocated to allow for waste trimming of the north east batter

7.5.2 Lining system

The following is the required outcome of the NSW EPA Landfill Guidelines (2016) for lining systems:

- *The base and walls of all solid waste landfill cells should be lined with a durable material of very low permeability to form a barrier between the waste and the groundwater, soil and substrata.*

Proposed lining system

To meet this required outcome, the proposed lining system for Cell 1 shall be as follows from top to bottom:

- Non-woven geotextile protection layer
- HDPE geomembrane liner
- Reworked in situ clay material

7.6 Leachate collection system

Cell 1 will be lined with a leachate collection system installed in accordance with the NSW Landfill Guidelines. Leachate in Cell 1 will drain to a sump from where it can be pumped to the new leachate evaporation pond. The leachate collection system will include, from top to bottom:

- Separation geotextile
- Perforated pipework within a 300 mm leachate drainage aggregate layer

7.7 Leachate pond

GHD used the United States Environmental Protection Agency's Hydrological Evaluation of Landfill Performance (HELP) model and a leachate water balance model to estimate the volume of leachate generated at the site and subsequently the required capacity of the leachate pond.

The proposed leachate pond for the site shall be as follows:

- Constructed to the south east of the landfill to a minimum capacity of 2.75 ML with sidewall grade of 1:3 (V:H)
- The pond will be lined (2 mm HDPE geomembrane) and have an appropriate gas relief system installed beneath the liner to prevent whaling
- The pond will collect leachate from the perimeter leachate cut-off trenches (refer Section 7.10) and leachate pumped from Cell 1 (Section 7.6)



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7.8 Sediment pond

The following is the required outcome of the NSW EPA Landfill Guidelines (2016) for surface water management:

Controls must be implemented to minimise erosion and reduce the sediment load (suspended solids) of surface water discharged from the site

Additionally, the NSW Department of Environment & Climate Change Managing Urban Stormwater, Soil and Construction: Volume 2B Waste Landfills (2008) (also referred to as the 'Blue Book') provides guidelines on mitigating the impacts of land disturbance activities on soils, landform and receiving waters by focussing on erosion and sediment control for solid waste landfills.

According to the Blue Book, sites expected to be in operation for more than three years, and with non-sensitive downstream receptors, are required to achieve retention in a 90th percentile 20-day rainfall event.

Based on the 90th percentile 20-day rainfall event of 75.6 mm for Goulburn (Managing Urban Stormwater, Soils and Construction, Volume 1, Landcom, 2004) and a catchment area of 4.9 ha (inlet from Drain 2 and Drain 3), a stormwater pond of 4,000 m³ capacity is required. Table 6 outlines the concept design for the sediment pond. The pond will be relatively shallow to mitigate potential issues caused by the shallow groundwater table. Final levels will be confirmed during detailed design.

Table 6 Sediment pond design (concept)

Component	Settling zone volume (m ³)	Storage zone volume (m ³)	Total volume (m ³)
Sediment pond	2,556	1,278	4,000

Further details on the design of the sediment pond are as follows:

- Sediment pond to be constructed to the south east of the landfill to a minimum capacity of 4 ML with sidewall grade of 1:4 (V:H)
- The pond will not be lined
- The pond will collect water from disturbed areas of the site
- The pond overflow will be located at the south east boundary of the site

7.9 Surface water drains

Refer to Sketch SK020 contained in Attachment B.

- Existing western drain will be formalised and redirected to divert run-on (clean water) to the south of the site. The drain to generally follow existing grades and generally fall to the south.
- Disturbed surface water drains to be constructed to divert run-off (disturbed water) towards sediment pond.
- The surface of the drains will be treated with grass or other suitable material to prevent erosion.



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7.10 Rehabilitation works

7.10.1 Final landform

The final landform shall be as per Sketch SK018 contained in Attachment B. According to the GHD Feasibility Study, the final landform shall be achieved by filling with maximised footprint area. The final landform shall be as follows:

- Minimum grades of 5% at the crest
- Maximum of grades of 25% for the landfill batters
- Allow for surface water drainage

7.10.2 Capping system

The following are the required outcomes of the NSW EPA Landfill Guidelines (2016) for final capping systems:

- *Reduce rainwater infiltration into the waste and thus minimise the generation of leachate (infiltration from the base of the final cap should be less than 5% of the annual rainfall)*
- *Stabilise the surface of the completed part of the landfill*
- *Reduce suspended sediment and contaminated runoff*
- *Minimise the escape of untreated landfill gas*
- *Minimise odour emissions, dust, litter, the presence of scavengers and vermin, and the risk of fire prepare the site for its future use; this includes protecting people, fauna and flora on or near the site from exposure to pollutants still contained in, or escaping from, the landfill.*

To meet this required outcome, the proposed capping system for the site is as follows, from top to bottom:

- Vegetation (grass)
- Minimum 150 mm revegetation layer – topsoil
- Minimum 500 mm revegetation layer – subsoil
- Drainage and / or soil reinforcement layers, if required
- LLDPE geomembrane
- Prepared subgrade
- Leachate interception trench to be installed at the toe of the eastern landfill batter. The leachate interception trench to be constructed in accordance to drawing SK019 contained in Attachment B.

7.11 Landfill gas

- The requirements of landfill gas management system is dependent on the outcome of the Landfill Gas Risk Assessment (LFGRA), which is still being drafted by GHD. However, at this time, it is expected that the following landfill gas management measures will be required as part of the



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Stage 1 works: Design of an appropriate LFG management system (likely a passive system with vertical vents)

- Design of perimeter landfill gas monitoring bore network

Concept designs for the LFG management system and perimeter bore network are provided in Attachment B.

7.12 Access

Vehicular access will be maintained around the northern perimeter of the site for the neighbouring property.

Vehicular access will be maintained around the western and southern perimeter of the site (inside the existing fence line) to allow maintenance of the proposed sediment and leachate ponds.

Access around the eastern perimeter of the site from the north will be provided where possible.

7.13 Existing vegetation

Existing vegetation will need to be removed on the landfill batters and in the locations of the proposed ponds. GHD have assumed that Council would obtain any required approvals to allow this to occur. **FOR DISCUSSION.**

7.14 Construction sequencing

The proposed construction sequence for the Stage 1 works is as follows:

- Construction of sediment pond in accordance to Section 7.8
- Construction of southern surface water drains in accordance to Section 7.9
- Construction of leachate pond in accordance to Section 7.7
- Construction of Cell 1 in accordance to Section 7.5 and Section 7.6
- Undertake rehabilitation works in accordance to Section 7.10 and 7.11
- Construction of northern surface water drains in accordance to Section 7.9

8 Documentation

GHD will prepare detailed design documentation for the works.

GHD anticipate that the drawing set will include the following:

- Locality Plan & Drawing List
- Existing Site Plan
- General Arrangement
- Longitudinal Sections
- Cross Sections



Memorandum

- Set Out Plan
- Leachate Collection and Conveyance System – Plan
- Leachate Collection and Conveyance System – Typical Sections
- Leachate Interception Trench – Plan
- Leachate Interception Trench – Details
- Surface Water Drains – Plan
- Surface Water Drains – Details
- Leachate Pond – Plan
- Leachate Pond – Typical Sections
- Sediment Pond – Plan
- Sediment Pond – Typical Sections

9 Closing

I trust that this DBM provides sufficient information for your purposes. Please do not hesitate to contact me on the telephone number provided above should you wish to discuss its contents further.

Regards

Adrian Roberts

Team Leader, Design Element - Waste Management

Attachment A: Geotechnical test results

Attachment B: Site sketches

Attachment C: Site visit memorandum

Attachment D: Safety in design assessment

Attachment A: Geotechnical test results



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

Aggregate/Soil Test Report

Report No: SYD1601937

Issue No: 1

This report replaces all previous issues of report no 'SYD1601937'.

Client: Upper Lachlan Shire Council
 PO Box 42
 Gunning NSW

Project: 2125974/08

Accredited for compliance with ISO / IEC 17025




NATA Accredited
 Laboratory Number: 679

Approved Signatory: D.P. Brooke (Sydney Laboratory Manager)
 Date of Issue: 14/12/2016

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Details

GHD Sample No SYD16-0434-01
 Client Sample ID Sample 1
 Date Sampled 29/11/2016
 Sampled By Sampled by GHD
 Location Crookwell Landfill
 Soil Description CLAY: with sand, pale brown

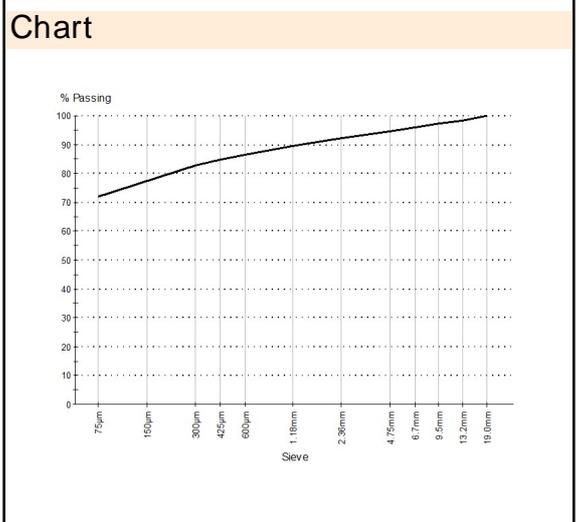
Particle Size Distribution

Method: AS 1289.3.6.1
 Drying by: Oven
 Date Tested: 1/12/2016
 Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	98	
9.5mm	97	
6.7mm	96	
4.75mm	95	
2.36mm	92	
1.18mm	90	
600µm	87	
425µm	85	
300µm	83	
150µm	77	
75µm	72	

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	19.1	
Date Tested		1/12/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	46	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	26	
Plasticity Index (%)	AS 1289.3.3.1	20	
Date Tested		7/12/2016	
Emerson Class Number	AS 1289.3.8.1	4	
Soil Description		CLAY: with sand	
Type of Water		Distilled	
Temperature of Water (°C)		24	
Date Tested		6/12/2016	
Standard Maximum Dry Density (t/m ³)	AS 1289.5.1.1	1.65	
Standard Optimum Moisture Content (%)		21.0	
Retained Sieve 19mm (%)		0	
Compactive Effort		Standard	
Date Tested		5/12/2016	
Coef of Permeability (m/sec)	AS 1289.6.7.3	1 E -09	
Mean Stress Level (kPa)		30	
Permeant Used		sydney tap	
Length (mm)		77.0	
Diameter (mm)		63.3	
Length/Diameter Ratio		1.20	



Comments

N/A



Sydney Laboratory
 57 Herbert St
 Artarmon NSW 2064
 email: artarmon@ghd.com.au
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Aggregate/Soil Test Report

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Issue No: 1

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NATA Accredited
 Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)
 Date of Issue: 14/12/2016

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Sample Details

GHD Sample No SYD16-0434-01
 Client Sample ID Sample 1
 Date Sampled 29/11/2016
 Sampled By Sampled by GHD
 Location Crookwell Landfill
 Soil Description CLAY: with sand, pale brown

Particle Size Distribution

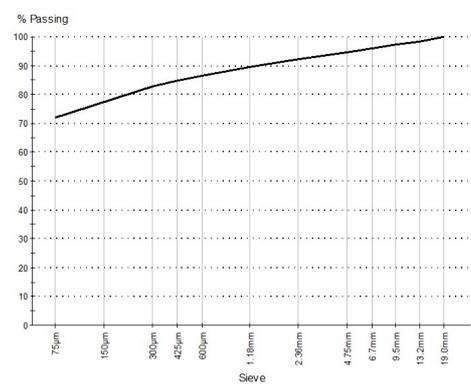
Method: AS 1289.3.6.1
 Drying by: Oven
 Date Tested: 1/12/2016
 Note: Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	98	
9.5mm	97	
6.7mm	96	
4.75mm	95	
2.36mm	92	
1.18mm	90	
600µm	87	
425µm	85	
300µm	83	
150µm	77	
75µm	72	

Other Test Results

Description	Method	Result	Limits
Laboratory Moisture Ratio (%)		100.0	
Laboratory Density Ratio (%)		99.0	
CompactiveEffort		standard	
Method of Compaction		tamped	
Surcharge Applied (Kg)		0.0	
Pressure Applied (Kpa)		10	
Oversize Sieve (mm)		13.2	
Percentage Oversize (%)		2.0	
Moisture Content (%)		26.1	
Date Tested		6/12/2016	

Chart



Comments

N/A



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

Aggregate/Soil Test Report

Report No: SYD1601939

Issue No: 1

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Client: Upper Lachlan Shire Council
 PO Box 42
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Project: 2125974/08

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NATA Accredited
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Approved Signatory: D.P. Brooke (Sydney Laboratory Manager)
 Date of Issue: 14/12/2016

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Sample Details

GHD Sample No SYD16-0434-03
 Client Sample ID Sample 5
 Date Sampled 29/11/2016
 Sampled By Sampled by GHD
 Location Crookwell Landfill
 Soil Description Sandy SILT: pale brown/pale grey trace gravel

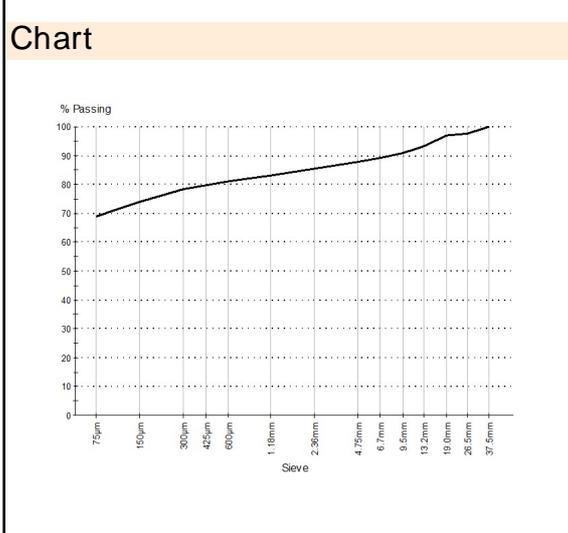
Particle Size Distribution

Method: AS 1289.3.6.1
 Drying by: Oven
 Date Tested: 1/12/2016
 Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	98	
19.0mm	97	
13.2mm	93	
9.5mm	91	
6.7mm	89	
4.75mm	88	
2.36mm	86	
1.18mm	83	
600µm	81	
425µm	80	
300µm	78	
150µm	74	
75µm	69	

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	20.8	
Date Tested		1/12/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	44	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	31	
Plasticity Index (%)	AS 1289.3.3.1	13	
Date Tested		7/12/2016	
Emerson Class Number	AS 1289.3.8.1	4	
Soil Description		Sandy SILT	
Type of Water		Distilled	
Temperature of Water (°C)		24	
Date Tested		6/12/2016	
Standard Maximum Dry Density (t/m ³)	AS 1289.5.1.1	1.64	
Standard Optimum Moisture Content (%)		22.0	
Retained Sieve 19mm (%)		3	
Compactive Effort		Standard	
Date Tested		5/12/2016	
Coef of Permeability (m/sec)	AS 1289.6.7.3	7 E -10	
Mean Stress Level (kPa)		30	
Permeant Used		Sydney Tap	
Length (mm)		74.8	
Diameter (mm)		63.3	
Length/Diameter Ratio		1.20	



Comments

N/A



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

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Issue No: 1

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NATA Accredited
 Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)
 Date of Issue: 14/12/2016

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Sample Details

GHD Sample No SYD16-0434-03
 Client Sample ID Sample 5
 Date Sampled 29/11/2016
 Sampled By Sampled by GHD
 Location Crookwell Landfill
 Soil Description Sandy SILT: pale brown/pale grey trace gravel

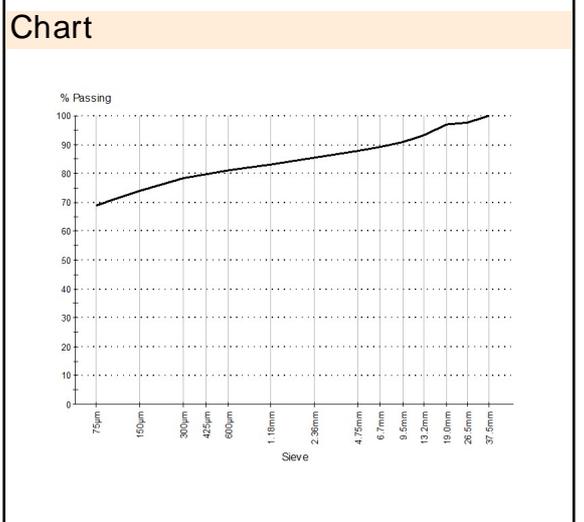
Particle Size Distribution

Method: AS 1289.3.6.1
 Drying by: Oven
 Date Tested: 1/12/2016
 Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	98	
19.0mm	97	
13.2mm	93	
9.5mm	91	
6.7mm	89	
4.75mm	88	
2.36mm	86	
1.18mm	83	
600µm	81	
425µm	80	
300µm	78	
150µm	74	
75µm	69	

Other Test Results

Description	Method	Result	Limits
Laboratory Moisture Ratio (%)		100.5	
Laboratory Density Ratio (%)		99.5	
CompactiveEffort		Standard	
Method of Compaction		tamped	
Surcharge Applied (Kg)		0.0	
Pressure Applied (Kpa)		10	
Oversize Sieve (mm)		13.2	
Percentage Oversize (%)		7.0	
Moisture Content (%)		25.8	
Date Tested		6/12/2016	



Comments

N/A



Sydney Laboratory
 57 Herbert St
 Artarmon NSW 2064
 email: artarmon@ghd.com.au
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 Fax: (02) 9462 4710

Aggregate/Soil Test Report

Report No: SYD1601938

Issue No: 1

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Client: Upper Lachlan Shire Council
 PO Box 42
 Gunning NSW

Project: 2125974/08

Accredited for compliance with ISO / IEC 17025




NATA Accredited
 Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)
 Date of Issue: 14/12/2016

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Sample Details

GHD Sample No SYD16-0434-02
 Client Sample ID Sample 3
 Date Sampled 29/11/2016
 Sampled By Sampled by GHD
 Location Crookwell Landfill
 Soil Description CLAY: with sand, pale brown

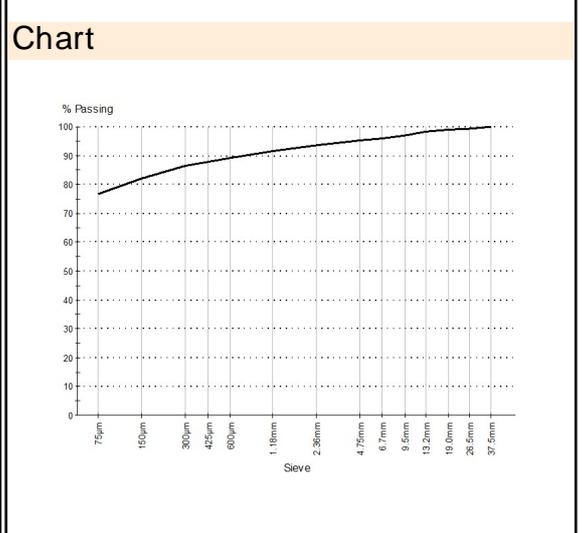
Particle Size Distribution

Method: AS 1289.3.6.1
 Drying by: Oven
 Date Tested: 1/12/2016
 Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	99	
13.2mm	98	
9.5mm	97	
6.7mm	96	
4.75mm	95	
2.36mm	94	
1.18mm	92	
600µm	89	
425µm	88	
300µm	86	
150µm	82	
75µm	77	

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	21.8	
Date Tested		1/12/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	N/A	
Mould Length (mm)		0	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	47	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	27	
Plasticity Index (%)	AS 1289.3.3.1	20	
Date Tested		7/12/2016	
Emerson Class Number	AS 1289.3.8.1	4	
Soil Description		CLAY: with sand	
Type of Water		Distilled	
Temperature of Water (°C)		24	
Date Tested		6/12/2016	
Standard Maximum Dry Density (t/m³)	AS 1289.5.1.1	1.60	
Standard Optimum Moisture Content (%)		23.0	
Retained Sieve 19.0mm (%)		1	
Compactive Effort		Standard	
Date Tested		5/12/2016	
Coef of Permeability (m/sec)	AS 1289.6.7.3	1 E -09	
Mean Stress Level (kPa)		30	
Permeant Used		Sydney Tap	
Length (mm)		74.8	
Diameter (mm)		63.2	
Length/Diameter Ratio		1.20	



Comments

N/A



Sydney Laboratory
 57 Herbert St
 Artarmon NSW 2064
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Aggregate/Soil Test Report

Report No: SYD1601938

Issue No: 1

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Client: Upper Lachlan Shire Council
 PO Box 42
 Gunning NSW

Project: 2125974/08

Accredited for compliance with ISO / IEC 17025




NATA Accredited
 Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)
 Date of Issue: 14/12/2016

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Sample Details

GHD Sample No SYD16-0434-02
 Client Sample ID Sample 3
 Date Sampled 29/11/2016
 Sampled By Sampled by GHD
 Location Crookwell Landfill
 Soil Description CLAY: with sand, pale brown

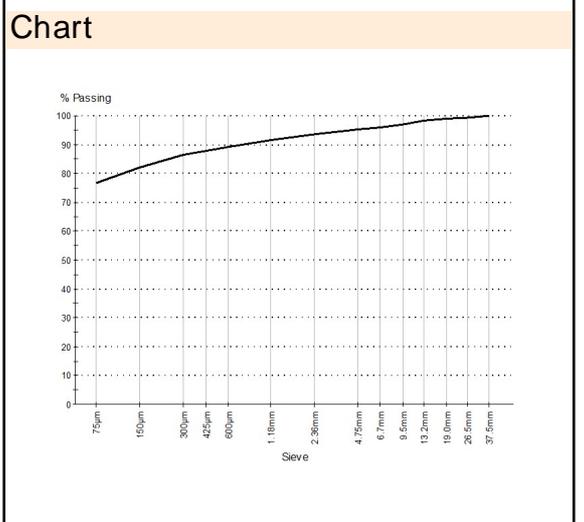
Particle Size Distribution

Method: AS 1289.3.6.1
 Drying by: Oven
 Date Tested: 1/12/2016
 Note: Sample Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	99	
13.2mm	98	
9.5mm	97	
6.7mm	96	
4.75mm	95	
2.36mm	94	
1.18mm	92	
600µm	89	
425µm	88	
300µm	86	
150µm	82	
75µm	77	

Other Test Results

Description	Method	Result	Limits
Laboratory Moisture Ratio (%)		100.0	
Laboratory Density Ratio (%)		100.0	
CompactiveEffort		standard	
Method of Compaction		tamped	
Surcharge Applied (Kg)		0.0	
Pressure Applied (Kpa)		10	
Oversize Sieve (mm)		13.2	
Percentage Oversize (%)		2.0	
Moisture Content (%)		26.5	



Comments

N/A

Attachment B: Site sketches



LEGEND

- BOUNDARY
- - - - EXISTING FENCELINE (VARIOUS MATERIALS)
- TOP OF BANK
- TOE OF BANK
- ▲ BENCH MARK
- ▲ SIGN
- GP GRATED PIT
- WW WING WALL
- SP STOCKPILES (VARIOUS MATERIALS)
- GROUNDWATER BORE LOCATION (INDICATIVE)



PRELIMINARY

B	FOR APPROVAL		16.09.16
A	INITIAL ISSUE	MW	13.07.16
rev	description	app'd	date

UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
EXISTING ARRANGEMENT



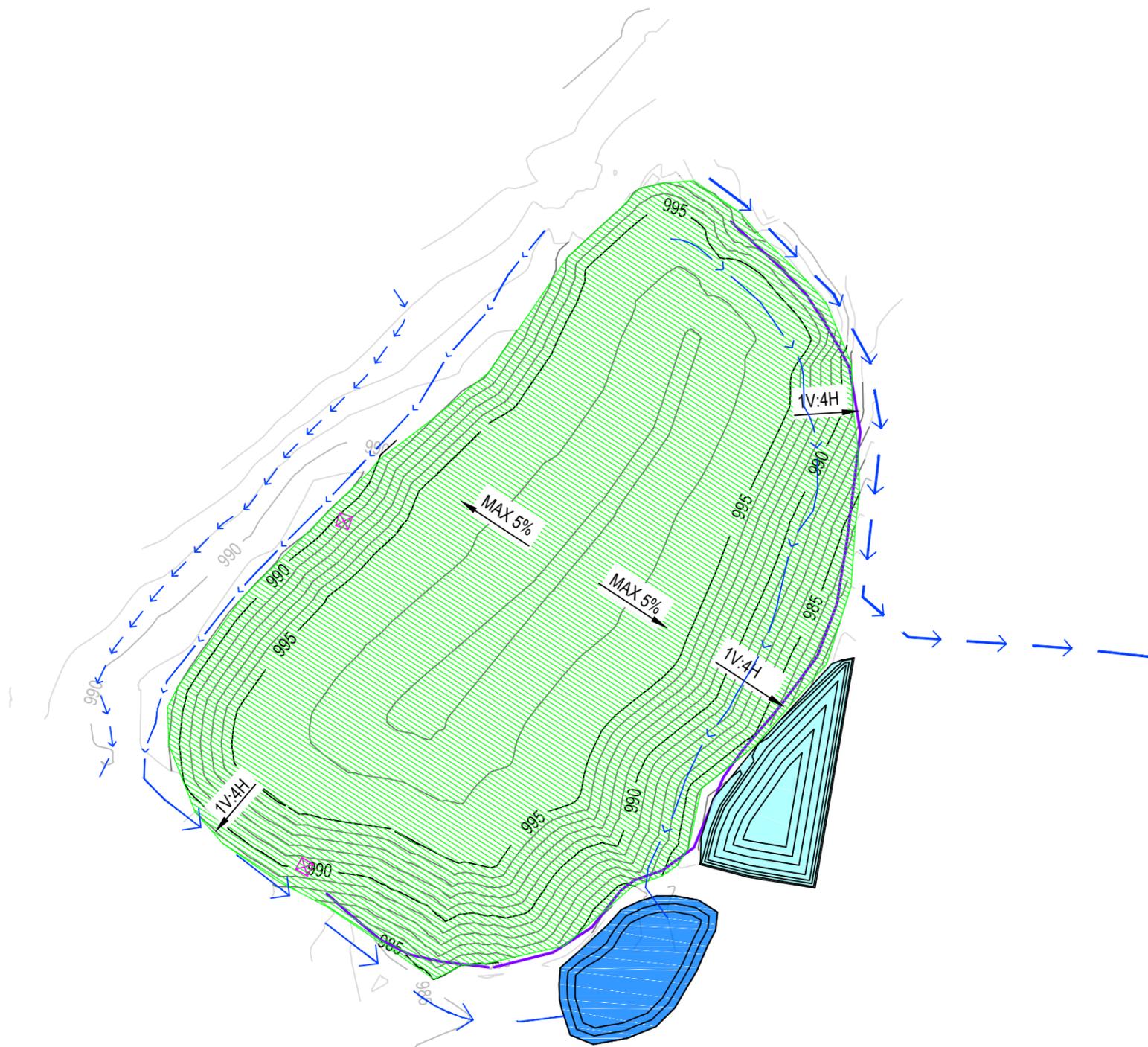
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date | SEP 2016 rev no. | B

approved (PD) **SK010**

SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015



LEGEND

- EXISTING SURFACE
- DESIGN SUBGRADE
- ACTIVE FILLING AREA
- FINAL CAP AREA
- SURFACE WATER MANAGEMENT
- LEACHATE INTERCEPTION TRENCH
- LEACHATE COLLECTION PIPE
- LEACHATE SUMP
- AREA OF WASTE TRIMMING
- EXISTING SURFACE WATER DRAIN
- SURFACE WATER DRAIN 1
- SURFACE WATER DRAIN 2
- SURFACE WATER DRAIN 3
- SURFACE WATER DRAIN 4



PRELIMINARY

B	FOR APPROVAL		16.09.16
A	INITIAL ISSUE	MW	13.07.16
rev	description	app'd	date

UPPER LACHLAN SHIRE COUNCIL
 CROOKWELL LANDFILL
 STAGING PLANS
 FINAL LANDFORM



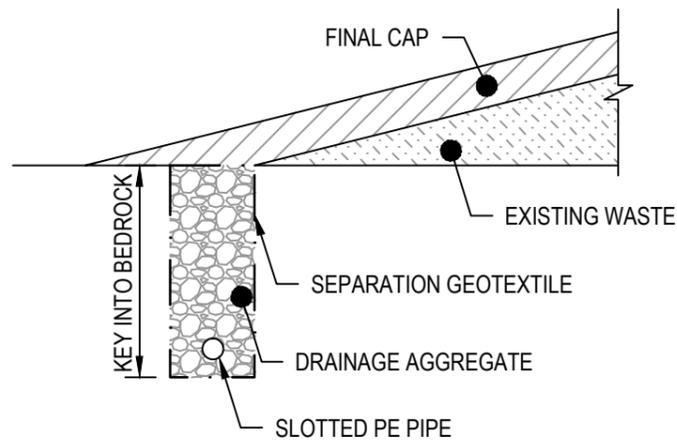
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 date | SEP 2016 rev no. | B

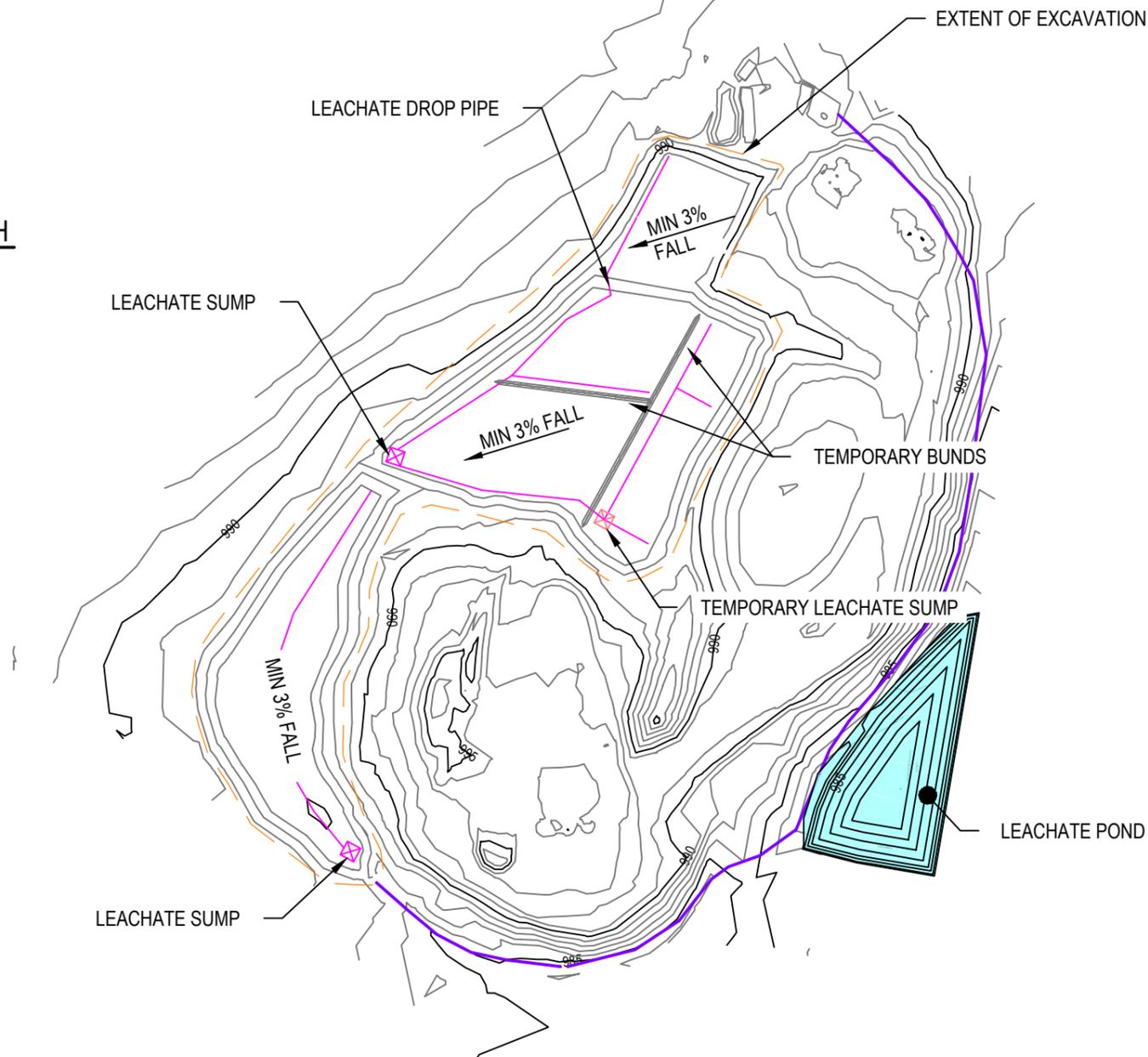
approved (PD) **SK018**

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1 DETAIL
SCALE 1 : 50

**LEACHATE INTERCEPTION TRENCH
TYPICAL DETAIL**



PRELIMINARY

rev	description	app'd	date
A	FOR APPROVAL		16.09.16

UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
**LEACHATE MANAGEMENT
CONCEPT LAYOUT**



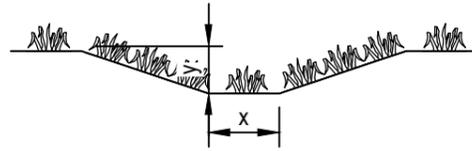
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date | SEP 2016 rev no. | A

approved (PD) **SK019**

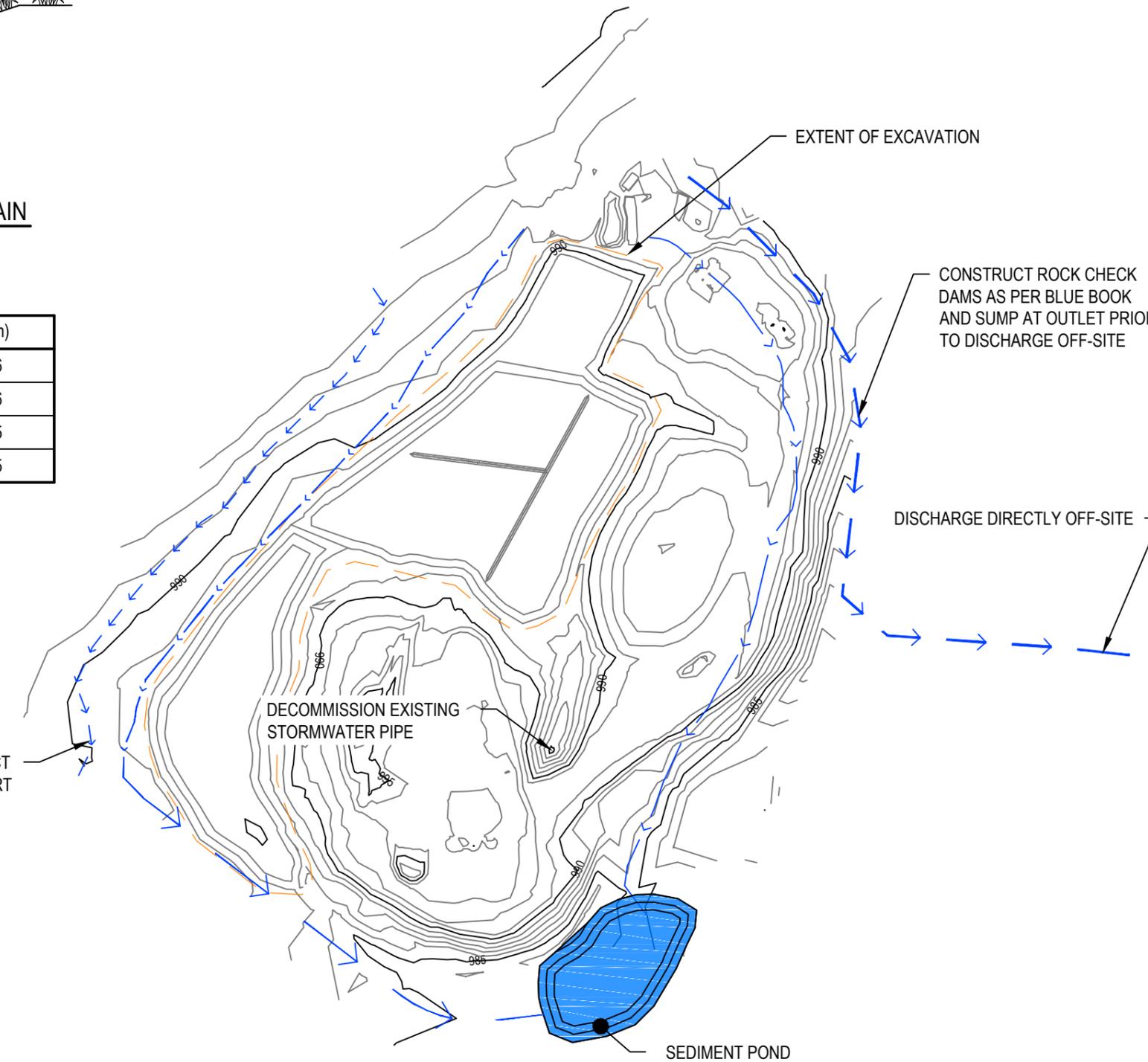
SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015



**SURFACE WATER DRAIN
TYPICAL DETAIL**

SURFACE WATER DRAIN	x (m)	y (m)
1	1.5	0.6
2	1.75	0.6
3	0.9	0.5
4	0.5	0.5

FORMALISE AND REDIRECT
EXISTING DRAIN TO DIVERT
RUN-ON OFF-SITE



LEGEND

- ===== DESIGN SUBGRADE
- - - - - EXCAVATION BOUNDARY
- → → EXISTING SURFACE WATER DRAIN
- > — SURFACE WATER DRAIN 1
- > — SURFACE WATER DRAIN 2
- > — SURFACE WATER DRAIN 3
- > — SURFACE WATER DRAIN 4



PRELIMINARY

rev	description	app'd	date
A	FOR APPROVAL	MW	16.09.16

**UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
SURFACE WATER MANAGEMENT
CONCEPT LAYOUT**



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T 61 2 9239 7100 F 61 2 9239 7199
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date | SEP 2016 rev no. | A

approved (PD) **SK020**



LEGEND

- EXISTING SURFACE
- DESIGN SUBGRADE
- ACTIVE FILLING AREA
- FINAL CAP AREA
- SURFACE WATER MANAGEMENT
- LEACHATE INTERCEPTION TRENCH
- LEACHATE COLLECTION PIPE
- LEACHATE SUMP
- AREA OF WASTE TRIMMING
- EXISTING SURFACE WATER DRAIN
- SURFACE WATER DRAIN 1
- SURFACE WATER DRAIN 2
- SURFACE WATER DRAIN 3
- SURFACE WATER DRAIN 4
- LANDFILL GAS VENT
- LANDFILL GAS COLLECTION BORE
- LANDFILL GAS COLLECTION TRENCH

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE	MW	

**UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
LANDFILL GAS SYSTEM
LAYOUT PLAN - STAGE 2**



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

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date | JAN 2017 rev no. | A

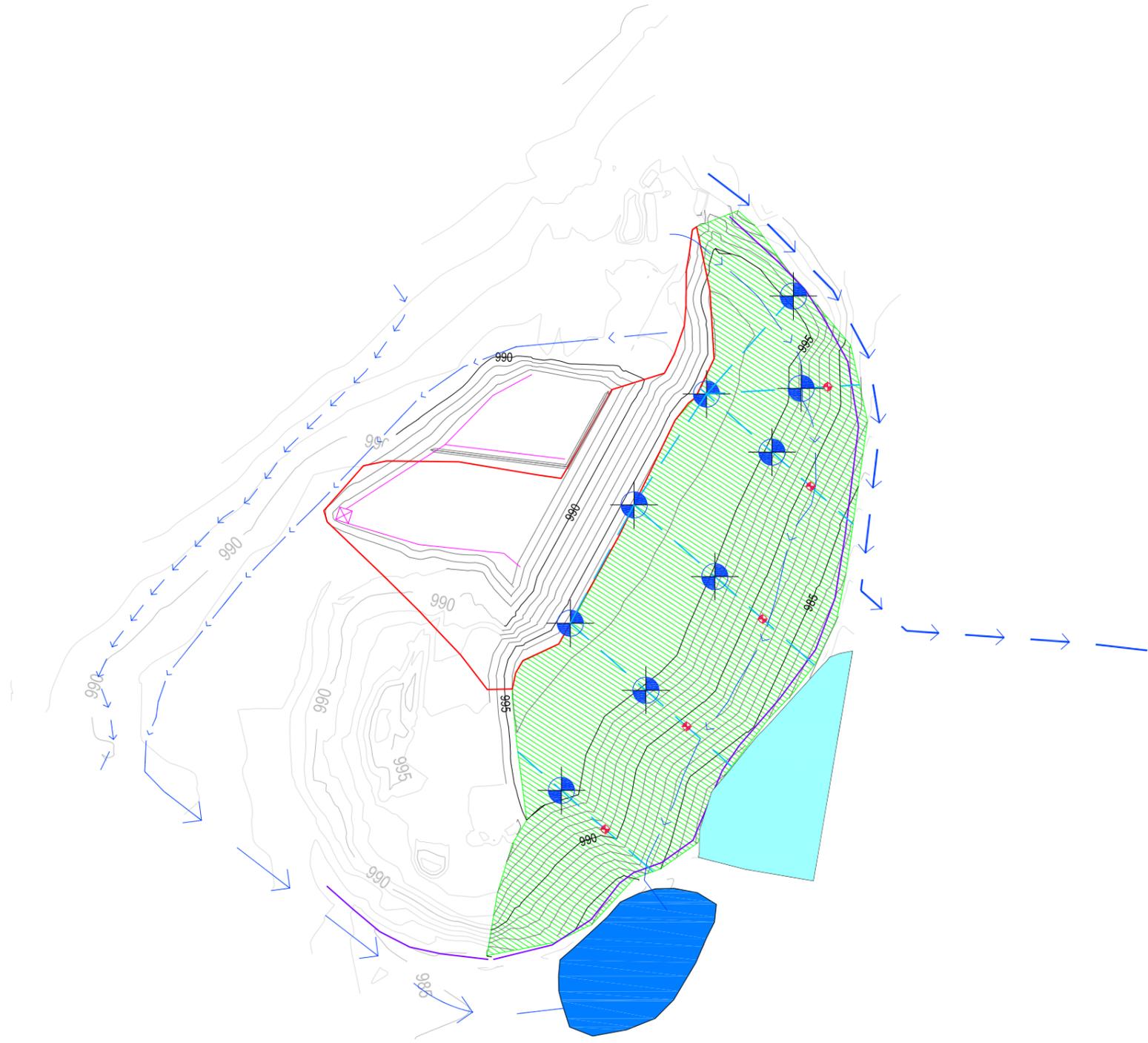
approved (PD) **SK021**

SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015



LEGEND

-  EXISTING SURFACE
-  DESIGN SUBGRADE
-  ACTIVE FILLING AREA
-  FINAL CAP AREA
-  SURFACE WATER MANAGEMENT
-  LEACHATE INTERCEPTION TRENCH
-  LEACHATE COLLECTION PIPE
-  LEACHATE SUMP
-  AREA OF WASTE TRIMMING
-  EXISTING SURFACE WATER DRAIN
-  SURFACE WATER DRAIN 1
-  SURFACE WATER DRAIN 2
-  SURFACE WATER DRAIN 3
-  SURFACE WATER DRAIN 4
-  LANDFILL GAS VENT
-  LANDFILL GAS COLLECTION BORE
-  LANDFILL GAS COLLECTION TRENCH



PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE		

**UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
LANDFILL GAS SYSTEM
LAYOUT PLAN - STAGE 3**



Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 F 61 2 9239 7199
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scale | 1:2000 for A3 job no. | 21-25153
date | JAN 2017 rev no. | A

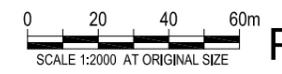
approved (PD) **SK022**

SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015



LEGEND

- EXISTING SURFACE
- DESIGN SUBGRADE
- ACTIVE FILLING AREA
- FINAL CAP AREA
- SURFACE WATER MANAGEMENT
- LEACHATE INTERCEPTION TRENCH
- LEACHATE COLLECTION PIPE
- LEACHATE SUMP
- AREA OF WASTE TRIMMING
- EXISTING SURFACE WATER DRAIN
- SURFACE WATER DRAIN 1
- SURFACE WATER DRAIN 2
- SURFACE WATER DRAIN 3
- SURFACE WATER DRAIN 4
- LANDFILL GAS VENT
- LANDFILL GAS COLLECTION BORE
- LANDFILL GAS COLLECTION TRENCH



PRELIMINARY

FOR APPROVAL			
A	INITIAL ISSUE		
rev	description	app'd	date

**UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
LANDFILL GAS SYSTEM
LAYOUT PLAN - STAGE 4**



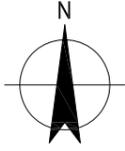
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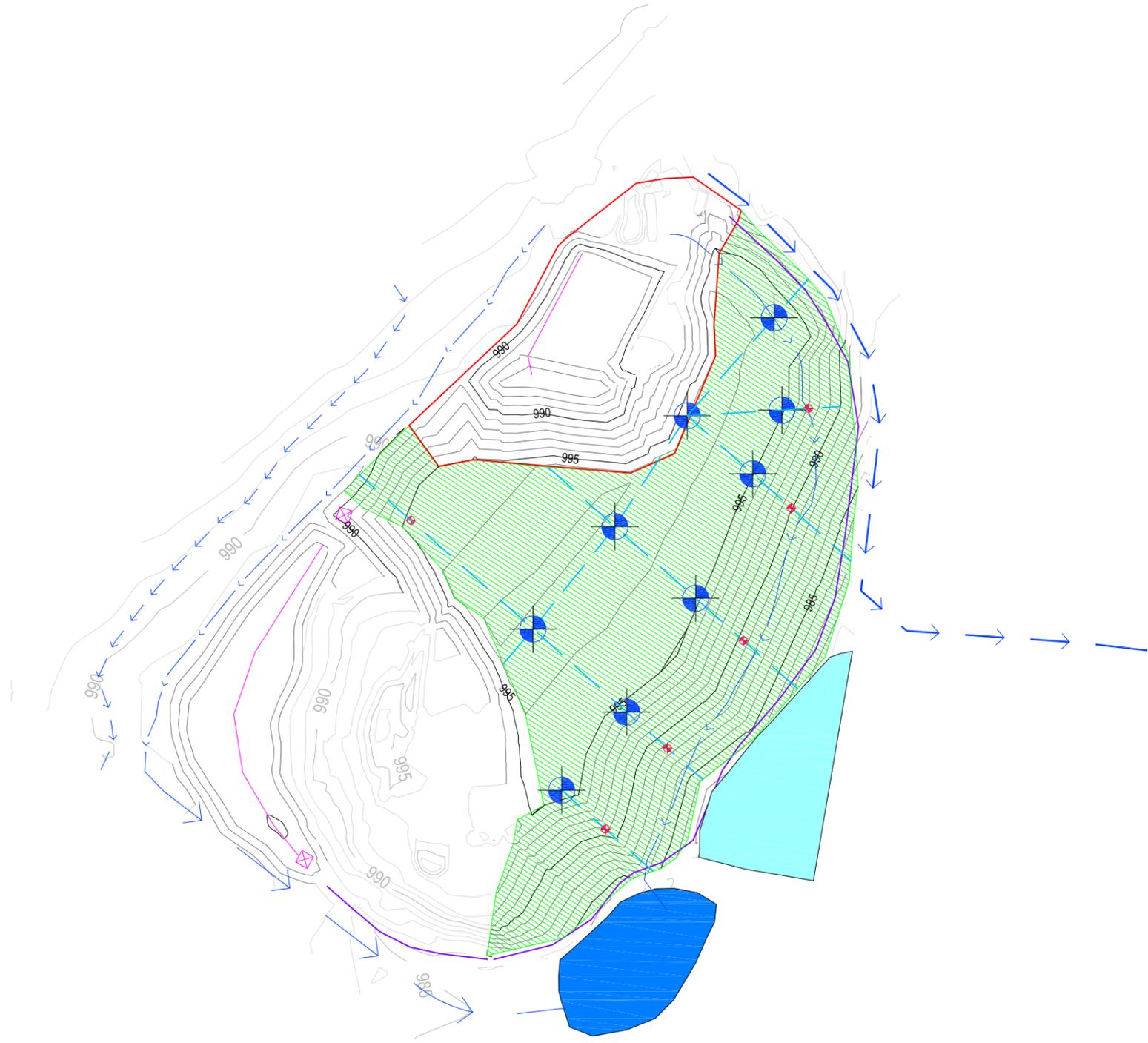
approved (PD) **SK023**

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LEGEND

-  EXISTING SURFACE
-  DESIGN SUBGRADE
-  ACTIVE FILLING AREA
-  FINAL CAP AREA
-  SURFACE WATER MANAGEMENT
-  LEACHATE INTERCEPTION TRENCH
-  LEACHATE COLLECTION PIPE
-  LEACHATE SUMP
-  AREA OF WASTE TRIMMING
-  EXISTING SURFACE WATER DRAIN
-  SURFACE WATER DRAIN 1
-  SURFACE WATER DRAIN 2
-  SURFACE WATER DRAIN 3
-  SURFACE WATER DRAIN 4
-  LANDFILL GAS VENT
-  LANDFILL GAS COLLECTION BORE
-  LANDFILL GAS COLLECTION TRENCH



0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE		

**UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
STAGING PLANS
STAGE 5**



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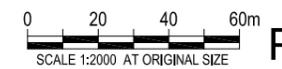
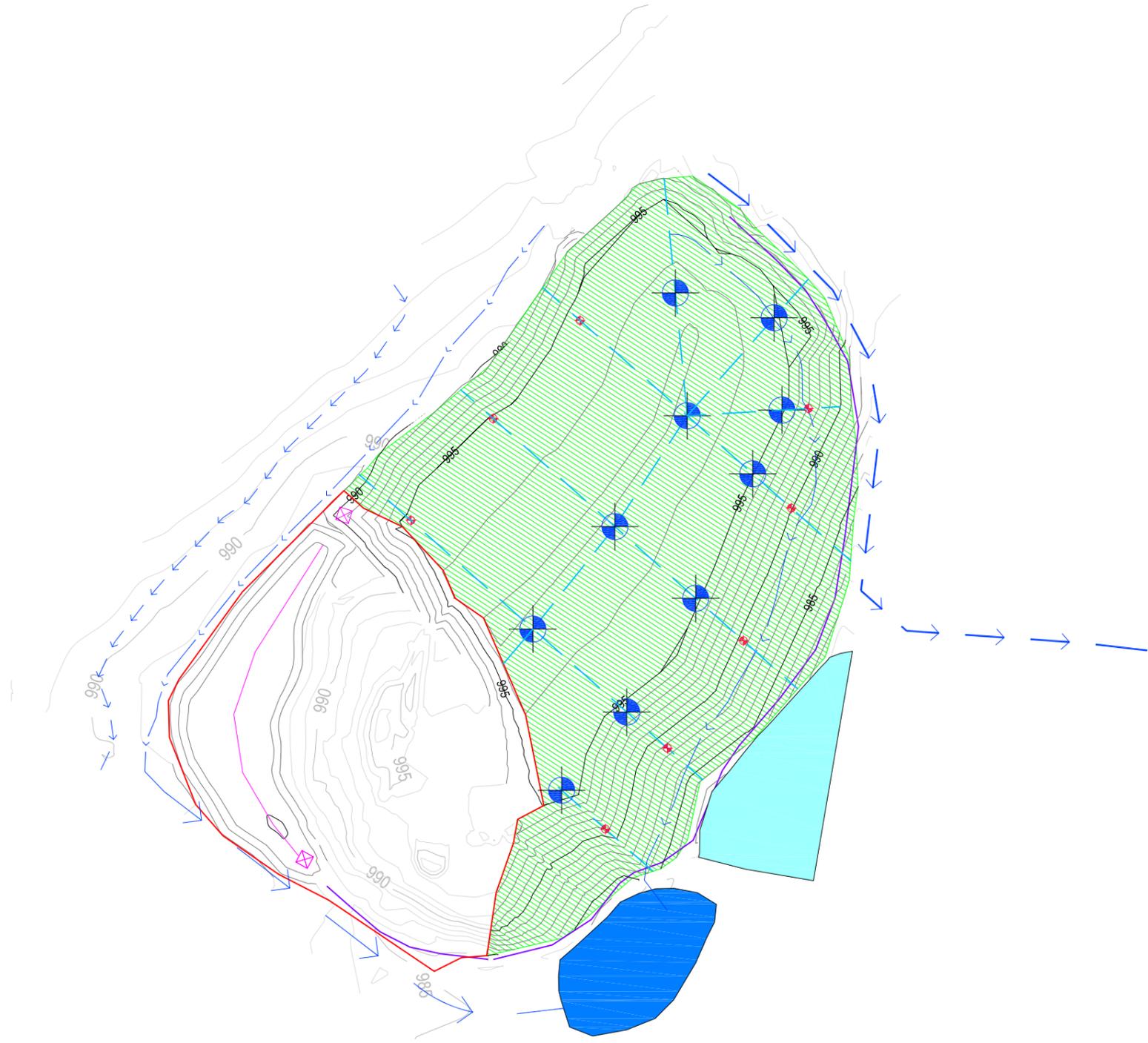
approved (PD) **SK024**

SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015



LEGEND

-  EXISTING SURFACE
-  DESIGN SUBGRADE
-  ACTIVE FILLING AREA
-  FINAL CAP AREA
-  SURFACE WATER MANAGEMENT
-  LEACHATE INTERCEPTION TRENCH
-  LEACHATE COLLECTION PIPE
-  LEACHATE SUMP
-  AREA OF WASTE TRIMMING
-  EXISTING SURFACE WATER DRAIN
-  SURFACE WATER DRAIN 1
-  SURFACE WATER DRAIN 2
-  SURFACE WATER DRAIN 3
-  SURFACE WATER DRAIN 4
-  LANDFILL GAS VENT
-  LANDFILL GAS COLLECTION BORE
-  LANDFILL GAS COLLECTION TRENCH



PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE		

**UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
LANDFILL GAS SYSTEM
LAYOUT PLAN - STAGE 6**



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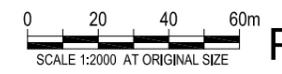
approved (PD) **SK025**

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LEGEND

- EXISTING SURFACE
- DESIGN SUBGRADE
- ACTIVE FILLING AREA
- FINAL CAP AREA
- SURFACE WATER MANAGEMENT
- LEACHATE INTERCEPTION TRENCH
- LEACHATE COLLECTION PIPE
- LEACHATE SUMP
- AREA OF WASTE TRIMMING
- EXISTING SURFACE WATER DRAIN
- SURFACE WATER DRAIN 1
- SURFACE WATER DRAIN 2
- SURFACE WATER DRAIN 3
- SURFACE WATER DRAIN 4
- LANDFILL GAS VENT
- LANDFILL GAS COLLECTION BORE
- LANDFILL GAS COLLECTION TRENCH



PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE	A	

**UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
LANDFILL GAS SYSTEM
LAYOUT PLAN - FINAL STAGE**



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 T 61 2 9239 7100 F 61 2 9239 7199
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 date | JAN 2017 rev no. | A

approved (PD) **SK026**

SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015



LEGEND

-  LANDFILL GAS MONITORING PERIMETER BORE
-  SITE BOUNDARY
-  150 M RADIUS FROM NORTH WEST DEVELOPMENT
-  250 M RADIUS FROM NORTH WEST DEVELOPMENT



NOTE

1. THIS SKETCH IS CONCEPTUAL ONLY AND IS TO BE REVISED BASED ON FUTURE MONITORING DATA OR OTHER RELEVANT ASPECTS
2. THIS SKETCH IS TO BE READ IN ACCORDANCE WITH GHD (2017) 'LANDFILL GAS PERIMETER BORE LOCATION JUSTIFICATION' DOCUMENTATION

PRELIMINARY

FOR APPROVAL			
rev	description	app'd	date
A	INITIAL ISSUE		

UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
LFG MONITORING SYSTEM
PERIMETER BORE LOCATIONS



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T 61 2 9239 7100 F 61 2 9239 7199
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scale | 1:2000 for A3 job no. | 21-25153
date | JAN 2017 rev no. | A

approved (PD) **SK027**

SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015

Attachment C: Site visit memorandum



Memorandum

21 November 2016

To	Matt Welsh		
Copy to	Project team		
From	Alison Horlyck	Tel	+61 2 9239 7108
Subject	Site visit notes – 17 November 2016	Job no.	2125974

Introduction

- Refer to attached site plan mark up for locations.
- Alison Horlyck (AH) arrived on site just before 9am (gate was open as truck was tipping). Note for others visiting site that “trucks turning in 250m” road sign on road between Crookwell and Gunning is good indicator of site entrance approaching.
- Took a few photos of the drain adjacent to the access road.
- Luke Moloney (LM) arrived just after 9am.

Segment 1 (from site sheds, heading south and around to leachate pond)

- Started at the site sheds, heading south.
- Area to north west of site sheds has been regraded with onsite soils (from active cell excavation) to improve drainage and make available for green waste storage and processing. Drainage channels have been established around the perimeter of the area, draining by pipe under the road to the perimeter of the landfill.
- Appears that gravel access has been extended/ made wider at the south end toward the asbestos pit.
- Observed gate in south western corner of the site (from Grabben Gullen Road).
- Farm dam to south of site very full (wet winter). Dam was source of soil material for the site.
- Clear drainage channel (wide and wet) around the toe of the landfill batter. Batter and drain are heavily vegetated with grass/weeds/shrubs.
- There is a bank between the perimeter access track (adjacent to the site fence) and the drain at the toe of the landfill batter. LM indicated that he thinks the bank is clean fill.
- Area in south corner of site likely location for sediment pond. LM indicated that pond would be good source of soil material so didn't mind if pond was bigger than required. LM noted that trees in the corner of the site are not of significance. AH noted that might need to consider roots of large gum if that tree is to be protected.
- Farm dam on other side of the fence (south east) observable from on-site. Very close to site boundary.



Memorandum

- Drain at toe of landfill noted to be quite wet (water ponding). Some large / dense trees along this edge of the landfill between future sediment and leachate pond areas.
- Leachate pond larger/more full than previous photos. LM indicated it had been shaped and material won out of it. Slumping of landfill toe observed. Clean (looking) stormwater coming in from south. One area of erosion/rilling observed. Dirt track leading to pond from south side quite wet. No observable way through to north side. Heavily vegetated.
- Discussed issue of temporary management of leachate while pond is being developed. LM noted that leachate pond is full due to wet weather and active pumping from new landfill cell and pond likely to be near empty by end of summer. Also discussed temporary plugging of transfer pipe with ponding at upstream side.
- Walked back along southern side of site

Segment 2 (asbestos pits heading north)

- Asbestos pit (vertical cut) full of water, overflowing to surface water drain (!). May also be animal waste. Excavation appeared stable.
- Drain along toe of waste draining south
- Walked up the access track (gravel track) up to the top of the southern stockpile area. LM noted bund on western side is probably clean fill. Generally building and demo waste. Some asphalt. Metal stockpile and some wood chip (which caught fire last year).
- Area of inlet to leachate transfer pipe is overgrown (near parked excavator). LM noted that this was old leachate pond.
- Leachate being pumped (blue layflat pipe) from new cell is being discharged to toe drain and flowing to the transfer pipe
- Green waste stockpile in middle of gravel area. Smaller base course/crusher dust (?) stockpile at southern end.
- New cell was excavated to approx. 5m deep (vertical walls!) and stockpiled on the landfill mound (central area). Material observed to be clayey and not susceptible to erosion. Not hard to excavate and appears to be weathering quickly. No groundwater was observed during excavation works. Interface between waste and natural soils observed at approx. natural ground level (ie appears little excavation was undertaken for landfilling). Soft, uncovered waste. Compactor and leachate extraction pump (on trailer) being used.
- Walked up gravel track to look at stockpiled soils (lots!)
- Walked across to southern platform, where hard household waste (less litter) is being stockpiled.
- Walked north to view reprofiled batter from top. LM noted bench which has been left to allow for stormwater drainage.
- New cell observed from the east. Tipping platform with bund on edge used by both commercial (Mon – Wed, Mon – Thurs alternate weeks) and private (Fri, Sat, Sun) vehicles.



Memorandum

- Reprofiled batter from bottom looking west, looks at reasonable grade. Again site materials don't seem to be eroding. Toe has been brought back. LM indicated that the road easement is back access for adjacent property (4WD access may be sufficient).
- Briefly discussed arrangement of leachate trench (concerns around size) and location of potential monitoring wells (preference for these to be on site).
- New northern mesh fence was installed by neighbour and neighbour does litter collection (council pays them). Neighbour likes existing trees (visual and as litter fence). Batter reprofiling works halted as neighbour didn't want the tree on the waste batter to be removed. LM says they will work on communications to outline long term benefits of undertaking the work.
- Waste breakthrough on the north eastern corner (over-tipping at from the top). Ground / track very wet in spots. Eastern batter very overgrown.

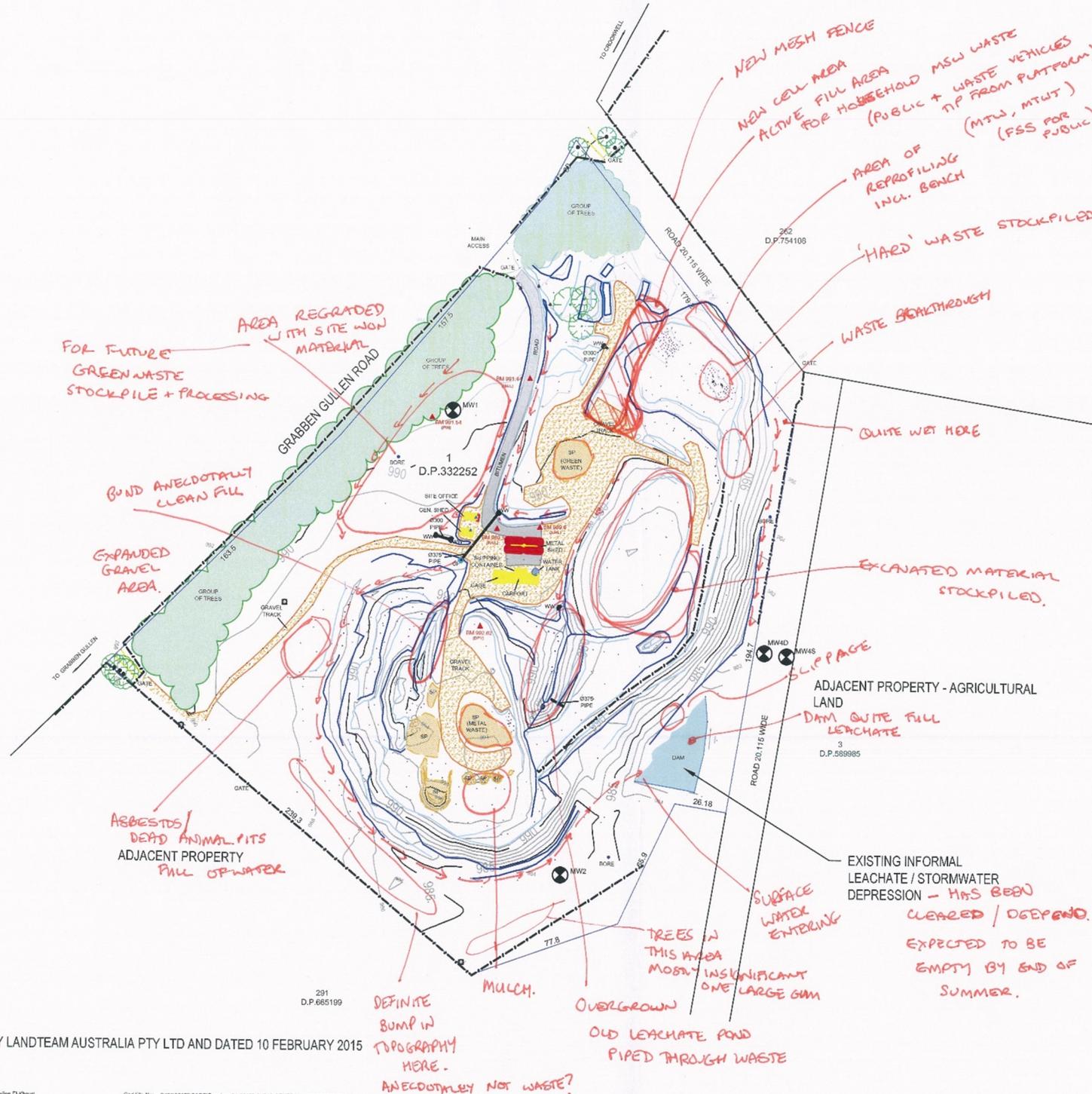
Other general discussion

- Discuss funding cycle (Council or EPA?) ends June 30 and ideal construction time is end of summer (ie get design works done ASAP).
- Discuss that works will generally be undertaken by Council general earthworks contractor with who they have a good working relationship. Works will not go out to tender (except specialist lining works).
- Discuss geomembrane vs GCL cap. LM seemed receptive. Only concern seemed to be thickness of the entire system (ie airspace consumption).
- Discussed lining options as it seemed that the batter slopes in cell is what would limit the depth of excavation. Consider options (maybe onsite clay?).
- AH noted next component is development of DBM.

Regards

Alison Horlyck

Civil Engineer



LEGEND

- BOUNDARY
- EXISTING FENCELINE (VARIOUS MATERIALS)
- TOP OF BANK
- TOE OF BANK
- BENCH MARK
- SIGN
- GRATED PIT
- WING WALL
- STOCKPILES (VARIOUS MATERIALS)
- GROUNDWATER BORE LOCATION (INDICATIVE)



PRELIMINARY

B	FOR APPROVAL		16.09.16
A	INITIAL ISSUE	MW	13.07.16
rev	description	app'd	date

UPPER LACHLAN SHIRE COUNCIL
CROOKWELL LANDFILL
EXISTING ARRANGEMENT



Level 15, 133 Castlereagh Street, Sydney NSW 2000 Australia
T 61 2 9239 7100 F 61 2 9239 7199
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scale | 1:2000 for A3 job no. | 21-25153
date | SEP 2016 rev no. | B

approved (PD) **SK010**

SURVEY PROVIDED BY LANDTEAM AUSTRALIA PTY LTD AND DATED 10 FEBRUARY 2015

291
D.P.665199

Attachment D: Safety in design assessment



15 February 2017

Luke Maloney
Upper Lachlan Shire Council

Our ref: 21-25974

Your ref:

Dear Luke

Safety in Design Obligations

GHD is steadfast in our commitment to comply with our legislative obligations and delivering industry leading safety in design (SiD) practices. Implementation and ongoing review of our Safety in Design Procedure provides you as our client comfort that our design teams are focussed on delivering a service that considers your risk throughout the asset lifecycle. Further information regarding the principles of SiD is available at www.safeworkaustralia.gov.au for your reference and we need your support to achieve these quality outcomes.

Workplace health and safety (WHS) is something that's important to all of us. Under the national WHS scheme, there are a range of legislative and regulatory requirements, backed up with a suite of codes of practice clarifying how these obligations can be met. In particular, there are specific requirements and expectations of entities and persons defined as a "designer".

The definition of "designer" in the abovementioned legislation not only affects the actual designer themselves but also attracts duties upon all those who are connected with the design (e.g. during construction), including parties where the end product is to be used, or could reasonably be expected to be used, as, or at a workplace (e.g. during end-use, inspection, operation, cleaning, maintenance and demolition). Furthermore, the "designer" must ensure, so far as is reasonably practicable, that the plant, substance or structure is designed to be without risks to health and safety where the design is for the purposes of a workplace.

It is therefore reasonable to consider the wider practical definition of "designer" to include:

- Design professionals, such as architects, civil, building services, electrical, acoustic, environmental, mechanical and structural engineers, landscape architects, interior designers, drafters and industrial designers;
- Head contractors, developers, builders, owners, project managers, purchasers, clients, end-users and workers;
- Quantity surveyors, insurers, quality assurance staff, work safety professionals and ergonomics practitioners; and
- Suppliers including manufacturers, importers, those who hire plant, constructors, installers and trades and maintenance people.

The guidance for effective safety in design outcomes are provided in the Codes of Practice for Safe Design of Structures, and Safe Design, Manufacture Import and Supply of Plant, which GHD played a lead role in drafting.

As a valued client of GHD, we wish to illustrate the important role you play in achieving a successful SiD outcome for your projects. To summarise, below are some key features of how you as owner/client can assist to make the design outcomes safer and healthier through SiD:

- Provision of information - providing the designer with any information about hazards and risks relating to the site at which any proposed construction work is to be undertaken that may affect the design. and provision of any information relevant to the operation and maintenance of the facility.
- Allocation of sufficient budget commensurate with project risk to enable legislative compliance and achievement of a quality outcome.
- Access to relevant maintenance staff –providing the designer with the opportunity to be briefed by relevant maintenance staff, assisting in minimising risks to their health and safety during the construction work connected with the design, and facility operation and maintenance once construction is complete,...

GHD enjoys the relationship with Council and sees SiD as a vehicle for further growth of our partnership into the future, and also a means of GHD assisting you improve workplace health and safety.

If you would like to discuss SiD further or for any other matter, please do not hesitate to contact the undersigned.

Sincerely
GHD Pty Ltd

A handwritten signature in black ink, appearing to read 'A. Roberts', written over a light blue horizontal line.

Adrian Roberts
Principal Engineer

Notes: *Designs with significant quantities of dangerous goods may require detailed risk assessments under Dangerous Goods or Major Hazard legislation

* Most industrial processes will require an industry specific assessment, e.g. HAZOP and/or Quantitative Risk Assessment for facilities that have chemical or high-pressure processes under Dangerous Goods or Major Hazard legislation.

Design Life Cycle:	Investigation and Design	Setup, Construction and Commissioning	Operation	Maintenance	Disposal	Date:	20/02/2017	Revision No:	A						
Job Name:	Crookwell Detailed Design		Job No:	21/25974	Client	Upper Lachlan Shire Council		Design:	Lined landfill cell, surface water drains, sedimentation pond, waste batter re-profiling, decommissioning of existing						
People involved in Risk		G.Yoon, A Horlyck													
Design Ref	Design Life Cycle Stage <small>(Select from Drop Down Box)</small>	Hazards <small>What could cause injury or ill health, damage to property or damage to the environment</small>	Risk <small>What could go wrong and what might happen as a result</small>	Existing Control Measures	Initial Risk Rating			Potential Control Measures <small>(Consider Hierarchy of Control - Elimination, Substitution, Isolation, Engineering Controls, Administrative Controls, PPE)</small>	Responsibility	By When	Decision / Status	Residual Risk Rating			Comments
					C	L	RR					C	L	RR	
Investigation and Design															
		No hazards in design phase - no additional investigation works or site visits are included in the scope of work at this stage													
Setup, Construction and Commissioning															
1.01	Setup, Construction and Commissioning	Exposure of future site workers to existing landfilled waste during construction works	Physical injury and illness due to uncontrolled exposure, including inhaling or coming into contact with the waste	Existing intermediate cover layer covering existing landfilled waste	C- Severe	3 - Possible	Moderate	- Minimise exhumation of landfilled waste during earthworks design based on inferred waste levels - Include provisions in the construction documentation for Contractor to prepare work method statements for waste exhumation and relocation	Designer	During design phase	To be actioned				
1.02	Setup, Construction and Commissioning	Exposure of future site workers to existing landfilled waste during construction works	Physical injury and illness due to uncontrolled exposure, including inhaling or coming into contact with the waste	Existing intermediate cover layer covering existing landfilled waste	C- Severe	3 - Possible	Moderate	- Include provisions in the construction documentation for Contractor to prepare safety plans and environmental management plans with regards to waste exposure, exhumation and relocation	Principal	During tender phase	To be actioned				
1.03	Setup, Construction and Commissioning	Risks to off-site receptors associated with exhuming landfilled waste	Physical injury and illness due to uncontrolled exposure, including inhaling or coming into contact with the waste. Disamenity (visual and/or odour) due to exposure to excessive dust and odour from exposed waste	Existing intermediate cover layer covering existing landfilled waste	C- Severe	3 - Possible	Moderate	- Minimise exhumation of landfilled waste during earthworks design based on inferred waste levels - Include provisions in the construction documentation for Contractor to prepare work method statements for waste exhumation and relocation	Designer	During design phase	To be actioned				
1.04	Setup, Construction and Commissioning	Risks to off-site receptors associated with exhuming landfilled waste	Physical injury and illness due to uncontrolled exposure, including inhaling or coming into contact with the waste. Disamenity (visual and/or odour) due to exposure to excessive dust and odour from exposed waste	Existing intermediate cover layer covering existing landfilled waste	C- Severe	3 - Possible	Moderate	- Include provisions in the construction documentation for Contractor to prepare safety plans and environmental management plans with regards to waste exposure, exhumation and relocation	Principal	During tender phase	To be actioned				

Design Ref	Design Life Cycle Stage (Select from Drop Down Box)	Hazards <small>What could cause injury or ill health, damage to property or damage to the environment</small>	Risk <small>What could go wrong and what might happen as a result</small>	Existing Control Measures	Initial Risk Rating			Potential Control Measures <small>(Consider Hierarchy of Control - Elimination, Substitution, Isolation, Engineering Controls, Administrative Controls, PPE)</small>	Responsibility	By When	Decision / Status	Residual Risk Rating			Comments
					C	L	RR					C	L	RR	
1.05	Setup, Construction and Commissioning	On-site workers being exposed to waste materials, including possible hazardous materials, during waste exhumation and relocation including airborne dust and fibres, chemical vapours and fumes	- Physical injury and illness due from inhaling or coming into contact with hazardous waste - Inhalation of hazardous waste fibres can lead to the development of respiratory diseases in humans - Inhalation or contact with chemical vapours or fumes can result in injury or illness	Existing intermediate cover layer covering existing landfilled waste	D - Critical	3 - Possible	Significant	- Include provisions in the construction documentation for Contractor to prepare safety plans and environmental management plans with regards to possible general waste and possible hazardous waste exposure, exhumation and relocation	Contractor	Prior to and during construction works	To be actioned				
1.06	Setup, Construction and Commissioning	Oversteepened landform slopes become unstable resulting in slumping and/or landslides, causing injury on to-site workers	Physical injury to on-site workers due to slippage	None	D - Critical	3 - Possible	Significant	- Reduce Works Area to provide sufficient safe working distance from edge of oversteepened batters - Design regraded landform to reduce grades in steep areas at key in area (1(V):4(H) max)	Designer	During design phase	To be actioned				
1.07	Setup, Construction and Commissioning	Oversteepened landform slopes become unstable resulting in slumping and/or landslides, causing injury on to-site workers	Physical injury to on-site workers due to slippage	N/A	D - Critical	3 - Possible	Significant	- Include provisions in the construction documentation for Contractor to prepare safety plans and traffic management plans with regards to working and trafficking in proximity to the oversteepened batters	Principal	During design phase	To be actioned				
1.08	Setup, Construction and Commissioning	Landfill gas inhalation/combustion impacting upon on-site workers and local receptors	Fire/explosion/asphyxiation, physical illness due to inhalation	Existing intermediate cover layer covering existing landfilled waste	D - Critical	3 - Possible	Significant	- Include provisions in the construction documentation for Contractor to prepare work method statements for working near existing gas management system to ensure no damage is incurred to this system	Designer	During design phase	To be actioned				
1.09	Setup, Construction and Commissioning	Landfill gas inhalation/combustion impacting upon on-site workers and local receptors	Fire/explosion/asphyxiation, physical illness due to inhalation	Existing intermediate cover layer covering existing landfilled waste	D - Critical	3 - Possible	Significant	- Include provisions in the construction documentation for Contractor to prepare safety plans and environmental management plans with regards to the presence of landfill gas, including monitoring requirements - Installation of gas collection system to be undertaken by others	Principal	During tender phase	To be actioned				
1.10	Setup, Construction and Commissioning	Uncontrolled release of site contaminants during the Works (including leachate, landfill gas, sediment laden water, odour, dust)	- Contamination to local water sources resulting in injury, illness or death of wildlife or damage to environment - Odour and dust causing disamenity and discomfort to off-site residents and fauna	- Existing intermediate cover layer covering existing landfilled waste - Subsurface leachate collection system	B - Major	3 - Possible	Low	- Include provisions in the construction documentation for Contractor to prepare safety plans and environmental management plans with regards to the mitigating release of site contaminants, including monitoring requirements	Principal	During tender phase	To be actioned				

Design Ref	Design Life Cycle Stage (Select from Drop Down Box)	Hazards <small>What could cause injury or ill health, damage to property or damage to the environment</small>	Risk <small>What could go wrong and what might happen as a result</small>	Existing Control Measures	Initial Risk Rating			Potential Control Measures <small>(Consider Hierarchy of Control - Elimination, Substitution, Isolation, Engineering Controls, Administrative Controls, PPE)</small>	Responsibility	By When	Decision / Status	Residual Risk Rating			Comments
					C	L	RR					C	L	RR	
1.11	Setup, Construction and Commissioning	Vehicle accident due to oversteepened batters on perimeter of the Works Area	Physical injury to on-site workers due to vehicle crash and/or overturn	N/A	E- Catastrophic	3 - Possible	Extreme	- Reduce Works Area to provide sufficient safe working distance from edge of oversteepened batters	Designer	During design phase	To be actioned				
1.12	Setup, Construction and Commissioning	Vehicle accident due to oversteepened batters on perimeter of the Works Area	Physical injury to on-site workers due to vehicle crash and/or overturn	N/A	E- Catastrophic	3 - Possible	Extreme	- Include provisions in the construction documentation for Contractor to prepare safety plans and traffic management plans with regards to working and trafficking in proximity to the oversteepened batters	Principal	During tender phase	To be actioned				
1.13	Setup, Construction and Commissioning	Working near water	Trip or fall into existing or new pond resulting in drowning	N/A	E- Catastrophic	3 - Possible	Extreme	- Include provisions in the construction documentation for Contractor to prepare work method statements for working near existing and to be built bodies of water to ensure no damage is incurred to the on-site workers	Designer	During design phase	To be actioned				
1.14	Setup, Construction and Commissioning	Trenches and/or anchoring system	Trip hazard - fall over edge into cell	N/A	C- Severe	4 - Likely	Moderate	- Design anchor trenches to maintain offset from crest of batter.	Designer	Finalisation of design documentation	To be actioned				
1.15	Setup, Construction and Commissioning	Trenches and/or anchoring system	Trip hazard - fall over edge into cell	N/A	C- Severe	4 - Likely	Moderate	- Include provisions in the construction documentation for Contractor to prepare safety plans - Install fencing system around possible trip hazards	Principal	During tender phase	To be actioned				
1.16	Setup, Construction and Commissioning	Landslide caused by instability of topsoil	Physical injury to on-site workers	N/A	D - Critical	3 - Possible	Significant	- Installation of geogrid layer	Designer	During design phase	To be actioned				
1.17	Setup, Construction and Commissioning	Vehicle accident due to passing on-site traffic/earthmoving equipment	Injury/death from collision	N/A	E- Catastrophic	3 - Possible	Extreme	- Develop and implement appropriate work health and safety plan and work method statements to address safety measures for managing earthworks/traffic movements during the construction works - Include access roads	Contractor	Prior to initiation of construction works	To be actioned				
1.18	Setup, Construction and Commissioning	Current and future on-site workers being exposed to hazardous waste materials during reprofiling works including airborne dust and fibres, chemical vapours and fumes	- Physical injury and illness due from inhaling or coming into contact with hazardous waste - Inhalation of hazardous waste fibres can lead to the development of respiratory diseases in humans - Inhalation or contact with chemical vapours or fumes can result in injury or illness	N/A	D - Critical	3 - Possible	Significant	- Minimise exposure of waste during earthworks design based on inferred waste levels - Include provisions in the construction documentation for Contractor to prepare plans to manage waste exposure/exhumation/relocation	Designer	Finalisation of design documentation	To be actioned				
1.19	Setup, Construction and Commissioning	Risks to off-site receptors associated with existing general solid waste and potential asbestos waste	Pollution of nearby waterways and wetlands	Existing intermediate cover layer covering existing landfilled waste	D - Critical	3 - Possible	Significant	- Contractor to install surface water and erosion sediment control measures to divert water around works area - Capture stormwater and test before release to surface waters to confirm not contaminated by waste material - Contractor to implement an Asbestos and Contamination Management Plan	Principal and Contractor	During tender phase	To be actioned				

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1.20	Setup, Construction and Commissioning	On-site workers coming into contact with landfill gas resulting in injury/illness	Illness or death relating to asphyxiation or explosion/fire by LFG during cell connection works	Existing intermediate cover layer covering existing landfilled waste	E- Catastrophic	3 – Possible	Extreme	- Contractor to prepare and implement appropriate work health and safety plan and work method statements to address safety measures for managing potential gas exposure - Provision of previous environmental monitoring results to Contractor (where available)	Principal and Contractor	During tender phase	To be actioned				
1.21	Setup, Construction and Commissioning	On-site workers coming into contact with leachate resulting in injury/illness during reprofiling works	Physical injury and illness in humans due to contact with or swallowing of uncontrolled leachate during cell connection works	Existing intermediate cover layer covering existing landfilled waste	D – Critical	3 – Possible	Significant	- Contractor to prepare and implement appropriate work health and safety plan and work method statements to address safety measures for managing potential leachate exposure - Provision of previous environmental monitoring results to Contractor (where available)	Principal and Contractor	During tender phase	To be actioned				
1.22	Setup, Construction and Commissioning	Off site receptors (local residents, flora and fauna) coming into contact with leachate resulting in injury/illness	Physical injury and illness due to contact with or swallowing of uncontrolled leachate	Existing intermediate cover layer covering existing landfilled waste	D – Critical	2 – Unlikely	Moderate	- Contractor to prepare and implement appropriate work health and safety plan and work method statements to address safety measures for managing potential leachate exposure - Provision of previous environmental monitoring results to Contractor (where available)	Principal and Contractor	During tender phase	To be actioned				
1.23	Setup, Construction and Commissioning	On-site workers falling from heights from bunds and installation of liner	Injury from impact	N/A	D – Critical	3 – Possible	Significant	- Contractor to prepare and implement appropriate work health and safety plan and work method statements to address safety measures for working with heights	Contractor	Throughout works	To be actioned				
1.24	Setup, Construction and Commissioning	Excavations	Falling down causing injury	N/A	D - Critical	4 - Likely	Significant	- Site should be fenced and secured after hours - Fence should be regularly inspected. Contractor to develop inspection plan. - Signage and barriers should be installed	Contractor	Throughout works	To be actioned				
1.25	Setup, Construction and Commissioning	Earthworks	Instability of fill or batter slopes causing injury to on-site workers	N/A	D – Critical	2 – Unlikely	Moderate	- Contractor to engaged suitably qualified engineer to inspect works regularly - Contractor to undertake suitable testing to ensure required installation requirements are being achieved - Testing to be undertaken to confirm design assumptions	Principal and Contractor	Throughout works	To be actioned				
1.26	Setup, Construction and Commissioning	Earthworks - stockpiles	Injury from falling stockpiles	N/A	D - Critical	3 - Possible	Significant	- Develop and implement appropriate work health and safety plan and work method statements to address safety measures for managing stockpile sizes and placements on site	Contractor	Prior to and during construction works	To be actioned				
1.27	Setup, Construction and Commissioning	Landslide caused by instability of topsoil	Physical injury to on-site workers	N/A	D - Critical	3 - Possible	Significant	- Installation of geogrid layer - Install layers in a bottom to up procedure	Contractor	During construction works	To be actioned				

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					C	L	RR					C	L	RR	
1.28	Setup, Construction and Commissioning	On-site workers falling from heights	Injury/death from impact	N/A	E- Catastrophic	3 - Possible	Extreme	- Prepare and implement appropriate work health and safety plan and work method statements to address safety measures for working with heights	Contractor	Ongoing	To be actioned				
1.29	Setup, Construction and Commissioning	Oversteepened landform slopes become unstable resulting in slumping and/or landslides	Physical injury to on-site workers due to being struck or buried by soil	N/A	D - Critical	3 - Possible	Significant	- Develop and implement appropriate work health and safety plan and traffic management plan to address safety measures for working and trafficking in proximity to the oversteepened batters (adjacent to the Works Area)	Contractor	Prior to and during construction works	To be actioned				
1.30	Setup, Construction and Commissioning	Trenches and/or anchoring system	Physical injury to on-site workers due to being struck or buried by soil	N/A	C- Severe	4 - Likely	Moderate	- Include provisions in the construction documentation for Contractor to prepare safety plans - Install fencing system around possible trip hazards	Principal	During tender phase	To be actioned				
1.31	Setup, Construction and Commissioning	Trenches and/or anchoring system	Injury to onsite workers from tripping over trenches/anchoring systems	N/A	D - Critical	3 - Possible	Significant	- Contractor to prepare and implement appropriate work health and safety plan and work method statements and to include safety measures for working around anchor trenches and on batter slopes - Include fencing and signage around anchor trenches as formed	Contractor	Throughout works	To be actioned				
1.32	Setup, Construction and Commissioning	Landfill gas inhalation/combustion impacting upon on-site workers and local receptors	Fire/explosion/asphyxiation, physical illness due to inhalation	Existing landfill gas management system	E- Catastrophic	3 - Possible	Extreme	- Develop and implement appropriate work health and safety plan and environmental management plan to address safety measures for managing potential landfill gas exposure - Provision of previous environmental monitoring results to Contractor - Environmental monitoring during the construction works as required	Contractor	Prior to and during construction works	To be actioned				
1.33	Setup, Construction and Commissioning	Landfill gas inhalation/combustion impacting upon on-site workers and local receptors	Fire/explosion/asphyxiation, physical illness due to inhalation	Existing landfill gas management system	D - Critical	3 - Possible	Significant	- Provision of previous environmental monitoring results to Contractor	Principal	During tender phase	To be actioned				
1.34	Setup, Construction and Commissioning	Landfill gas inhalation/combustion impacting upon on-site workers and local receptors	Fire/explosion/asphyxiation, physical illness due to inhalation	Existing landfill gas management system	D - Critical	3 - Possible	Significant	- Maintain ongoing operation of existing landfill gas management system - Alert Principal and Contractor if system is offline and develop response plan to address this potential issue	Landfill Gas Operator	Prior to and during construction works	To be actioned				

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					C	L	RR					C	L	RR	
1.35	Setup, Construction and Commissioning	Landfill gas inhalation/combustion impacting upon on-site workers and local receptors	Fire/explosion/asphyxiation, physical illness due to inhalation	Existing landfill gas management system	D - Critical	3 - Possible	Significant	- Include provisions in the construction documentation for Contractor to prepare safety plans and environmental management plans with regards to the presence of landfill gas, including monitoring requirements - Installation of gas collection system to be undertaken by others	Principal	During tender phase	To be actioned				
1.36	Setup, Construction and Commissioning	Landfill gas combustion during welding of geosynthetic layers	Fire/explosion consequencing in injury or death	Existing landfill gas management system	E- Catastrophic	3 - Possible	Extreme	- Extend the existing landfill gas management system in the Works Area as required prior to construction to ensure gas is adequately managed during construction and future operation - Caution and countermeasures taken by installer	Geosynthetic installer	During construction works	To be actioned				
1.37	Setup, Construction and Commissioning	Landfill liner system - geosynthetics	Manual handling of welding equipment on sidewall causing injury to on-site workers	N/A	D - Critical	4 - Likely	Significant	Contractor to develop safe work method.	Contractor	Throughout works	To be actioned				
1.38	Setup, Construction and Commissioning	Landfill liner system - geosynthetics	Wind uplift causing injury or death	N/A	C- Severe	4 - Likely	Moderate	Contractor to develop safe work method and cease work under unsafe wind conditions	Contractor	Throughout works	To be actioned				
1.39	Setup, Construction and Commissioning	Landfill liner system - geosynthetics	Manual handling of geosynthetic rolls causing injury to on-site workers	N/A	C- Severe	4 - Likely	Moderate	- Contractor to develop WMS and supply and use suitable plant for moving material	Contractor	Throughout works	To be actioned				
1.40	Setup, Construction and Commissioning	Working near water	Trip or fall into existing or new pond resulting in drowning	N/A	E- Catastrophic	3 - Possible	Extreme	- Contractor to develop safe work method for working around ponds - Include barriers/fencing, signage, ladders for getting out of ponds, life saving equipment	Contractor	Throughout works	To be actioned				
1.41	Setup, Construction and Commissioning	Injury due to falling objects	Objects falling or flung on workers	N/A	D - Critical	3 - Possible	Significant	- Contractors to develop safe work method. E.g. make sure tools and materials are placed on a safe, surfaced level when not in use - Minimise workers in the cell while transferring saltcake - Wear hard hats.	Contractor	Throughout works	To be actioned				
1.42	Setup, Construction and Commissioning	Bushfire while workers are on-site	Physical injury/death to on-site workers due to smoke inhalation or burns	N/A	E- Catastrophic	2 - Unlikely	Significant	- Develop and implement appropriate EMP and work health and safety plan / safe work method statements to address safety measures for managing bushfire risks	Principal and Contractor	Prior to initiation of construction works	To be actioned				
1.43	Setup, Construction and Commissioning	Extreme weather - rain	Inundation of subgrade	N/A	D - Critical	2 - Unlikely	Moderate	- Contractor to develop safe work method and evacuation procedures for forecast bad weather	Contractor	Throughout works	To be actioned				
1.44	Setup, Construction and Commissioning	Extreme weather - rain	Increased risk of leachate from waste materials under the monocell under construction	N/A	C- Severe	3 - Possible	Moderate	- Effective liner system designed - Liner system installed in schedule before expected extreme weather	Designer and Contractor	Finalisation of design documentation, Throughout works	To be actioned				

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1.45	Setup, Construction and Commissioning	Perforation of geological features and release of groundwater	Groundwater could enter the construction area. Groundwater could become contaminated by leachate	N/A	E- Catastrophic	3 - Possible	Extreme	- design to consider groundwater levels and associated low permeability layers.	Designer	During design phase	To be actioned				
1.46	Setup, Construction and Commissioning	Unauthorised access to site and monitoring infrastructure	Physical injury, discomfort, illness, or potential asphyxiation (and death)	N/A	D - Critical	3 - Possible	Significant	- Install suitable security measures to prevent unauthorised access to the site and the monitoring infrastructure	Operator	Ongoing	To be actioned				