

Construction Verification Audit Report

Shoal Bay Waste Disposal Facility, Stage 3 and 4 - Landfill Cap

Approval Holder: City of Darwin
EPA Approval No.: EPA321-02

Prepared for:
City of Darwin

Prepared by:

EHS  **Support**TM

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Prepared By:	Stephen Cambridge – EPA Victoria Appointed Auditor (Contaminated Land) 
Client:	City of Darwin Council

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Abbreviations

Technical Terms	
AS	Australian Standard
BOM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CQA	Construction Quality Assurance
EHS Support	EHS Support Pty Ltd
EMP	Environmental Management Plan
EPA(V)	Environment Protection Authority (of Victoria)
ESCP	erosion and sediment control plan
GCL	Geosynthetic Clay Liners
GITA	Geotechnical Independent Testing Authority
GRI	Geosynthetic Research Institute
HSE	Health, Safety and Environment
IFC	Issued for Construction
mbgs	metres below ground surface
NSW	New South Wales
NT	Northern Territory
NTLG	Northern Territory Landfill Guidelines
NT EPA	Northern Territory Environment Protection Authority
QA/QC	Quality Assurance / Quality Control
TDS	total dissolved solids
WMPC Act	<i>Waste Management and Pollution Control Act 1998</i>
Units	
ha	Hectare
L/s	Litres per second
m	Metres
m bgs	Metres below ground surface
m bTOC	Metres below Top of Casing
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
ML	Megalitre
m/s	Metres per second
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Litre



Executive Summary

Table E-1 Summary of Audit Information

Auditor	Stephen Cambridge
Auditor account number	186656 (Victoria)
Auditor appointment end date	13 December 2022 (Victoria)
Audit type	Environmental Audit of Landfill Cap Construction
Date EPA notified of audit	Initial Audit scope letter dated 29 July 2021 (Final Audit Scope letter for Stage 3 and 4, and intention to submit an Interim Stage 3 Audit Report letter, are included in Appendix B)
EPA Permit Number	EPA321-02
Name of person requesting audit	Mr Mathew Vitucci (Council representative is now Mr Nik Kleine)
Relationship to premises/location	Executive Manager Infrastructure – City of Darwin
Name of premises owner	Department of Defence, leased by City of Darwin (until 2034)
Date of Auditor engagement	23 July 2021
Completion date of the audit	7 March 2024
Reason for Audit	Compliance with Northern Territory EPA Environment Protection Approval #EPA321-02 conditions (refer to Section 1.1 and 7.1 for relevant conditions), and requirements of the EPA approved Design Documents for Darwin Landfill Stages 3 and 4 Cap
Audit category	Risk to environment from construction of landfill cap
Environmental elements	Air, land, groundwater, and surface water
If the audit was required by an EPA notice, licence or other, please provide EPA reference number	Environment Protection Approval #EPA321-02 EPA Licence EPL188-03
Current land use zoning	CA - No Planning Scheme Controls
Audit categorisation	Risk to the environment
EPA Region	Darwin, Northern Territory
Municipality	City of Darwin
Dominant – Lot on Plan	Not applicable
Additional – Lot on Plan (s)	Not applicable
Site / Premises name	Darwin Landfill (Shoal Bay Waste Management Facility)
Building / complex sub-unit No	Not applicable
Street / Lot – Lower No.	Lot 03952 Town of Sanderson plan(s) S79/149A



Street / Lot – Upper No.	Not applicable
Street Name	Vanderlin
Street type (road, court, etc)	Drive
Street suffix (North, South etc)	Not applicable
Suburb	Holmes
Postcode	0812
GIS Coordinate of Site centroid	GDA94
Latitude	-12.383017
Longitude	130.924963
Members and categories of support team utilized	Under direction from the Auditor, William Dillon (Environmental Scientist) and Teresa Klingelhofer (Environmental Engineer) provided audit support, including assisting with the review of the completed Construction Quality Assurance report. The Auditor also obtained expert geotechnical and geosynthetics advice from Fook Chi Soo (Senior Engineer) and Prathama Igor (Associate Engineer) of ATC Williams Pty Ltd with regard to design variation requests and non-conformances, where required.
Further Work requirements	It is the Auditor's opinion, based on quality control measures implemented during the works in accordance with the approved design documents, and reporting thereof, that the landfill Stage 3 and 4 Cap has been constructed in general accordance with the approved design documents and is suitable for irrigation with treated leachate. Future management of the cap, including leachate irrigation and ongoing aftercare management are to be undertaken in accordance with any relevant NT EPA Environment Protection Approvals and City of Darwin management and monitoring plans relevant to the Stage 3 and 4 cap.
Nature and extent of continuing risk	As determined in the Auditor's risk assessment in Section 6.1, the residual risk associated with the design variations implemented during construction works are considered to be low and acceptable. Based on the Auditor's appraisal of the construction works and having given due consideration to relevant environmental values of the environment, the Auditor concludes that taken together, the design and construction of Stage 3 and 4 cap has not resulted in any unacceptable risk of any possible harm or detriment to the environment. The



	Auditor's conclusions regarding the nature and extent of continuing risk are presented in Sections 6 and 7 .
Outcome of Audit	The outcome of this Audit is confirmation that the new landfill Stage 3 and 4 Cap at the site has been constructed in accordance with NT EPA endorsed design documents (inclusive of Auditor approved design variations), and the requirements of the NT EPA Publication <i>Guidelines for the siting, design, and management of solid waste disposal sites in the Northern Territory</i> (January 2013). Specific details of the Auditor's assessment of compliance with the relevant conditions of the Environment Protection Approval #EPA321-02 are documented in Section 7.1 of this Audit report. This conclusion should be read in conjunction with the Audit report, the statement of limitations in Section 8 and the recommendations provided in Section 7.3.

Based on the Audit of the Construction Quality Assurance (CQA) Report (refer to **Appendix E**), together with independent observations of construction activities by the Auditor and Auditor representatives, the Auditor considers the construction of the Stage 3 and 4 cap has been conducted in general accordance with the NT EPA approved design, and the requirements of NT EPA Publication *Guidelines for the siting, design, and management of solid waste disposal sites in the Northern Territory* (January 2013) as per the Environmental Protection Approval (EPA321-02).

Whilst there have been some departures from the Design Specifications and CQA requirements, these have been given due consideration and the conclusion reached that such departures do not impact on the overall construction quality and functioning of the Stage 3 and 4 landfill cap.



1 Introduction

The Shoal Bay Waste Management Facility (Darwin Landfill) currently operates under Northern Territory Environment Protection Authority (NT EPA) Licence EPL 188-03 issued to City of Darwin (Council). Council received Environmental Protection Approval (EPA321-01) from the NT EPA providing approval relating to the construction of the Stage 3 and 4 cap at the Shoal Bay Waste Disposal Facility (the 'site'), with a commencement date of 11 May 2021. EPA321-01 was superseded by EPA321-02 issued 11 May 2023 with no change apart from the expiry date. Environmental Protection Approval EPA321-02 is provided in **Appendix A**.

EPA321-02 (Condition 47) required that the construction of Stage 3 and 4 cap be reviewed by a Qualified Person (Environmental Auditor). The NT EPA has approved persons (i.e., 'Qualified Persons') who are accredited under either the New South Wales Site Auditor Scheme (NSW) or the Victorian Environmental Auditor Scheme (Victorian EPA) as a class of persons suitable to undertake Environmental Audits in the Northern Territory (NT) in accord with Part 6 of the NT's Waste Management and Pollution Control Act. The appointed Auditor (Stephen Cambridge) is therefore a Qualified Person able to undertake this Audit.

On 23 July 2021, Mr Stephen Cambridge, an Environmental Auditor in Victoria appointed pursuant to the *Environment Protection Act 2017*, was engaged as a Qualified Person by Mr Mathew Vittuci of City of Darwin to conduct an environmental audit of Stage 3 and 4 construction works (the works) at the Shoal Bay Waste Disposal Facility (Darwin Landfill) at Vanderlin Drive, Holmes, Northern Territory (Refer **Figure 1**, attached). It should be noted that since Auditor engagement, the Council representative Mathew Vitucci has departed from Council and the Council representative is now by Mr Nik Kleine, Executive Manager of Infrastructure.

The Auditor provided a notification and Audit Scope in compliance with EPA Approval EPA321-02 to Council on 29 July 2021. Council provided the Audit Scope to the NT EPA, who subsequently reviewed the Audit Scope and requested updates to the Audit Scope to address Condition 48 of EPA321. The Auditor issued an amended Audit Scope on 9 November 2021 to Council who in turn issued it to NT EPA. This Final Audit Scope is included in **Appendix B**.

Design documentation for Stage 3 and 4 cap construction including the Drawings, Technical Specifications, and Construction Quality Assurance (CQA) plan are included in Appendix B of the CQA Report which is included in **Appendix E** of this Audit report. Collectively, these 'Design Documents' were prepared by Golder Associates Pty Ltd (now WSP-Golder). It is noted that the Drawings have been updated to reflect the main Design Variations approved by the Auditor during the cap construction works.

The Auditor review of the design documentation for the Stage 3 and 4 cap construction, and design declaration to NT EPA, was completed by Mr Anthony Kortegast of Tonkin & Taylor Pty Ltd. NT EPA subsequently approved the design documentation in the form of the Environmental Protection Approval EPA321 (now EPA321-02).

In accordance with the *Waste Management and Pollution Control Act 1998* (WMPC Act), the NTEPA EPA321-02, and the *Water Act 1992*, this Audit report provides Auditor assessment of compliance of the works undertaken in accordance with the NT EPA approved Design Documents.



1.1 Objectives and Requirements of Environment Protection Approval #EPA321-02

The scope of the audit in relation to NT EPA Approval EPA321-02 is in relation to Conditions 47 to 50, which are presented below. It should be noted that EPA321-02 is an update of the original approval EPA 321, as EPA321-01 and EPA321-02 were updated by NT EPA to remove a Condition and as such the Condition numbering stated in the Audit scoping letter (**Appendix B**) do not align with the updated condition numbers (within EPA321-02) as stated below:

- Condition 47 The approval holder must undertake, on completion of the activity, an environmental audit by a qualified person to evaluate the extent to which compliance has been achieved with this approval.*
- Condition 48 The approval holder must submit the proposed scope for the environmental audit no later than 20 business days prior to the proposed commencement date of the environmental audit (which must be specified when the proposed scope is submitted), to the NT EPA for review and approval.*
- Condition 49 The NT EPA may require the approval holder to revise or amend and resubmit any proposed scope for an environmental audit. Where the NT EPA requires the environmental audit scope to be resubmitted, the approval holder must submit it to the NT EPA by the date specified by the NT EPA.*
- Condition 50 The approval holder must submit to the NT EPA, at completion of the activity, a review of the completed activity with certification from a qualified person(s) that the works conducted:*
- *50.1 were constructed in accordance with the plans provided in condition 27 (CQAP) or as revised under condition 18; and*
 - *50.2 'as constructed' will deliver the required outcomes as prescribed in condition 13.*

Additionally, the Audit Scope included assessment of City of Darwin and the Construction Contractor's works with respect to compliance with operational items (e.g., noise, dust, odour, sediment control, etc.) related to the construction works. This included assessment of operational items conforming to the Construction Environmental Management Plan (CEMP or EMP) related to capping construction of Stage 3 and 4 as required by Condition 19 of EPA321-02:

- Condition 19 Prior to commencing the activity, the approval holder must develop and provide to the NT EPA a CEMP for the activity that identifies potential environmental impacts associated with the activity and mitigation measures to be implemented to reduce the environmental impacts.*

An updated Audit Scope including this item was provided by the Auditor to City of Darwin on 9 November 2021, who in turn provided the updated Audit Scope to NT EPA.

The work conducted constitutes an environmental Audit of any possible harm or detriment to the environment caused by the manner in which the new cap construction works have been undertaken and completed. Compliance with the relevant Conditions noted above, is documented in **Section 7.1**.



1.2 Scope of Works

The scope of the Audit was confirmed in EHS Support letter dated 9 November 2021, as included in **Appendix B**. The location of Stage 3 and 4 of the Shoal Bay Waste Management Facility is presented in **Figure 1-1**, below. This Audit is limited to the construction of Stage 3 and 4 only. Detailed design drawings are included in Appendix A of the Construction Quality Assurance Report (see **Appendix E** of the Audit report).

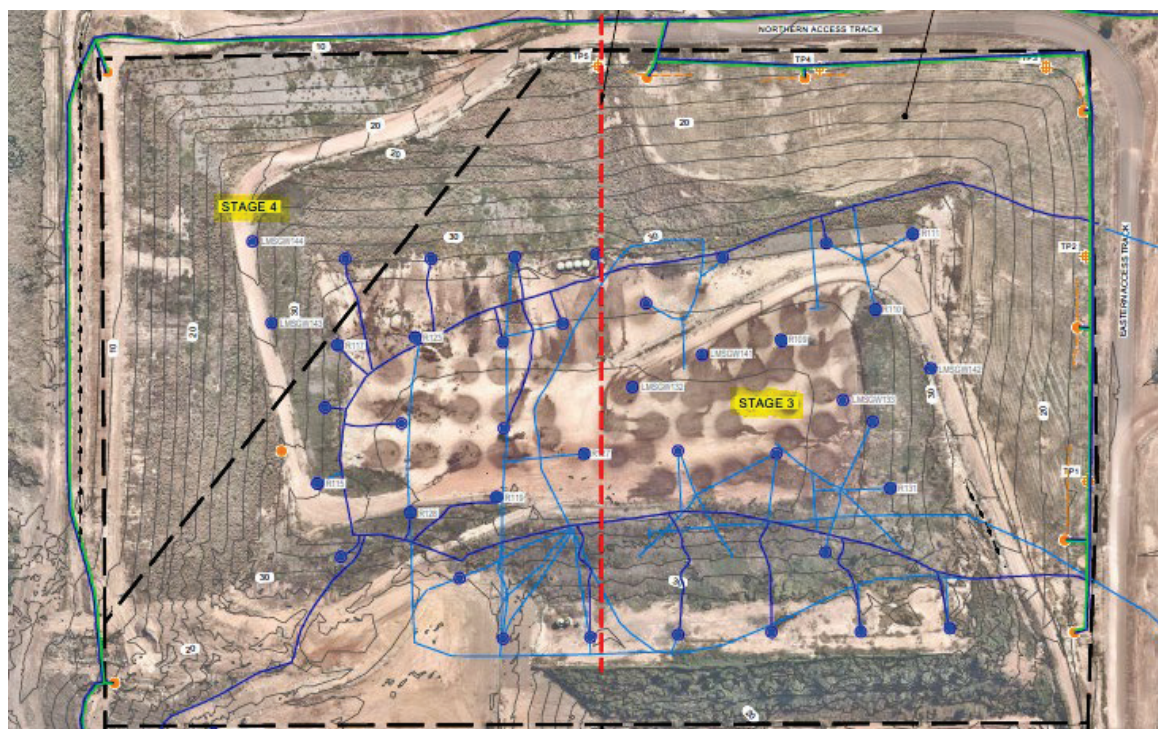


Figure 1-1 Shoal Bay Landfill Stage 3 and 4 Layout Plan (Golder, Drawing 002 Extract, 2021)

The scope of work for the Audit of the cap construction works has followed the guidance provided in EPA Approval 321-02 which refers to NT EPA Publication *Guidelines for the siting, design, and management of solid waste disposal sites in the Northern Territory* (January 2013). The scope of work comprised:

- Review of and familiarisation with the EPA approved construction drawings, technical specifications, and CQA Plan.
- Consideration of the design verification of the approved technical specification and CQA plan.
- Appraisal of material acceptance testing data and confirmation that the materials conform to specification.
- Monitoring of construction progress via regular meetings with the Superintendent and Geotechnical Independent Testing Authority (GITA)/CQA representative and conducting periodic site inspections at key milestones.
- Recording observations and results of progressive CQA data and providing feedback to Council including approval and hold point release of works completed at key milestones.
- Review of all reports, measurements and other data provided as output from the implementation of the CQA Plan.
- Review of all other records and/or management systems relevant to the construction of the cap.



- Conduct an assessment of the risk of any possible harm or detriment to the environment caused by the manner in which the cap has been constructed and completed, including any Design Variations or Non-Conformances during the works.
- Preparation of an Interim Audit Report and this Final Audit Report.

1.2.1 Stage 3 Interim Audit

An interim audit relating to the Stage 3 area of the cap was completed and submitted to the EPA in October 2022 (EHS Support, 2022). The Stage 3 Interim Audit Report was considered a requirement to allow Council to irrigate treated leachate over the Stage 3 cap area in accordance with Condition 16 of Environment Protection Approval EPA304-01 (an approval for commissioning a leachate treatment plant and irrigation area at the site), in advance of completion of the remainder of the capping works.

Along with the Stage 4 area, a number of features were excluded from the Stage 3 interim audit as construction was still underway at the time of the Stage 3 Interim reporting. These included the passive landfill gas depressurisation system, subsurface water management, and access track and perimeter stormwater management. These features have since been constructed allowing this final audit report to be completed encompassing the Stage 3 and 4 cap.

1.3 Design Documents, Audit Criteria, and Guidelines

The Audit criteria used, to ensure that the objectives of the audit have been met, have been sourced principally from the EPA approved construction drawings, technical specification and CQA plan proposed for the works. Collectively these documents, taken together with the specified construction standards and quality assurance methods prescribed in the *Guidelines for the siting, design, and management of solid waste disposal sites in the Northern Territory* (NTEPA, January 2013), provide the primary sources of construction requirements and quality checks relevant to the project. These key documents comprised:

- Design Documents for Stage 3 and 4 cap construction:
 - Golder Associates Pty Ltd (April 2021). *“Shoal Bay Waste Disposal Facility, Stage 3/4 Capping Detailed Design Report”*, submitted to City of Darwin, ref. 20145676-012-R-Rev1.
 - Golder Associates Pty Ltd (August 2021). *“Technical Specification, Shoal Bay Waste Disposal Facility, Stage 3/ Stage 4 Capping Project”*, submitted to City of Darwin, ref. 20145676-014-S-Rev3 (refer Appendix B in CQA Report).
 - Golder Associates Pty Ltd (December 2020). *“Construction Quality Assurance Plan, Shoal Bay Waste Management Facility Stage 3/Stage 4 Capping Project”*, submitted to City of Darwin, ref. 20145676-016-R-Rev0 (refer Appendix B in CQA Report).
 - Golder Associates Pty Ltd (September 2021). *“Shoal Bay Waste Disposal Facility: Stage 4 / Stage 4 Capping - Issued For Construction (IFC) Drawings”*, submitted to City of Darwin, ref. 20145676-013-T-Rev5 (refer Appendix A in CQA Report).
 - EPA design approval provided in EPA321-02.
 - Tonkin and Taylor Pty Ltd (December 2020) *“Design verification Report, Shoal Bay Landfill Cap Design Verification”*, ref 1014301.v1.
- NT EPA (January 2013). *Guidelines for the siting, design, and management of solid waste disposal sites in the Northern Territory*.



The Auditor also referred to the Victorian EPA Audit guidance, specifically:

- Guidelines for Conducting Environmental Audits (EPA Publication 2041).
- Landfill Licensing guidelines (EPA Publication 1323.3).
- Best Practice Environmental Management Guideline for the Siting, Design, Operation and Rehabilitation of Landfills (EPA Publication 788.3).

A number of other guidance documents also set out environmental compliance requirements and performance criteria for landfill construction and/or management. These were also referred to in the audit process and included:

- Geosynthetic Research Institute (GRI) – GCL3 “Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCL)”, 26 July 2010.
- GRI – GT12 (a) “Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials”, 18 February 2002.
- Standards Australia (2007) “Guidelines on Earthworks for Commercial and Residential Development”, (AS 3798-2007).

With the additional scope of auditing the operational items of the construction works, the following documents, issued to and accepted by the NT EPA have been referred to:

- DTA Contractors (October 2021). *Construction Management Plan - Construction of stage 3-4 Cap at Shoal Bay*, submitted to City of Darwin (refer **Appendix F**).
- DTA Contractors (August 2021). *Health, Safety and Environmental (HSE) Management Plan - Construction of Stage 3-4 Cap at Shoal Bay*, submitted to City of Darwin (refer **Appendix F**).

Any additional references used by the Auditor are listed in **Section 9**.

1.4 Stakeholder Involvement

During the course of the Stage 3 and 4 construction Audit, the Auditor consulted with the following stakeholders:

- NT Environment Protection Authority (provision of Audit scopes and Design Variations via Council);
- City of Darwin Council, including their consultant advisors, as the Licence Duty Holder and Principal;
- WSP-Golder Associates Pty Ltd as the Designer, Superintendent, GITA and CQA officer; and
- DTA Contractors Pty Ltd as the Earthworks Contractor.

1.5 Auditor Independence

The Auditor and EHS Support have been involved in the following works at the landfill:

- Cell 6 landfill liner construction Audit in accordance with EPA272, which was completed in February 2021;
- Auditor review of the Integrated Leachate Management Program (site wide) in accordance with EPL188 Condition 88 and 89;
- Auditor review and verification of the Irrigation Management Plan for the Stage 3 and 4 cap, in accordance with EPA321 Condition 40 and 41; and
- Section 48 Landfill Operations audit completed in December 2023.

The Auditor was not involved in any aspects of the design of the Stage 3 and 4 landfill cap. The Auditor considers that no Conflict of Interest exists with the current Stage 3 and 4 Construction Audit and the previous Auditing roles listed above.



2 Site Details

The following site details have been primarily obtained from the Stage 3 and 4 Detailed Design Report (Golder, 2021) and Conceptual Site Model (URS, 2016). Only those site details relevant to the Stage 3 and 4 Construction Audit are included in this section.

2.1 Site Location and Details

The site is located on Shoal Bay Access Road (off Vanderlin Drive) Karama, NT and operates as a municipal waste resource recovery and disposal site operated by the City of Darwin. The site services both domestic and commercial customers in the Darwin area. It operates under NT EPA Licence 188-03.

The site is approximately 12 km north east of Darwin city within Lot 3952, Town of Sanderson. It is leased by City of Darwin from the Commonwealth Department of Defence. The operational area of the Shoal Bay Waste Management Facility is located within the southern part of the property and is bound to the north and east by floodplains, wetlands, and mangrove of Leanyer Swamp, to the south by Holmes Jungle Nature Reserve and to the west by bushland. The nearest residential area is the suburb of Karama ~700m to the south west.

Under the terms of the lease the property is designated as a Waste Management Project Area in which City of Darwin is authorised to conduct waste management and ancillary activities. The landfill is licensed to act as an operating premises for the disposal of waste by burial, that service, or are designed to service, the waste disposal requirements of more than 1,000 persons. The landfill includes Stages 1 to 6. Active waste filling is understood to be currently undertaken within Stage 6.

2.2 Topography and Stormwater

Topography across the site and surrounds is generally flat, with onsite stormwater flowing west to east. Stormwater from surrounding Stage 3 and 4 has been upgraded and stormwater is directed into existing stormwater channels along the west, north, and eastern perimeters of Stage 3 and 4, which subsequently drains to the east and west of the site.

The Stormwater, Erosion and Sediment Management Plan (Shoal Bay Waste Management Facility Environmental Management Plan, June 2016) describes how each category of water is managed at the site. Sediment laden stormwater is managed onsite via control measures preventing the release to the environment via rock dams, silt fences, mulch, hydro mulch, and diversion bunds/drains.

2.3 Climate

According to Bureau of Meteorology (BOM) (Darwin Airport Station ID 014015), the average annual rainfall is 1,726.9 mm and the average annual evaporation is 2,445.5 mm (based on average daily evaporation is 6.7 mm). Rainfall at Darwin is distinctly seasonal (wet and dry seasons) with the far majority of rainfall occurring in the wet season (nominally November through to March), as presented on the following BOM long term mean rainfall graph for Darwin Airport.

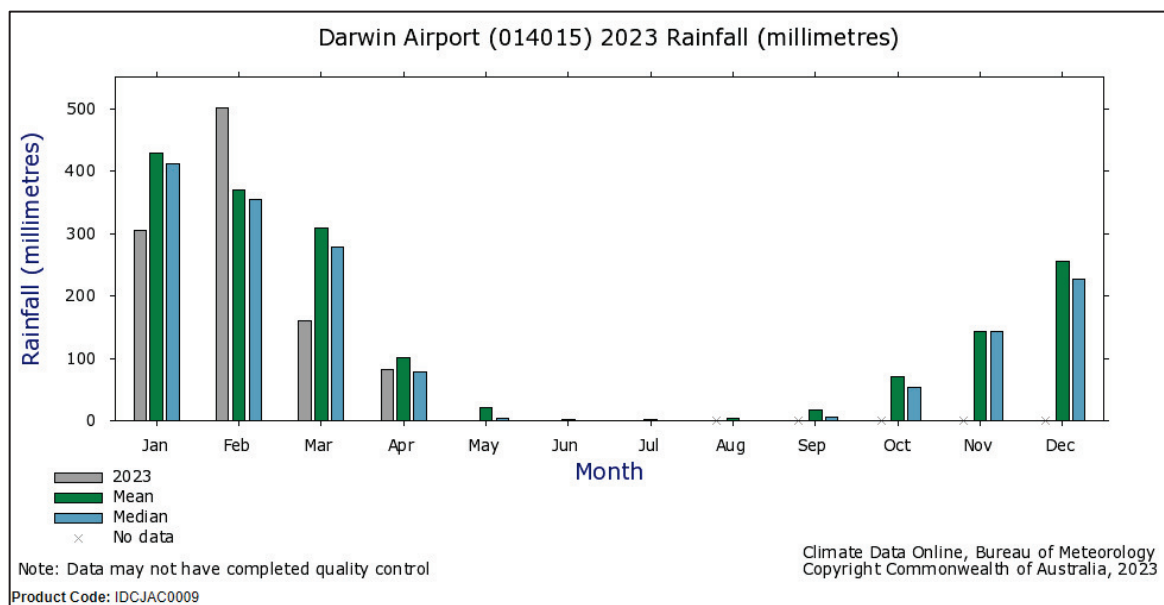


Figure 2-1 Darwin Airport Long Term Mean Rainfall (1941 to 2023)

2.4 Geology

The geological water resource maps of Darwin (Sheet 5073) indicates the presence of Quaternary unconsolidated sand, clayey sand, ferruginous clayey sand at the site, underlain by the Orosirian Burrell Creek formation. Site geology, as described by URS (2016), was found to be topsoils (silts and clays), generally underlain by weathered siltstone, with claystone encountered east of Stage One. Sandstone was encountered at approximately 9 to 20 metres below ground surface (mbgs) across the site. No karst or limestone strata was encountered in the URS investigation.

2.5 Hydrogeology

According to URS (2016), groundwater within the area as detailed in the 1:100,000 Water Resources Map of Darwin, (Sheet 5073), indicates Total Dissolved Solids (TDS) concentrations less than 1,000 mg/L are expected in the vicinity of the site; however, the results of historical investigations at the site indicate highly variable groundwater quality exists at the site with salinities ranging from fresh to hypersaline.

Groundwater levels recorded on site (URS, 2016) indicate variable water table gradients with groundwater depths indicative of upward hydraulic gradient north east of Stage 2 and downward hydraulic gradient in the centre of the site between Stages 1 and 2. The groundwater level data indicated that groundwater may be preferentially flowing through one or more of the lateritic materials and the weathered bedrock.

The high variation in rainfall between wet and dry seasons results in large seasonal fluctuations in groundwater levels under the site.



3 Conduct of the Audit

3.1 Parties Involved

Table 3-1 provides a list of parties involved in the construction of the capping works.

Table 3-1 Summary of the Organisations Involved in the Audit

Role	Organisation	Key Personnel
Principal	City of Darwin Council	Nik Kleine
Principal's advisor	Waste and Management Services Pty Ltd	Geoffrey Webster
Superintendent	WSP-Golder Associates Pty Ltd	Iwan Owen
Cell Designer	WSP-Golder Associates Pty Ltd	James Begg Fred Gasner Sven Waurwich
Auditor responsible for cell design review	Tonkin & Taylor Pty Ltd	Tony Kortegast
Environmental Auditor for cap construction works	EHS Support Pty Ltd	Stephen Cambridge and support team including staff from EHS Support, ATC Williams and EcOz
The Contractor performing the site preparation, subgrade, lining system and associated stormwater management works construction (Contractor)	DTA Contractors Pty Ltd	David Divilly
GCL and Geotextile Installer	Kenviro Pty Ltd (2021) DTA Contractors Pty Ltd (2022)	Various personnel
Pipe installer	DTA Contractors Pty Ltd	Various personnel
Level 1 Inspection and Testing contractor (the GITA) and CQA Consultant	WSP - Golder Associates Pty Ltd	Jack Norman and Meggan Brown
Geotechnical Testing Authority – field and laboratory testing necessary under the QA requirements for the clay liner construction.	Douglas Partners Pty Ltd	Various personnel
GCL, geotextile, reinforcement geogrid and geotextile Independent Testing Authority	TRI Australia Pty Ltd	Warren Hornsey
Filter Geotextile (Unit 5) Manufacturer Geocomposite (Unit 11) Manufacturer LFG Panel Drain (Unit 12) Manufacturer	Geofabrics	-
Coated GCL (Unit 7A) Manufacturer	Naue Asia	-
Reinforcement Geotextile (Unit 8) Manufacturer	TenCate Industrial Zhuhai Co., Ltd	-
Surveyor (licensed)	FYFE Earth Partners	-



3.2 Auditor Support (Expert and Other)

Under direction from the Auditor, the following Audit support was provided to the Auditor as part of the works:

- William Dillon (Environmental Scientist of EHS Support) provided audit support, including assisting with the review of the completed Construction Quality Assurance report.
- Teresa Klingelhofer (Environmental Engineer of EHS Support) provided audit support.
- Chris Pratt (Senior Environmental Scientist of EHS Support), provided audit support, undertaking a site visit on behalf of the Auditor during Covid-19 travel restrictions.
- Prathama Igor (Associate Engineer of ATC Williams Pty Ltd) provided audit support, undertaking a site visit on behalf of the Auditor during Covid-19 travel restrictions.
- The Auditor obtained expert geotechnical and geosynthetics advice from Fook Chi Soo (Senior Engineer) of ATC Williams Pty Ltd with regard to design variation requests and non-conformances where required.
- The Auditor engaged EcOz Pty Ltd to undertake site inspections for operational compliance during the wet season.

3.3 Activities Undertaken

The Audit was conducted using a staged approach comprising pre-construction review; construction monitoring via site visits/observations and progressive review of reported CQA data; and Audit Reporting.

The Audit team undertook the following site inspections during the construction works, including:

- 1) Earthworks construction (20 - 21 September 2021);
- 2) Geosynthetics construction (1 - 3 November 2021);
- 3) Operational controls inspection (e.g., sediment controls) by EcOz (22 December 2021);
- 4) Operational controls inspection (e.g., sediment controls) by EcOz (28 January 2022);
- 5) Earthworks and geosynthetics construction (1 - 2 June 2022);
- 6) Ongoing inspection of Stage 3/geosynthetics construction on Stage 4 (8 - 9 August 2022); and
- 7) Vetiver grass establishment over Stage 3/geosynthetics construction on Stage 4 (18 - 19 October 2022).

Table 3-2 provides a description of the activities completed by the Auditor and his support team during the audit.



Table 3-2 Summary of Audit Activities

Stage	Activity
Pre-construction	- EPA notification by Council of Auditor appointment. - Familiarisation of design documents including specifications, CQA Plan and drawings. - Communication and meetings with the client and earthworks contractor with regards to hold point inspection by the Auditor, including addressing Auditor expectations in terms of the construction, CQA processes and reporting.
Construction monitoring and related activities	- Review of subgrade and cover soil data, geosynthetic materials, MQA data, and geosynthetic materials independent Quality Assurance (QA) compliance test report. - Assessing design variations/non-conformance reports and reporting to Council/NT EPA. - Site visits were conducted during construction works to appraise construction activities and application of appropriate construction and CQA methodology (as per project documentation). - Provision of advice regarding site observations and various construction related issues including changes that emerged during the works program. - Approvals at nominated hold points during construction based on review of construction Quality Control (QC) data supplied by the appointed GITA and/or CQA consultant. - On-going liaison with Council, Superintendent and GITA/CQA Consultant.
As-built Data Review	- Construction Quality Assurance Report prepared by WSP-Golder. - Survey plans prepared by FYFE Earth Partners (licensed surveyor), included within the CQA Report.
Reporting	- Preparation of an Interim Audit report, for Stage 3 area. - Preparation of this Final Audit report.

3.4 Auditor Hold Points Required by Specification

Hold Points are specified for Stage 3 and 4 Landfill Cap Construction in the Technical Specification – Appendix B of the CQA Report (**Appendix E**).

The Technical Specification states that:

“a hold point is a mandatory verification point beyond which the Contractor shall cease work at the completion of identified items, and on any related or dependent items, until the Hold Point is released in writing by the Superintendent. Release of Hold Points shall be dependent on the Contractor providing the required information to the satisfaction of the Superintendent, GITA and the Environmental Auditor as required by the Hold Point.”

The Hold Points for Stage 3 and 4 are summarised in **Tables 1 to 12** attached.

3.5 Summary of Site Visits Completed

This section of the Audit report has been structured to include capping construction inspections (**Section 3.5.1**) and inspections of environmental controls during the wet season when capping works were on hold due to weather conditions (**Section 3.5.2**). The Auditor also appraised the environmental operational controls as part of the capping construction inspections, however only the operational aspects (such as sediment controls) were inspected during the wet season and therefore these inspections are discussed separately in **Section 3.5.2**.



3.5.1 *Capping Construction Inspections*

The Audit team undertook site inspections during key construction milestones, including:

- 1) Earthworks construction (20 - 21 September 2021);
- 2) Geosynthetics construction (1 - 3 November 2021);
- 3) Earthworks and geosynthetics construction (1 - 2 June 2022);
- 4) Inspection of Stage 3 / and progressive geosynthetics construction on Stage 4 (8 - 9 August 2022); and
- 5) Vetiver grass establishment over Stage 3/ geosynthetics construction on Stage 4 (18 - 19 October 2022).

The construction phase site inspections conducted by the Auditor's and Auditor's representatives are detailed below; relevant photographs taken during these visits can be found in **Appendix C**.

Regular meetings with the Principal, Superintendent, GITA/CQA, and Auditor were held throughout the construction period to discuss updates of construction, approvals, and any issues encountered. Meetings were generally held on a fortnightly basis during construction or at more regular intervals if issues were encountered.

3.5.1.1 20 - 21 September 2021

An initial site visit was completed by the Auditor's representative (Chris Pratt) between 20 and 21 September 2021. The following was noted from the inspection:

- Subgrade preparation works (including compaction) were taking place across the top and batters of the Stage 3 cap area (Photo 3).
- Anchor trenches were being excavated across the Stage 3 area and being backfilled with temporary Unit 1 Fill material (Photo 1).
- Unit 1 material was being placed along the toe of Stage 3 along with leachate collection pipework (Photo 2).
- Unit 7A Coated GCL rolls were stored appropriately within tarpaulins and elevated within a hardstand area north of the Stage 3 cap (Photo 4).
- The Unit 1 borrow pit was observed (onsite).

3.5.1.2 1 - 3 November 2021

Site inspections were completed by the Auditors representative (Prathama Igor) between 1-3 November 2021. The following was noted during the inspection:

- Installation of the geocomposite drain with leachate collection pipe and 20/40mm aggregate and Unit 7A Coated GCL was being undertaken on the toe area of the northern batter (Photo 10).
- Unit 1 placement along the toe of the eastern batter of stage 3 (Photo 11).
- Sump 1 excavation and Sump 2 installation with leachate pumping (Photo 13).
- The Unit 7A Coated GCL was being installed with the leading edge covered builders' plastic.
- The Unit 8 Reinforcing Geotextile (overlying the Unit 7A coated GCL) had been installed over the south eastern and northern portion of Stage 3 (Photo 5).
- The mid slope anchor trench along the northern and eastern benches of Stage 3 were partially backfilled with cement stabilised sand (Photos 6 - 8).
- Passive Unit 12 landfill gas panel drains were being installed across Stage 3.
- Subgrade preparation and maintenance across exposed area of Stage 3 prior to geosynthetics placement (Photo 9).



- Geosynthetics roll storage was being conducted in accordance with the Specification.
- Unit 1 and Unit 2 stockpiled material (Photo 12).
- Rain was noted on 2 November 2021 and minor areas of the Unit 7A coated GCL along the eastern batter were noted to be hydrated and in need of repair.

3.5.1.3 1 - 2 June 2022

A construction site visit was completed by the Auditor between 1 and 2 June 2022. The following was noted during the inspection:

- Preparation of subgrade prior to geosynthetics placement was being undertaken with smooth drum proof rolling taking place over Stage 4 (Photos 15 - 16):
 - Minor deflection and divots were noted during proof rolling; however, these were deemed acceptable by the GITA and suitable for overlying Unit 7A placement.
- Placement of Unit 7A Coated GCL over the plateau of the Stage 3 cap (Photo 18):
 - Placement of Unit 7A layer was occurring downslope with compliant panel overlaps (> 0.3m) and textured/coated side facing upwards.
 - Strips where taping of joins were being cleaned prior to taping.
- Placement of Unit 2 second layer on the northern slope of stage 3 (Photo 14 and 17):
 - Compaction was being undertaken; the Unit 2 material was observed to be a sandy clay.
- Observation of landfill gas geocomposite drains and panel drains:
 - These areas were noted to be in good condition with the filter geotextile heat bonded to seal the drainage layer from silt.
- Mixing of Unit 2 with mulch in the borrow pit area.
- Hauling fill material onto the southern part of the cap to create a platform for the irrigation pivot system platform.
- Reworking mid-bench platform (access track) due to failed compaction tests.
- Geosynthetic roll storage:
 - Unit 7A coated GCL roll storage was inspected with some rolls observed to have minor water staining – the GITA was requested to inspect these rolls as they were placed with any damage to be removed.
- Vetiver Grass nursery:
 - The vetiver grass was growing within the nursery (growth rate at approximately 150 mm per week was reported).

3.5.1.4 9 - 10 August 2022

An inspection of the Stage 3 - 4 construction was completed by the Auditor's representative William Dillon between 9 and 10 August 2022. The following was noted during the inspection:

- **Stage 3:**
 - The final Unit 2 layer had been placed and Vetiver Grass planted and appeared to be growing over the cap (Photo 22).
 - The pivot irrigation system had been completed with tracks extending across the Stage 3 interim area. (Photo 26).
 - The subsurface Drains were partially installed (Photo 20).
 - Leachate collection sump 2, at the toe of in the northeast section of Stage 3 was operational and pumping leachate (Photo 19).



- **Stage 4:**
 - Preparation of subgrade and placement of Unit 7 coated GCL on north-west hip area (Photo 21 and 22).
 - Unit 11 LFG Strip drain placement throughout Stage 4 (Photo 25).
 - Anchor trenching along midslope bench area at the north-west hip (Type D anchor trench) and discussion of Design Variation DV15 (Photo 24).
 - Anchor trenching along midslope bench of western batter (Type C anchor trench).
 - Trenching and placement of Unit 12 LFG Panel Drain on midslope bench (Photo 23).

3.5.1.5 18 - 19 October 2022

A final inspection of the Stage 3 interim area and Stage 4 construction was completed by the Auditor between 18 and 19 October 2022. The following was noted during the inspection:

- **Stage 3:**
 - Pivot Irrigation system has been setup with concrete pathways laid out (Photo 32).
 - Grasses growing well in established area.
 - Some areas of grass not growing, as pivot irrigation system did not irrigate some areas (Photo 28). May get scouring/erosion in these areas during wet season if grass does not establish.
 - The grasses require about 5mm of water per day for establishment period.
 - Stormwater chute on northern slope under construction (Photo 29). Rocks being placed by hand into wire baskets. Sacrificial GCL is being removed progressively from chute, at direction of Designer due to veneer stability concerns between coated GCL and wire baskets filled with rock.
- **Stage 4:**
 - Soil (Unit 25 and topsoil) placement mostly completed, except areas around access track and near entrance of access track to cap on northern part of cap (Photo 30).
 - LMS (landfill gas contractor) putting in landfill gas collection pipes from active extraction wells to landfill gas collection system.
 - Northern stormwater bund largely installed.
 - Main areas that need completion are the western access road and mid bench on Stage 4 (Photo 31).
- **General Site activities:**
 - Screening Unit 2 material to make Unit 25 material. One stockpile of Unit 25 has tested with less than 30 percent fines and was being retested.
 - Some storage of waste/cover soil from cap subgrade preparation was being stored in the stockpile mixing area. The Contractor was instructed to relocate material into waste cell as soon as was reasonably practicable.
 - Sediment run-off with rainfall was being directed to stormwater basin in north-western part of site. No apparent stormwater run-off from the site was observed.
 - No significant amounts of exposed waste were observed in the areas remaining to be capped.
 - Chemical storage appeared adequate.
 - No dust issues were observed. Due to morning rain, no dust suppression was needed.



3.5.1.6 2023 Inspections

Additional rehabilitation works completed over Stage 4 following the wet season (end of 2022 and beginning of 2023) were completed due to scouring of areas on Stage 4 where vegetation had not established sufficiently prior to the wet season. Inspections of these works were undertaken by Council. These works included rectification of the topsoil and subsoils over areas of Stage 4 where the vegetation had not been established and rectification of stormwater management features along the Stage 4 Ramp. These areas were not able to be completed in time prior to heavy rainfall and the commencement of the wet season. One notable rainfall event occurred between 27 - 28 November 2022 where 168 mm of rain was recorded at the site overnight.

Council provided the Auditor with updates and photographs of the rectification works through email correspondence and virtual meetings throughout the first half of 2023. Photos of the rehabilitation works were included in Appendix K of the CQA Report (WSP/Golder, 2023) (see **Appendix E**). In addition, Council provided a recent drone photograph of the vegetation establishment across the Stage 3 and 4 cap (see Photo 33 in **Appendix C**). This drone photograph indicates that vegetation had established across the whole of the Stage 4 area, including areas where erosion was previously noted. The Stage 3 area appears to have some bare patches where soil can be seen, however this is understood to be due to the slashing of the Vetiver grass after the growing season. The Auditor has previously observed that the Vetiver grass had become well established across the Stage 3 cap area.

3.5.2 *Additional Operational Inspections*

Audit inspections were conducted with specific focus on the environmental controls associated with operational items for the construction works. Operational items were assessed against the Construction Management Plan and Health, Safety and Environmental Management Plan produced by DTA Contractors (refer to **Appendix F**).

The operational inspections (provided in **Appendix G**) are summarised below inclusive of observations, issues and any actions taken.

3.5.2.1 22 December 2021

An inspection was undertaken early in the wet season by EcoZ on behalf of the Auditor. The inspection referred to the erosion and sediment control plan (ESCP) which was implemented by the contractor (DTA) during the wet season. The following was noted during the inspection:

- Stockpiles were not covered, and one stockpile was partially submerged in water holding in the sediment basin.
- All fuels and machinery were being removed from site for the wet season. A purpose-built Dangerous Goods container with an internal bund was to remain on site with old and new oils, coolants, and other fluids.
- Inspection of the northern and eastern toe of the Stage 3 and 4 capping showed no evidence of leachate leakage. The leachate pumps in the collection wells were reported to be functioning correctly and there was no evidence of wells overflowing.
- An erosion control measure that had been implemented was the application of soil binder (Vital Bon-Matt Stonewall 20 percent mix). This was applied mid-December but did not always have the required curing time (one hour) before it rained on site.



- There was a very heavy rainfall event the day prior to the inspection (79 mm in a short period of time on 21 December 2021). Early wet season rain had resulted in extensive rill erosion of the two layers of soil that were part of the capping works. The Auditor notes that this erosion was rectified when the contractor remobilized to site after the wet season.

3.5.2.2 25 January 2022

An inspection was undertaken in the mid-wet season by EcOz with the following noted:

- Stockpiles were still submerged.
- Machinery and fuels had been removed. Dangerous goods container still on site.
- No evidence of leachate leakage along northern or eastern toe of Stage 3 and 4.
- Leachate pumps in collection wells functioning properly with no evidence of overflow.
- No additional soil binder had been applied since initial application mid-December 2021.
- Most areas were still too wet for machinery to access and begin repairs/maintenance.
- Maintenance to the toe and bund on the east and north side was considered possible from the road. Rock check dams needed to be rebuilt.

Observations regarding management of environmental issues and controls were also made as part of the Audit inspections for the cap construction works. These observations were communicated to Council and relevant parties at the time of the inspections.



4 Landfill Cap Design and Design Variations

4.1 Stage 3 and 4 Cap Design

Stage 3 and 4 landfill cap was designed by WSP-Golder and documented in the Technical Specification, CQA Plan, construction drawings as referenced in **Section 1.3** and included in Appendix A (Design Drawings) and Appendix B (Technical Specification and CQAP) of the Construction Quality Assurance Report (included as **Appendix E** to this Audit report).

The cap comprised of the following elements (from top down):

- **Stage 3:**
 - Vegetation (Vetiver grass).
 - Cap stormwater drainage system.
 - Soil capping layer (0.75 m thick soil over reinforcement geotextile).
 - Reinforcing geotextile.
 - Coated GCL.
 - Soil subgrade (300 mm).
 - Network of passive LFG depressurisation strips connected to passive vents.
- **Stage 4**
 - Vegetation (Grass cover).
 - Cap stormwater drainage system.
 - Topsoil (0.25 m thick).
 - Soil capping layer (0.5 m thick soil over reinforcement geotextile).
 - Reinforcing geotextile.
 - Drainage blanket.
 - Coated GCL.
 - Soil subgrade (300 mm).
 - Network of passive LFG depressurisation strips connected to passive vents.

The capping system varies across the northern, eastern, and western areas of Stage 3 and 4 where the cap grades down to ground level. Mid-slope benches with anchor trenches occur along the batters, while along the toe of the northern and eastern batters a leachate interception trench with pipework is present.

The capping system constructed for Stage 3 and 4 is presented in **Figure 4-1** and **Figure 4-2** below.

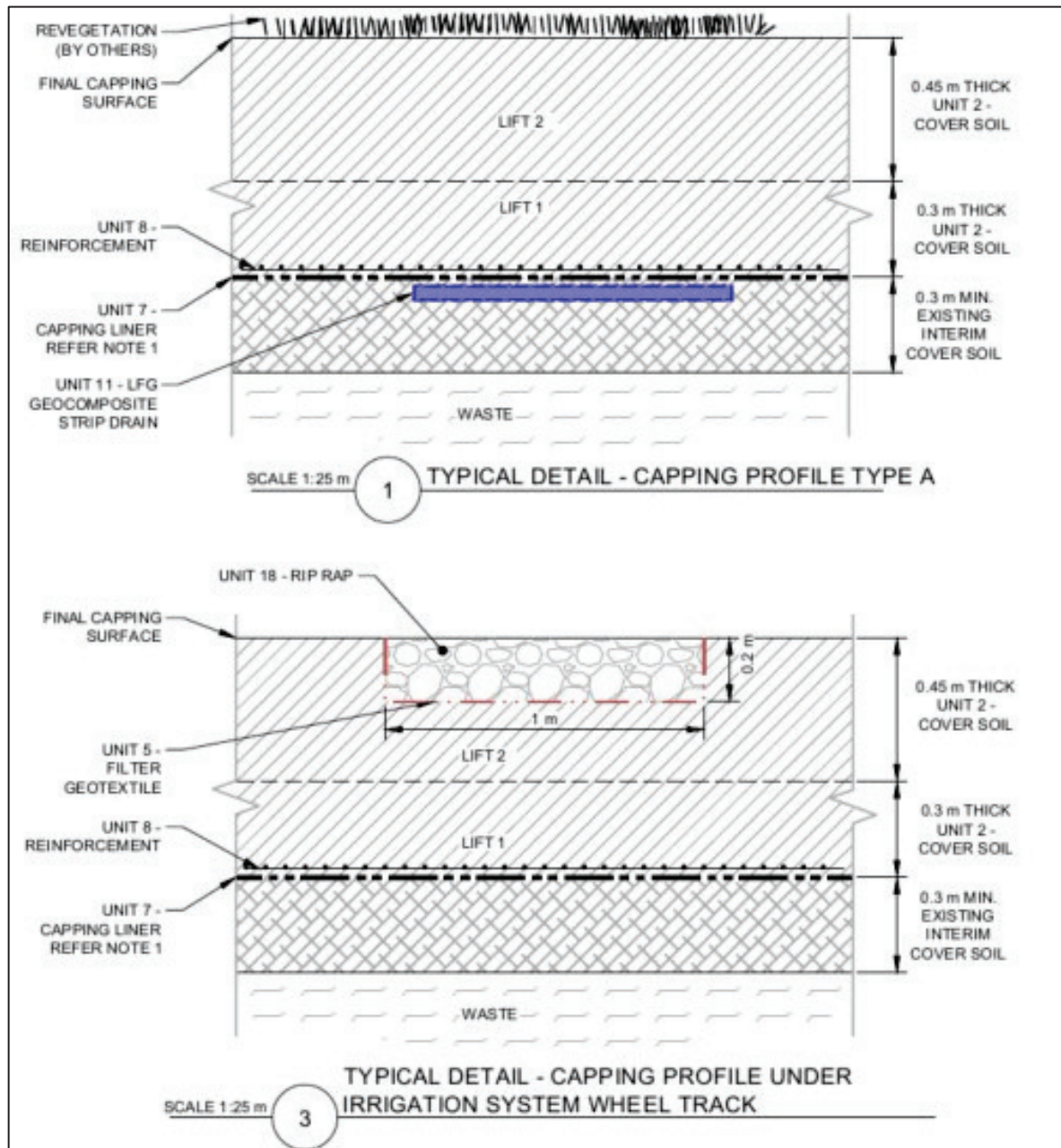


Figure 4-1 Typical Detail for Stage 3 / Type A Cap (Golder Associates, D012, 2021)

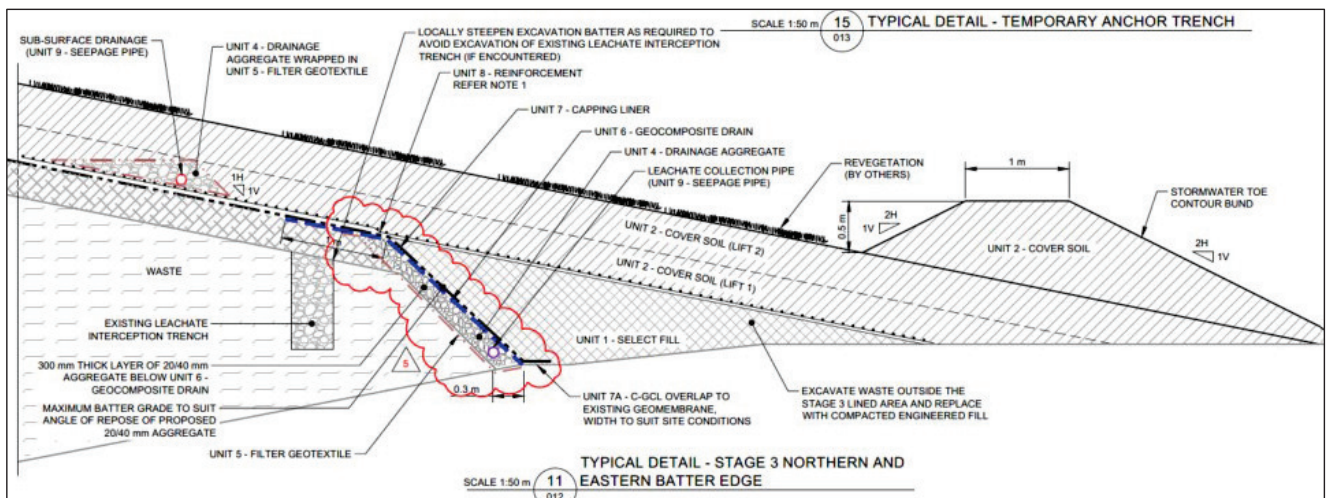


Figure 4-2 Typical Detail for Stage 3 Northern and Eastern Batter Edge (toe) (Golder Associates, D013, 2021)

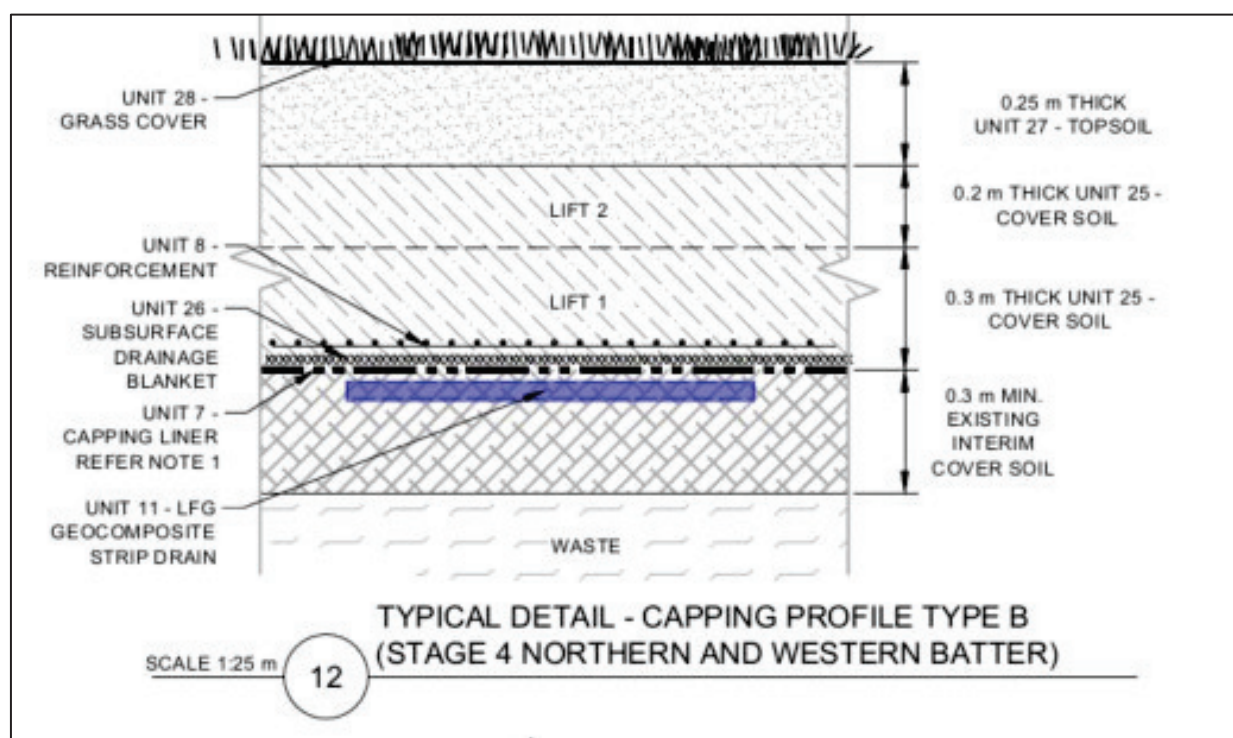


Figure 4-3 Typical Detail for Stage 4 / Type B Cap (Golder Associates, D012, 2021)

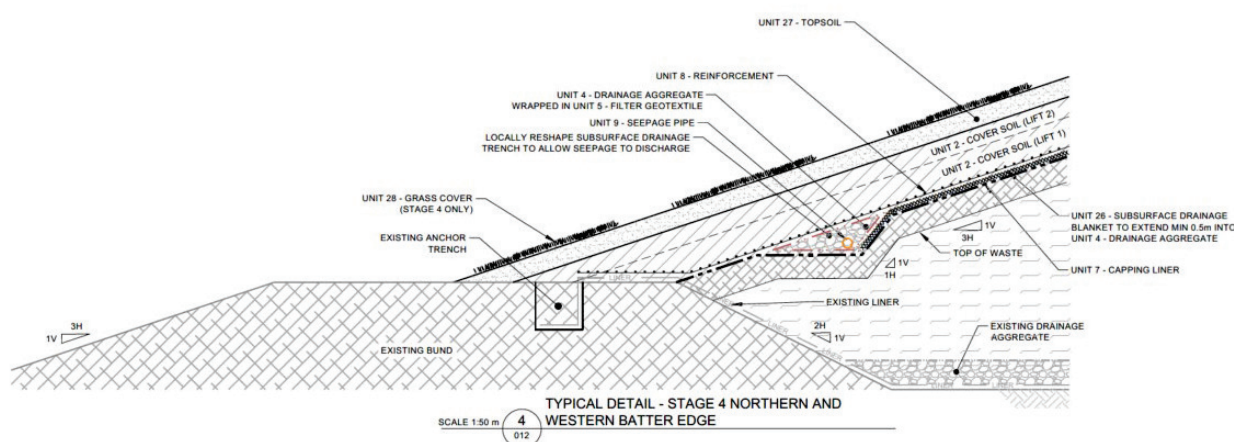


Figure 4-4 Typical Detail for Stage 4 Northern and Western Batter Edge (toe) (Golder Associates, D013, 2021)

The original design was reviewed by a qualified person (Environmental Auditor), Anthony Kortegast of Tonkin and Taylor (Tonkin and Taylor ref 1014301.v1, 23 December 2020) and subsequently approved by the EPA in approval permit EPA321-02 (refer to **Appendix A**).

The Design Verification Auditor (Anthony Kortegast) identified certain elements of the design that posed an increased level of risk and recommendations relating to these, as detailed **Section 4.1.1**, below. These items were approved by NT EPA, based on the Design Verification Auditor's assessment.



4.1.1 Design Auditor Verification

The Auditor design verification report “*Design verification Report, Shoal Bay Landfill Cap Design Verification*” was completed by Anthony Kortegast of Tonkin and Taylor on 23 December 2020 and submitted to EPA. The design was assessed against the following of the guidelines considered applicable to the design of the Stage 3 and 4 cap:

- NT EPA Publication: *Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory*, January 2013 referred to as the Northern Territory Landfill Guidelines (NTLG) in the design report.

Section 7 of the report summarised aspects of the design that may pose a potential risk. It was noted in this section of the report that “aspects of the design present technical challenge in relation to global and veneer stability... exacerbated by the proposal to boom irrigate treated leachate onto the cap surface”.

The design review specified veneer stability challenges the design deals with, and highlighted the following elements:

- The design has incorporated deep anchor trenches to account for relatively high reinforcement loads. The Reviewer highlighted that while conditions to account for the loads have resulted in a conservative design, “they rely on development of tension forces in the reinforcing layer and there is concern that where anchorages are formed in waste, the impact of waste compression may result in uneven development of reinforcement loads”.
- There is a risk of veneer stability issues developing under saturated conditions in steeper areas of the site, particularly until the vetiver grass sward is fully established.
- The potential long-term impact of root development on internal drainage is an aspect that may require future management.

The Reviewer noted that “*the site conditions present significant challenges and to a degree the approach being taken is a large-scale trial. This verification is therefore made in the context of ensuring key technical issues have been adequately addressed, recognizing that the cap design involves a degree of engineering risk that may require repair or reinstatement of cap areas if damage occurs due to weather or other factors*”.

The review concluded with the following recommendations:

- 1) Prior to finalising the design, material-specific interface friction testing is undertaken to confirm the appropriateness of parameters adopted for design.
- 2) The final design package ensures that Construction Quality Assurance processes are fully documented.
- 3) The final design incorporate a review of anchor trench design viability and as necessary a field trial to determine its effectiveness in relation to the reinforcement layer.
- 4) The process of final barrier geomembrane selection should further consider durability and material strength in relation to veneer load transfer and anchor trench design.



The status of these recommendations are described in **Table 4-1**.

Table 4-1 Recommendations from Design Verification Auditor

Recommendation Actions
Recommendations from the Stage 3 and 4 Detailed Design Report (Tonkin and Taylor, 2020) There are a number of considerations and recommendations within the <i>Design verification Report, Shoal Bay Landfill Cap Design Verification</i>, which are directly relevant to the performance of the Stage 3 and 4 cap. These considerations have been extracted from the <i>Design verification Report</i>. The recommendations from the <i>Design Verification Report</i> include: 1) Prior to finalising the design, material-specific interface friction testing is to be undertaken to confirm the appropriateness of parameters adopted for design. 2) The final design package to ensure that Construction Quality Assurance processes are fully documented. 3) The final design to incorporate a review of anchor trench design viability and as necessary a field trial to determine its effectiveness in relation to the reinforcement layer. 4) The process of final barrier geomembrane selection should further consider durability and material strength in relation to veneer load transfer and anchor trench design.
1) Material-specific interface friction testing Material specific interface friction testing was completed and reported as per release of Hold Point #9 in Golder Memo: 21453643-026-M-Rev0, 26 October 2021. (Also refer to Table 1 and 8).
2) Construction Quality Assurance Processes documentation The CQAP is inclusive of all relevant inspection and monitoring, hold points and performance indicators for the construction of the Stage 3 and 4 landfill cap. Compliance of items along with the technical specification and drawings have been assessed in Tables 1 – 12.
3) Review of anchor trench design viability Anchor trench details have been altered from the original approved design with details outlined in DV06, DV09, DV12 and DV15– these have been assessed and approved (refer to Section 4). It is understood that the Designer was satisfied with the final anchor trench design viability, and at the time of the Audit report preparation, the anchor trenches had been suitably constructed.
4) Geomembrane selection This recommendation is not applicable as the Unit 7 GCL (Option 1) was selected by the contractor for the works and as such no geomembrane was used during the construction of the landfill cap.

4.2 Design Variations – Construction Phase

Over the course of the construction of Stage 3 and 4 landfill cap, there were 18 design variations requested. Under the definitions provided in EPA Victoria Publication 1323.3 (Appendix 19), and based on the Auditor's professional judgement, the design variations were generally considered to be minor in nature. The exception being DV01, which was considered a major variation, and involved changing the design of the Stage 4 area to not include Vetiver grass, but conventional grass cover with a sub-surface drainage blanket and overlying soils with higher fines content to promote run-off rather than infiltration.



The design variations were reviewed and approved by the Auditor as detailed below. All design changes were required to be forwarded to the EPA by Council under Condition #18.3 of the EPA Approval (EPA321-02). It is understood that this occurred.

A summary of the Design Variations and the Auditor's assessment of risk for the Design Variations for Stage 3 and 4 are presented in **Table 13** attached. Golder Design Variation documentation is provided in Appendix D of the CQA Report (refer **Appendix E**) and the Auditor approval is provided in **Appendix D**. As part of the Auditor's approval, the Auditor undertook an environmental risk assessment, which is presented in **Table 13** attached. All risks were identified as being 'low' with the exception of two design variations which were identified as being 'medium' risk.



5 Compliance with Specification

5.1 Materials Testing and Construction Compliance

The construction of the Stage 3 and 4 landfill cap was subject to the construction specifications, quality assurance plan, and quality control testing requirements set out in the design documents as listed in **Section 1.3** of the report.

The source of data documenting the construction process for the cell capping works were:

- WSP-Golder Pty Ltd (January 2024). *“Stage 3 and 4 Construction Report, Shoal Bay Waste Management Facility Stage 3/Stage 4 Capping Project”* (refer **Appendix E**).

Data from the Construction Quality Assurance Report was supplemented by the site inspections conducted by the Audit team, and ongoing data review during the construction works.

5.1.1 Auditor Assessment of Compliance with Specification for the Stage 3 and 4 Landfill Cap

The Auditor has undertaken an assessment of compliance with the Specification for materials testing and for the construction works undertaken for Stage 3 and 4 landfill cap. The compliance with the Design Documents has been assessed and the tabulated assessment is included in attached **Tables 1 to 12**. This assessment contains the evidence which the Auditor relied upon to assess compliance with the Specification and commentary on whether the works complied with the Specification. Where deviations from the Specification occurred, the significance of these, with respect to the protection of environmental values of the site, has been discussed in **Section 6** of the Audit report.

The construction of the following construction ‘Units’ has been reviewed (as listed within the CQA Report).

- Task 1 - Subgrade Construction:
 - Select Fill (Unit 1).
- Task 2 - Lateral Leachate Interception System:
 - Drainage Geocomposite (Unit 6).
 - Seepage Pipes (Unit 9) and Solid Wall pipes (Unit 10).
 - Drainage Aggregate (Unit 4).
 - Filter Geotextile (Unit 5).
 - Precast leachate sumps (Unit 22).
- Task 3 - Passive Landfill Gas System:
 - Geocomposite strip drains (Unit 11).
 - Panel Drains (Unit 12).
 - Drainage Aggregate (Unit 4).
 - Filter Geotextile (Unit 5).
 - Passive Vents (Unit 24).
- Task 4 - Geosynthetics Liner Supply and Installation:
 - Coated GCL (Unit 7A).
 - Reinforcement (Unit 8).



- Task 5 – Subsurface Drainage System:
 - Subsurface Drainage Blanket (Unit 26).
 - Seepage Pipes (Unit 9) and Solid Wall pipes (Unit 10).
 - Drainage Aggregate (Unit 4).
 - Filter Geotextile (Unit 5).
- Task 6 – Cover Soil:
 - Cover Soil (Unit 2).
 - Cover Soil (Unit 25).
 - Cover Soil (Unit 29).
 - Pavement Material (Unit 20).
- Task 7 – Surface Water Drainage Structures:
 - Filter Geotextile (Unit 5).
 - Steel Wire Baskets (Unit 17).
 - Rip Rap (Unit 18).
 - Cover Soil (Unit 2/25/29).
 - Select Fill (Unit 1).
 - Concrete (Unit 19).

The Auditor's review of the above items is detailed in attached **Tables 1 to 12** and is considered compliant with the Design Documents or Design Variations, with the exception of the non-compliances listed below in **Table 13** attached. A risk assessment for each of these non-compliances is presented in **Table 13** attached.

5.1.2 Auditor Assessment of Compliance with Condition 19 - Construction Environmental Management Plan (CEMP)

The Auditor has undertaken an assessment of compliance with the approved CEMP for the capping construction works. Assessment of compliance was based on periodic site inspections by the Auditor and the Auditor's support team, including EcoZ who conducted two inspections during the wet season.

Overall, the Auditor considered that Council and the main contractor (DTA) complied with the requirements of EPA321-02 and the approved CEMP, noting the following items:

- Early in the works program, an overflow of leachate from a pump occurred at the toe of the landfill and was contained in a bunded area with the capping footprint, which subsequently drained back into the landfill cell. Council submitted a Non-Conformance report to EPA at the time in accordance with EPA321 Condition 59 requirements. This Non-Conformance report is included in **Appendix G**. The measures that were implemented to prevent a similar incident occurring again were considered to be effective, as no further leachate overflow reportedly occurred during the works.
- Sediment controls were put in place prior to the start of the 2021 wet season. Inspection of these controls during the wet season identified some aspects of the controls which required rectification. These items were rectified by DTA and considered to be adequate to minimise sediment run-off from the cap. Although not all sediment could be prevented from run-off from cap, the Auditor considers that the majority of the sediment was likely to be contained within on-site drains and retention basins, rather than being discharged from site.
- During the Auditor's inspection in June 2022, some operational aspects required attention, including storage of machinery oils in bunded areas, and cover of exposed waste in the Stage 4 area as soon as was reasonably practical. These items were promptly addressed by DTA.



- During the Auditor's inspections, significant dust from the soil on the cap was observed, and despite DTA using a water truck, the dust issues persisted. Dust was not observed to be blown beyond the Licensed site boundary; however, the dust did present challenges for taping of the joins in the GCL. Following hand cleaning of the joins, the GITA/CQA deemed that the taped joins were compliant with the Specification.
- During the Auditor's inspections in October 2022, some storage of waste/cover soil from cap subgrade preparation was being stored in the stockpile mixing area. The Contractor was instructed to relocate material into waste cell as soon as was reasonably practicable.

5.2 As-Built Drawings

The Table below presents a list of As-Built Drawings which verify compliance with the Specification. Copies of these as-built drawings are provided in the Figures attached to the Audit report, as extracted from the Construction Quality Assurance Report including in **Appendix E**.

Table 5-1 As-Built Figures

Figure	Title	Auditor Comment
Survey Plans		
73852-1-SV-AS01-r7 (Subgrade), 04/11/2022	Top of Subgrade	No comments.
73852-1-SV-AS02-r4 (Pipe), 16/11/2022	Leachate Drainage Pipe	No comments.
73852-1-SV-AS03-r4 (Anchor Trench), 21/10/2022	Anchor Trench	No comments.
73852-1-SV-AS04-r4 (Subsurface Pipe), 09/01/2023	Subsurface Drainage Pipe	Also includes drainage blanket extent.
73852-1-SV-AS05-r1 (Stage 3 FSL), 19/12/2022	Finished Surface Level (Top of Unit 2)	No comments. Northern Stormwater Diversion Bund not shown.
Panel Plans		
A3/02 Stage 3 and 4 Passive Gas, 24/10/2022	Unit 11 LFG Geocomposite Strip Drain.=	Noting the change in orientation of the strip drains over the eastern batter as per DV10. Passive Gas Vents locations not shown.
	Unit 12 LFG Panel Drain	No comments.
A3/01 Stage 3 and 4 Capping Plan, 19/09/2022	Unit 7 GCL	No comments.
Untitled	Unit 8 Reinforcement Geogrid Placement Schematic	No comments.

Condition 38 of EPA321-02 required that *'The approval holder must provide clear and legible markers where the polymer coated geosynthetic clay liner has been taped for future integrity inspections'*. The Auditor considers that the GCL as-constructed drawings, combined with the taping of the overlaps with black tape, will provide sufficient information to facilitate the locating of the taped overlaps for future integrity inspections of the GCL overlaps, if required.



6 Assessment of Risk

The Auditor has undertaken an appraisal of risks to the environment associated with the construction of Stage 3 and 4 landfill cap. The potential risks associated with the constructed cap relate principally to possible impacts to groundwater and air (landfill gas) that may accrue as a result of leakage from cap elements. Surface water has also been considered, with respect to the segregation of leachate from surface water, and the risk of impacts from leachate to surface water surrounding Stage 3 and 4.

The Auditor has also undertaken an assessment of risk to the environment associated with design variations and non-conformances identified during this Audit, which is detailed in **Table 13** attached. The risks associated with the design variations and non-conformances were assessed by the Auditor as being generally low, with some medium ranked risks, and no high-risk rankings. The design variations and non-conformances were approved by the Auditor during the construction works, based on the Designer's appraisal of these items, and the Auditor's own risk assessment in accordance with the relevant EPA guidelines.

6.1 Risk to Groundwater

The construction (and standards of construction) of a landfill cap has potential to impact on groundwater as a consequence if the capping system did not prevent the uncontrolled release of leachate. In assessing the risk to groundwater posed by the construction of the Stage 3 and 4 area, the Auditor has considered:

- The design of the capping system deployed;
- The methods of construction including CQA outputs in terms of determining satisfactory conformance to the Specification and CQA requirements; and
- Whether the design and construction of the cap liner are considered adequate and sufficient to protect relevant groundwater uses.

The key elements of the capping design for Stage 3 and 4 cap includes the preparation of subgrade, a passive landfill gas system, the placement of GCL, reinforcing geotextile, subsurface drainage layer, soil capping layer, vegetation, and stormwater controls along with a leachate interception trench along the northern and eastern toe of the cap.

The design and construction for the Stage 3 and 4 landfill cap is considered by the Auditor to be commensurate with current best practice and in general accordance with NT EPA *"Guidelines for Siting, Design and Management of Solid Waste Disposal Sites within the Northern Territory"*. Based on the design and the construction quality assurance measures implemented during construction, the capping is considered to be sufficient to protect groundwater at the site from additional leachate generation in Stage 3 and 4 after capping has been completed, by significantly reducing leachate generation as a result of the capping layer being constructed. This does not address leachate already present within the Stage 3 and 4 landfill cells, which is beyond the scope of this Audit, except for drainage of existing leachate within the Stage 3 and 4 areas into the newly constructed leachate toe drain, which is then collected in the leachate sumps and transferred to the leachate treatment system.



6.2 Risk to Air

The risk to air from the landfill is predominantly considered to be due to odour and landfill gas. The completion of the capping construction will reduce the risk of odour emissions from Stage 3 and 4 of the landfill, due to the surface barrier provided by the cap. A system of existing landfill gas wells and condensation pipes is present across the Stage 3 and 4 area and maintained by an external contractor (LMS). The cap design also includes a passive gas depressurisation system which consists of a series of interconnected landfill gas panel drains and strip drains over top of waste (and passive gas vents along the southern boundary of Stage 3 and 4). These elements along with the low permeability layer (GCL) will provide a control over landfill gas emissions from Stage 3 and 4. It is noted that the passive gas depressurization system is not going to be utilised until the active landfill gas extraction ceases at the site, which is not in the near term.

Based on the design and the construction quality assurance measures implemented during construction, the capping is considered to be sufficient to reduce the risk of odour and landfill gas emissions generated in Stage 3 and 4.

6.3 Risk to Surface Water

The site setting indicates that there are no naturally occurring water courses on the site. Onsite water bodies include three leachate ponds. Stormwater from the Stage 3 and 4 cap surface is directed towards perimeter drains to the north, west, and east. The “northern diversion bund” is located north of the Stage 3 and 4 cap area diverting all stormwater to two sediment ponds (adjacent to the north of Stage 4). From these ponds discharge of surface water occurs offsite to the west of the site via overland flow when full. Stormwater run-off from Stage 3 eastern batter, drains to the south towards the stormwater drains adjacent to Cell 6, then to the east to the western boundary of the site.

In addition to the stormwater diversion drains, a subsurface drainage system within the Stage 3 and 4 cap has been included in the design. Subsurface water flow would be collected across the Stage 3 and 4 cap and be discharged at outlets into the main drainage chute which discharges towards the northern diversion bund north of the Stage 3 and 4 cap.

Based on the surface water diversion features implemented for Stage 3 and 4 landfill cap, the risk to surface waters is considered to be low from waste within Stage 3 and 4, providing the stormwater system is adequately maintained during irrigation across the Stage 3 and 4 cap. Irrigation of treated leachate to the cap will also be required to be undertaken in accordance with the leachate *Irrigation Management Plan* (The Water and Carbon Group Pty Ltd, 24 February 2022), which was previously verified by the Stage 3 and 4 cap construction Auditor in accordance with Conditions 40 and 41 of the EPA321 Permit.



7 Conclusions and Recommendations

7.1 Compliance with Environment Protection Approval (EPA 321-02)

The following table outlines the Auditor's assessment of compliance with the clauses of EPA321-02 which were included within the Audit scope.

Table 7-1 Compliance with Environment Protection Approval 321-02 Conditions

Environment Protection Approval Condition	Auditor's Summary	Condition Met?
Condition 47 in EPA321-02 (previously Condition 48 in EPA321) The approval holder must undertake, on completion of the activity, an environmental audit by a qualified person to evaluate the extent to which compliance has been achieved with this approval.	The Auditor (Mr Stephen Cambridge), is a qualified person accredited under the Victorian Environmental Auditor Scheme (Victorian EPA), considered to be suitable to undertake Environmental Audits in the NT in accord with Part 6 of the NT's Waste Management and Pollution Control Act.	Yes
Condition 48 in EPA321-02 (previously Condition 49 in EPA321) The approval holder must submit the proposed scope for the environmental audit no later than 20 business days prior to the proposed commencement date of the environmental audit (which must be specified when the proposed scope is submitted), to the NT EPA for review and approval.	The Auditor provided a notification to conduct an Environmental Audit in compliance with EPA Approval EPA321 (now updated to EPA321-02) to Council on 29 July 2021. Council provided this information to the NT EPA, and EPA required some amendments to the scope which were included in the Final Audit Scope dated 9 November 2021. The Final Audit Scope is included in Appendix B .	Yes
Condition 49 in EPA321-02 (previously Condition 50 in EPA321) The NT EPA may require the approval holder to revise or amend and resubmit any proposed scope for an environmental audit. Where the NT EPA requires the environmental audit scope to be resubmitted, the approval holder must submit it to the NT EPA by the date specified by the NT EPA.	An updated scope (inclusive of Condition 19) was provided by the Auditor to Council in a letter dated 9 November 2021. A further update notifying EPA of the preparation of an Interim Audit Report for the Stage 3 interim area was provided to Council on 16 August 2022.	Yes



Environment Protection Approval Condition	Auditor's Summary	Condition Met?
Condition 50 in EPA321-02 (previously Condition 51 in EPA321) The approval holder must submit to the NT EPA, at completion of the activity, a review of the completed activity with certification from a qualified person(s) that the works conducted: • 50.1 were constructed in accordance with the plans provided in Condition 27 (CQAP) or as revised under Condition 18; and • 50.2 'as constructed' will deliver the required outcomes as prescribed in Condition 13.	The Auditor certifies that the Stage 3 and 4 of the Landfill Cap: 50.1 were constructed in accordance with the approved plans (Condition 27), or as revised under Condition 18 (refer to Design Variations section of Audit report); 50.2 was constructed in accordance with the approved Design, and the 'as-constructed' landfill cap will deliver the intended performance (Condition 13), subject to any qualifications associated with the design documents and verification thereof by the Design Auditor. Evidence of compliance with the approved Design documents, and design variations, is presented throughout this Audit report and attached Construction Quality Assurance report. The Stage 3 and 4 construction works were conducted in accordance with the approved plans. Any deviation from the final capping design were: • approved by the Designer and Independent Environmental Auditor, generally prior to implementation of the change or modification¹; and • provided to the EPA as soon as practical during the works. Where design variations related to changes to materials, construction methods, or quality assurance testing, the as-constructed details are included within: • Table 13 attached to this Audit report, which details the Auditor approved design changes; and • Throughout the Construction Quality Assurance Report, for details on the as-constructed conditions for all placed materials.	Yes
Condition 19 in EPA321-02 Prior to commencing the activity, the approval holder must develop and provide to the NT EPA a CEMP for the activity that identifies potential environmental impacts associated with the activity and mitigation measures to be implemented to reduce the environmental impacts.	The Auditor certifies that the construction of Stage 3 and 4 of the Landfill Cap: • Has generally been constructed in accordance with the Construction Management Plan and Health Safety and Environmental Management Plan prepared for the works, insofar as the Auditor was able to verify this from the Audit inspections and information provided to the Auditor during the course of the works.	Yes

¹ Note: in some instances the Contractor elected to implement design variations in advance of approval by the Environmental Auditor.



7.2 Conclusions

In accordance with the requirements of the NT EPA approved design and specification, the Auditor has:

- A. Reviewed the approved Technical Specification, Design Drawings and CQA Plan relevant to the Stage 3 and 4 Cap Construction.
- B. Reviewed all reports, measurements and other data provided in the context of the approved design documents.
- C. Reviewed all other records, memos, and submittals relevant to the construction of Stage 3 and 4.
- D. Collected and reviewed all other data or information which the Auditor considered relevant.
- E. Undertaken inspections of the site and construction works as they were in progress.
- F. Assessed the risk of any possible harm or detriment to the environment caused by the manner in which the landfill cap has been constructed.

Based on the review of the *Stage 3 and 4 Construction Report, Shoal Bay Waste Management Facility Stage 3-4 Capping Project* (WSP-Golder, 2024), other relevant reports and documentation included in the appendices, and together with independent observations of construction activities conducted at the site by the Auditor and Auditor representatives, the Auditor considers the construction of Stage 3 and 4 landfill cap has been conducted in general compliance with the approved design specifications and the general design precepts of NT EPA Publication *Guidelines for the siting, design, and management of solid waste disposal sites in the Northern Territory* (January 2013). Whilst there have been some departures from the Specifications and CQA requirements, these have been given due consideration and the conclusion reached that such departures do not impact on the overall construction quality or long-term function of the cap.

Based on the appraisal of the Stage 3 and 4 Cap construction, the Auditor concludes that the construction of the Stage 3 and 4 landfill cap has largely conformed to the NT EPA approved Specification and CQA documents and that, where there have been departures from these approved design documents, these will not compromise the future performance of Stage 3 and 4 landfill cap.

Based on the Auditor's appraisal of the construction works, the Auditor concludes that taken together, the design and construction of the works constructed to date has not resulted in any unacceptable risk of any possible harm or detriment to the environment. The Auditor also concludes the 'as constructed' cap will deliver the required outcomes as prescribed in Condition 13 of EPA321-02 Permit, provided the cap is operated and maintained appropriately, and within the limitations of the capping design; noting that some level of surface erosion of the capping soils is likely to occur during the wet season which will require rectification and maintenance.



7.3 Recommendations

The above conclusions have been reached within the scope of work required by this Audit. It is noted that the effective long-term performance of the landfill cap will be dependent on operational activities being undertaken once the cap has been commissioned.

The Recommendations resulting from the Audit are presented as follows:

- 1) The irrigation of the cap vegetation with treated leachate is conducted in accordance with the *Irrigation Management Plan* (The Water and Carbon Group Pty Ltd, 24 February 2022), or future updates to this Plan.
- 2) Specific requirements for inspection of the landfill cap, such as for erosion and any required monitoring, are added to the existing site Environmental Management Plan.



8 Limitations

EHS Support Pty Ltd (EHS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of City of Darwin Council, NT EPA, and only those third parties who have been authorised in writing by EHS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 17 February 2021 (Cap Construction Audit) and 15 October 2021 (Operational Items related to cap construction).

The methodology adopted and sources of information used by EHS Support are outlined in this report. EHS Support has made no independent verification of this information beyond the agreed scope of works and EHS Support assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to EHS Support was false.

This report was prepared between February and March 2024 and is based on the conditions encountered and information reviewed at the time of preparation. EHS Support disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, EHS Support must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore, this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.



9 References

General

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- EPA Victoria. (2015). Best Practice Environmental Management - Siting, Design, Operation and Rehabilitation of Landfills. Publication 788.3. August.
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Golder Associates Pty Ltd. (2021). Shoal Bay Waste Disposal Facility: Stage 4 / Stage 4 Capping - Issued For Construction (IFC) Drawings, ref. 20145676-013-T-Rev5. 6 September.

URS. (2016). Conceptual Site Model, Shoal Bay Waste Disposal Site. 26 February.



Tables

Table 1 - TS Section 1 Introduction - Audit Compliance Table

TS Section 1 Introduction

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 1.7 Authorisation of Modifications to Design and WUC <u>Hold Point 1</u>	CQA Report - Section 2.5 and Appendix D	Y	
Section 1.11.1 Site Access <u>Hold Point 2</u>	CQA Report - Appendix F (ITPs)	Y	
Section 1.14.2 Conformance and Non-conformance Report <u>Hold Point 3</u>	CQA Report - Section 2.6 and Appendix C	Y	
Section 1.16.1 Geosynthetic Materials - Contractor Quality Control and Planning <u>Hold Point 4</u>	CQA Report - Appendix F (ITPs)	Y	
Section 1.16.2 Geosynthetic Materials - Delivery, Storage and Handling <u>Hold Point 5 and Continuous Inspection 1</u>	CQA Report - Appendix F (ITPs) and Appendix K (Daily Site Visit Report). Noted in Section 4.2.2 for GCL, Section 4.4.2 for Unit 8 Reinforcement, Section 5.4.2 for Unit 5 Filter Geotextile, Section 5.5.2 for Unit 6 Geocomposite Strip Drain, Section 6.2.1 Unit 12 LFG Panel Drain, Section 6.2.2 Unit 11 LFG Geocomposite Drain	Y	
Section 1.16.3.1 - Geosynthetic Materials - MQC and Independent Testing - Contractor Testing <u>Hold Point 6</u>	CQA Report - Appendix F (ITPs) CQA Report - Section 4.2.1, Appendix H and Memos 21453643-009-M-Rev0 and 21453643-042-M-Rev0, 21453643-085-M-Rev0 (Unit 7 Coated GCL)	Y	
Section 1.16.3.2 - Geosynthetic Materials - MQC and Independent Testing - Independent Inspection and Testing <u>Hold Point 7</u>	CQA Report - Section 4.4.3.1 and Appendix H (Unit 8 Type A) CQA Report - Section 4.4.4.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type B) CQA Report - Section 4.4.5.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type C) CQA Report - Section 4.4.6.1, Appendix H and Memo 21453643-051-M-Rev0 (Unit 8 Type D) CQA Report - Section 5.4.1 and NC2 (Memo 21453643-018-Rev1) (Unit 5 Filter Geotextile) CQA Report - Section 5.5.1 and Golder memo 21453643-025-M-Rev0 in Appendix C (Unit 6 Drainage Geocomposite) CQA Report - Section 6.1 and Memo 21453643-045-M-Rev0 (Unit 11 Landfill Gas Geocomposite Drains, Unit 12 Landfill Gas Panel Drain)		
Section 1.16.3.3 - Geosynthetic Materials - MQC and Independent Testing - Interface Friction Testing <u>Hold Points 8-9</u>	CQA Report - Section 2.7 WSP Memo: 21453643-026-M-Rev0 WSP Memo: 21453643-65-M-Rev0	Y	
Section 1.16.3.4 - Geosynthetic Materials - MQC and Independent Testing - Material Use <u>Hold Point 10</u>	CQA Report - Section 4.2.1 (Unit 7)	Y	
Section 1.16.4 - Geosynthetic Materials - Panel Layout Plans CQA Documentation	CQA Report - Section 4.2.3 (Unit 7), 4.4.2 (Unit 8) and Appendix H	Y	
Not relevant			
Drawings			
Not relevant			
Design Variations and Non Conformances			
Not relevant			

Table 2 - Construction Management Plan - Audit Compliance Table

TS Section 2 Construction Management Plan

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 2.1 CMP - General Hold Point 11	CQA Report - Section 1.1, Appendix F (ITPs)	Y	
Section 2.2 CMP - Contractor Construction Procedures Hold Point 12	CQA Report - Appendix F (ITPs)	Y	
Section 2.3 CMP - Health and Safety Management Plan Hold Point 13	CQA Report - Appendix F (ITPs)	Y	
Section 2.4 CMP - Environmental Management Plan Hold Point 14	CQA Report - Appendix F (ITPs)	Y	
Section 2.5 CMP - Erosion and Sediment Control Management Plan Hold Point 15	CQA Report - Appendix F (ITPs)	Y	
Section 2.6 CMP - Wet Weather Mitigation Hold Point 16	CQA Report - Appendix F (ITPs)	Y	
Section 2.7 CMP - Quality Management Plan Hold Point 17	CQA Report - Appendix F (ITPs)	Y	
CQA Documentation			
Not relevant			
Drawings			
Not relevant			
Design Variations and Non Conformances			
Not relevant			

Table 3 - Survey and Setout - Audit Compliance Table

TS Section 3 Setout and Survey

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 3.1 Survey Quality Control Hold Point 18	CQA Report - Appendix F (ITPs)	Y	
Section 3.2 Tolerances Hold Point 19	CQA Report - Appendix F (ITPs)	Y	
Section 3.3.1 Pre-construction survey and design review - base liner extent Hold Point 20-21	CQA Report - Appendix F (ITPs)	Y	
Section 3.3.2 Pre-construction survey and design review - Waste Landform Hold Point 22-23	CQA Report - Appendix F (ITPs)	Y	
Section 3.4 Work Lots Hold Point 24	CQA Report - Appendix F (ITPs)	Y	
Section 3.5 As Constructed Records Hold Point 25	CQA Report - Appendix F (ITPs), Appendix E (surveys) and Appendix H (geosynthetics)	Y	
CQA Documentation			
Not relevant			
Drawings			
Not relevant			
Design Variations and Non Conformances			
Not relevant			

Table 4 - Waste Disturbance and Management - Audit Compliance Table

TS Section 4 Waste Disturbance and Management

Relevant Section of the Design	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Documentation			
Technical Specification			
Section 4.3 Exposure of Base Liner Perimeter Hold Point 26	CQA Report - Section 4.2.2 and 4.3, Appendix K (Daily notes) and Appendix E (73852-1-SV-AS01-r7 (Subgrade))	Y	
CQA Documentation			
Not relevant			
Drawings			
Not relevant			
Design Variations and Non Conformances			
Not relevant			

Table 5 -Lateral Leachate Collection System - Audit Compliance Table

TS Section 5 Lateral Leachate Collection System

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 5.2.1 Construction - Unit 6 Geocomposite Drain	CQA Report - Section 5.5.2, Appendix K (Daily Site notes)	Y	
Continuous Inspection 2			
Section 5.2.2 Construction - Collection Mound	CQA Report - Section 5.1.2 (Seepage Pipes), 5.3.2 (Aggregate) and 5.4.2 (Unit 5 Filter Geo). Appendix K (photos)	Y	
Continuous Inspection 3			
Section 5.2.3 Construction - External Leachate Collection Sumps	CQA Report - Section 5.2.2, Appendix K (Daily Site notes)	Y	
Hold Point 27			
Section 5.2.4 Construction - Raising Existing Internal Leachate Collection Sumps	CQA Report - Section 5.2.2, Appendix K (Daily Site notes)	Y	
Hold Point 28			
Section 5.2.5 Construction - Leachate Pump Air Supply and Discharge Pipes	CQA Report - Section 5.1.2, Appendix K (Daily Notes)	Y	
Hold Point 29			
Section 5.3.1 Inspection and Testing - Unit 3 Air Supply Pipe Unit 9 Seepage Pipe and Unit 10 Solid Drainage Pipe	CQA Report - Section 5.1.2	Y	
Hold Point 30			
Section 5.3.2 Inspection and Testing - Unit 5 Filter Geotextile	CQA Report - Section 5.4.1 and NC2 (Memo 21453643-018-Rev1)	Y	
Hold Point 31			
Section 5.3.2 Inspection and Testing - Unit 6 Geocomposite Drain	CQA Report - Section 5.5.1 and Golder memo 21453643-025-M-Rev0 in Appendix C	Y	
Hold Point 32			
CQA Documentation			
Task 2 - Lateral Leachate Interception System			
Inspection and Monitoring			
Monitoring of Drainage Geocomposite Installation	CQA Report - Section 5.5.2 and Appendix I	Y	
Inspection of installed seepage pipes including drilling detail and absence of swarf	CQA Report - Section 5.1.2, Appendix K (Daily Notes)	Y	
Inspection of Drainage Aggregate material	CQA Report - Section 5.3.1, Appendix K (Daily Notes)	Y	
Monitoring of Drainage Aggregate installation	CQA Report - Section 5.3.1	Y	
Monitoring of Filter Geotextile installation	CQA Report - Section 5.4.2, Appendix K (Daily Notes)	Y	
Inspection of Leachate sumps installation	CQA Report - Section 5.2.2, Appendix I, Appendix K (Daily Notes)	Y	
Survey of top of seepage pipes and sump inverts	CQA Report - Section 5.2.2, Appendix E (Leachate Drainage Pipe: 73852-1-SV-AS02-r4 (Pipe)), Appendix I	N	Survey of sump inverts not in CQA report. Refer to NC09
Hold Points			
Geocomposite Drains material properties	CQA Report - Section 5.5.1 and Golder memo 21453643-025-M-Rev0 in Appendix C	Y	
Seepage Pipes	CQA Report - Section 5.1.1	Y	
Drainage Aggregate properties	CQA Report - Section 5.3.1 and Appendix I	Y	Refer to NC2
Filter geotextile properties	CQA Report - Section 5.4.1 and NC2 (Memo 21453643-018-Rev1). Appendix I	Y	
Performance Indicators			
Drainage geocomposite	CQA Report - Section 5.5.2 and Golder memo 21453643-025-M-Rev0 in Appendix C	Y	
Seepage Pipes	CQA Report - Section 5.1.1	Y	
Drainage Aggregate properties	CQA Report - Section 5.3.1 and Appendix I	Y	Refer to NC2
Drainage geocomposite installation	CQA Report - Section 5.5.2 and Appendix I	Y	
Seepage pipe installation	CQA Report - Section 5.1.2, Appendix K (Daily Notes)	Y	
Drawings			
Drawing 003 - General Arrangement Plan - Top of Reshaped Waste	CQA Report - Appendix E (Leachate Drainage Pipe: 73852-1-SV-AS02-r4 (Pipe))	Y	
Drawing 011 - Subsurface Water Management - Sections and Details	CQA Report - Appendix E (Leachate Drainage Pipe: 73852-1-SV-AS02-r4 (Pipe)), Appendix K	Y	
Design Variations and Non Conformances			
NC01 - Unit 6 Transmissivity anomaly quoted in the Technical Specification - material acceptable to the Designer			
NC02 - Unit 4 Aggregate Nominal 19mm - Contractor proposing 25mm Aggregate Unit 5 Filter Geotextile - Pore Size anomaly due to manufacturer using an			

Table 6 - Passive LFG Depressurisation System - Audit Compliance Table

TS Section 6 Passive LFG Depressurisation System

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 6.2.1 Construction - Unit 11 Landfill Gas Geocomposite Drain Hold Point 33	CQA Report - Section 6.2.1, Appendix E - As built drawing A3/02, Appendix K (Daily Site Visit Reports)	Y	
Section 6.2.2 Construction - Unit 12 Landfill Gas Panel Drain Trench Hold Point 34	CQA Report - Section 6.2.2, Appendix E - As built drawing A3/02, Appendix K (Daily Site Visit Reports)	Y	
Section 6.2.3 Construction - Unit 24 Passive Gas Vent Installation Hold Point 35	CQA Report - Section 6.2.4, Memo 21453643-090-M-Rev0 (Appendix D)	Y	DV18
Section 6.3 Inspection and Testing Hold Point 36-37	CQA Report - Section 6.1	Y	
CQA Documentation			
Task 3 Passive Landfill Gas System			
Inspection and Monitoring			
Inspection of installed geocomposite strip drains	CQA Report - Section 6.2.1 and Appendix K (Daily Site Visit Reports)	Y	
Inspection of installed panel drains	CQA Report - Section 6.2.1 and Appendix J	Y	
inspection of installed passive vents, including all components and footings	CQA Report - Section 6.2.4, Memo 21453643-090-M-Rev0 (Appendix D)	Y	DV18
Survey of top of geocomposite strip drains and panel drains and passive vent locations Hold Points	CQA Report - Section 6.2.1 and Appendix E - As built drawing A3/02	Y	
Geocomposite Strip drain material properties	CQA Report - Section 6.2.2, Appendix I	Y	
Panel Drains material properties	CQA Report - Section 6.2.1, Memo 21453643-045-M-Rev0 (DV10)	Y	
Filter geotextile material properties	CQA Report - Section 6.1 (refers to Lateral Leachate Collection system as materials the same), Section 5.4.1, Appendix D - 21453643-018-M-Rev1, Appendix I	Y	NC2
Drainage aggregate material properties	CQA Report - Section 6.1 (refers to Lateral Leachate Collection system as materials the same), Section 5.3.1, Appendix D - 21453643-018-M-Rev1, Appendix I	Y	
Performance Indicators			
Geocomposite Strip Drains	CQA Report - Section 6.2.2, Appendix I	Y	
Panel Drains	CQA Report - Section 6.2.1, Memo 21453643-045-M-Rev0 (DV10)	Y	
Filter Geotextile	CQA Report - Section 6.1 (refers to Lateral Leachate Collection system as materials the same), Section 5.4.1, Appendix D - 21453643-018-M-Rev1, Appendix I	Y	
Drainage Aggregate	CQA Report - Section 6.1 (refers to Lateral Leachate Collection system as materials the same), Section 5.3.1, Appendix D - 21453643-018-M-Rev1, Appendix I	Y	
Geocomposite Strip Drains installation	CQA Report - Section 6.2.1 and Appendix K (Daily Site Visit Reports)	Y	
Panel Drains installation in filter geotextile wrapped drainage aggregate filled trenches	CQA Report - Section 6.2.1, Appendix J, Appendix K (Daily Site Visit Reports)	Y	
Passive vents	CQA Report - Section 6.2.4, Memo 21453643-090-M-Rev0 (Appendix D)	Y	DV18
Passive vents installation	CQA Report - Section 6.2.4, Memo 21453643-090-M-Rev0 (Appendix D), As built drawing A3/02 (Appendix E)	N	Refer to DV18. The updated design involved 2 Passive Gas Vents south of the Stage 3 Pivot Irrigation Area. Construction of these were overseen by the GITA. Refer to NC10
Drawings			
Drawing 007 - General Arrangement Plan - Passive Gas	Appendix E As built drawing A3/02	Y	Refer to DV18. The updated design involved 2 Passive Gas Vents south of the Stage 3 Pivot Irrigation Area. Construction of these were overseen by the GITA. The vents can be surveyed at any time post construction.
Drawing 014 - Passive Gas Sections and Detail (Sh 1/2)			
Drawing 015 - Passive Gas Sections and Details (Sh 2/2)			
Drawing 016 - Capping System Penetration Details			
Design Variations and Non Conformances	Design changes are listed in CQA Report Appendix D and NCs in Appendix C		
DV05 - Unit 11 Strip Drain Orientation adjusted to suit Unit 7 Coated GCL deployment sequence; Unit 12 Anchor Trench Crossing detail	Appendix E As built drawing A3/02		
DV10 - Orientation of Landfill Gas Panel Drain under compressive strength testing revised	CQA Report - Section 6.1		

Table 7 - Fill - Audit Compliance Table

TS Section 7 Fill

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 7.2.2 Construction - Liner Subgrade Works <u>Hold Point 38-39</u>	CQA Report - Section 3.2 and Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Section 7.2.3 Construction - Toe Bund Subgrade Preparation <u>Hold Point 40</u>	CQA Report - Section 3.2 and Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Section 7.2.4 Construction - Construction of Toe Bund Unit 1 Select Fill <u>Continuous Inspection 4</u>	CQA Report - Section 3.3, 3.4.2 and Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Section 7.2.5 Construction - Anchor Trenches <u>Hold Point 41 and Continuous Inspection 5</u>	CQA Report - Section 3.4.3 and Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	DV07
Section 7.2.6 Construction - Construction of Cover Soil - General <u>Hold Point 42-43 and Continuous Inspection 6-8</u>	CQA Report - Section 3.5.2.1 and 3.5.2.2 and Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Section 7.2.6.2 Construction - Construction of Cover Soil Trial Pad <u>Hold Point 44-45</u>	CQA Report - Section 3.5.2 and Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Section 7.3.1 Inspection and Testing - Pre-construction compliance (Unit 1, 2, 25, 26) <u>Hold Point 46</u>	CQA Report - Section 3.4.1 and Appendix G (Unit 1) and Memo 21453643-036-M-Rev0 NCR#3 CQA Report - Section 3.5.1 and Appendix G (Earthworks QA Records) CQA Report - Section 3.8.1 and Appendix G (Earthworks QA Records)	Y	NC3 Note Unit 25 and Unit 29 not used for Stage 3
Section 7.3.2.2 Construction - Construction Compliance - Unit 1 Select Fill <u>Continuous Inspection 9</u>	CQA Report - Section 3.4.2, 3.4.3 and Appendix G (Earthworks QA Records)	Y	
Section 7.3.2.3 Construction - Construction Compliance - Unit 2 Cover Soil and Unit 25 Cover Soil <u>Continuous Inspection 10</u>	CQA Report - Section 3.5.2.1 and 3.5.2.2 and Appendix G (Earthworks QA Records) CQA Report - Section 3.6 (Unit 25) CQA Report - Section 3.8.2 and Appendix G (Unit 29 on hips)	Y	NC08 - Unit 25 No section on construction compliance of Unit 25
Section 7.3.2.4 Construction - Construction Compliance - Anchor Trenches <u>Continuous Inspection 11</u>	CQA Report - Noted in Section 3.4.3.2 and Appendix G	Y	
CQA Documentation			
Task 1 - Subgrade Preparation			
Inspection and Monitoring			
Supply of Unit 1 - Select Fill	CQA Report - Section 3.4.1 and Appendix G	Y	
Approval of Unit 1 - Select Fill	CQA Report - Section 3.4.1 and Appendix G	Y	
Testing Placement of Unit 1 - Select Fill by GITA	CQA Report - Section 3.4.2 and Appendix G	Y	
Monitor Placement of Unit 1 - Select Fill	CQA Report - Section 3.4.2 and Appendix G	Y	
Monitor the proof rolling of the top of the subgrade material	CQA Report - Section 3.2 and Appendix G	Y	
Survey the top of subgrade by licenced surveyor	CQA Report - Section 3.2 and Appendix E: 73852-1-SV-AS01-r5 (Subgrade)	Y	
Performance Indicators			
Toe Bund Subgrade surface	CQA Report - Section 3.2 and Appendix G	Y	
Landfill subgrade shape	CQA Report - Section 3.2 and Appendix G	Y	
Landfill subgrade surface	CQA Report - Section 3.2 and Appendix G	Y	
Task 6 - Cover Soil			
Inspection and Monitoring			
Inspection of Cover Soil	CQA Report - Section 3.5.2.1 and 3.5.2.2 and Appendix G (Earthworks QA Records) CQA Report - Section 3.6 (Unit 25) CQA Report - Section 3.8.2 and Appendix G (Unit 29 on hips)	Y	NC08 - Unit 25 No section on construction compliance of Unit 25 (Section 3.6)
Cover soil trial testing	CQA Report - Section 3.5.2	Y	
Inspection of cover soil trial	CQA Report - Section 3.5.2.1, Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Monitoring of Cover Soil placement	CQA Report - Section 3.5.2.1, 3.5.2.2, 3.8.2, Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	No section on construction compliance of Unit 25 (Section 3.6)
Survey of top of cover soil	CQA Report - Section 3.5.2.1, Appendix G (Earthworks QA Records), Appendix E (Finished Surface Level, : 73852-1-SV-AS05-r1 (Stage 3 FSL) 19 December 2022)	Y	
Inspection of Pavement material	CQA Report - Section 10.2.2	Y	
Monitoring of Pavement material placement	CQA Report - Section 10.2.2, Appendix K (Daily Notes)	Y	
Survey of top of Pavement Material layer	Appendix E (Finished Surface Level, : 73852-1-SV-AS05-r1 (Stage 3 FSL) 19 December 2022)	Y	
Hold Points			
Cover soil properties	CQA Report - Section 3.5.1 and Appendix G (Unit 2), Section 3.6 (Unit 25), Section 3.8 Unit 29), Section 3.9 (Topsoil)	Y	NC08 - Unit 25

Table 7 - Fill - Audit Compliance Table

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Cover soil placement method	CQA Report - Section 3.5.2.1, 3.5.2.2, 3.8.2, Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Cover soil construction	CQA Report - Section 3.5.2.1, 3.5.2.2, 3.8.2, Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Pavement material properties	CQA Report 10.2.1, Appendix L (Miscellaneous QA)	Y	Slight nonconformance for PSD at 9.5 mm sieve
pavement material construction	CQA Report - Section 10.2.2, Appendix K (Daily Notes)	Y	
Performance Indicators			
Cover soil	CQA Report - Section 3.5.1 and Appendix G (Unit 2), Section 3.6 (Unit 25), Section 3.8 Unit 29), Section 3.9 (Topsoil)	Y	NC08 - Unit 25
Cover soil indicators	As above	Y	
Cover soil layer placement - full time supervision no damage to underlying geo	CQA Report - Section 3.5.2.1, 3.5.2.2, 3.8.2, Appendix G (Earthworks QA Records), Appendix K (Daily Notes)	Y	
Cover soil layer placement - as per TS	As above	Y	
Cover soil layer thickness	CQA Report - Section 3.5.2.1, Appendix G (Earthworks QA Records)	Y	
Pavement material	CQA Report 10.2.1, Appendix L (Miscellaneous QA)	Y	Minor nonconformance for PSD at 9.5 mm sieve
Pavement material placement - as per TS	CQA Report - Section 10.2.2, Appendix K (Daily Notes)	Y	
Pavement material placement - moisture and density tests	CQA Report - Section 10.2.2, Appendix K (Daily Notes), Appendix L (Miscellaneous QA)	Y	
Pavement material layer thickness	CQA Report 10.2.1, Appendix L (Miscellaneous QA)	N	The pavement area is not considered to impact the cap design intent. It is understood that council will maintain the pavement area post cap construction NC11
Top of pavement material grades	CQA Report 10.2.1, Appendix E (Finished Surface Level, : 73852-1-SV-AS05-r1 (Stage 3 FSL) 19 December 2022), Appendix L (Miscellaneous QA)	Y	
Design Variations and Non Conformances			
DV02b - Field Density testing of Unit 1 Select Fill placed to form the toe bund on the N and E toe of Stage 3 changed from that in S 7.3.2.2 to S 7.3.2.4 - 1 test per every second layer per 50m of	CQA Report - Section 3.5.2.1		
DV02c - Reduction in design levels of crest/plateau area of the cap by 300 mm. Interim cover soils are thicker than assumed in the design	CQA Report - Appendix E: 73852-1-SV-AS01-r5 (Subgrade)		
DV08 - Revision to Unit 2 Specification, including Particle Size Distribution, and Organic Matter content, as assessed by Water and Carbon	CQA Report - Section 3.5.1		
DV11 - Proposal of material that is non conforming for % passing 0.075mm sieve and change in thickness of Unit 29 layer to at least 25mm (rather than 300mm) and relocated to be between Type D Geogrid and Type B Reinforcement	See above		
NC03 - Unit 1 Some minor non-compliance for Particle size greater than 19mm	See above		
NC05 - Unit 2 Cover soils PSD % passing 19 mm with material between 19 and 37.5 mm in size for soil stockpiles 1 (mixed) and 2 (unmixed) Unit 25 PSD	CQA Report - Section 3.5.2, Section 3.6		

Table 8 - Unit 7 Liner 9 Unit 8 Reinforcement - Audit Compliance Tables

TS Section 8 Unit 7 Liner & 9 Unit 8 Reinforcement

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Coated GCL			
Section 8.1.1 Unit 7A Coated GCL - Construction - Daily Installation Records Continuous Inspection 12	CQA Report - Section 4.2.2, Appendix K (Daily Notes)	Y	
Section 8.1.2.2 Unit 7A Coated GCL - Construction - Field Panel Placement Hold Point 47 and Continuous Inspection 13	CQA Report - Section 4.2.2, 4.2.3 and Appendix H (as built)	Y	
Section 8.1.2.3 Unit 7A Coated GCL - Construction - Damage and Defects Continuous Inspection 14	CQA Report - Section 4.2.2 and 4.2.3	Y	
Section 8.1.2.4 Unit 7A Coated GCL - Construction - Connection to Existing Base Liner Continuous Inspection 15	CQA Report - Section 4.3, Appendix K (Daily Notes)	Y	
Section 8.1.3 Unit 7A Coated GCL - Inspection and Testing Hold Point 48-49	CQA Report - Section 4.2.1, Appendix H and Memo 21453643-009-M-Rev0 (Unit 7 Coated GCL)	Y	
Section 8.4 Anchor Trench Overlaps - Special Installation Continuous Inspection 23	CQA Report - Section 4.2.2	Y	
Reinforcement			
Section 9.2.1 Construction - Installation by Subcontractor Hold Point 57	CQA Report - Section 4.4.3.2 (Type A), 4.4.4.2 (Type B), 4.4.5.3 (Type C), 4.4.6.3 (Type D)	Y	
Section 9.2.2 Construction - Placement Hold Point 58 and Continuous Inspection 24	As above	Y	Although no detailed as constructed figure for reinforcement geotextile placement, there is sufficient information present to confirm construction and location of reinforcement layer types.
Section 9.3 Inspection and Testing Hold Point 59-60	CQA Report - Section 4.2.2, Appendix H CQA Report - Section 4.3.4.1 and Appendix H (Unit 8 Type A) CQA Report - Section 4.3.5.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type B) CQA Report - Section 4.3.6.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type C) CQA Report - Section 4.3.7.1, Appendix H and Memo 21453643-051-M-Rev0 (Unit 8 Type D)	Y	
CQA Documentation			
Task 4 Geosynthetics Liner Supply and Install			
Inspection and Monitoring			
Inspect storage conditions of geosynthetic materials	CQA Report - Section 4.2.2 for GCL, Section 4.4.2 for Unit 8 Reinforcement, Section 5.4.2 for Unit 5 Filter Geotextile, Section 5.5.2 for Unit 6 Geocomposite Strip Drain and Appendix K (Daily Site notes)	Y	
Inspect geosynthetic materials for damage or manufacturing defects	CQA Report - Section 4.2.3	Y	
Monitor installation of geosynthetics	CQA Report - Section 4.2.2 and 4.2.3	Y	
Monitor testing of geosynthetic joins	CQA Report - Section 4.2.2 and 4.2.3	Y	
Independent Laboratory Testing	CQA Report - Section 4.2.1, Appendix H and Memos 21453643-009-M-Rev0 and 21453643-042-M-Rev0 (Unit 7 Coated GCL)	Y	
Inspection of overlying protective layers	CQA Report - Section 4.4.2	Y	
Geosynthetics Inspection and Monitoring: Option 1 Coated GCL			
Coated GCL covered without hydrating	CQA Report - Section 4.2.2 and 4.2.3	Y	
Coated GCL panels overlap as required by TS	CQA Report - Section 4.2.2 and 4.2.3	Y	
Coated GCL defects patched as required by TS	CQA Report - Section 4.2.2 and 4.2.3	Y	
Coated GCL anchored as required by TS	CQA Report - Section 4.2.2	Y	
Inspection and Monitoring: Reinforcement Geotextile			
Reinforcement geotextile panels installed with no cross seams on batters	CQA Report - Section 4.4.2 (general) Section 4.4.3.2 and 4.4.3.3 (Type A) Section 4.4.4.2 and 4.4.4.3 (Type B) Section 4.4.5.2 and 4.4.5.3 (Type C) Section 4.4.6.2 and 4.4.6.3 (Type D)	Y	
Reinforcement geotextile panels are joined as required by TS	As above	Y	
Defects in the reinforcement geotextile are patched	As above	Y	
Reinforcement geotextile panels anchored as required by TS	As above	Y	
Hold points			
Geosynthetics supplied - MQC and Independent testing	CQA Report - Section 4.2.2, Appendix H and Memos 21453643-009-M-Rev0 and 21453643-042-M-Rev0 (Unit 7 Coated GCL) CQA Report - Section 4.3.4.1 and Appendix H (Unit 8 Type A) CQA Report - Section 4.3.5.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type B) CQA Report - Section 4.3.6.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type C) CQA Report - Section 4.3.7.1, Appendix H and Memo 21453643-051-M-Rev0	Y	
Geosynthetics supplied - Interface friction results	CQA Report - Section 2.7 WSP Memo: 21453643-026-M-Rev0 WSP Memo: 21453643-65-M-Rev0	Y	

Table 8 - Unit 7 Liner 9 Unit 8 Reinforcement - Audit Compliance Tables

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Subgrade condition	CQA Report - Section 3.2, 4.2.2 and Appendix K (Daily Site notes)	Y	
Geosynthetics installed - seam and repairs reviewed by GITA	CQA Report - Section 4.2.3, 4.2.4 and Appendix H (Unit 7 Coated GCL) Section 4.4.3.2 (Type A) Section 4.4.4.2 (Type B) Section 4.4.5.2 (Type C) Section 4.4.6.2 (Type D)	Y	
Geosynthetics covered - under full time supervision	As above	Y	
Performance Indicators			
Geosynthetic material - testing results	CQA Report - Section 4.2.2, Appendix H and Memos 21453643-009-M-Rev0 and 21453643-042-M-Rev0 (Unit 7 Coated GCL) CQA Report - Section 4.3.4.1 and Appendix H (Unit 8 Type A) CQA Report - Section 4.3.5.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type B) CQA Report - Section 4.3.6.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type C) CQA Report - Section 4.3.7.1, Appendix H and Memo 21453643-051-M-Rev0	Y	
Geosynthetic material storage	CQA Report - Section 4.2.2 for GCL, Section 4.4.2 for Unit 8 Reinforcement, Section 5.4.2 for Unit 5 Filter Geotextile, Section 5.5.2 for Unit 6 Geocomposite Strip Drain and Appendix K (Daily Site notes)	Y	
Geosynthetic installation and anchorage	CQA Report - Section 4.2.3, 4.2.4 and Appendix H (Unit 7 Coated GCL) Section 4.4.3.2 (Type A) Section 4.4.4.2 (Type B) Section 4.4.5.2 (Type C) Section 4.4.6.2 (Type D)	Y	
Geosynthetic installation testing	No installation testing required	NA	
Independent laboratory testing of geosynthetic materials	CQA Report - Section 4.2.2, Appendix H and Memos 21453643-009-M-Rev0 and 21453643-042-M-Rev0 (Unit 7 Coated GCL) CQA Report - Section 4.3.4.1 and Appendix H (Unit 8 Type A) CQA Report - Section 4.3.5.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type B) CQA Report - Section 4.3.6.1, Appendix H and Memo 21453643-024-M-Rev0 (Unit 8 Type C) CQA Report - Section 4.3.7.1, Appendix H and Memo 21453643-051-M-Rev0 (Unit 8 Type D)	Y	
Drawings			
Drawing 006 - General Arrangement Plan - Capping Reinforcement	CQA Report - Section 4.2.3, 4.2.4 and Appendix H (Unit 7 Coated GCL) Section 4.4.3.2 (Type A) Section 4.4.4.2 (Type B) Section 4.4.5.2 (Type C) Section 4.4.6.2 (Type D)	Y	
Drawing 012 - Anchor Trench and Liner Connection Sections and Details (Sh 1/2)	As above	Y	
Drawing 013 - Anchor Trench and Liner Connection Sections and Details (Sh 2/2)	As above	Y	
Drawing 020 - Reinforcement at Corners Typical Sections and details	As above	Y	
Design Variations and Non Conformances			
DV02a - Drawing 13, Detail 11. Movement of northern and eastern batter edge. Addition of aggregate below Unit 6. Steepening of batter where required	Appendix E (73852-1-SV-AS02-r4 (Pipe), 16/11/2022)	Y	
DV06 - Coated GCL Anchor trench along cap ridge/corner to allow panels to be orientated perpendicular to the slope	CQA Report - Section 4.2.2, Appendix H (As-built) and Appendix K (Daily Site Visit Reports)	Y	
DV09 - Revised Type B and D anchor trench dimensions. Use of Cement Stabilised sand as backfill to anchor trenches. Reduced tensile strength of Type D reinforcing geogrid	CQA Report - Section 3.4.3.1 and Memo 21453643-039-M-Rev0 (in Appendix D)	Y	
DV11 - Proposal of material that is non conforming for % passing 0.075mm sieve and change in thickness of Unit 29 layer to at least 25mm (rather than 300mm) and relocated to be between Type D Geogrid and Type B Reinforcement Geotextile	CQA Report - Section 3.8.2 and Memo: 21453643-058-M-Rev0 (Appendix D)	Y	
DV12 - Anchor trench optimisation	CQA Report - Section 3.4.1 and Memo: 21453643-068-M-Rev0 (Appendix D)	Y	
DV15 - Stage 4 - Type D Anchor Trench - GCL Extent	CQA Report - Section 3.4.2 and Memo: 21453643-076-M-Rev0 (Appendix D)	Y	
NC04 - Unit 8 Type B. Strain at breakage from the independent testing was marginally less than 10% (specified value) for 3 out of 10 samples	CQA Report - Section 4.4.4.1, Memo: 21453643-024-M-Rev0 (Appendix D)	Y	
NC06 - Unit 8 Type D roll lengths preventing continuous panel over full slope length	CQA Report - Section 4.4.6.2 and Memo 21453643-062-M-Rev0 (Appendix D)	Y	
NC07 - Unit 8 Type C Reinforcement Geotextile Installation Damage adjacent to stormwater chute crest	CQA Report - Section 4.4.5.3 and Memo 21453643-066-M-Rev1 (Appendix D)	Y	

Table 9 - Subsurface Drainage System - Audit Compliance Table

TS Section 10 Subsurface Drainage System

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 10.2.1 Construction - Unit 26 Subsurface Drainage Blanket	CQA Report - Section 8.1.2, Appendix H (Lining and QA)	Y	
Continuous Inspection 25			
Section 10.3.1 Inspection and Testing - Unit 26 Subsurface Drainage Blanket Hold Point 61-62	CQA Report - Section 8.1.1, Appendix H (Lining and QA)	Y	
Section 10.3.2 Infiltration collection mound Hold Point 63-65	CQA Report - Section 7.1.2, Appendix I (Subsurface Drainage Pipework), Appendix K (Daily Notes)	N	Not specifically noted in CQA report
CQA Documentation			
Task 5 Subsurface Drainage System			
Inspection and Monitoring			
Inspection of installed seepage pipes including inspection of drilling detail and absence of swarf	CQA Report - Section 7.1.2	Y	
monitoring of seepage pipe installations	As above	Y	
survey of top of seepage pipes and outlet locations	Appendix E (73852-1-SV-AS04-r4 (Subsurface pipe))	Y	
Inspection of Drainage aggregate material	CQA Report - Section 8.1.1, Appendix H (Lining and QA)	Y	
Monitoring of Drainage aggregate installation	CQA Report - Section 8.1.2, Appendix H (Lining and QA)	Y	
Monitoring of Filter geotextile installation	CQA Report - Section 7.3.2	Y	
Hold Points			
Drainage Aggregate material properties	CQA Report - Section 7.2.1, Appendix I (LCS QA)	Y	
Performance Indicators			
Seepage Pipes	CQA Report - Section 7.1.2	Y	
Drainage aggregate	CQA Report - Section 7.2.2	Y	
Leachate drainage gravel trial placement	CQA Report - Section 5.3.2	Y	No trial pad completed as deemed not necessary by GITA
Seepage Pipe installation	CQA Report - Section 7.1.2	Y	
Design Variations and Non Conformances			
Drawing 008 - General Arrangement Plan - Subsurface Water Management	Appendix E (73852-1-SV-AS04-r4 (Subsurface pipe))	Y	
Drawing 010 - Subsurface water management - Sections and details			
Design Variations			
DV03 - Based on the Contractor's pre-construction survey, the position of the three new Leachate Sumps have been relocated to align with the low points along the eastern create of Stage 3, and optimise the drainage and collection of leachate	Appendix I (LCS QA)	Y	
DV14 - Stage 3 Capping - Subsurface Drains	21453643-067-M (Appendix D)	Y	

Table 10 - Surface Water Control Structures - Audit Compliance Table

TS Section 11 Surface Water Control Structures

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 11.2.1 Construction - Stormwater Surface Drains <u>Hold Point 66</u>	CQA Report - Section 9.0, 9.1 and 9.2	Y	
Section 11.2.2 Construction - Stormwater Bunds <u>Hold Point 67</u>	CQA Report - Section 9.1, 21453643-067-M-Rev0 (Appendix D)	Y	
Section 11.2.3 Construction - Unit 2 Cover Soil for Stormwater Bund <u>Continuous Inspection 26</u>	CQA Report - Section 9.2, Appendix G (Earthworks QA)	Y	
Section 11.2.4 Construction - Construction of Stormwater Chutes and Lined Drains <u>Hold Point 68</u>	CQA Report - Section 9.3	Y	
Section 11.3 Inspection and Testing <u>Hold Point 69-70</u>	CQA Report - Section 9.2, Appendix G (Earthworks QA)	Y	
CQA Documentation			
Task 7 Surface Water Drainage Structures			
Inspection and Monitoring			
Inspection of Filter Geotextile	CQA Report - Section 8 (refers to Section 7)	Y	
Monitoring of Filter geotextile installation	As above	Y	
Inspection of rip rap	CQA Report - Section 9.3.2.1	Y	
Monitoring of rip rap placement	CQA Report - Section 9.3.2.2, Appendix L (Miscellaneous QA)	Y	
Inspection of Steel Wire baskets	CQA Report - Section 9.3.1.1	Y	
Monitoring of steel wire baskets installation including backfilling with rip rap	CQA Report - Section 9.3.1.2, Appendix L (Miscellaneous QA)	Y	
Inspection of Cover soil	CQA Report - Section 9.1	Y	
Monitoring of cover soil placement	CQA Report - Section 9.2, Appendix G (Earthworks QA)	Y	
Inspection of Select fill	NA	NA	
Monitoring of Select Fill placement	NA	NA	
Inspection of concrete causeway formworks and reinforcement	CQA Report - Section 10.1.2	Y	
Survey of drain and diversion bund inverts and crests	CQA Report - Section 9.2, Appendix E (73852-1-SV-AS05-r3 (Stage 3 FSL))	Partial	All drains surveyed except the northern diversion bund. The GITA confirmed the northern stormwater bund construction was conducted in accordance with the Design. Refer to NC12
Hold Points			
Filter Geotextile	CQA Report - Section 8 (refers to Section 7)	Y	
Steel wire baskets	CQA Report - Section 9.3.1.1	Y	
Rip rap properties	CQA Report - Section 9.3.2.1	Y	
Cover soil properties	CQA Report - Section 9.1 and Section 3.5	Y	
Select fill properties	NA	NA	
Concrete causeway - concrete mix	CQA Report Section 10.1.1, Appendix L (Miscellaneous QA)	Y	
Concrete causeway - concrete reinforcement	As Above	Y	
As-built survey	Appendix E (73852-1-SV-AS05-r3 (Stage 3 FSL))	Partial	All drains surveyed except the northern diversion bund. The GITA confirmed the northern stormwater bund construction was conducted in accordance with the Design. Refer to NC12
Performance Indicators			
Filter Geotextile	CQA Report - Section 8 (refers to Section 7)	Y	
Filter Geotextile installation	As above	Y	
Rip rap	CQA Report - Section 9.3.2.1	Y	
Rip Rap placement	CQA Report - Section 9.3.2.2	Y	
Cover soil	CQA Report - Section 9.1, refers to Section 3.5	Y	
Cover soil placement - installation	CQA Report - Section 9.2	Y	

Table 10 - Surface Water Control Structures - Audit Compliance Table

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Cover soil placement - moisture and density tests	CQA Report - Section 9.2, Appendix G (Earthworks QA)	Y	
Select fill	NA	NA	
Select fill placement - installation	NA	NA	
Select fill placement - moisture and density tests	NA	NA	
Concrete	CQA Report Section 10.1.1, Appendix L (Miscellaneous QA)	Y	
Drain grades	CQA Report - Section 9.2 (73852-1-SV-AS05-r3 (Stage 3 FSL))	Partial	All drains surveyed except the northern diversion bund. The GITA confirmed the northern stormwater bund construction was conducted in accordance with the Design. Refer to NC12
Drawings			
Drawing 009 - General Arrangement Plan - Surface Water Management	CQA Report - Section 9.2 (73852-1-SV-AS05-r3 (Stage 3 FSL))	Y	
Drawing 017 - Stormwater Chute Inlet - Sections and Details	CQA Report - Section 9.2 (73852-1-SV-AS05-r3 (Stage 3 FSL))	Y	
Drawing 018 - Stormwater Chute Inlet - Sections and Details	CQA Report - Section 9.2 (73852-1-SV-AS05-r3 (Stage 3 FSL))	Y	
Drawing 019 - Northern Diversion Bund - Layout Plan and Longitudinal Section	CQA Report - Section 10.1.2	Partial	All drains surveyed except the northern diversion bund. The GITA confirmed the northern stormwater bund construction was conducted in accordance with the Design. Refer to NC12
Design Variations and Non Conformances			
DV13 - Northern Boundary Stormwater Bund	CQA Report - Section 9.1, 21453643-073-M-Rev0 (Appendix D)	Y	

Table 11 - Miscellaneous - Audit Compliance Table

TS Section 12 Miscellaneous

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 12.1.3 Unit 19 Concrete - Inspection and Testing <u>Hold Point 71-74</u>	CQA Report - Section 10.1.1, Appendix L (Miscellaneous QA)	Y	
Section 12.2.2 Unit 20 Pavement Material - Construction <u>Hold Point 75</u>	CQA Report - Section 10.1.2	Y	
Section 12.2.3 Unit 20 Pavement Material - Inspection and Testing <u>Hold Point 76-77</u>	CQA Report - Section 10.2.1, Appendix L (Miscellaneous QA)	Y	
Section 12.3.1 Unit 21 Guide Posts - Materials <u>Hold Point 78</u>	CQA Report - Section 10.2.2	Y	
Section 12.3.2 Unit 21 Guide Posts - Construction <u>Hold Point 79</u>	CQA Report - Section 10.3.1	Y	
Section 12.4.2 Unit 27 Topsoil - Construction <u>Hold Point 80</u>	CQA Report - Section 10.3.2	Y	
Section 12.5.1 Unit 28 Grass Cover - Materials <u>Hold Point 81</u>	CQA Report - Section 3.7	Y	
Section 12.5.2 Unit 28 Grass Cover - Construction <u>Hold Point 82</u>	CQA Report - Section 3.7, 11.0	Y	
CQA Documentation			
Refer to Fill for pavement material			
Design Variations and Non Conformances			
Not relevant			
Design Variations			
Not relevant			

Table 12 - Project Close Out - Audit Compliance Table

TS Section 13 Project Close Out

Relevant Section of the Design Documentation	Final Report (7 August 2023)	Compliance (Y/N)	Comments
Technical Specification			
Section 13.1 As constructed Documentation Requirement Hold Point 83	CQA Report - Appendix F (Signed ITPs)	Y	
Section 13.2.2 Reinstatement Hold Point 84	CQA Report - Section 11	Y	
Section 13.2.3 Final Inspection Hold Point 84	CQA Report - Section 11	Y	
Section 13.2.4 Final Survey Hold Point 85	CQA Report and surveys	Partial	All drains surveyed except the northern diversion bund. The GITA confirmed the northern stormwater bund construction was conducted in accordance with the Design. Refer to NC12
CQA Documentation			
Not relevant			
Drawings			
Not relevant			
Design Variations and Non Conformances			
Not relevant			

Table 13 - Design Variation and Non-Conformance Register and Risk Assessment

Design Variation Register:
Project Name: Shoal Bay Waste Disposal Facility
Project Number: PTX CD006
Site Address: Shoal Bay Waste Disposal Facility
Auditor: Stephen Cambridge
Project Manager: Will Dillon
Date Updated: 05-Mar-24
Reference: Technical Specification (Spec), CDA Plan, Drawings and Design Report for Stage 3 and 4
Client: City of Darwin

ID	Type	Key Design Component	Design Variation Description	Designer Approval	Auditor Approval	EPA Notification	Risk Scenario	Jeopardy	Consequence	Auditor Risk Ranking	Auditor Comments
Change to the Risk to the Environment (see key below)											
Design Variations											
DV01	Major	Redesign of western and north-eastern cap areas to remove velvet grass and leachate irrigation system.	Removal of velvet grass, replace with standard grasses, and change capping system to include geocomposite drain above coated GCL and additional geotextile reinforcement layers. In addition, soil specification changed to reduced permeability and infiltration	Memo: 21403843-005-M-Rev0	Letter dated 19 November 2021	Council has submitted to EPA	Venueer slope failure on redesigned Cell 4 area due to change in design (no Velvet grass)	Not likely	Minor to moderate	Low to Medium	To compensate for the removal of the velvet grass on the Cap 4 side slopes and crest areas, the Designer has incorporated the following items into the revised design: 1. Inclusion of sub-surface geocomposite drain on top of the GCL and reinforcement geosynthetic, to increase sub-surface drainage and reduce hydrostatic pressure build-up; and 2. Increased the fines content of the overlying cover soils, to increase surface run-off and reduce infiltration of surface water down to the interface between the geosynthetic and the cover soils. Based on the Factor of Safety calculated by the Designer, the revised design is considered unlikely to present a risk of veneer slope failure. In the unlikely event that slope veneer damage did occur, then it would be expected to be localised, and would only have a minor consequence which could be rectified.
DV02a	Minor	Amendment to Stage 3 Butler Tote Detail	Drawing 011, Detail 11. Movement of northern and eastern letter edge. Addition of aggregate below unit 6. Steepering of letter where required	Memo: 21403843-002-M-Rev1	Letter dated 4 October 2021	Council has submitted to EPA	Increased risk of leachate infiltration between GCL and soil liner (geomembrane) leading to leachate escape at toe of landfill	Not likely	Minor	Low	The design has improved the capacity of the secondary leachate drain to capture any leachate moving past the existing leachate trench, as the aggregate drainage layer is now sitting on the downslope portion of the cell liner, rather than on the crest. The design change was also necessary due to the shorter length of existing liner available for overlap by the GCL at the crest of the base liner.
DV02b	Minor	Amendment to Unit 1 Testing Frequency at Toe Burd	Field Density testing of Unit 1 - Select Fill placed to form the toe band on the N and E toe of Stage 3 changed from that is 7.3.2.2 to 7.3.2.4 - 1 test per every second layer per 50m of length	Memo: 21403843-004-M-Rev0	Letter dated 4 October 2021	Council has submitted to EPA	Inadequate compaction of Unit 1 material at Toe Burd, leading to leachate management issues at toe and instability	Rare	Minor	Low	The reduced testing density will still provide sufficient evidence that compaction has been achieved of the Unit 1 material at the toe of the landfill cap
DV02c	Minor	Capping 3D Model - Lowering of Crest/Plateau Level	Reduction in design levels of crest/plateau area of the cap by 100 mm. Interim cover soils are thicker than assumed in the design	Memo: 21403843-005-M-Rev0	Letter dated 4 October 2021	Council has submitted to EPA	No potential impacts identified			Not applicable	Minor reduction in height of the top of the cap is not considered to present any increased risks to the environment, and if anything will marginally reduce any risk of the side slopes due to reduced slope length
DV03	Minor	Refining positions of proposed leachate sumps	Based on the Contractor's pre-construction survey, the positions of the three new Leachate Sumps have been relocated to align with the low points along the eastern crests of Stage 3, and optimise the drainage and collection of leachate	Memo: 21403843-012-M-Rev0	Letter dated 4 October 2021	Council has submitted to EPA	Risk of leachate drainage from the sumps not being adequate	Rare	Minor	Low	Relocation of the three proposed leachate sumps is not considered to present any increased risks to the environment, and is an improvement in the design based on observed conditions on site during the excavation works to expose the existing landfill liner for Cell 3
DV04	Not Used - was changed to NC062										
DV05	Minor	Strip Drain Configuration - Eastern Butler; Unit 12 Anchor Trench Crossing	Unit 11 Strip Drain Orientation adjusted to suit Unit 7 Coated GCL deployment sequence; Unit 12 Anchor Trench Crossing detail	Memo: 21403843-022-M-Rev0	Approved. Auditor sent email for clarifications on 12 Nov 2021. Auditor approved in letter dated 9 December 2021	Council has submitted to EPA	1. Unit 7/Unit 8 failure at anchor trench - increased risk of infiltration through cap. 2. Reduced effectiveness of landfill gas collection in Panel Drain	Not likely	Minor	Low	The risk of the anchor trench effectiveness being reduced by this design change has been considered. The risk considered is cutting of the GCL (Unit 7) and Reinforcing Geotextile (Unit 8) to allow for Panel Drain penetration through these materials, in that of producing a potential point of weakness within Unit 7/8 at crest of slope, and resulting in a less effective anchor trench, or localised ripping of the GCL and Reinforcing Geotextile. The Auditor agreed whether the Designer had considered this risk, and the response from the Designer was that the materials will have sufficient residual strength to mitigate this risk. The second risk considered by the Auditor, was whether the Panel Drain would be less effective for landfill gas collection, as it will now be located above the Unit 1 soil material, rather than close to the waste mass. The Auditor considers that given that the Panel Drain will only be above the Unit 1 material for a relatively short length, and only in limited locations within the cap (i.e. 3 locations), then this will not affect the overall performance of the landfill gas collection system for the cap.
DV06	Minor	Additional GCL Anchor Trench on North-Eastern ridge/corner of Cell 3	Coated GCL Anchor trench along cap ridge/corner to allow panels to be orientated perpendicular to the slope	Memo: 21403843-023-M-Rev1	Approved. Auditor sent email for clarifications on 12 Nov 2021. Auditor approved in letter dated 9 December 2021	Council has submitted to EPA	Anchor trench creating additional pathway for infiltration into cap	Not likely	Minor	Low	Anchor trench will reduce amount of cross slope seepage and points of potential leakage within Unit 7A Coated GCL in north-east corner. In addition, an additional layer of GCL is required to be placed over the GCL which terminates into this new anchor trench, and overlap by at least 1m with the side slope GCL. Therefore this will provide suitable barrier to prevent infiltration into the new anchor trench
DV07	Not used - was changed to NC062										
DV08	Minor	Unit 2 - Particle Size Distribution, and method for assessment of achieving organic matter content	Revision to Unit 2 Specification, including Particle Size Distribution, and Organic Matter content, as assessed by Water and Carbon	Memo: 21403843-029-M-Rev0	Approved. Auditor approved in letter dated 19 May 2022	Council has submitted to EPA	1. Revised Unit 2 cover soils with higher fines content resulting in reduced factor of safety for veneer stability.	1. Probable	2. Minor	Medium	1. The veneer stability analysis conducted by the Designer indicates that the higher fine contents will result in a veneer stability friction angle of 35.6 degrees, which is higher than the design target of 30 degrees, therefore the soils should be stable. It should be noted that the original design did include a potential risk of short term instability of the capping soils until such time as the Velvet Grass is established, and this short term risk remains as probable, although if it resulted in localised erosion and slumping of soils, this consequence would be minor.
							2. Revised Unit 2 cover soil properties resulting in reduced water holding capacity of soils and/or restriction on Velvet Grass growth	1. Not likely	2. Minor	Low	2. The revised fine contents of the soils (i.e. change from maximum of 20% to 40%) was assessed by Water & Carbon to be acceptable, and the method of determining the organic content by physical load recording (i.e. volume to volume assessment by mixing), was also assessed by Water & Carbon Group to be acceptable. There are a number of factors that could affect the water retention in the Unit 2 soils and the growth of the Velvet Grass. However based on the low compaction of the soils, the addition of organic matter, low dispersivity, and addition of gypsum, along with on-site growth trials conducted at the Velvet Grass, the risk of restricted growth due to the soils, or poor water retention of the soils, is considered not to be increased by this design variation. It is also noted that a higher fines content, provided it contains a proportion of silt and isn't overly a clay, is likely to result in better water holding capacity of the soils as compared to the original design.
DV09	Minor	Anchor Trench Dimensions and Dead Man Anchor	Revised Type B and D anchor trench dimensions. Use of Cement Stabilised sand in landfill to anchor trenches. Reduced tensile strength of Type D reinforcing geogrid	Memo: 21403843-028-M-Rev0 and Memo: 21403843-029-M-Rev0	Approved. Auditor approved in letter dated 4 May 2022	Council has submitted to EPA	1. Cracking within cement stabilised sand could cause water seepage and increase risk of geosynthetic pull out or other related issues. 2. If anchor trench design is not suitable, this could lead to damage or premature pull out of geosynthetic under load	1. Not likely 2. Not likely	Minor	Low	1. Inspections have been undertaken by the GFA of the cement stabilised sand periodically after placement, and no shrinkage has been observed. Golder has identified that cement stabilised sand is unlikely to shrink to any significant degree, based on the literature. 2. The revised anchor trench design and veneer stability assessment has been reviewed by the Auditor's expert support Engineer and, is satisfied that the revised design has suitable input parameters and factors of safety

Table 13 - Design Variation and Non-Conformance Register and Risk Assessment

Change to the Risk to the Environment (see key below)											
ID	Type	Key Design Component	Design Variation Description	Designer Approval	Auditor Approval	EPA Notification	Risk Scenario	Method	Consequence	Auditor Risk Ranking	Auditor Comments
Design Variations											
DV10	Minor	Unit 12 Landfill Gas Panel Drain	Orientation of Landfill Gas Panel Drain under compressive strength testing revised	Memo: 22453643-040-M-Rev0	Approved. Auditor approved in letter dated 4 May 2022	Council has submitted to EPA	LPG Panel Drain failure causing localized LPG build-up	Rare	Minor	Low	Construction loading (above panel drains) is expected to remain <100kPa during construction, due to the use of low Ground Pressure chisel during overlying soil placement. This is well below the tested compressive strength of 285 kPa.
DV11	Minor	Unit 29 Cover Soil in Corner Ridge	Proposal of material that is not conforming for % passing <0.75mm sieve and change in thickness of Unit 29 layer to at least 25mm (rather than 300mm) and relocated to be between Type D Geogrid and Type B Reinforcement Geotextile	Memo: 22453643-038-M-Rev0	Approved. Auditor approved in letter dated 2 July 2022	Council has submitted to EPA	Unit 29 material does not provide adequate friction to prevent veneer instability between capping reinforcement layers on corner ridge line of cap	Not Likely	Minor	Low	The Designer has assessed the veneer stability to be acceptable, and the change to the location of Unit 29 is predicted to increase the veneer stability of the cap at these locations.
DV12	Minor	Stage 4 Anchor Trench Optimization	Revision to Anchor Trench Type A-t cross and access ramp, and Type C anchor trench on bench. Changes include changing dimensions, backfill and removal of breather anchor	22453643-088-M-Rev0_DCM12	Approved. Auditor approved in letter dated 23 August 2022	Council has submitted to EPA	Potential risk scenarios considered: 1. Cracking within current stabilised sand could cause water ingress and increase risk of geosynthetics pull out or other related issues. 2. If anchor trench design is not suitable, this could lead to damage or premature pull out of geosynthetics under load	1. Not Likely 2. Not Likely	Minor	Low	1. Inspections have been undertaken by the GTS of the current stabilised sand periodically after placement, and no shrinkage has been observed. Golder has identified that current stabilised sand is unlikely to shrink to any significant degree, based on the literature. 2. The revised anchor trench design and veneer stability assessment has been reviewed by the Auditor's expert support Engineer and, is satisfied that the revised design has suitable input parameters and factors of safety
DV13	Minor	Northern Boundary - Stormwater Bund	Diversion of the northern stormwater bund so that stormwater diverts into the settling ponds prior to discharging beyond the site boundary	22453643-073-M-Rev0_DCM13	Approved. Auditor approved in letter dated 23 August 2022	Council has submitted to EPA	Potential risk scenario considered is if the settling ponds are not sufficient to reduce sediment, turbidity or salinity prior to off-site discharge.	Probable	Minor	Medium	Diversion of the stormwater through the existing on-site settling ponds on the northern part of the site will reduce the risk of sediment, turbid or saline water discharging off-site above the Licence limits. Once the cap will be vegetated, the risk of significant sediment and turbid water discharge will likely be low, however as a conservative approach the Auditor has considered that the likelihood is probable (i.e. might occur), prior to vegetation establishment, and is subject to ongoing monitoring of surface water monitoring points as part of the ongoing site operations.
DV14	Minor	Stage 3 Capping - Subsurface Drains	Amendment to the subsurface drain level so that it sits 50mm above the lining system to avoid damage during construction	22453643-067-M-Rev0_DCM14	Approved. Auditor approved in letter dated 23 August 2022	Council has submitted to EPA	Potential risk scenario assessed was damage to the liner from construction equipment, and changes to the drainage resulting in subsurface drain not performing adequately	Not Likely	Minor	Low	The change to the have a 50mm separation from the subsurface drain base and the underlying geosynthetics reduces the risk of damage during construction. Based on the Designer's review and the minor change to the vertical location of the subsurface drains, this change is not considered to affect how the drains are likely to perform under wet conditions.
DV15	Minor	Stage 4 - Type D Trench - GCL Extent	Due to the large size of this anchor trench, it was not deemed safe for construction workers to enter the trench to install the GCL, therefore the GCL was assessed for suitability to be joined at the top of the anchor trench to avoid workers entering the trench	22453643-076-M-Rev0_DCM15 and email dated 14/9/22	Approved. Auditor approved in letter dated 15 September 2022	Council has submitted to EPA	Potential risk scenario considered was for the GCL to not be sufficiently anchored leading to veneer stability issues on the slope	Not Likely	Minor	Low	The Designer has assessed the veneer stability without the GCL anchored in the trench, and has determined that it is acceptable, as the geogrid materials will provide the necessary anchoring for the lining system
DV16	Minor	Anchor Trench Stage 4 Ramp Removal	The contractor has requested the removal of Anchor trench along Stage 4 Ramp area. The Unit 8 Type A Geogrid reinforcement layer is proposed to be anchored by the weight of the cover soil on a runoff length (4.6m) beyond the crest of the slope.	22453643-082-TM-Rev0_DCM16	Approved. Auditor approved in letter dated 30 September 2022	Council has submitted to EPA	Increased risk of slope veneer failure at the Type A crest and geosynthetics sloping down western slope with no anchor trench present.	Not Likely	Minor	Low	The Designer has assessed the veneer stability for the slope in this area to estimate magnitude of load to be resisted by the runoff length. The veneer stability assessment considers the same parameters adopted for the detailed design and updated with site specific interface testing. From the Auditor's review it appears that conservative assumptions have been adopted by the Designer. The analysis is also predicated on the Geocomposite Drain functioning as intended to prevent the build up of water within the capping profile.
DV17	Minor	Stage 4 Ramp Subsurface Drainage	To allow for subsurface drainage within the Stage 4 Access ramp the designer has proposed the inclusion of ONE of the following options: 1. Unit 26 Subsurface Drainage Blanket to extend across the footprint of the Stage 4 Access Ramp 2. Unit 6 Geocomposite Strip Drain (900mm wide) installed along the centre line of the Stage 4 Access Ramp and terminate into the subsurface drainage pipe at the bend in the ramp (NW corner) and toe of the ramp (Northern toe). This option requires a Custom Geotextile to be placed (below the Unit 7 Coated GCL) over the footprint of the Stage 4 Access Ramp area	22453643-082-TM-Rev0_DCM17	Approved. Auditor approved in letter dated 30 September 2022	Council has submitted to EPA	Subsurface drainage not performing in accordance with the design due to clogging or damage to the geocomposite drain from overlying traffic.	Rare	Minor	Low	The Designer supports the implementation of either option and considers that it will improve the current design. The auditor agrees this assessment. Construction of either option shall be in accordance with the Technical Specification, with approved materials only to be used.
DV18	Minor	Passive Landfill Gas Vents (two in Stage 3 area)	Revised design of the location and construction of the two affected passive gas vents on the southern edge of Stage 3, to move further to the south, so that they don't conflict with the operation of the pivot irrigation system. Change to riser pipe design	22453643-090-M-Rev0_DCM18	Approved. Auditor approved in letter dated 14 November 2022	Council to submit to EPA	If the landfill gas pipe is not sealed correctly at the GCL penetration point, then this could act as a preferential pathway for landfill gas to escape from the cap in an uncontrolled manner	Not Likely	Minor	Low	The Designer has amended the design to incorporate a bentonite plug around the pipework at the entry and exit point through the penetration in the coated GCL. This, in combination with the operation of the active landfill gas extraction system, should prevent any significant landfill gas migration through this penetration.

Table 13 - Design Variation and Non-Conformance Register and Risk Assessment

ID	Type	Key Design Component	Design Variation Description	Designer Approval	Auditor Approval	EPA Notification	Risk Scenario	Likelihood	Consequence	Auditor Risk Ranking	Auditor Comments
Change to the Risk to the Environment (see key below)											
Design Variations											
Non-Conformances											
NC01	Minor	Unit 6/7/1 Transmissivity Non-Conformance	Transmissivity anomaly quoted in the Technical Specification - material acceptable to the Designer	Memo: 22453645-025-L-Rev0	Email from Auditor dated 12 November 2021	Not required to be submitted to EPA as this is not a Design Variation	Reduction in transmissivity resulting in inadequate leachate drainage (for Unit 6) or inadequate landfill gas venting capacity	Rare	Minor/Moderate	Low/Medium	If leachate or landfill gas was not being adequately drained or vented, due to reduced transmissivity, this could lead to rectification works which would be difficult to rectify. However, noting that the likelihood of the Unit 6 or Unit 7/1 materials not performing in accordance with the design intent, due to reduced transmissivity, is considered to be 'very' low likelihood, and the Designer confirming that the materials meet the design intent, then the residual risk to the environment is considered to be low.
NC02	Minor	Units 4 and 5 Material Changes	Unit 4 Aggregate Nominal 10mm - Contractor proposing 20mm Aggregate Unit 5 Filter Geotextile - Pore Size anomaly due to manufacturer using an isolated test method	Memo: 22453645-028-L-Rev0	Email from Auditor dated 12 November 2021	Not required to be submitted to EPA as this is not a Design Variation	Unit 4: Additional fines in aggregate resulting in clogging Unit 5: Filter geotextile not meeting specification and resulting in failure due to reduced strength	Not likely	Minor	Low	Unit 4: Only a small percentage of fines are present in the material, based on the testing. Therefore clogging is considered unlikely to occur. Unit 5: Geotext has rejected the use of the Unit 5 material which failed the strength tests, and required that the non-conforming rolls of Biotex4 (i.e. rolls 1302243 and 1302292) will only be used for the sealing the ends of the Unit 11 Passive Gas Geocomposite Drains. Therefore this issue has been addressed.
NC03	Minor	Unit 1 Fill	Some minor non-compliance for Particle size greater than 10mm	Approved. Auditor approved in letter dated 4 May 2022	Approved. Auditor approved in letter dated 4 May 2022	Not required to be submitted to EPA as this is not a Design Variation	Larger particle sizes causing issues with overlying materials or cohesion of soils	Rare	Minor	Low	Only maximum of 5% of Unit 1 tested exceeded 10mm (but less than 26.5 mm). This is not expected to have any material impact of the performance of the Unit 1 soils.
NC04	Minor	Unit 8 Type B Reinforcement Geotextile	Strain at breakage from the independent testing was marginally less than 12% (specified value) for 3 out of 10 samples	Memo: 22453645-039-M-Rev0	Email from Auditor dated 21 December 2021	Not required to be submitted to EPA as this is not a Design Variation	Failure of reinforcement geotextile due to inadequate strength	Rare	Minor	Low	Given that the estimated long term strength at 7% strain (after application of reduction factors) are all well above the specified value of 130 kN/m, the minor non-conformance of strain at breakage being slightly less than 12% for three samples out of ten samples, indicates that the material has adequate strength to meet the design intent. If failure did occur, it would likely be localised, rather than a large catastrophic failure, leading to localised minor slippage only (although this is considered unlikely based on Unit 8 strength test results).
NC05	Minor	Unit 2 Cover Soil - Overseeded Particles	Unit 2 PSD % passing 63 mm with material between 10 and 37.5 mm is less for soil (samples 1 (inert) and 2 (Limestone))	22453645-070-M-Rev0_NC0405	Email from Auditor dated 23 August 2022	Not required to be submitted to EPA as this is not a Design Variation	Potential risk scenario is for overseeded Unit 2 cover soil particle size to result in underperformance of the soil as a growth medium for the Vetiver grass	Not likely	Minor	Low	Although vigorous growth of the Vetiver grass is important for stabilising the capping soils, the change in particle size distribution is minimal, and still meets the design intent and is considered by the Vetiver grass specialist consultants (Water & Carbon) to be a suitable growth medium. The Designer considered the material is suitable for use, providing the overseeded materials are not placed in the first layer of Unit 2 material in areas where traffic is likely to occur, to avoid damage to the GCL. The Auditor agrees with this recommendation, although also notes that the Unit 2 larger particle sizes were observed to breakdown into smaller sizes under load (i.e. it was clumped soil, rather than rock), therefore the risk of damage to the GCL is likely to be low.
NC06	Minor	Unit 8 Type D Geogrid Overlays	Unit 8 Type D roll lengths preventing continuous panel over full slope length	22453645-082-M-Rev0_NC0406	Email from Auditor dated 23 August 2022	Not required to be submitted to EPA as this is not a Design Variation	Potential risk scenario is for failure of the north-west and north-east hips on the slopes, due to insufficient veneer stability	Not likely	Minor	Low	The Designer has conducted veneer stability analysis, and this has been reviewed by the Auditor's support team, and the risk of veneer failure of the hip areas are constructed as per the design documents, inclusive of this design variation, is considered to be low.
NC07	Minor	Unit 8 Type C Reinforcement Geotextile Installation Damage	Unit 8 Type C Reinforcement Geotextile Installation Damage adjacent to stormwater chute crest	22453645-085-M-Rev0_NC0407	Emails from Auditor dated 23 August 2022 and 18 October 2022.	Not required to be submitted to EPA as this is not a Design Variation	Potential risk scenario is failure of the reinforcement geotextile (bearing) leading to slope failure (veneer stability)	Rare	Minor	Low	The repair proposed by the Designer provides the same level of veneer stability and strength in materials as the original design, therefore the risk remains unchanged from the original design, and is considered to be low and acceptable.
NC08	Minor	Unit 25 Cover Soil - Particle Size Distribution	Refer to NC05								
NC09	Minor	Survey top of Leachate Sumps	Leachate Sumps and Sump inverts were not surveyed	NA	Final Audit Report	Not required to be submitted to EPA as this is not a Design Variation	Reduced sump capacity resulting in potential for overflow	Not likely	Minor	Low	The contractor confirmed a minimum depth of 1.5m below the invert levels of the sump, and this appeared to be the case during the Auditor's inspection, therefore an absence of survey is not considered to represent a risk of leachate overflow.
NC10	Minor	Survey of Passive gas vents	Passive Landfill Gas vents were not surveyed	NA	Final Audit Report	Not required to be submitted to EPA as this is not a Design Variation	LFG Vents decommissioned during Cell 5/B cap construction as not surveyed	Not likely	Minor	Low	Refer to D12B. The updated design involved 2 Passive Gas Vents south of the Stage 3 Paved Irrigation Area. Construction of these were overseen by the GFA. The vents are visible and are not considered to present a risk of damage due to the absence of a survey of their location.
NC11	Minor	Pavement Thickness	Pavement thickness of 250mm not confirmed by survey	NA	Final Audit Report	Not required to be submitted to EPA as this is not a Design Variation	Pavement area falls into disrepair causing damage to the underlying features of the cap, in the event that the pavement thickness was less than the design thickness of 250mm.	Rare	Minor	Low	The pavement area is not considered to impact the cap design intent. It is understood that Council will maintain the pavement area post cap construction.
NC12	Minor	Northern Stormwater Diversion Bund	Northern Stormwater Diversion Bund not surveyed	NA	Final Audit Report	Not required to be submitted to EPA as this is not a Design Variation	Without a survey, it cannot be confirmed if the northern stormwater diversion bund is adequately constructed to manage stormwater run-off from the northern portion of the site. Therefore, the risk scenario considered is if the stormwater diversion bund has not been constructed as per the design requirements, then it may result in localised ponding or failure of the stormwater drainage in this area.	Not likely	Minor	Low	The GFA confirmed the stormwater bund construction had been undertaken in accordance with the design, based on field observations. Although an as-constructed survey has not been conducted, the oversight of the construction by the GFA, and visual inspection by the Auditor, provides a level of assurance that the stormwater bund has been constructed in accordance with the design and will function as intended.

Qualitative measures of likelihood		
Rating	Indicator	Frequency
5	Almost certain	Multiple incidents have been recorded
4	Likely	Several incidents have been recorded
3	Probable	Some incidents have been recorded
2	Not likely	Few recorded or known incidents
1	Rare	No recorded or known incidents

Qualitative measures of consequence/impact		
Rating	Indicator	Description
5	Severe	Human deaths, operations cause catastrophic off-site impacts, immense financial loss or severe environmental impact
4	Significant	Extensive human injuries or illness, operations cause substantial off-site impacts, major financial loss or major environmental impact
3	Medium	Some health impacts to humans, operations cause some external impacts, large financial loss or moderate environmental impact
2	Minor	First aid treatment, operations cause minimal off-site impacts, small financial loss or minimal environmental impact
1	Negligible	No recorded or known incidents

Severity		Probabilistic likelihood					
		Almost Certain	Likely	Probable	Not Likely	Rare	
Severe	V	V	V	V	V	H	
Significant	S	S	S	S	H	H	
Medium	M	L	L	L	L	L	
Minor	M	L	L	L	L	L	
Negligible	N	L	L	L	L	L	



Figures



LEGEND

 TOP OF 90mm POLY PIPE

AERIAL IMAGERY SHOWN HAS BEEN
OBTAINED FROM FYFE UAV FLIGHT
30/09/21



T412, Building 4, Lvl 1
631 Stuart Highway
PO Box 1726
Berrimah NT 0828
Telephone 61 8 8344 7888



ISO 9001
CERTIFIED
QUALITY
MANAGEMENT

0 25 50 75 100

SCALE 1: 1000

LEVEL DATUM :	AHD	DATE OF SURVEY :	VARIOUS
LEVEL AUTHORITY :		SURVEYOR :	JMO & BW
CO-ORD DATUM :	MGA94 (ZONE 52)	TITLE REF :	

DTA CONTRACTORS

ASCONSTRUCTED SURVEY

LEACHATE DRAINAGE PIPE

STAGE 3/4 CAPPING

SHOAL BAY WASTE MANAGEMENT FACILITY

DRAWING: 73852-1-SV-AS02-r4 (Pipe).dwg

INSTRUCTION:
73852-1

DATE
16/11/2022

SHEET
1 OF 1

REV.
4

FILE NAME: F:\SHOALBAY\73852-1\73852-1-SV-AS02-r4.dwg

ORIGINAL SIZE A3





T412, Building 4, Lvl 1
631 Stuart Highway
PO Box 1726
Berrimah NT 0828
Telephone 61 8 8944 7888



ISO 9001
CERTIFIED
QUALITY
MANAGEMENT

0 25 50 75 100 125

SCALE 1: 1250

LEVEL DATUM :	AHD	DATE OF SURVEY :	VARIOUS
LEVEL AUTHORITY :		SURVEYOR :	VARIOUS
CO-ORD DATUM :	MGA94 (ZONE 52)	TITLE REF:	

DTA CONTRACTORS

ASCONSTRUCTED SURVEY

ANCHOR TRENCH

STAGE 3/4 CAPPING

SHOAL BAY WASTE MANAGEMENT FACILITY

DRAWING: 73852-1-SV-AS03-r4 (Anchor Trench).dwg

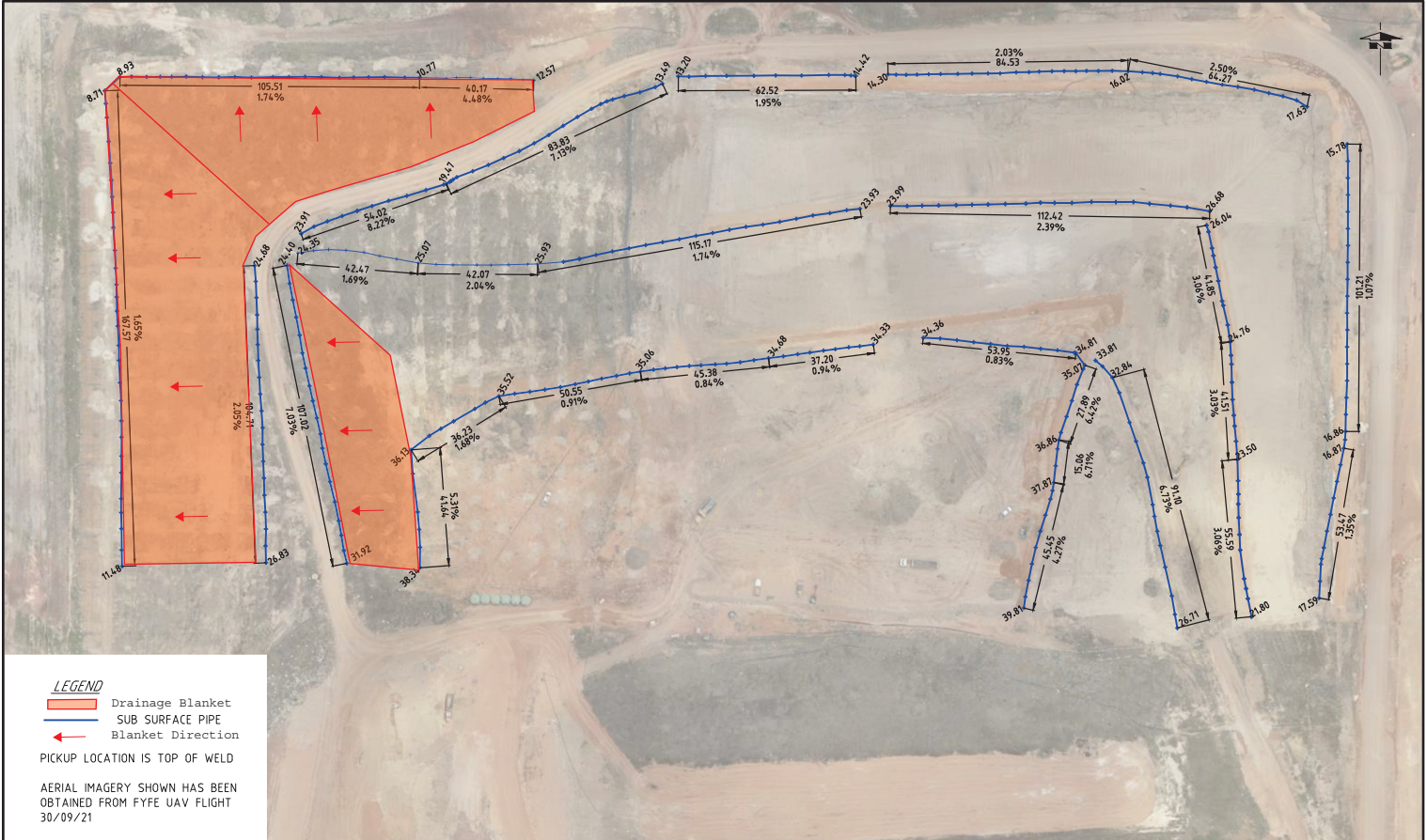
INSTRUCTION:
73852-1

DATE
21/10/2022

SHEET
1 OF 1

REV.
4

FILE NAME: F:\73852\73852-1-SV-AS03-r4.dwg; SCALE: 1:1250; DATE: 21/10/2022; SURVEYOR: DTA CONTRACTORS; PROJECT: SHOAL BAY WASTE MANAGEMENT FACILITY



LEGEND

- Drainage Blanket
- SUB SURFACE PIPE
- Blanket Direction

PICKUP LOCATION IS TOP OF WELD

AERIAL IMAGERY SHOWN HAS BEEN OBTAINED FROM FYFE UAV FLIGHT 30/09/21



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ISO 9001
CERTIFIED
QUALITY
MANAGEMENT



SCALE 1: 1250

LEVEL DATUM :	AHD	DATE OF SURVEY :	VARIOUS
LEVEL AUTHORITY :		SURVEYOR :	VARIOUS
CO-ORD DATUM :	MGA94 (ZONE 52)	TITLE REF :	

DTA CONTRACTORS

ASCONSTRUCTED SURVEY
SUB SURFACE PIPE
STAGE 3/4 CAPPING

SHOAL BAY WASTE MANAGEMENT FACILITY

DRAWING: 73852-1-SV-AS04-r4 (Sub Surface Pipe).dwg

INSTRUCTION:	73852-1
DATE	09/01/2023
SHEET	1 OF 1
REV.	4

ORIGINAL SIZE A3





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ISO 9001
CERTIFIED
QUALITY
MANAGEMENT

0 30 60 90 120 150

SCALE 1: 1500

LEVEL DATUM :	AHD	DATE OF SURVEY :	VARIOUS
LEVEL AUTHORITY :		SURVEYOR :	VARIOUS
CO-ORD DATUM :	MGA94 (ZONE 52)	TITLE REF :	

DTA CONTRACTORS

ANCONSTRUCTED SURVEY
FINISHED SURFACE LEVEL
STAGE 3 / 4

SHOAL BAY WASTE MANAGEMENT FACILITY

DRAWING: 73852-1-SV-AS05-r3 (Stage 3 FSL).dwg

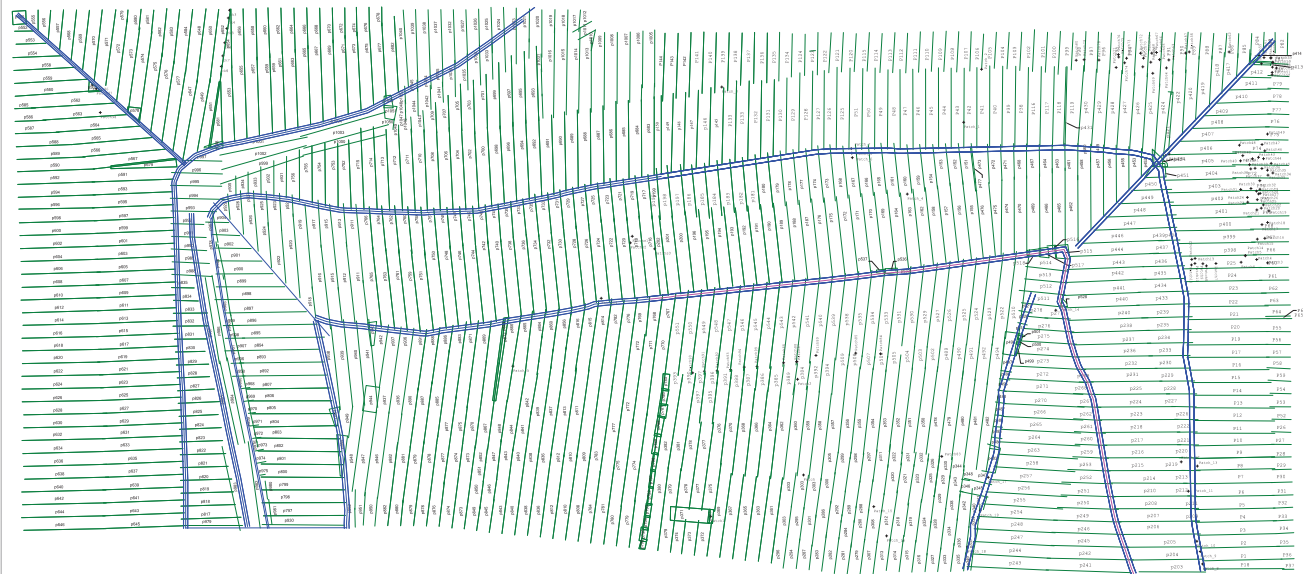
INSTRUCTION:
73852-1

DATE
19/12/2022

SHEET
1 OF 1

REV.
3

FILE NAME: F:\SHOALBAY\73852-1\SV-AS05-r3.dwg; DATE: 19/12/2022; TIME: 14:00; USER: J. HARRIS; PLOT: 19/12/2022 14:00



Notes:

Rev To: 0000.

REV:	DESCRIPTION:	BY:	DATE:
STATUS:	AS CONSTRUCTED		



CLIENT:

DARWIN CITY COUNCIL

CONSULTANT:

WSP GOLDER

SITE:

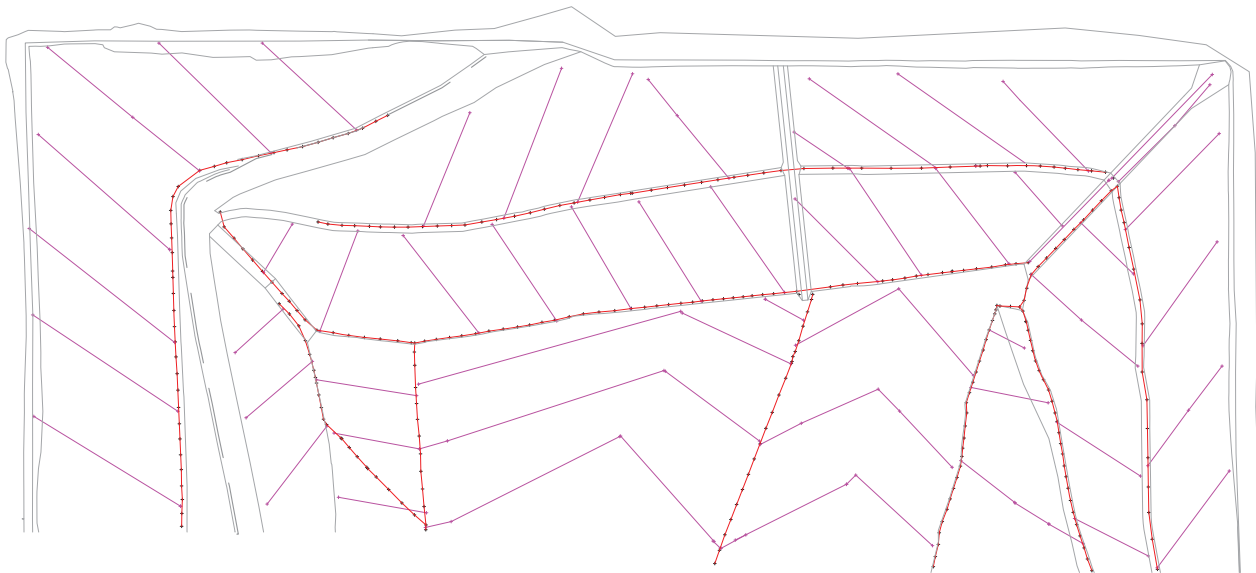
SHOAL BAY
WASTE MANAGEMENT SITE

TITLE:

STAGE 3 AND 4 CAPPING PLAN

SCALE AT A1:	DATE:	DRAWN:	CHECKED:
-	19/09/22	DD	DD
PROJECT NO:	DRAWING NO:	REVISION:	
P2007	A3/01	3	

— Unit 12
— Unit 11



Notes:

Insert Your Details...

REV:	DESCRIPTION:	BY:	DATE:
STATUS: AS CONSTRUCTED			



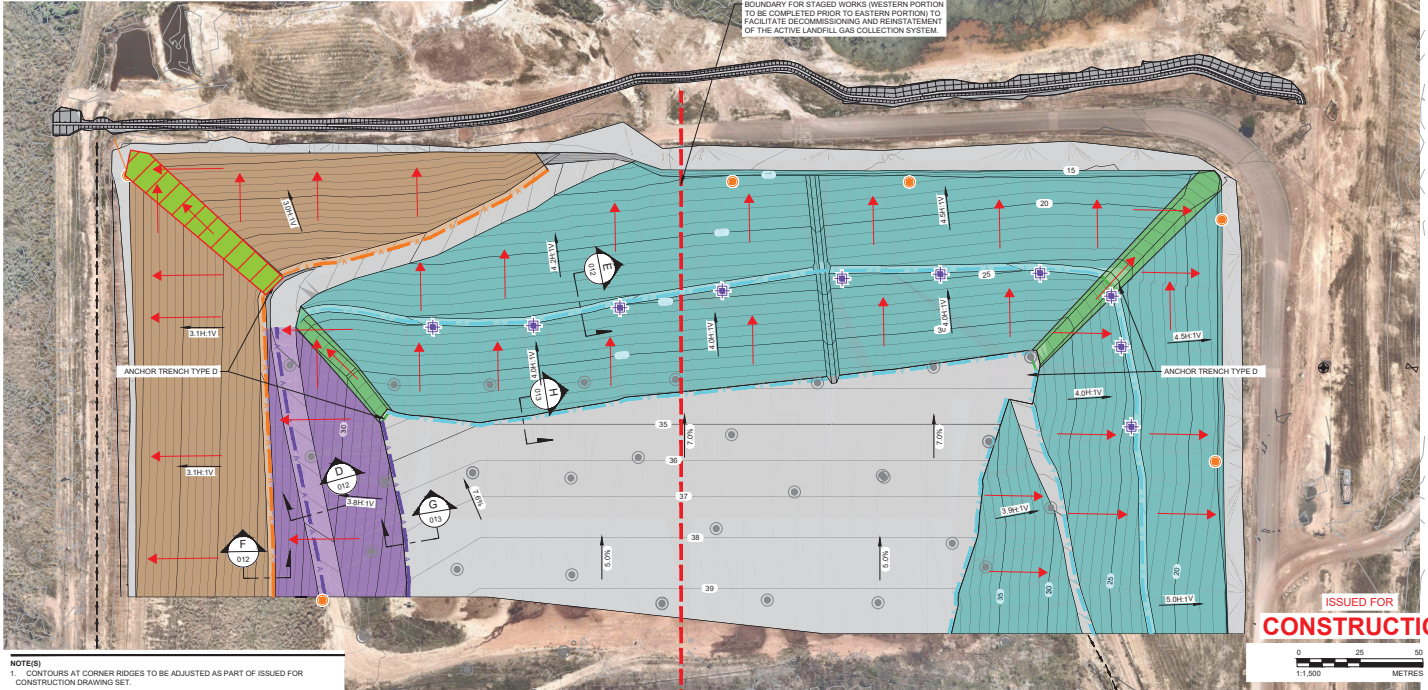
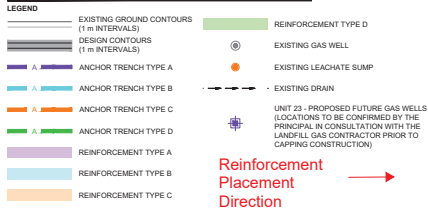
CLIENT: DARWIN CITY COUNCIL

CONSULTANT: WSP GOLDER

SITE: SHOAL BAY
WASTE MANAGEMENT SITE
TITLE: STAGE 3 AND 4 PASSIVE GAS

SCALE AT A3:	DATE:	DRAWN:	CHECKED:
-	24/10/22	DD	DD
PROJECT NO:	DRAWING NO:	REVISION:	
P2007	A3/02	0	

Reinforcement Placement Schematic



NOTE(S)

1. CONTOURS AT CORNER RIDGES TO BE ADJUSTED AS PART OF ISSUED FOR CONSTRUCTION DRAWING SET.

5	2021-09-06	RE-ISSUE	SW	ADGC	JSB	JSB
4	2021-08-25	ISSUED FOR CONSTRUCTION	SW	BGK	JSB	JSB
3	2021-06-11	ISSUED FOR CONSTRUCTION	BGK	BGK	SW	FWG JSB
2	2021-03-30	ISSUED FOR TENDER	SW	BGK	FWG	JSB
1	2020-12-22	ISSUED FOR TENDER	SW	SMW	FWG	JSB
0	2020-12-10	ISSUE FOR CLIENT REVIEW	SW	SMW	FWG	JSB
REV	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED

CLIENT
CITY OF DARWIN



BRISBANE OFFICE
147 CORONATION DRIVE
MILTON, QLD 4064
AUSTRALIA
(+61) (7) 3721 5400
www.golder.com

PROJECT
SHOAL BAY WASTE MANAGEMENT FACILITY
STAGE 3 / STAGE 4 CAPPING PROJECT

TITLE
GENERAL ARRANGMENT PLAN - CAPPING REINFORCEMENT

PROJECT NO. 20145676 CONTROL 013 REV. 5 6 of 20 DRAWING 006