Attachment to item number 5.1 -

Environmental Effects Report; and

Environmental Assessment Report

PLANNING & ENVIRONMENT

Copping Landfill Expansion Cells 10 and 11

Southern Waste Solutions

Environmental Effects Report | 11 July 2023

ERA Planning Pty Ltd trading as ERA Planning and Environment

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1 Part A – Proponent Information

Proponent entity name	Copping Refuse Disposal Site Joint Authority
Proponent trading name	Southern Waste Solutions (SWS)
Registered address of proponent	129 Derwent Park Road, Derwent Park, TAS, 7009
Postal address of proponent	PO Box 216 New Town, TAS, 7008
ABN/ACN of proponent	87 928 486 460
Contact person's details	Chris Adekunle 0409 574 727 chrisadekunle@swstas.com.au
Consultant's details	Dan Elson (03) 03 6165 0443 daniel@eraplanning.com.au

The Copping Refuse Disposal Site Joint Authority, trading as Southern Waste Solutions (SWS) is a jointly owned entity by Clarence City, Sorell, Tasman, and Kingborough Councils. The joint authority consists of four Members appointed by Participating Councils, who may be either elected Councillors or Council employees.

SWS services the Break O 'Day, Brighton, Clarence City, Glamorgan Spring Bay, Glenorchy City, Hobart City, Huon Valley, Kingborough, Sorell, Southern Midlands and Tasman Local Government Areas.

2 Part B – Proposal description

2.1 Background to this assessment

Southern Waste Solutions (SWS) operates and manages the existing Copping Landfill, which provides waste management services to eleven municipal areas in southern Tasmania. The existing landfill is a level 2 activity under the *Environment Protection and Pollution Control Act 1994* (EMPC Act), operating under several Environment Protection Notices (EPNs) for various aspects of the site. Development approval under the *Land Use Planning and Approvals Act 1993* (LUPA Act) for the Copping Landfill was originally obtained in 1999. Subsequent planning permits have been issued associated with the development of different elements of the landfill and changes to the landfill operations.

Copping Landfill operates with two classes of waste cell. The 'B-Cells' accept municipal solid wastes, commercial, building and industrial wastes, clinical and related waste, and Level 1 classified contaminated soil (category A and B waste), which constitutes most of the waste received at the site. The 'C-Cell' has been engineered and constructed to accept Level 2, 3 and 4 classified contaminated soil (category C waste) as per the EPA Tasmania *Information Bulletin 105 Classification and Management of Contaminated Soil for Disposal*. The current application is only associated with the operation of the B-Cells at the landfill, with the C-Cell managed as a completely separate process under its own permit.

The Copping Landfill was assessed and approved by the Sorell Council and the Environment Division (now the EPA Tasmania) in September 1999 under Development Application (DA) 46/98 and attached Permit Conditions – Environmental (PCE) 6133. The DA approved the construction of 17 landfill cells in two stages; with cells 1-9 representing Stage 1A and cells 10-17 representing Stage 1B. Approval for landfill cell construction and filling of the constructed cells was separated; with approval currently in place for construction and filling of cells 1-9 (Stage 1A) and construction only for cells 10-17 (Stage 1B). The original maximum quantity of waste to be received by the Stage 1A cells was 35,000 tonnes/year.

Subsequent approvals relevant to the construction and operation of Stage 1A and Stage 1B cells are outlined below:

- In 2004, the conditions of PCE 6133 were varied by EPN 690/1 to regulate disposal of Low-Level Contaminated Soil and the disposal of quarantine waste, increase the volume of waste to a maximum quantity of 104,000 tonnes per year (B-Cells), and to update/clarify some conditions.
- In 2008, a minor amendment to DA 46/98 was granted by Sorell Council to increase the permitted height of cells 1-3 from 75m to 90 m AHD.
- In 2021, DA 2020/484 was approved to increase the permitted heights of cells 4-9 from 75 m AHD to 90 m AHD, this was reflected as a G7 approval against EPN 690/1.
- In 2022, the early design and construction of cells 10-11 was approved by the EPA in accordance with conditions G7, E1 and E2 of Permit No. 46/98 as varied by EPN 690/1. This addressed detailed construction requirements but did not authorise filling of the constructed cells.

The existing Stage 1A cells are estimated to reach capacity in August 2023, ahead of original forecasts. This is due in part to the closure of the McRobies Gully Waste Management Centre in South Hobart, and additionally the reduction of available airspace at other landfills in southern Tasmania. These factors have resulted in additional waste being diverted to the Copping Landfill.

To address the approaching capacity issue at the existing B-Cells, in 2021 a permit application for the landfilling of Stage 1B was lodged with the Sorell Council (DA 5.2021.98.1), who subsequently referred the project to the EPA. The EPA determined the class of assessment under the EMPC Act to be class 2B and issued Project Specific Guidelines for the proposal.

Drafting of the EIS commenced on the basis of using an experimental wetland leachate treatment system to treat B-Cell leachate, a trial of which was running concurrently with the EIS drafting. In 2022 the results of the experimental wetland indicated that, whilst somewhat effective, it would be ineffective at treating leachate to an environmentally acceptable level at the eventual throughput capacity required for the B-Cells.

In light of this, drafting of the EIS was paused and an alternative leachate treatment system sought. SWS opted to trial a forced evaporative system used successfully in other states in Australia. The 'BeneVap' system was approved for a 12-month trial in early 2023 under condition E2 of EPN 690/1.

To enable the proposal for the Stage 1B cells and associated leachate treatment system to be adequately assessed, the EPA required in-situ monitoring results of the system to prove it can adequately treat leachate at the site in an environmentally acceptable manner. The trial results will not be available until late 2023. If SWS were to await the completion of the trial and then commence an application for landfilling of Stage 1B in its entirety, the approval timeframes would exceed the predicted capacity of the landfill (of August 2023) creating a shortfall in available space to accept the expected waste volumes.

This presents a significant issue for landfilling requirements for southern Tasmania, and so in conjunction with the EPA and Sorrell Council, an interim solution was proposed, namely, to seek approval for the landfilling of Stage 1B cells 10 and 11 in advance of the remaining Stage 1B cell (i.e., cells 12 through to 17). This proposed approach involves landfilling of cells 10 and 11 in accordance with existing landfilling and leachate management practices (including the use of the new BeneVap trial system). This approach will allow SWS to begin filling landfill cells 10 and 11 in late 2023, to address the expected waste volume shortfall capacity in the Stage 1A B-Cells (1 to 9), in parallel with seeking approval for the upgraded leachate treatment system and landfilling of the remaining Stage 1B B-Cells (12 to 17).

Approval for the interim solution was proposed to be achieved through the submission of a new Development Application and the completion of a class 2A assessment of the new proposal (this document) to ensure it will not present an unacceptable environmental risk under the EMPC Act.

This EER therefore seeks approval for the interim proposal to allow the filling of cells 10 and 11. In parallel with this application, SWS will complete the leachate trial and prepare an application for upgrades to the leachate treatment system and subsequent landfilling of cells 12 to 17 (hereafter referred to as the 'future application').

Project site (the Land)
Landfill footprint
Stage 1B B-Cell 10 & 11
Stage 1A B-Cells
Dwellings

EXISTING INFRASTRUCTURE
Road
NATURAL FEATURES
Contour lines (10m)
Rivers and streams
Food plain or wetland
Water body

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Copping Landfill

Figure 2-1
Project site

2.2 Description of proposed activity

Proposed activity

Activity	The existing Stage 1A cells will reach capacity in August 2023 and the construction of the approved Stage 1B B-Cells 10 and 11 will be commenced in the coming months, as approved for construction by the Director, EPA under condition G7, E1 and E2 of EPN 690/1. The existing approvals facilitate landfill construction for Stage 1B cells 10 and 11, but not filling. The proposed activity is therefore the expansion of permitted landfilling into cells 10 and 11 of the Stage 1B B-Cells using the existing operational processes used for the Stage 1A B-Cells. Landfilling of the remaining cells (i.e. cells 12-17) and new operational processes (including upgraded leachate treatment system) will form a separate future application. In addition to landfilling of Cells 10 and 11, the proposal also seeks to increase the approved heights of Cells 10 and 11 from 75 m AHD to 90 m AHD (consistent with cells Stage 1A B-Cells 1 to 9), and to increase the maximum allowable annual waste tonnages for acceptance at the B-Cells from 104,000 tonnes/year to 200,000 tonnes/year, commensurate with the predicted waste flow from southern Tasmania. Collectively, the above proposed activities are referred to as 'the Project' throughout this document. The classification of the activity under Schedule 2 of the *Environment Protection and Pollution Control Act 1994* (EMPC Act) is Waste Treatment and Disposal.
New or existing activity	The Project is for the modification and intensification of an existing landfilling activity.
Product or purpose	The purpose of the Project is landfilling of primarily municipal and clean fill waste.
Maximum quantity/limit	The Project seeks approval for the acceptance of 200,000 tonnes/year of waste at the existing Copping Landfill facility and an increase of allowable Stage 1B B-Cell height from 75 m AHD to 90 m AHD (for cells 10 and 11).
Methods/s	Cell construction (excluded from application, provided for context only) The construction of cells 10 and 11 will occur in a similar fashion to the existing B-Cells. The following is a brief explanation of the construction process of the cells for contextual purposes (noting this application relates to landfilling of these cells only, because construction of the cells is already separately approved and has been commenced). Earthworks will initially be completed to achieve a flat foundation surface in the cell footprint area. Cell bases will then be prepared using a suitable stable sub-base of compacted crushed rock of approximately 200 mm, the sub-base will be sourced from the existing onsite borrow pit(s). The premise of the sub-base is to provide a suitable flat surface to compact a subsequent clay layer on top of. Once the sub-base is in place, clay berms will be constructed around the cell(s), the berm slopes are generally 1.5:1, with shallower slopes at the downstream berm outer sides of 2.5:1. The clay will also be sourced from the existing onsite borrow pit(s). Once berms are shaped, a 1 m clay layer will be compacted over the cell floor, and leachate drain cavities trenched into the clay. A 2 mm HDPE geosynthetic liner will then be installed across the cell floor up on to the sides of the berms. The liner will then be anchored on to the top of the berms. A 300 mm drainage blanket of approximately 20 mm round gravel will then be spread over the cell floor. Leachate collector drains will be installed in the leachate cavities on a thick bed of base gravel and then filled up with more gravel until the drains are level with the rest of the cell floor. The drains are essentially slotted agricultural pipes that gravity drain through the berms surrounding the cells in to the existing leachate collection system (described further below). The final layer of the cell is a non-woven geotextile fabric, which will be co-anchored with the geosynthetic liner in the liner anchor trenches in the berms. A final layer of 300 mm of general fill material will then be placed on top of the geotextile fabric, making the cell viable for landfill operation. Cell operation (landfilling)

Once constructed, landfilling of cells 10 and 11 (the focus of this application) will make use of existing landfilling practices and existing leachate collection and treatment systems in place (inclusive of the BeneVap leachate treatment system currently being trialled).

Waste will be deposited directly from waste transfer trucks onto working cell faces, where a variety of earth moving equipment (rollers, dozers, and excavators) will be used to compact and cover the waste with soil.

At the end of each working day, a cover of clean fill material will be placed over the active landfill cell face. This cover material will be sourced from the Project's clay borrow pits or from stockpiled resources of clean fill from cell preparation. Landfilling will be completed in approximately 2 m bench lifts, with faces smoothed as the benches progress up to maintain good drainage function.

The cells will then be filled to their maximum allowable height (i.e. 90 m AHD). Cells 10 and 11 are expected to take approximately 2-3 years to fill to capacity. Once full, a process of capping will take place (refer Proposal Timeline section below). The operation of the active landfill cell faces within the cells will be restricted to a maximum area of 2,000 m^2 at any one time, as far as reasonably practicable.

Leachate draining from the base of the leachate collection system installed in each new cell will be gravity fed to the existing dedicated B-Cell leachate pond where it is currently stored for passive evaporation or pumped through to the new trial BeneVap leachate treatment system (subject to separate approvals). The experimental leachate treatment wetland on site is not currently in use.

The BeneVap system is a forced evaporative system designed to reduce leachate volume by 95% and higher (based on leachate quality), rather than treating and discharging the leachate through filtration or chemical fixation. The major benefit of the process that large volumes of effluent are not required to be managed and discharged post-treatment due to the evaporation of the water component of the leachate; only the remaining sludge from the process is required to be disposed of (which goes to the C-Cell). If successful and approved, the new system will negate the need for any further leachate management at the site as it will be capable of treating all leachate from both the B-Cell and C-Cell areas in the future. No discharge to the environment is therefore proposed for the leachate produced by the Project.

Stormwater from cells 10 and 11 will feed into the existing stormwater system. Stormwater from existing operations is categorised into two separate types, Primary stormwater is considered to be 'clean' surface runoff from the margins of the site that has not had direct contact with landfill cells, or runoff from capped and rehabilitated cells. Secondary stormwater is potentially contaminated surface run off that has been in contact with the uncapped landfill cells, internal roads or other potentially contaminated surfaces.

These stormwater flows are collected in two separate ponds, namely a primary stormwater pond, which collects stormwater from the external perimeter drains (cut-off drains) of the landfill (before it has come into contact with the landfill site) and capped cell stormwater drains, and a secondary stormwater pond, which collects stormwater run-off internal to the remaining landfill areas. New interim primary and secondary stormwater drains will be dug to connect the new cells to the existing ponds. An upgraded stormwater management system will be installed as part of the separate future application; this is discussed further in Section 3.2.

Primary stormwater is considered clean and is free to discharge to the receiving environment as required. Upstream of the site, to the north and east of the Stage 1B B-Cells, the clean stormwater diffusely discharges into the surrounding environment at the end of the cut-off drain. The stormwater collected in the primary stormwater pond is discharged as required via a man-made channel and subsequent drainage line through to an ephemeral tributary of the Carlton River that runs adjacent to the landfill site, shown in Figure 3-1.

Secondary stormwater has been found, through the existing water quality monitoring program, to contain traces of contaminants from the landfill site and so is stored separately for stabilisation and settlement. Once solids have settled, the resulting water is either being reused on site or pumped to the primary stormwater pond, to be shandied with the primary stormwater (to dilute any residual contaminants) and is then discharged along with the primary stormwater as required.

Each B-Cell has a network of landfill gas pipelines installed which transfer the generated landfill gas (methane) to a co-generation system at the landfill site. The new cells 10 and 11 will employ the same system. The current system comprises a network of several gas collection wells in each capped cell, which consist of slotted or perforated 90 mm PVC tube casings, which are installed vertically to a depth of between 50 – 90% of the cell depth. Gas flows passively into the wells as a result of the cell capping being in place. The individual gas well flowlines are connected to intermediary lateral flowlines that then feed to the main

	280 mm diameter gas transfer flowlines that surround the site. These main flowlines deliver the gas under a low-pressure vacuum to one of two gas-powered generators onsite. The site uses two 1 megawatt (MW) Jenbacher gas-powered generators, which generate approximately 17,000 MW/hours of electricity per annum. The power generation is managed and on-sold by LMS Energy Pty Ltd, who purchased the rights to the landfill gas from SWS. Energy production through this system commenced on 17 February 2019. SWS is currently working with LMS Energy to progress the installation of a permanent landfill gas supply line and metering unit for the BeneVap forced evaporation system. As mentioned, clay, gravel, and soil for landfill cover is sourced from one of two on-site borrow pits. There is no planned change to existing borrow pit operation or size to facilitate landfilling of the new cells. The Copping Landfill is a private facility (not open to the public) that operates through a customer account system, who purchase the right to use the facility. The landfill accepts waste directly and also via the Lutana Waste Transfer Station (129 Derwent Park Road, Lutana), which is operated by SWS. Figure 2-4 displays the locations of each of the abovementioned operational components.
Industry standards	Applicable industry standards and guidelines include: • Tasmanian Landfill Sustainability Guide 2004 • Information Bulletin No.105 - Classification and Management of Contaminated Soil for Disposal (IB:105)
Transport	Transport of waste material from the Lutana Waste Transfer Station and other waste transfer stations occurs via the existing public road network to the Copping Landfill site which is accessed via Blue Hills Road from the Arthur Highway. Approximately 16 vehicles currently access the landfill site per day (including to and from the site, this equates to 32 trips in total), including site workers in light vehicles and waste deliveries in waste trucks. It is expected that the proposal will result in a small increase in the number of trips, to 43 (to and from) (~34% increase), including 12 trips to and from the site within the morning peak hour (between 7-8.30 am) (Howarth Fisher and Associates, 2023).
Stockpiling	Aside from the waste stream itself, the only stockpiled material will be soil for covering the waste, which will be sourced from the existing clay borrow pits on-site and stockpiled within the working cell area and used as required. The final capping of the cells will use clay from the existing clay borrow pits on-site.
Area of disturbance	The maximum area of the site proposed for disturbance for Cells 10 and 11 is 0.9 ha, as approved under the existing permit for the site.
Major equipment	The proposal includes the continued use of existing delivery vehicles and earth moving equipment (rollers, dozers, and excavators). Delivery vehicles will unload waste directly into the landfill cells. Earth moving equipment will then relocate, spread and compact waste within each cell. No new major equipment is required for the proposal.
Infrastructure	This project does not propose any new infrastructure, as it relates only to filling of cells 10 and 11, the construction of which was subject to separate approvals. New infrastructure for the cell construction (authorised via separate approval) includes the two new cells (B-Cells 10 and 11), an extended access road to the base of the cells, extended stormwater and leachate collection system, and an extended landfill gas collection system. All of which will be constructed in line with the existing permit for the site. The key aspects of the new infrastructure are as follows: • The new access road will be an extension of the existing access road on-site. • The new stormwater collection extensions will connect to the existing stormwater treatment systems operating on-site in an interim measure until the larger stormwater system is installed as part of the separate future application. • The new leachate collection extensions will connect to the existing leachate treatment systems operating on-site, including the new BeneVap system. • The new landfill gas collection system will connect to the existing co-generation system within the landfill site and will supply additional gas to the system. • The existing clay borrow pits will be used to supply the proposal with soil and clay.

Proposal timeline	Construction of the new B-Cells 10 and 11 commenced in early 2023 (via separate approval), with landfilling proposed to commence in Cell 10 after August 2023. No specific commissioning steps are required after the construction of the cells has been completed. Landfilling will continue in the two cells until capacity is reached in approximately 2 years' time (mid-2025). Once cell height limits are reached, a temporary clay capping will be placed over the cells for a period of 1-2 years (around 2026-2027) to allow natural settling and consolidation of the waste material to occur. Once sufficient settling has occurred, a final clay capping will be applied to the cell (around 2027-2028) to encapsulate it, preventing migration of further rainwater into the cell and also trapping landfill gas and directing it to the landfill gas management system. Essentially, once capped, cells will be in an inert state from the surface and vegetation regrowth will likely commence over the capped cell.
Operating hours	The Copping Landfill operates Monday to Friday 7 am-5 pm (last loads 4 pm), Saturday 7 am-4 pm (last loads 3 pm) and public holidays 7 am-4 pm (last loads 3 pm). The landfill is closed on Sunday, Good Friday and Christmas Day. There are no proposed changes to existing operating hours as a result of this project.

Location and planning context

Location	The site is located at Arthur Highway, Copping (entrance through Blue Hills Road) and the activity will take place on Title Reference 1260731/1, Property ID 1824896. The boundary of the title constitutes the Land on which the proposal will occur, this is referred to as the 'Project Site' throughout the remainder of this document.
Planning permit	A Planning Permit is required under the *Land Use Planning and Approvals Act 1993* (LUPA Act), as advised by Sorrell Council (see Appendix A). This was lodged on 30 March 2023 and referred to the EPA.
Land zoning and tenure	The Project Site is zoned Utilities under the Tasmanian Planning Scheme – Sorell and is owned by Sorrell Council, Clarence City Council, and Tasman Council. The surrounding zoning is as follows: • Land immediately to the north, north-west, west, south west and south-east is zoned Rural. • Land immediately to the south is zoned Utilities. • Land immediately to the north-east is zoned Agriculture.
Use Class and Permissibility	The use class of the Project is Recycling and Waste Disposal; the use is permitted in the zone under the Tasmanian Planning Scheme – Sorell.

Description of site and surrounds

Land use	The Project Site is used exclusively for landfilling. Surrounding land is primarily used for agricultural purposes, with large tracts of native bushland and several private conservation reserves. The area surrounding the Project Site is sparsely populated, with occasional residential dwellings associated with farm land. The only recreational area in the vicinity is a shooting range located at the entrance to the landfill. The nearest sensitive receptor is located approximately 220 m from the boundary of the Project Site (~1.1 km from the centre of current landfill operations).
Topography	The Project Site is located within a broad valley, surrounded by ridges to the north (containing Castles Hill), south-east (containing Little Blue Hill) and near the southern and western boundaries of the Land. The topography of the site is shown in Figure 2-1.
Climate	Climate data is available from the Hobart Airport (west) weather station (094008), located approximately 20 km from the Project Site. The climate is cool temperate, with an annual mean minimum temperature of 8.2°C and a mean maximum temperature of 17.6°C (Bureau of Meteorology, 2023). January is the hottest month, with a mean maximum temperature of 22.7°C and July the coldest, with a mean maximum of 12.6°C.

	An annual mean rainfall of 492 mm was recorded between 1958-2022. Winds are predominantly north-west, with the strongest winds recorded in spring and summer, with calmer winter winds (annual average wind roses are provided in Figure 2-2 and Figure 2-3).
Geology	The majority of the Project Site consists of very low permeability sandy clay to clayey sand on top of felspathic (low quartz) sandstone bedrock. The ridges surrounding the Project Site consist of sandy clay on top of weathered dolerite bedrock. Gravelly sand/clay scree deposits have formed on the sides and bases of steep slopes. Colluvial deposits of sandy to silty clay are present in the base of the valley and marsh areas (Woodward-Clyde, 1998). Investigations undertaken at the Project Site have identified groundwater within a shallow unconfined aquifer lying on the bedrock, and within deeper sandstone fractures, as outlined in Appendix B. Groundwater levels vary across the site and range between 0.4 m to 12 m below ground surface. The static water level is approximately 1.14 m below ground surface. Groundwater flows from the valley to the north, passing through the marsh system at the northern boundary of the Project footprint before discharging to the Carlton River and tributary (Woodward-Clyde, 1998). There are no sites of geoconservation values within or adjacent to the Project Site.
Soils	The majority of the Project Site consists of very low permeability sandy clay to clayey sand. There are no acid sulfate soils (ASS) or potential acid sulfate soils (PASS) identified within the Project Site (theLIST, 2023). The Project Site contains occasional marsh areas which can harbour acidic soils, however there are no intrusive works planned for these areas. There is a small area of extremely low probability of occurrence outside of the Project Site to the north. Field investigations undertaken for the original site Development Proposal Environmental Management Plan (DPEMP) did not identify any ASS or PASS (Woodward-Clyde, 1998). Past and current use of the Project Site as a waste disposal facility presents the risk of occurrence of contamination within the soils and groundwater of the site.
Hydrology	The Carlton River intersects the north-western boundary of the Project Site and an unnamed tributary of the river (referred to as the Carlton River Tributary) flows through the northern part of the site (approximately 325 m north-east of cells 10 and 11) which captures water from the valley. Other surface water features located within the Project Site are associated with the current landfill operations, including surface water drains, sedimentation ponds, leachate ponds and wetlands. Some surface water discharges to an ephemeral marsh to the north of the Project footprint. There is a small creek that flows through the wetland area capturing drainage from the sedimentation pond drain and marsh area (colloquially known as Marsh Creek), eventually discharging to the Carlton River Tributary, as shown in Figure 3-1.
Natural values	The Project Site contains both native vegetation and cleared areas. The proposed footprint for cells 10 and 11 is already cleared of native vegetation. The Project Site more broadly contained one threatened native vegetation community, namely *Eucalyptus ovata* forest and woodland (DOV) (see Figure 3-2). The DOV community is listed as threatened under the *Nature Conservation Act 2002* and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Vegetation at the Project Site was severely impacted by the 2012-2013 bushfires (NBES, 2021). The Project footprint occurs on land classed as extra-urban miscellaneous (FUM). There will be no disturbance to the mapped native vegetation. No threatened flora species have been identified or are expected to occur within the Project Site. Three weed species declared under the Tasmanian *Weed Management Act 1999* were identified within the Project Site: Spanish heath, serrated tussock and slender thistle (NBES, 2021). Native vegetation within the Project Site contains suitable habitat for several threatened fauna species, including the Tasmanian devil (*Sarcophilus harrisii*), spotted-tail quoll (*Dasyurus maculatus* subsp. *maculatus*), eastern quoll (*Dasyurus viverrinus*) and the chaostola skipper (*Antipodia chaostola* subsp. *leucophaea*). A targeted den survey was undertaken for the Tasmanian devil which confirmed the presence of this species within the Project Site (NBES, 2021); the identified dens are a significant distance from the current Project footprint of cells 10 and 11. Potential foraging habitat for several listed bird species was identified, albeit with low to moderate likelihood of occurrence of the species, including the grey goshawk (*Accipiter novaehollandiae*), wedge-tailed eagle (*Aquila audax* subsp. *Fleayi*), swift parrot (*Lathamus discolor*) and Tasmanian masked owl (*Tyto novaehollandiae* subsp. *Castanops*). No suitable nesting habitat was identified for these species (NBES, 2021).

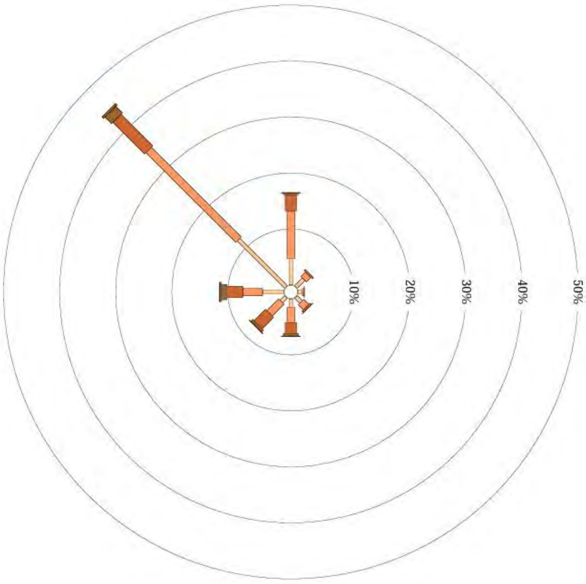


Figure 2-2 9 am wind rose (weather station 094008) (Bureau of Meteorology, 2023)

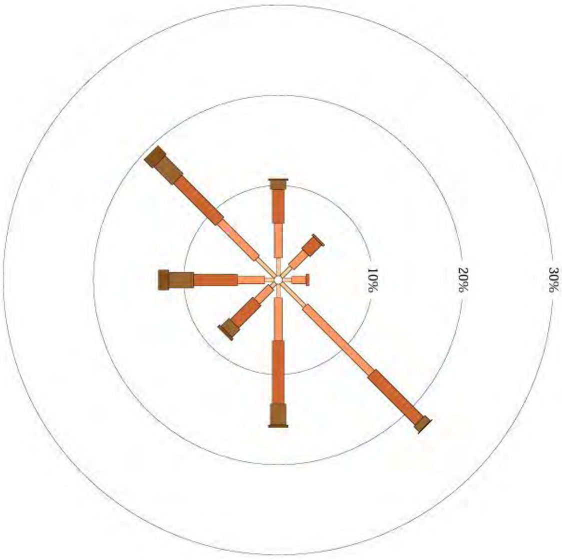
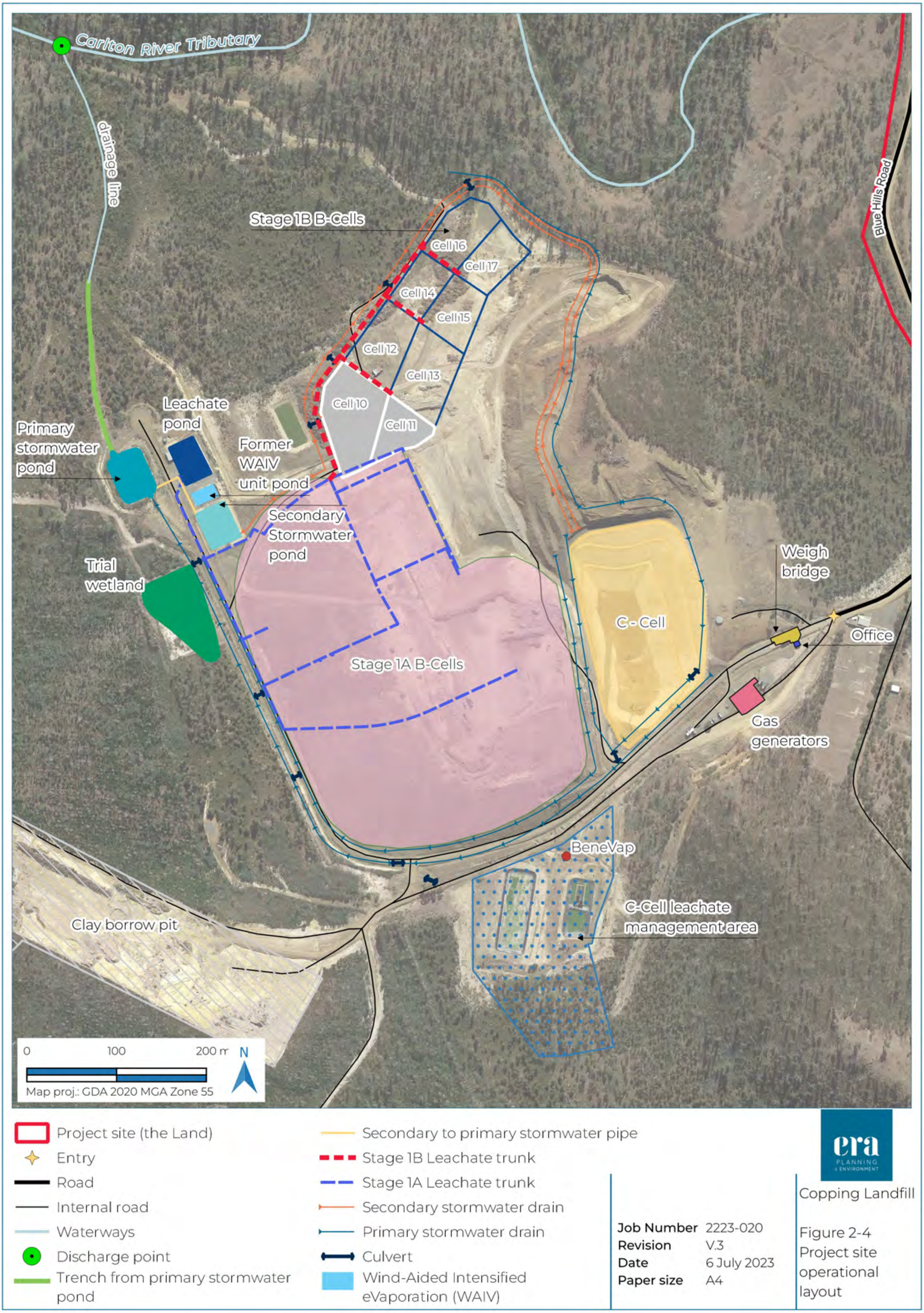


Figure 2-3 3 pm wind rose (weather station 094008), (Bureau of Meteorology, 2023)



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Copping Landfill

Figure 2-4
Project site operational layout

2.3 Project rationale and alternative

As discussed in Section 2.1, the Project is considered an interim measure to allow the continued acceptance of landfill waste in the B-Cell area of the facility whilst a more comprehensive proposal is developed for the future operation of the Stage 1B B-Cells, which is currently in train with the EPA. This will include a new advanced leachate management system (BeneVap), that must complete trials prior to being assessable for approval under the EMPC Act, expansion of one of the existing clay borrow pits within the Project Site, and additional ancillary infrastructure.

As previously discussed, the existing Stage 1A B-Cell area is rapidly reaching capacity significantly faster than initially anticipated due to closure of other facilities and the subsequent redirection of waste streams to the Copping facility. The additional landfilling capacity that forms the Project will allow landfilling to continue uninterrupted whilst the more complex future application progresses through its development application approval process timeline.

In the event landfilling was to cease in the Copping Landfill B-Cells, an alternative landfilling site would be required to accept the ongoing waste disposal requirements of the involved municipalities. There are currently no alternative landfill sites in southern Tasmania with spare capacity to accept the additional waste loads currently accepted by the Copping Landfill; this would present a significant problem for waste management in the Hobart region. In consideration of the above, no alternatives outside of the current landfill site were considered and it was not considered an option to do nothing as the waste stream must be collected somewhere for public safety.

Continued filling of the existing Stage 1A B-Cells by extending allowable height limits was not considered viable due to the existing final capping systems in place, including landfill gas infrastructure.

Alternative locations for the new B-Cells within the broader Project Site were not considered due to the extensive engineering and design work that had already been undertaken for the current Stage 1B plans; other locations also contain higher quality vegetation.

2.4 Existing activity

The Copping Landfill facility commenced operation in 2001 and has continued to operate successfully since that date.

A single known leachate leak event occurred in March 2023. Approximately 30 kL of leachate recirculated on top of the active landfill cells flowed into the secondary stormwater drains (rather than seeping into the cell), as a result of human error, and started flowing towards the secondary stormwater pond. The leachate was contained with a temporary bund prior to it reaching the secondary stormwater pond and was pumped back to the leachate pond. The affected drains and bund were excavated and remediated prior to any rain events occurring. This incident was reported to the EPA.

An extensive quarterly environmental water quality monitoring program has been in place at the landfill since inception, which has been further improved over the operational period. The program monitors surface and groundwater, with a primary focus on detecting leachate leaks into the receiving environment. Monitoring results indicate o leachate leaks or spills associated with the existing B-Cells have occurred prior to the abovementioned event (AquaSci, 2021c; AquaSci, 2019). . Further information on environmental monitoring is included in Part C of this document.

A single odour complaint was made by a resident of Copping in 2021. Generally public complaints have been minimal in regard to the Copping Landfill.

The only other environmental breaches associated with the Copping Landfill have been exceedances in allowable waste tonnages received. This has occurred in the last three annual periods due to the unforeseen additional waste tonnages required to be accepted, as discussed previously. An increase in licensed annual tonnages is being sought as part of this application for the new cells to avoid a similar situation in the future.

3 Part C – Environmental impacts and management

The following sections (Sections 3.1 through to 3.13) document the potential impacts and proposed management, mitigation, monitoring and reporting for the Project. Management and monitoring measures are documented separately in each section and collated into summary tables in Part D - Summary of proposed management, mitigation and monitoring measures.

The Project will have no construction phase, as the construction of Cells 10 and 11 and associated infrastructure are covered in a separate permit and already underway. The environmental impact assessment therefore focusses solely on the operation of the Project (i.e. the filling of the cells), with any construction impact assessment provided for context only.

Additional to the discipline-specific measures documented in the following sections, there are also several measures that are applicable more broadly across all environmental disciplines. These key measures are summarised in the following table and will be applied to the Project in its entirety.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
Various MM 1	The existing site Operational Environmental Management Plan (OEMP), which captures all relevant existing operational phase management measures, will be updated to include any new operational permit conditions as a results of the Project. The document will be made available to the EPA upon request. The OEMP will be implemented throughout operation.
Various MM 2	During the operational phase of the Project, the results of relevant environmental management and monitoring stipulated in this EER (and any resulting approval conditions) will be documented in Annual Environmental Reports to be submitted to the EPA within 3 months of the conclusion of the annual reporting period each year.
Monitoring	
Various MON 1	Monitoring procedures for operational environmental controls are documented in the existing OEMP and will be implemented during the operational phase, including as a minimum: • Development of an online complaints register and weekly monitoring of the register. • Daily visual monitoring of active operational areas for dust and other visible emissions (e.g. wind-blown waste and visible water quality issues including high sediment loads or surface sheen). • Fortnightly audits of the physical site operational controls (including sediment and erosion control measures and waste management). Additional audits will be undertaken after extreme weather events. • Annual audits of all management measures set out in the OEMP. • Any non-conformance identified during inspections and audits will be documented, investigated, and resolved. • Audits will be made available to the EPA on request. • Any non-conformance or incident with the potential for serious or material environmental harm will be reported to the Director, EPA within 24 hours.

3.1 Air quality

3.1.1 Existing environment

Local airshed flows in the area of the Project Site are influenced by proximity to the coast and topographic features in region, resulting in a predominantly north-westerly wind direction (Hobart Airport [west] weather station [094008]). The air quality in the region is expected to be of a high quality given the relative lack of industry and low population level.

The nearest sensitive receptor to the site is located on a ridge, approximately 224 m north-east of the boundary of the Land (approximately 1.1 km from the centre of the current landfill footprint), as shown in Figure 2-1. In addition, there is a recreational receptor (Blue Hills Sporting Shooters Club and South East Field and Game) located next to the entrance of the Project Site. Apart from this receptor, the Project Site is surrounded by agricultural and rural land uses, the density of sensitive receptors surrounding the site is therefore considered very low.

Existing operations at the Project Site result in the release of odour from operating cell faces, potential for leaks of landfill gas, and the generation of dust during dry months due to onsite activity and traffic on and off site.

There have not been any complaints received within the last five years regarding odour or other air emissions from the existing operation.

3.1.2 Potential impacts

Potential sources of atmospheric emissions associated with the operation of the Project include odour emissions from the working faces of the cells, leachate and stormwater ponds, possible fugitive emissions of landfill gas and associated odour, fugitive emissions from the trial leachate evaporation system, and dust and exhaust emissions associated with vehicles accessing the facility and on-site equipment and machinery. The new B-Cells (10 and 11) will not be significantly closer to the nearest sensitive receptor when compared to the existing Stage 1A B-Cells. The abovementioned odour sources are shown on Figure 2-4.

Uncontrolled fugitive emissions (odour and landfill gas) can occur from the landfill cells whilst in active operation (i.e. prior capping). However, the area of active landfill cell face is minimised and covered at the end of each working day to reduce the potential impacts associated with fugitive emissions. Odour emissions have the potential to affect the amenity of surrounding land uses and residents alike. Odour is likely to be worst-case under warm/calm conditions where less dispersion would occur in the local airshed and volatility of odorous gases from waste would be higher. Given the remoteness of the Project Site and the limited number of surrounding residences and their distance from the landfilling activity, impacts from odour emissions during cell operation are expected to be negligible under all wind conditions. This is evidenced by the lack of complaints in relation to the operational landfill, with no known complaints received to date.

Significant quantities of landfill gas (mainly methane) are generated by each cell, which once capped will passively leak out of the cell surface. Left unmitigated the landfill gas could leak uncontrollably and present a fire and odour risk. To mitigate this and to capture and utilise the gas, landfill gas wells are installed in each cell once they are capped, with the gas fed to the existing landfill gas network within the Project site. The gas is then transferred by a constant light vacuum to the gas generators onsite, which are managed by LMS Energy, who own the generators and the rights to the gas generated by the Project; gas is consumed by the generators on a 24-hour basis. SWS is currently working with LMS Energy to progress the installation of a permanent landfill gas supply line and metering unit for the BeneVap forced evaporation system.

Once cells are permanently capped and linked to the landfill gas system, the potential for odour generation reduces significantly. Based on a fugitive emissions survey conducted on the existing Stage 1A B-Cells in 2019 (pitt&sherry, 2019), the potential for fugitive emissions from the closed cells with the landfill gas management system in place is considered low.

Emissions from the trial leachate evaporation system have the potential to impact on the local airshed. The BeneVap system generates a steam by-product, which is released from the system's evaporative chamber through twin exhaust stacks. The steam emitted by the BeneVap system comprises water vapour (~60 %), carbon dioxide (CO_2) (~32 %) and air (N_2 and O_2) (~8 %), with trace amounts of cobalt (CO), volatile organic compounds (VOCs), oxides of nitrogen (NO_x) and sulphur (SO_x), and aerosols (< 0.25 %). Site specific monitoring of these outputs is proposed and will further clarify the potential environmental impacts of the system and any necessary management. Monitoring will commence in 2023. At the time of writing, no data suitable for publishing was yet available, noting that the BeneVap system has been subject to separate approvals and does not form part of this application.

The proposed increase in capacity of the landfill is estimated to increase heavy vehicle trips to the Project Site via Blue Hills Road to 43 per day (~34% increase from the existing from 32 trips per day) (Howarth Fisher and Associates, 2023) (refer Section 3.9). This additional traffic has the potential to generate additional dust within and adjacent to the Project Site, especially during the drier months of the year.

Generation of dust can cause the following impacts:

- Dust can coat vegetation which can affect photosynthetic and transpiration processes.
- Both fauna and humans can inhale dust particles, leading to respiratory stress.
- Dust clouds can result in a loss of visual amenity and can result in health and safety impacts from reduced visibility.

With management measures in place (as discussed below) dust emissions can, and will, be managed to avoid residual environmental or amenity impacts.

Given the Project involves ongoing landfilling (into cells 10 and 11) and does not propose any significant changes to the operation of the B-Cells (aside from the proposed increase in annual capacity), overall air emissions are not expected to change measurably from current operations. Nonetheless, the management and mitigation measures are proposed in the following sections to address the ongoing operational air impacts from the site.

3.1.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
Air Quality MM 1	Potentially dust generating material stockpiles, roads or excavated areas will be sprayed during periods of dry weather with water or a suitable dust suppressant as required.
Air Quality MM 2	Existing speed restrictions will continue to be applied and adhered to for all internal roads to minimise dust generation. Vehicles accessing the site will adhere to the sign-posted speed limits on Blue Hills Road.
Air Quality MM 3	Earth moving equipment will be regularly serviced and maintained to minimise exhaust emissions.
Air Quality MM 4	Potentially dust generating activities on-site will be avoided during periods of dry, windy weather (where practicable).
Air Quality MM 5	Daily cover will be applied to working cell faces to reduce odour emissions.
Air Quality MM 6	A maximum working area of 2,000 m^2 will be opened on a working cell at any one time.
Monitoring	
Air Quality MON 1	Landfill operating staff will monitor odour and dust levels on site and respond appropriately.
Annual audits of all aspects of air quality management, mitigation, and monitoring will be undertaken as part of the OEMP monitoring program (as documented in Various MON 1) and made available to the Director, EPA, upon request.	

3.1.4 Residual impacts

With the existing B-Cell landfilling operation not generating significant dust or odour issues, the small increase in licenced capacity and the associated increased traffic is not expected to significantly change the current impact levels. Given the isolated nature of the site, it is considered that the Project is consistent with the *Tasmanian Environment Protection Policy (Air Quality) 2004*.

3.2 Water quality (surface, discharge and groundwater)

This section considers the potential impacts of the Project on the water quality of the surface and groundwaters of the Project Site and surrounds, including to any downstream environmental receptors. Figure 3-1 shows the surface water receiving environment and the major surface water monitoring points as referenced in the surface and groundwater monitoring plan provided in Appendix C.

3.2.1 Existing environment

The Project Site is within the headwater area of the Carlton River catchment. The nearest natural waterbody to the site is an ephemeral tributary of the Carlton River (colloquially referred to as Carlton River Tributary), which lies approximately 325 m north of the landfill. The Carlton River Tributary flows into the Carlton River approximately 750m downstream. The Carlton River then continues in a south-westerly direction for approximately 10 km to the estuarine section of the river that discharges through the Carlton River mouth to Frederick Henry Bay to the west.

The existing man-made surface water features relating to the B-Cells include the leachate pond, primary stormwater pond, secondary stormwater pond, fire dam, and the trial leachate treatment wetland, as shown in Figure 2-4.

Primary stormwater captured in the northern and eastern upstream cut-off drains discharge diffusely to the environment at the end of the drain to the north of the B-Cells. All other stormwater drainage flows from the Project Site via the primary stormwater pond, into a man-made trench that travels north and discharges to a drainage line (colloquially referred to as Marshes Creek) which then reports to the Carlton River Tributary mentioned above. The tributary receives all perimeter stormwater drainage diffuse discharge flows, stormwater from the primary stormwater pond, and natural flows from the marshlands present in the north of the Project Site, as shown in Figure 3-1. There are no other significant links from the Project to surface waters in the area due to topographical constraints (noting that leachate does not report directly to any surface water bodies).

To describe the groundwater of the Project Site, several versions of a conceptual model have been worked on for various projects associated with the site between 2016 and 2021 (Cromer, 2021), with incremental improvements in understanding of the hydrogeology of the area resulting from the development of additional groundwater bores; the latest 2021 model iterations are provided in Appendix B. To date, the conceptual groundwater model suggests the geology present results in fractured hard rock aquifers where groundwater moves in joints and fault zones between the rock, which gravity feed down to the quaternary valley sediments constituting an intergranular aquifer where groundwater moves between the individual sediment grains; this is the predominant aquifer characteristics within Cells 10 and 11. Overall the general vicinity of the site is considered a single unconfined gravity-driven aquifer, as evidenced by observations of groundwater levels and water quality samples available for the site (Cromer, 2021).

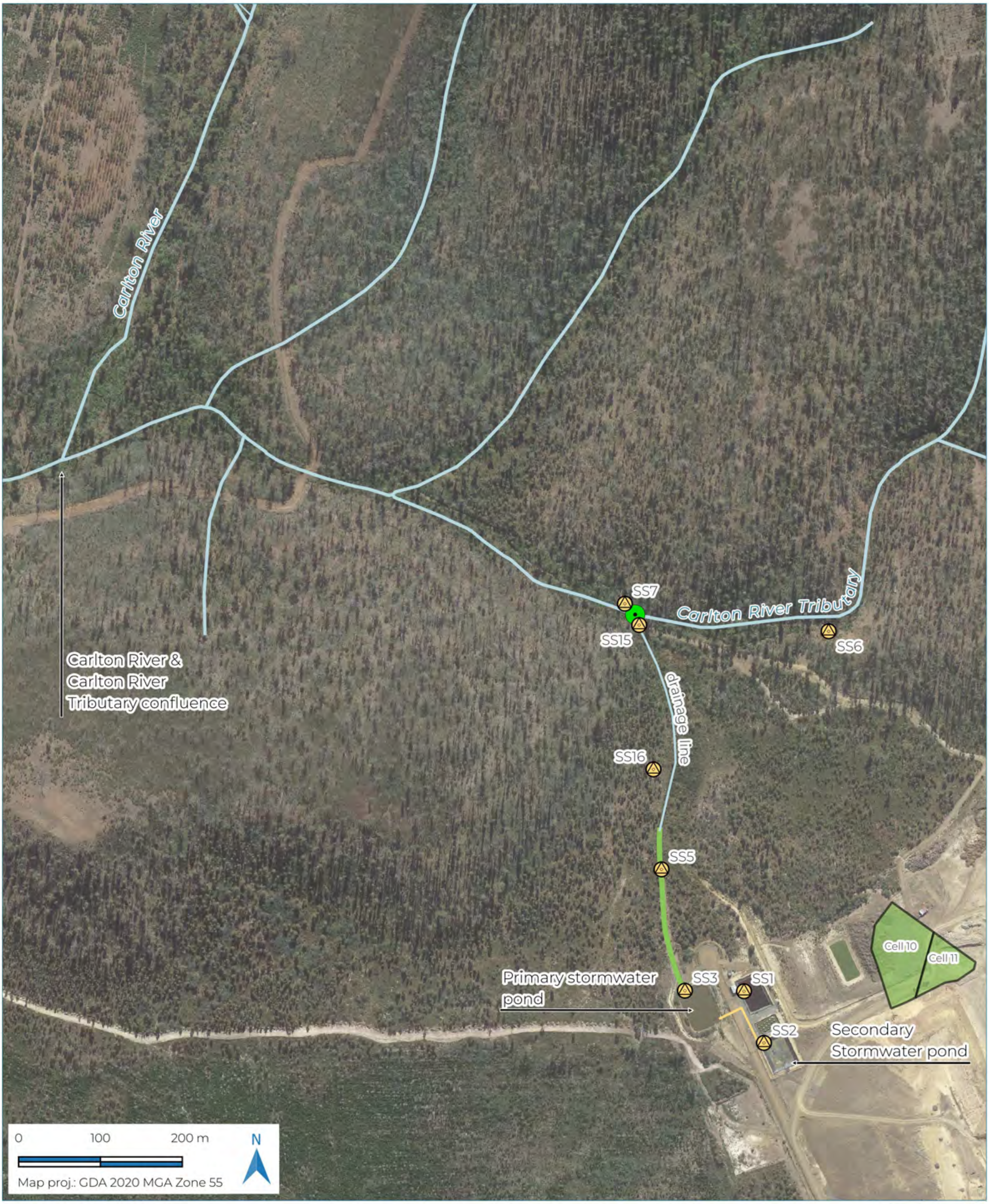
The flow rates of groundwater around the Project Site are estimated to be years to decades in the local system range, decades to centuries in the intermediate range and centuries to millennia at the regional scale. The fastest flowing groundwater at site is expected to occur through the quaternary sediments in the bottom valley areas of the Project Site, albeit still at flow rates in the region of 0.1 m/day (Cromer, 2021).

With regard to water quality, extensive monitoring of the Project Site and surrounds has historically been undertaken as part of the site's existing Surface and Groundwater Monitoring Program, with the latest triennial review of the program undertaken in 2019 by (AquaSci, 2019).

Historical data has identified that the surface water quality of the Carlton River tributary is highly variable, with the physiochemical characteristics of the water changing with periods of wet and dry weather. The drier periods tend to coincide with higher electrical conductivity, total dissolved solids and major ions, whereas after periods of rain, samples show elevated nutrients (especially nitrates) thought to be associated with the mainly agricultural catchment (e.g. through use of fertilisers, impacts of farming stock etc.) and the use of the waterway by native species as a water source. Total metals concentrations in the waterway have been found at generally low concentrations, with some occasional detections of elevated total copper, total aluminium and total chromium; however, in terms of dissolved metals, only manganese and iron have been detected above laboratory limits of reporting. No pesticides, hydrocarbons or per- and poly-fluoroalkyl substances (PFAS) has been detected in the waterway. The waterway is considered in a generally natural state apart from occasional agricultural runoff impacts (AquaSci, 2019).

Groundwater quality is characterised as slightly saline (>2,500 µS/cm) and slightly acidic (~pH 6.5) and, as is the case with surface waters, somewhat correlated with weather patterns. Low levels of some metals have been detected, but no detections of pesticides, hydrocarbons or PFAS has occurred throughout the Project Site. As with surface water sites, the groundwater is thought to be in a generally natural state and tends to have highly variable water quality somewhat correlated with long-term weather patterns (AquaSci, 2019).

To date, monitoring of water quality has not identified any evidence of leachate impacting surface or groundwater (AquaSci, 2021b).



Monitoring site
DischargePoint
Waterways
Man-made trench from primary stormwater pond
Secondary to primary stormwater pond pipe
Stage 1B B-Cell 10-11

Job Number	2223-020
Revision	V.2
Date	6 July 2023
Paper size	A4

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Copping Landfill

Figure 3-1
Surface water features and monitoring sites

3.2.2 Potential impacts

Water quality of the receiving environment can be affected by the Project through leachate generated by the Project, stormwater generated on site, and through spills of environmentally hazardous materials. The potential impacts of each are explained in detail in the following sections.

Leachate

The key potential water quality impact from the operation of the Project is from leachate produced within the B-Cells reaching the surface and groundwaters of the Project Site and surrounds, via a spill, leak or overtopping of the leachate pond or system.

The degree of increase for potential impacts are proportional to the increases in additional leachate volume and/or the leachate toxicity. As no additional toxicity is expected, the increase in risk of impact from the Project is limited to volume increase.

Some basic theoretical leachate generation modelling was undertaken by Pitt and Sherry using the Hydrologic Evaluation of Landfill Performance (HELP) model (unsupported software program) with rain inputs from the BoM rainfall data for Copping and Yaxely from 2020-22. The assumptions of the modelling were that

- In an uncapped state:
  - All rainfall after the first 1.0 mm on any day that falls onto the open cell face is converted to leachate.
  - 25 % of rainfall after the first 5 mm on any month that falls onto the open cell face is converted to leachate.
- In a capped state 5.6 % of rainfall after the first 10 mm on any month that falls onto the capped cell face is converted to leachate.

The results of the modelling are presented in Table 3-1 (modelling was undertaken for the site as a whole, and hence considers all Stage 1A and 1B cells). The results show a sharp decrease in leachate generation as capping of several Stage 1A cells is finalised and filling of Cells 10 and 11 commences. Leachate production then remains steady in the middle steps as more cells from Stage 1A are capped and more Stage 1B cells are opened for fill. As filling commences and continues in the final two cells of Stage 1B, the leachate production starts to reduce as more of the Stage 1B cells are capped. The final capped Stage 1A and 1B Cells results in a leachate volume generation total of 641 kL/year on average.

Although the accuracy of the modelling is unconfirmed, the premise remains valid: as the ratio of capped to uncapped cells increases with time, leachate production decreases.

Table 3-1 Leachate generation modelling results for Stage 1B development (values from Pitt and Sherry 2023)

Step[1]	Operation	Capping	Capped area (m^2)	Covered area (m^2)	Open area (m^2)	Total (m^2)	Annual average leachate production (kL)
Step 0	Initial situation		67,666	47,062	2,000	116,728	9,671
Step 1	Working Cells 10 and 11	Cells 1 to 3 and 6 fully capped and cells 6 and 9 partially capped	102,304	23,674	2,000	127,978	5,735
Step 1	Working cell 13	Cells 1 to 6 capped and cell 9 partially capped	111,583	26,277	2,000	139,859	6,219
Step 2	Working cell 12	Cell 9 fully capped and cells 7 and 8 partially capped	116,728	25,910	2,000	144,638	6,174
Step 3	Working cell 15	Stage 1 fully capped and cell 10 partially capped	122,769	29,206	2,000	153,975	6,768
Step 4	Working cell 14	Cells 10 and 11 fully capped and cells 12 and 13 partially capped	138,439	16,622	2,000	157,061	4,639
Step 5	Working cell 17	Cells 10 to 13 fully capped and Cells 14 and 15 uncapped capped	144,638	21,035	2,000	167,673	5,427
Step 6	Working cell 16	Cells 10 to 13 fully capped and cells 14 and 15 partially capped and cell 17 uncapped	152,725	17,966	2,000	172,691	4,923
Step 7	Pre-Closure	Cells 10 to 15 fully capped and cells 16 and 17 uncapped	157,061	15,630	0	172,691	3,272
Step 8	Closure	All cells capped	172,691	0	0	172,691	641

[1] Note that landfilling of cells 10 to 17 does not occur in a chronological order, due to the layout of the site and the associated topography.

Given the volumes of leachate production are expected to reduce significantly from the current scenario as a result of the Project and continued capping of the Stage 1A cells, no significant increase in risk of leachate impacts are anticipated. Hence consideration of leachate impacts herein addresses existing and proposed operation, noting no significant increase expected.

The primary toxicants and ecosystem stressors associated with the leachate, as described in (AquaSci, 2019), include:

- Heavy metals, namely arsenic, chromium, nickel and vanadium.
- Cyanide
- PFAS – notably perfluorooctane sulphonic acid (PFOS)
- High concentrations of nitrogenous compounds (including high ammonia) and phosphorus compounds, high dissolved solids concentrations, and moderate salinity.
- From a human health perspective, along with the abovementioned toxins, elevated *E.coli* found in the leachate is also of concern.

The key vectors available for leachate to leave the Project Site and reach the receiving environment include groundwater seepage in cells that are not sufficiently lined, through spills of leachate from overtopping storage pond(s), spills from broken storage pond banks, or through pipeline infrastructure leakage.

If leachate were to reach the surface waters of the Carlton River Tributary and subsequently the Carlton River in a spill or leak scenario, it may result in significant impacts to the flora and fauna of the downstream environment, including out as far as the marine environment for more persistent toxins (e.g. PFAS). Given the low flows generally experienced in the Carlton River Tributary, the first several hundred metres of the waterway are considered to be most at risk, with little dilution available from base flows.

The degree of impact to the receiving environment would depend on the volume of leachate that reaches the groundwater and surrounding waterway(s) and the rate of release. Given there is only ever the leachate pond contents available for the largest instantaneous spill, the potential impacts from this release type are essentially limited to this volume. Smaller continuous leaks to the receiving environment also have the potential to occur; however amelioration of leachate contaminants would occur more readily in these situations, with more dilution available for smaller leachate quantities and more time for contaminants to bind with particulate matter in the slow-moving waters of the receiving environment.

The following paragraphs describe the individual constituents of the leachate profile and their potential impacts to the receiving environment.

Heavy metals reaching the receiving environment can have a range of potential impacts to flora and fauna depending on concentration, the bioavailability of the metal in question, and the hardness of the water. Factors in the receiving environment that affect bioavailability include the concentration of organic carbon and the pH of the water (ANZG, 2018). Metals in ionic form readily bind to organic (and inorganic) substances in receiving waters, and once bound are unavailable for uptake through ion channels at flora and fauna absorption sites, which results in a reduced toxicity potential. The pH of the water dictates the concentration of the free available metal ions, with a lower pH resulting in a higher bioavailability of metals as they become ionised. High water hardness reduces the toxicity of heavy metals in the receiving environment through the presence of a higher concentration of low toxicity ions that compete with toxic metal ions during flora and fauna absorption (ANZG, 2018). When readily bioavailable, effects to flora and fauna range from chronic to acute, depending on concentration, with a variety of detrimental biological effects possible.

The toxicity of cyanide is dependent on its chemical form, which, similar to heavy metals, is influenced by a range of physicochemical parameters as well as sunlight and other complexes in the receiving environment. The toxicity to fauna occurs from cyanide's ability to cross biological membranes and inhibit cellular respiration processes. Small volumes of cyanide can be extremely toxic to aquatic flora and fauna and hence present a high risk to the receiving environment of the Project Site if released in large enough doses. Given the cyanide concentrations identified in the B-Cell leachate during the March 2021 sampling round (AquaSci, 2021a) were approximately eight times above the ANZG (2018), an 8-fold dilution would be required in the receiving environment to sufficiently dilute the leachate for this toxicant. Potential impacts would thus be limited to the lower flow sections of the receiving environment where this dilution may not be readily achieved under low flow conditions, such as the Carlton River Tributary. Impacts are not expected to extend downstream of the confluence with the main Carlton River, as significant additional natural flows are introduced at this point, thus rapidly diluting any flows in the Carlton River Tributary.

PFAS derivatives have been found to be extremely persistent in the environment and even at small doses are suspected to present long-term biological risks to flora and fauna, and human receptors. For humans, suspected side effects of exposure include altered immune and thyroid function, kidney disease, developmental issues, and dysregulation of insulin (Fenton , et al., 2021). Accumulation of this group of chemicals in the downstream environment is considered a significant risk from the Project if a leak or instantaneous spill were to occur from the Project Site.

Potential impacts from high nutrient loads reaching the receiving environment are generally related to the potential risk of algal blooms, which can rapidly deplete oxygen in the receiving environment and can also be toxic to fauna and human receptors. Given the volumes available from the onsite leachate pond, the potential impacts from spill or leak are likely to be limited and localised to the low flowing tributary sections of the river.

Dissolved solids and salinity impacts from leaks or spills would be unlikely to significantly impact the downstream environment given the volumes involved. Impacts would likely be limited to the lower flowing tributary adjacent to the Project Site.

Stormwater

Secondary stormwater that has flowed over the Project Site has been found to contain traces of contaminants, including some heavy metals and PFAS, albeit at very low concentrations. Similarly to the leachate ponds, if this waste stream were to leak or discharge to the receiving environment there is a risk, albeit very low, of contamination occurring in the receiving environment. Stormwater captured within the clay borrow pit areas is unlikely to contain any significant contamination other than sediment loads, which once settled in the respective sedimentation ponds, presents a negligible risk to the environment.

Historically, primary stormwater has occasionally seen traces of contamination, which were thought to be a result of spray drift from the adjacent WAIV unit that operated between 2015 – 2018; but generally primary stormwater is considered to have a negligible risk to the environment upon release, with the exception of some increased turbidity in the receiving environment during heavy rainfalls where overtopping of the holding pond may occur (AquaSci, 2019).

To date at the Project Site, monitoring suggests that contaminants from the B-Cells has been contained to the existing leachate and water management infrastructure, with no parameters of concern detected in the receiving environment, including in all groundwater bores. Given the extensive safeguards installed during the construction of the B-Cells, including multiple clay and geofabric liners and a leachate collection system, there is very little chance of multiple failures resulting in leachate leaking to the environment from the cells themselves.

In terms of sizing and function of the stormwater ponds and design ratings, Pitt and Sherry completed a Surface Water Management Plan for the new Stage 1B cells (10-17), which will accompany the future application, the salient points from that report as they relate to the current Project follow:

- The primary stormwater pond has been designed to cope with a 1 in 1-year ARI storm event. The pond has a depth of 0.60 m and a surface area of approximately 2000 m^2, equating to an approximate volume of 1,188 kL. The pond was designed as a type-C basin in accordance with the IECA Best Practice Erosion and Sediment Control standards - this type of pond allows water to travel across the top of the pond while the sediment settles to the floor.
- Primary stormwater drains and any drains that can overtop into the leachate holding pond are all sized to cope with a 1 in 100-year ARI storm.
- Secondary stormwater drains are designed to cope with a 1 in 20-year ARI storm event.
- The secondary stormwater pond has been sized to cater for a 1 in 20-year 24-hour ARI storm for its current catchment.

In terms of suitability of the existing stormwater system, the primary stormwater pond is of sufficient size to manage the existing flows, plus the additional primary stormwater that will be captured as a result of the new additional cells 10 and 11. An additional smaller 828 kL primary sedimentation pond is likely to form part of the future application, which will be able to accept all capped and rehabilitated Stage 1B cells at the end of project life.

The calculations undertaken by Pitt and Sherry indicate that the existing secondary stormwater pond is undersized for the projected completed Stage 1A and Stage 1B scenario, using the conservative assumption that all stormwater from these cells will be secondary. This is however not the case: as soon a cell is capped and rehabilitated with vegetation, stormwater is again classed as primary and can be redirected to the primary stormwater pond. Hence, as only a small portion of Stage 1B is being progressed, and a large portion of Stage 1A is capped and rehabilitate with surface flows now redirected to the primary stormwater pond, the secondary stormwater pond is considered adequately sized for the current Project; it will however need to be enlarged for the future application. Secondary stormwater will continue to be managed in an interim manner until the future application infrastructure is built, which will include new secondary stormwater ponds to cater for the increased catchment size.

As outlined in Section 2, under the current management scenario, once secondary stormwater has settled for several weeks, the secondary stormwater is pumped to the primary pond via a buried pipeline, to be shandied with the primary stormwater. Stormwater ponds are carefully desludged as required using an excavator or pump truck, with waste sludge discharged to the B-Cell working faces.

During overflow events of the secondary stormwater pond, the water travels into the road drain and through a culvert which discharges directly into the primary stormwater pond.

Environmentally hazardous substances

Spills of environmentally hazardous substances, discussed in Section 3.7, have the potential to reach surface and groundwaters if not managed appropriately. Materials such as diesel, oils and petrol can cause significant environmental impacts from direct toxicity and through direct coating of flora and fauna.

3.2.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

Leachate management will continue to occur in an interim manner under the trial BeneVap arrangement until the end of the trial, and then will be managed under a new Leachate Management Plan which will be submitted as part of the future application for B-Cells 12 - 17. No new leachate management infrastructure forms part of the current Project. The trial to date is currently being monitored, with results to be supplied in an ongoing manor to the EPA as they become available.

Similarly, stormwater management will continue to occur in an interim manner utilising the existing system until new management and mitigation measures are provided in a new Stormwater Management Plan as part of the future application; this will include the construction of new sedimentation ponds.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
No additional management and mitigation in relation to stormwater or leachate forms part of the Project, with existing systems proposed to be used until the larger Stage 1B approval and associated management plans are in force.	
Monitoring	
Water Quality MON 1	The extensive Surface and Groundwater Monitoring Program already in place for the existing operations at the Project Site will continue for the Project.
Annual audits of all aspects of water quality management, mitigation, and monitoring will be undertaken as part of the OEMP monitoring program (refer Various MON 1) and made available to the Director, EPA, upon request.	

3.2.3.1 Surface and groundwater monitoring program summary

A comprehensive surface and groundwater monitoring program is currently in place at the Project Site, as required by the existing site EPNs. The initial monitoring program was developed in 2001 with a suite of surface water sites (some of which are shown in Figure 3-1) and groundwater bores, including reference and impact sites. A large suite of water quality parameters are included in the sampling program, with parameters measured at various annual intervals. The parameters were chosen based around detecting leachate in the receiving environment.

The program has evolved significantly since 2001, with a host of additional bores added to the program and several new surface water locations, including for detection of leachate leaks from the C-Cell.

Monitoring is undertaken on a quarterly basis, with triennial reviews of the program also undertaken. All monitoring reports are provided to the EPA.

The existing monitoring program will be continued and detect any new leachate leaks from the Project; the monitoring program is detailed in Appendix C.

3.2.4 Residual impacts

Surface and groundwater management and mitigation already undertaken on-site for the existing Stage 1A B-Cells will continue for the Project. This has shown to be effective in preventing environmental impacts to both surface and groundwater to date and therefore, with the same measures in place, the residual impacts from the filling of the additional cells that form the Project are not expected to present an increased residual risk to the receiving environment, including the Protected Environmental Values of the Carlton River and its tributary, consistent with the *State Policy on Water Quality Management 1997*. The constructed cells will feature all the existing mitigation that the existing Stage 1A B-Cells utilise, including clay and geofabric lining, leachate drains, stormwater diversion drains, and clay caps.

The additional leachate volumes that will arise as a result of the Project will be manageable with the current infrastructure and will be counterbalanced with the reduced leachate production from the Stage 1A Cells as they are progressively capped. Additionally, given the planned use of the BeneVap system, which will be in place as Cells 10 and 11 begin to be filled, there is expected to significantly less leachate to manage.

In the event alternative leachate management is required (i.e., if the current trials are unsuccessful), the existing system of storage, evaporation, and use in the wetland will need to continue until an alternative can be arranged. Potential temporary alternatives include the development of an additional leachate management pond or temporary recirculation through the open tip face, noting this is not preferable. As outlined previously, a long term solution to leachate management at the site is being pursued in parallel with this application to ensure a suitable system in in place for the eventual filling of the remaining Stage 1B cells (12 to 17).

No significant impact to stormwater management will occur as a result of the Project, with the additional secondary stormwater to be collected and treated as currently occurs.

3.3 Noise emissions

3.3.1 Existing environment

The Project Site is located within a broad valley, surrounded by agricultural and rural land uses, with the nearest sensitive receptor located on a ridge approximately 224 m from the boundary of the Land (approximately 850 m from the Project footprint and 1.1 km from the centre of the current landfill footprint).

The existing sources of noise at the Project Site are associated with operational truck and machinery movements within the facility. Based on a traffic volume count undertaken for the Project Site in December 2022, there were approximately 32 trips to the Copping Landfill per day (Howarth Fisher and Associates, 2023) (refer Section 3.9). These trips occurred within the operating hours of the landfill, with last loads accepted at 4 pm (Monday to Friday) and 3 pm (Saturdays and public holidays).

Other existing sources of noise at the Project Site include:

- The operation of machinery used at the landfill, including excavators and crushers. The typical sound pressure level for a 5 tonne tracked excavator at 200 m is 48 decibels (dB)(A)[2] Leq (15 mins)[3] (DIT, 2021). The typical sound pressure level for a crusher (compactor) at 200 m is 59 dB(A) Leq 15 mins (DIT, 2021). This noise source is restricted to the operational hours detailed in Section 2.2, in accordance with the existing EPN for the site.
- Minimal noise associated with the operation of the two 1 MW Jenbacher gas-powered generators. The generators use flares to burn off excess methane as required, which can produce noise. However, this is an occasional event and noise impacts are confined to the boundary of the Land.
- Noise associated with the trial of the BeneVap forced evaporative leachate treatment system. The BeneVap system has an operating noise level of 70 dB (equivalent to the sound level of a regular washing machine), with no offsite impacts. The system operate 24 hours a day, seven days a week, with approximately 10 days per year of downtime for maintenance. The system is located approximately 350 m from the boundary of the Project Site and 1.2 km from the nearest sensitive receptor. A full noise assessment of the permanent BeneVap system (if successful) will form part of the larger approval process for the remaining Stage 1B Cells.

There have been no noise complaints received for the site to date.

3.3.2 Potential impacts

As the licensed capacity of the landfill is proposed to increase to 200,000 tonnes/year, noise impacts associated with additional trucks accessing the facility will increase proportionately. It is estimated that trips to Copping Landfill via Blue Hills Road will increase from 32 to 43 per day (to and from site) (~34% increase), including 12 trips within the peak hour to and from site (between 7:00-8:30 am). There is no proposed night-time traffic associated with the Project. The resultant impact from the increase in traffic is likely to be negligible given the existing traffic movements and isolated nature of the Project Site.

Other operational noise sources, including operation of machinery used at the landfill (excavators and crushers) and the gas-powered generators, will remain unchanged for the operation of the Project.

The closest sensitive receptor to the Stage 1B Cells 10 and 11 is approximately 850 m, this is approximately the same distance as is currently occurring at the existing Stage 1A Cells and hence no significant change to distance to receptors overall is anticipated.

Given the distance to the nearest sensitive receptor and that noise generating activities are restricted to the licensed operating hours of the landfill, the Project is unlikely to result in nuisance conditions for nearby land users. Noise impacts are unlikely to significantly change from the existing situation and are unlikely to affect wildlife and/or livestock within the area.

[2] dB(A) is an A-weighted decibel. A-weighting is an adjustment made to the sound pressure level measurement to reflect the frequency range of the human ear.

[3] Leq (15 mins) is the A-weighted equivalent continuous (energy average) sound pressure level over a 15 minute period.

3.3.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
Noise MM 1	Operation of noise generating machinery and equipment will be restricted to normal daytime operating hours, in accordance with the conditions of the existing EPN, namely: • Monday to Friday 7 am – 5 pm • Saturday 7 am - 4 pm • Public holidays (excluding Christmas Day and Good Friday) 7 am – 4 pm • The site will be closed on Sundays.
Noise MM 2	Low noise generating plant and equipment will be used where practicable.
Noise MM 3	Broadband reversing alarms will be utilised where practicable over traditional tonal alarms to minimise any nuisance noise generated.
Noise MM 4	Equipment will be regularly serviced and maintained to minimise noise emissions.
Noise MM 5	Where practical, machinery will be operated at low speed or power and be switched off when not in use, rather than left idling for prolonged periods.
Noise MM 6	Trucks will be advised not to use exhaust brakes near residences on Blue Hills Road.
Monitoring	
There is no specific noise related monitoring proposed for the project, noting that the online complaints register (refer Various MON 1) will provide a mechanism to identify and resolve noise issues if they occur.	

3.3.4 Residual impacts

Based on the implementation of the above mitigation measures, the distance to the nearest sensitive receptors, and the restriction of noise generating activities to the licenced operating hours, the residual noise impacts associated with the Project are expected to be negligible.

The Project is considered to be consistent with the objectives of the *Environment Protection Policy (Noise) 2009* and other relevant guidelines and legislation.

3.4 Natural values

3.4.1 Existing environment

North Barker Ecosystem Services (NBES) completed a natural values assessment of parts of the Project Site in 2021, namely the Stage 1B Cells and a proposed borrow pit; this was undertaken to support the upcoming larger application for the entire Stage 1B Cells. The assessment covered the location of the Project and salient information has been taken from that report, which is provided in full in Appendix D.

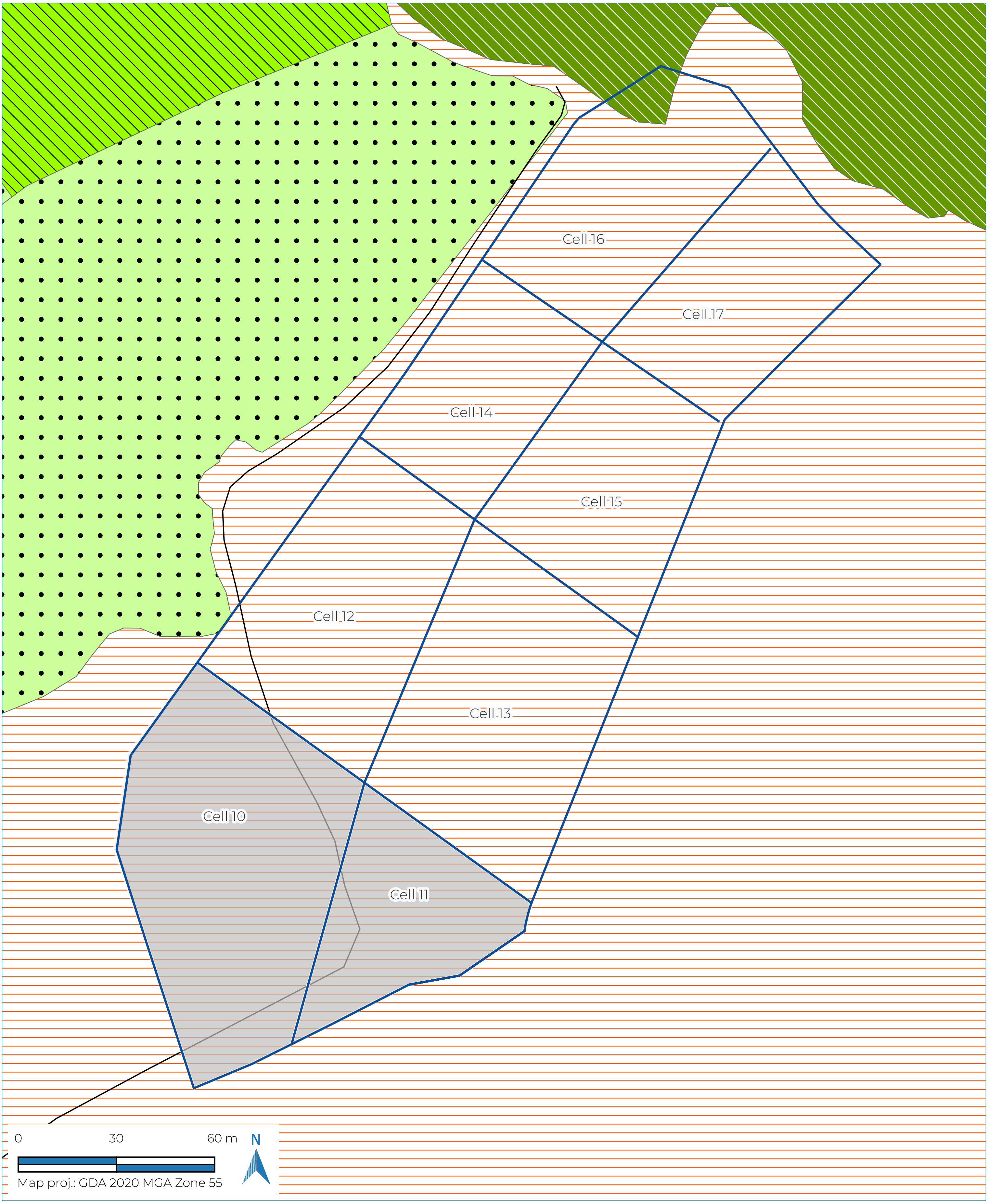
The assessment included both desktop assessment of available databases, including the Tasmanian Natural Values Atlas and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool, and an on-ground site survey.

3.4.1.1 Vegetation communities

The area for the new B-Cells is predominantly cleared land, with fringes of native vegetation. The area for cells 10 and 11 is mapped as non-native (extra urban miscellaneous). There are areas of native vegetation bordering these cells, including *Eucalyptus ovata* forest and woodland (DOV). Refer Figure 3-2.

Eucalyptus ovata forest and woodland (DOV) is listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA) and the community onsite is considered by NBES to meet the criteria of the EPBC Act Critically Endangered community Tasmanian Forests and Woodlands dominated by black gum or Brooker's gum (*Eucalyptus ovata* / *E. brookeriana*) (NBES, 2021); this vegetation will not be impacted by the Project.

The NBES site assessment found the condition of the eucalypts in the area of DOV to be severely impacted by bushfire (specifically the 2013 bushfire in the area), as evidenced by the presence of regrowth trees around 5 m in height. The understory of the vegetation was found to have low diversity and was dominated by *Leptospermum lanigerum* and *Leptospermum scoparium* (NBES, 2021).



EXISTING INFRASTRUCTURE

Internal road

VEGETATION (NBES 2021)

(DAZ) Eucalyptus amygdalina forest and woodland on Cainozoic deposits

(DOV) Eucalyptus ovata forest and woodland (threatened)

(DPU) Eucalyptus pulchella forest and woodland

(FUM) Extra urban miscellaneous

Job Number	2223-020
Revision	V.1
Date	29 May 2023
Paper size	A4

Copping Landfill

Figure 3-1
Vegetation

3.4.1.2 Flora

The NBES survey noted 96 species of vascular plants within the broader Project Site, with no listed species found within the survey areas. The desktop assessment revealed that no listed species have been identified to date within 500 m of the B-Cell area. NBES consider that none of the listed species identified in the desktop assessment within 5 km of the study area are likely to occur within the survey area (NBES, 2021).

3.4.1.3 Fauna and associated habitat

The survey by NBES included an assessment of fauna habitat and any indicators of presence of listed fauna species in the survey areas. No listed fauna species were directly observed during the NBES surveys of the Project Site, but several indicators of potential use of the area by threatened species were noted in the broader areas surveyed:

- Tasmanian devil (*Sarcophilus harrisii*) scats were identified along the roads in the area surveyed for the proposed clay borrow pit expansion (to be assessed as part of the larger approval process for the remaining Stage 1B Cells); no scats or evidence of devils were found within the B-Cell survey area. NBES note that the devil is likely to use the broader area for foraging and movements within their home ranges.
- Denning habitat suitable for the spotted-tail quoll (*Dasyurus maculatus subsp. maculatus*) and eastern quoll (*Dasyurus viverrinus*) was observed near the B-Cell survey area (although no actual dens were observed during survey) with a moderate likelihood of use. A single burrow was located in a 2018 survey of the Project Site that that may have been utilised by the eastern quoll, given there are several records of the species within 5 km of the study site. In terms of foraging habitat, the study area was considered to have a low to moderate likelihood of use.
- The eastern barred bandicoot (*Perameles gunnii*) was considered to have a moderate likelihood of occurrence given the survey area is within the core range of the species and multiple records exist within 5 km of the area.
- The chaostola skipper (*Antipodia chaostola*) was considered to have a low to moderate likelihood of occurrence within the study area as its host plant, thatch saw sedge (*Gahnia radula*), was observed throughout the understory of the FPU vegetation found within the Project Site (NBES, 2021). However, there are no known occurrences of the chaostola skipper within 5 km of the survey area, with the closest population approximately 30 km to the west in the Meehan Range. The mapped area of potential occurrence for the species is outside of the footprint of cells 10 and 11.
- Potential foraging habitat for several listed bird species was identified, albeit with low to moderate likelihood of occurrence of the species, including the grey goshawk (*Accipiter novaehollandiae*), wedge-tailed eagle (*Aquila audax subsp. Fleayi*), swift parrot (*Lathamus discolor*) and Tasmanian masked owl (*Tyto novaehollandiae subsp. Castanops*). No suitable nesting habitat was identified for these species.
- No visible tree hollows were found within the survey area suitable for nesting of vertebrate species.

3.4.1.4 Rivers and creeks

There are no natural rivers or creeks within the project footprint, but there are several within the broader Project Site as discussed in Section 2.2.

The Carlton River Tributary to the north of (but outside) the B-Cell footprint is mapped as having a low CFEV rating, which transitions to a high rating downstream where the current discharge of primary stormwater occurs to the north-west of the Project Site.

3.4.1.5 Geoconservation

No geoconservation sites occur within or adjacent to the Project Site.

3.4.1.6 Reserves

No reserves, including any high-quality wilderness areas as identified in the Tasmanian Regional Forest Agreement, occur within or adjacent to the Project Site. The survey area is considered by NBES to have no to very low wilderness quality (NBES, 2021).

3.4.2 Potential impacts

The potential impacts to natural values through the operation of the Project are limited in nature and are restricted to the increased risk of roadkill from the increase in vehicle movements to and from the Project Site. No native vegetation clearance is required for cells 10 or 11, as shown in Figure 3-2.

As outlined in Section 2.2 and Section 3.9, the Project is expected to result in an approximate 25 % increase in existing traffic movements, which in terms of numbers is an additional 11 movements per day. Given the bushland setting of the Project, this may result in a small increase in the risk of roadkill occurring along the Blue Hills Road, especially during the dawn and dusk periods when fauna are most active. The increase in movements will result from an increase in the number of waste deliveries, which will occur throughout normal business hours. The number of operational staff will not change as a result of the Project.

No specific monitoring has been undertaken on the route to site to date, however there a several roadkill records of listed and non-listed species along Arthur Highway (theLIST, 2023). The small increase in traffic numbers is unlikely to impact roadkill on the Arthur Highway based on the high volume of traffic already using this road.

Overall, the risk of roadkill increasing is considered negligible given the small total number of additional vehicles and the operating hours of the site, meaning there will be no night time traffic generated (noting some movements may occur in the dawn and dusk period in winter when daylight hours are less, however this will be limited).

There is expected to be a slight increase to the risk of the spread of weeds, pests or pathogens through increased traffic to site, as discussed in Section 3.5.

The operation of the Project is unlikely to result in any other measurable impacts to flora and fauna, given there is no vegetation clearance proposed and operation will be similar to existing operations. Movement, noise, or lights associated with the operation of the Project are unlikely to impact avifauna during breeding seasons based on the available habitat on site and the existing (long-term) use of the site.

3.4.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
Natural Values MM 1	Speed limits within the Project Site will be limited to 40 km/hr at all times to minimise roadkill.
Natural Values MM 2	Truck drivers will be informed of the risks to roadkill of threatened fauna and will be instructed to report any roadkill incident on the way to or from the site. Any confirmed kills of listed fauna will be reported in the Annual Environmental Report for the site.
Monitoring	
There is no specific natural values related monitoring proposed.	

3.4.4 Residual impacts

With the above stated management, mitigation and monitoring measures in place the residual risk to natural values is considered negligible. Whilst there will be a small increase in traffic along the roads to the Project, they will generally occur outside of the higher roadkill risk dawn and dusk periods.

3.5 Weeds, pests and pathogens

3.5.1 Existing environment

Weeds and pathogens

NBES were engaged to complete a natural values assessment of parts of the Project Site in 2021, namely the Stage 1B Cells and a proposed borrow pit (as mentioned in Section 3.4). This assessment included weeds, pests and pathogens; the report is provided in full in Appendix D. The assessment included both desktop assessment of available databases, including the Tasmanian Natural Values Atlas and the EPBC Act Protected Matters Search Tool, and an on-ground site survey.

Three species of weeds declared under the *Tasmanian Weed Management Act 1999* were observed during site assessment:

- Spanish heath (*Erica lusitanica*) – present as scattered plants around the B-Cell area and clay borrow pit.
- Serrated tussock (*Nassella trichotoma*) – recorded along the road edge that will form the northern boundary of the clay borrow pit
- Winged thistle (*Carduus tenuiflorus*) – a single individual was found within the clay borrow pit area.

No evidence of plant pathogens or pest species were noted by NBES in the areas surveyed.

Pests

Pest species with the landfill site include scavenging birds, cats, and vermin.

Birds and scavenging mammals are currently managed through normal landfill operations. Ensuring waste is pushed and shaped into the face by the dozer and compacted by the landfill compactor and then daily cover applied. This eliminates stockpiled wastes sitting on the landfill and minimises availability for scavenging animals.

An SWS pest contractor manages vermin around the offices and workshops at the site and a dedicated cat trapper is also employed to ensure the feral cat population is kept to a minimum.

3.5.2 Potential impacts

The operation of the Project has the potential to introduce or spread weeds, pests and diseases through the acceptance of waste and through the transfer of dirt and debris from offsite vehicles visiting the Project Site. Any introduction of foreign material has the potential to lead to outbreaks of unwanted species, which can lead to impacts of the existing natural values onsite.

Given the majority of the Project Site is in a highly disturbed state, the potential for serious impacts from the introduction of a pest species or disease is limited. However, it is best practice to ensure that the likelihood of introduction is minimised. Managing the existing onsite weed population will be necessary to prevent further spread.

Potential impacts on pest numbers are considered negligible with the operation of the new cells; as the old cells become capped, no net increase in pests are expected. Current management and mitigation is considered adequate to manage the pest issues on site.

3.5.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	

Reference number	Management, mitigation or monitoring measure
Weeds, pests & pathogens MM 1	An updated Weed, Disease and Hygiene Management Plan will be developed and provided to the Director, EPA, within 6 months of project approval. The plan will be in general accordance with the Weed, Disease Planning and Hygiene Guidelines (DPIPWE, 2015) and include provisions for: • Weed control for areas of existing weed infestation where equipment will be required to work. • Hygiene protocols, including vehicle washdown (if warranted) prior to site entry/exit to avoid the spread of weeds and pathogens in general accordance with the Tasmanian Washdown Guidelines for Weed and Disease Control and Keep It Clean - A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens.
Monitoring	
Weeds, pests & pathogens MON 1	Annual weed monitoring will be undertaken as part of the Operational Weed, Disease and Hygiene Management Plan, with results of management to be presented in the Annual Environment Reports for the site.
Annual audits of all aspects of weed, pest and pathogen management, mitigation, and monitoring will continue to be undertaken as part of the OEMP monitoring program (as documented in Various MON 1) and made available to the Director, EPA, upon request.	

3.5.4 Residual impacts

With the implementation of an Operational Weed, Disease and Hygiene Management Plan, the spread of weeds will be managed and are likely to be reduced from their current distribution as a result of the Project.

3.6 Waste

3.6.1 Existing environment

The Copping Landfill is considered a Category C Landfill in accordance with the Tasmanian Landfill Sustainability Guide 2004 (DPIWE, 2004), specifically: *Landfills able to accept the same wastes as Putrescible Landfills as well as contaminated soil, controlled waste, other hazardous waste and special waste. Also referred to as Secure Landfills.*

The B-Cells at the Project Site, which includes Cells 10 and 11, accept Category B waste, that is:

- General domestic waste
- Animal effluent and residues
- Asbestos waste (fully wrapped)
- Scrap tyres
- Low level contaminated soil
- Suitably treated and dried sewage sludge including grit, silt and screening (equivalent to low level contaminated soil)
- Medical waste, including sharps containers (no infectious or cytotoxic waste)
- Quarantine waste, subject to Biosecurity Tasmania approval
- Solid inert fill material

The waste streams are categorised and screened at the Lutana Waste Transfer Station, which accepts all material other than Category C waste. Lutana accepts the waste streams from eleven municipal areas in southern Tasmania. Once waste is received at Lutana, it is compacted and then transferred to the Copping Landfill. Customers are provided with a vehicle identity tag that is used at the weighbridges at the entrance to the two facilities to ensure waste is not mixed and to maintain waste tonnage records. Low level contaminated soil may be delivered directly from its origin.

Category C controlled waste is required to be assessed and approved on a case-by-case basis by the Director, EPA, and can only be accepted into the C-Cell at the Copping Landfill. Waste destined for the C-Cell has specific paperwork associated with it to ensure it is not disposed of into the B-Cells.

After being weighed on the weigh bridge, Category B waste is delivered directly to the B-Cell onto the working area of the cell, which is then dozed into the working face and compacted with a roller (aiming at a 2:1 compaction ratio), which assists in minimising windblown waste and maximises the use of available airspace. Waste is covered on a daily basis with topsoil from the clay borrow pits onsite to minimise odour generation and further prevent windblown waste. The maximum area of open cell at a time is 2,000 m^2, with a 20 m wide working face.

Once a 2 m lift in the cell is completed, more topsoil is spread over the whole of the lift and then compacted again. The next 2 m lift is then commenced. The faces of the cell are smoothed between the lifts to minimise water pooling, maintaining a slope of less than 1:3, ideally aiming for a 1:4 slope.

Topsoil is taken from the clay borrow pit area within the Project Site and stockpiled for use at the working area of the B-Cell.

Once a cell is filled a temporary clay capping is placed over the cell for a period of 1-2 years to allow natural settling and consolidation of the waste material to occur, with a final cap placed after this settling period.

Aside from operational waste associated with the landfilling activities (e.g. machinery service wastes, used oils, general refuse), actual waste generation at the Copping Landfill is minimal. The main waste streams are wind-borne litter from landfilling activities, leachate residue from the new BeneVap system, sediment sludge from the primary and secondary stormwater ponds, and general waste from employees on-site. The movement of wind-blown litter offsite is also mitigated by a perimeter fence, which is regularly monitored to collect litter. There is no off-site disposal of waste, with all waste directed to the existing cells onsite depending on waste category.

3.6.2 Potential impacts

Wind-borne litter is an ongoing challenge for the management of the Project Site however there were no records of pollutants leaving the Project Site during the 2020-21 monitoring period (CRDS Joint Authority, 2021). Potential impacts are generally associated with visual amenity impacts to the surrounding land.

Leachate residue (sludge) from the BeneVap system is not considered to pose a significant threat to the environment as it will be collected in a controlled environment and disposed of within the C-Cell onsite. The BeneVap system is fully bunded.

Similarly with desludging of the primary and secondary stormwater ponds, the sludge would be collected and stored in the appropriate cell onsite and does not present a significant risk to the environment.

General waste is not considered a significant threat to the environment at the site as all waste is collected and disposed of to the B-Cells.

3.6.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

.Reference number	Management, mitigation or monitoring measure
Management and mitigation	
Waste MM 1	All trucks transporting waste to the site must be appropriately covered to avoid wind-blown litter.
Waste MM 2	The operation of the active landfill face within the cells will be restricted to a maximum area of 2,000 m^2, as far as reasonably practicable. At the end of each working day, a cover of clean fill material will be placed over the active landfill cell face.
Waste MM 3	Acceptance of waste at the Project Site will cease an hour before the closure of the landfill, to allow adequate time to cover waste at the end of each day.
Monitoring	
Waste MON 1	Regular monitoring and removal of litter will be undertaken along the perimeter fence and surrounding the Project Site.
Annual audits of all aspects of waste management, mitigation, and monitoring will be undertaken as part of the OEMP monitoring program (as documented in Various MON 1) and made available to the Director, EPA, upon request.	

3.6.4 Residual impacts

With the implementation of the management and mitigation measures outlined, the residual impacts associated with waste generation at the site is expected to be low. Based on the area of active landfill face, the amount of wind-blown rubbish is not expected to increase as a result of the Project.

3.7 Environmentally hazardous substances

3.7.1 Existing environment

Environmentally hazardous materials currently stored at the Copping Landfill include:

- 6,000 L capacity tank, containing a maximum of 5,250 L diesel and 750 L diesel exhaust fluid (e.g. AdBlue)
- 400 L capacity tank mounted on a bunded trailer, containing diesel
- 200 L capacity drum on a bunded pallet, containing diesel exhaust fluid (e.g. AdBlue)
- Hydraulic oil and lubricants for machinery (several hundred litres)

The following herbicides are routinely applied within the Copping Landfill but are not stored on-site:

- Garlon 600, pulse, dye (applied to gorse and Spanish heath)
- Flupropanate (applied to serrated tussock)
- Weedmaster Duo (applied to cumbungi)
- Lontrel Extra (applied to Californian thistle)

Controlled wastes are also present on site within the C-Cell.

3.7.2 Potential impacts

The Project will generate landfill gas, which is largely comprised of methane and carbon dioxide (99%). Methane is a flammable gas and is listed as a hazardous chemical in the *Work Health and Safety Regulations 2012*. Landfill gas is to be managed through the landfill gas system outlined in Section 2.2.

Dangerous goods and environmentally hazardous materials present a risk to the environment and human health if used, stored or disposed of incorrectly. Spills of these material to waterways, drainage lines and wetlands can present significant risks to aquatic flora and fauna, ranging from direct toxicity impacts to smothering effects (e.g. from hydrocarbons). Spills of these materials to ground can present similar risks if the water table is reached by the spilt materials or washed into drainage lines during rains.

3.7.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
Environmentally hazardous substances MM 1	All dangerous goods or environmentally hazardous materials will be stored in appropriately bunded containers within the construction compound(s), in accordance with relevant Australian Standards and state regulations.
Environmentally hazardous substances MM 2	A register of dangerous goods and environmentally hazardous materials used on site will be maintained throughout operation. The register will be accompanied by the appropriate safety, storage, segregation and handling information (including Safety Data Sheets).
Environmentally hazardous substances MM 3	Hydrocarbon and chemical spill kits will be stored on site and wherever dangerous goods and environmentally hazardous materials are used throughout the Project Site. Spill kits will also be stored in select vehicles.
Environmentally hazardous substances MM 4	All disposal of dangerous goods and environmentally hazardous materials will be undertaken in accordance with relevant Australian Standards and state regulations.

Reference number	Management, mitigation or monitoring measure
Environmentally hazardous substances MM 5	Clean-up measures, reporting and notification procedures for equipment breakdowns and accidental releases will be incorporated in an Emergency Response Plan for the Project. This will include incident response in the event of fire, chemical release, or an explosion.
Environmentally hazardous substances MM 6	All spills of dangerous goods or environmentally hazardous materials will be reported to the site supervisor.
Environmentally hazardous substances MM 7	The site induction for all workers will include training in the use and disposal of all dangerous goods and environmentally hazardous materials to be used on site, as well as protocols to follow in the even to an incident involving these materials.
Monitoring	
Annual audits of all aspects of environmentally hazardous substances management, mitigation, and monitoring will be undertaken as part of the OEMP monitoring program (as documented in Various MON 1) and made available to the Director, EPA, upon request.	

3.7.4 Residual impacts

With the implementation of the management, mitigation and monitoring measures outlined, the risk from environmentally hazardous substances can be well managed and residual risks are low. No measurable impacts to the current or future land use are anticipated.

3.8 Site contamination

3.8.1 Existing environment

Past and current use of the Project Site as a waste disposal facility presents the risk of contamination within the soils and groundwater of the site. The soils internal to the Project Site associated with the B-Cells and C-Cell are likely to be contaminated due the nature of waste disposal. The use of cell liners and management of water associated with the cells is the safeguard in this case to minimise the risk of contaminants migrating offsite.

Extensive leachate management systems, including cell lining, drainage, and treatment are present at the existing site, as explained in Section 2.2. This is also the case for stormwater, both external and internal to the footprint of the existing facility. Both stormwater and leachate management systems will continue to be used for the Project

Extensive monitoring of groundwater since the inception of the facility has not identified any significant leaks of leachate generated by landfilling activity, and monitoring of surface waters has not indicated any significant contaminants beyond the boundaries of the Project Site.

3.8.2 Potential impacts

The potential impacts associated with leachate and stormwater site contamination have been discussed in Section 3.2.

As solid wastes are proposed to remain is situ as part of the Project (as a landfill), no further consideration of potential risks are presented here.

3.8.3 Management, mitigation and monitoring

The following management, mitigation and monitoring measures are proposed for the operational phase of the Project.

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
No specific additional management and mitigation to that already undertaken at the Project Site is proposed as part of the Project.	
Monitoring	
No specific additional management and mitigation to that already undertaken at the Project Site is proposed as part of the Project.	

3.8.4 Residual impacts

Site contamination is well managed through the design and operation of the existing facility. The potential for any change to impacts as a result of filling the additional B-Cells 10 and 11 is considered negligible.

3.9 Environmental impacts traffic

A traffic impact assessment was prepared for the Project Site are part of preparation for the eventual application for the completion of Stage 1B of the landfill, in accordance with the Department of State Growth (DSG) publication, Traffic Impact Assessment Guidelines, August 2020 (Howarth Fisher and Associates, 2023). The full report is presented in Appendix E, the salient points associated with the operation of this Project have been used here to assess potential traffic impacts.

3.9.1 Existing environment

Baseline traffic counts were undertaken by Howarth Fisher and Associates (2023) between 7am-8am on Tuesday 13 December, with this time and day noted by the landfill operators as representing the worst-case traffic movement period on an hourly basis during an average week. The counts found four vehicles turning in and five turning out of Blue Hills Road, with 153 movements along Arthur Highway during the one-hour period.

Based on these measurements, Howarth Fisher and Associates (2023) estimate baseline conditions to be 32 vehicle movements to and from Blue Hills Road per day, with 9 trips during the peak hour; the majority are assumed to be associated with the landfill and to be heavy vehicles. The largest vehicle is a 19 m semi-trailer. A range of heavy vehicles, including 8.8 m skip trucks, medium rigid vehicles and 12.5 m heavy rigid vehicles are used to service the Project Site.

3.9.2 Potential impacts

The proposed increase in tonnage acceptance will result in an increase from 32 to 43 vehicles per day in and out of the site (~25% increase), with an increase from 9 to 12 trips in and out of the site during the peak hour (Howarth Fisher and Associates, 2023). This was calculated based on a 25% increase in waste currently deposited, which will increase from approximately 150,000 tonnes per year to 200,000 (noting that the current EPN limit is 104,000 tonnes per annum). The increase in traffic will predominantly be heavy vehicles.

The increase in traffic will be restricted to the operating hours of the landfill however during winter, the peak hour (7 am-8 am) will be within the one-hour period after dawn where there is an increased risk of roadkill.

Environmentally, the potential impacts from increased traffic are associated with increased roadkill risk (refer Section 3.4), increased noise (refer Section 3.3), and increased dust (refer Section 3.1).

3.9.3 Management, mitigation and monitoring

Management and mitigation associated with the environmental impacts of traffic are addressed under the relevant sections of this EER, namely increased roadkill risk (refer Section 3.4), increased noise (refer Section 3.3), and increased dust (refer Section 3.1).

3.9.4 Residual impacts

The potential for any significant impacts as a result of an increase in traffic in the order of 25% is considered negligible given the remoteness of the site, the generally low number of vehicle movements and the restriction of movements to during operational hours (day time).

3.10 Other off-site impacts

It is considered unlikely that any off-site impacts will result from the Project. The increases in waste volume from the Lutana Transfer Station are unlikely to significantly impact that site or the road network.

Environmental impacts of traffic have been addressed elsewhere in this EER.

3.11 Fire risk and prevention

During operation, there will be standard fire risks associated with electrical faults, smoking, or mishandling or incorrect storage of chemicals and fuels. The Project does not present any major change to the existing overall fire risk at the site. The overall risk is considered low and is addressed in the existing operational and emergency plans for the Project Site.

The Project Site is mapped as a Bushfire Prone Area under the TPS and was affected by the 2012-2013 bushfires. The risk from fire originating from outside the site (i.e. wildfire) is therefore considered moderate given the previous major fires that have occurred in the area.

The existing Project Site has a fire-fighting tank in place that can be accessed with a portable pump if required, additionally the stormwater ponds can be used for firefighting purposes.

Any firefighting waters uses during fires onsite would be captured in the existing secondary stormwater system, preventing direct discharge to the receiving environment.

The overall risk of fire associated with the Project is considered low, given the low levels of vegetation within the site and the proximity of the Project Site to emergency services.

3.12 Decommissioning and rehabilitation

Due to the nature of the Project, decommissioning and rehabilitation of landfill cells will be ongoing as each cell reaches capacity, following the capping process outlined in Section 2.2. The B-Cell capping process will be captured in the existing site Operational Environmental Management Plan.

The Project has been designed to have an operational life of up to 2 years, which will then be followed by the further expansion of the B-Cells (subject to separate approval). In light of this, only an outline of the concepts to be included in a final Decommissioning and Rehabilitation Plan are provided here. A final Decommissioning and Rehabilitation Plan will be provided to the Director, EPA for approval within 12 months of the planned cessation of the operation of the Project Site as a whole.

The decommissioning process for the Project Site would be expected to include the following actions, the order of which would depend on the final plan:

- Infilling, stabilisation, and final capping of all landfill areas, including the B-Cell and C-Cell areas, to minimise the volume of rainfall able to percolate through to the waste layers, thus minimising leachate production.
- Installation of final gas wells to minimise fire and odour risks associated with gas generation.
- Installation of a final leachate catchment and treatment system to replace active leachate treatment (e.g. BeneVap system).
- Removal of final ancillary infrastructure, this would include all site offices, sheds, the pilot wetland treatment system, gas generator system and pipelines, water and leachate ponds and associated pipelines, and site roads (where not needed for ongoing monitoring).
- Installation of long-term sedimentation and erosion controls to stabilise the environment where appropriate.
- Ripping, contouring, and reseeding of all voids left at the Project Site. Reseeding would be undertaken in consultation with a qualified agricultural/ecological consultant.
- Treatment and removal of any established weed outbreaks.
- Development of a post-decommissioning monitoring plan that incorporates surface and groundwater monitoring and monitoring of site stability.

3.12.1 Management, mitigation and monitoring

Reference number	Management, mitigation or monitoring measure
Management and mitigation	
Decommissioning and rehabilitation MM 1	A final Decommissioning and Rehabilitation Plan will be provided to the Director, EPA for approval within 12 months of the planned cessation of the Project Site as a whole.

3.13 Greenhouse gas emissions and climate change

Reporting of greenhouse gas (GHG) emissions is currently regulated under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act), through the National Greenhouse and Energy Reporting Scheme (NGER Scheme). The NGER Scheme outlines thresholds for facilities and corporations which trigger reporting obligations under the NGER Act (Clean Energy Regulator, 2022).

The current thresholds for facilities are:

- Emission of 25 kilotonnes (kt) carbon dioxide equivalent (CO2-e) GHG
- Energy production of 100 terajoules (TJ)
- Energy consumption of 100 TJ

The current thresholds for corporate groups are:

- Emission of 50 kt (CO2-e) GHG
- Energy production of 200 TJ
- Energy consumption of 200 TJ

The Project will not trigger the facility reporting thresholds for the Copping Landfill. SWS as a corporate group does not trigger the corporate group thresholds.

The Climate Change Action Plan 2017-2021 concluded in June 2021 and development of an updated Plan is currently underway (RECFIT, 2023). A draft Climate Change Action Plan 2023-2025 was released for public comment in March 2023. The Project is most relevant to Priority Area 2 of the draft plan, which relates to reducing emissions across all industries. Relevant opportunities for emissions reduction identified in the draft plan include reducing landfill methane emissions by diverting more organic waste from landfills and increase landfill gas capture (RECFIT, 2023).

Action 2.1 of the Plan is to promote emissions reduction and energy security. The Copping Landfill incorporates a landfill gas management system which generates approximately 17,000 MW/hours of electricity per annum (currently fed into the electricity gird). The system currently extracts approximately 4,930,000 m^3 of landfill gas per year. The Project is expected to generate a proportional increase with the filling of the two additional B-Cells.

The Project minimises GHG emissions associated with the transport of materials from the Lutana Waste Transfer Station to Copping Landfill through the compaction of waste prior to transport (resulting in reduced vehicle trips).

Potential impacts of climate change relevant to the Project include increased frequency and intensity of storm events (and associated increases in stormwater and leachate generation) and more severe fire weather. Management of stormwater is discussed in section 3.2.3. The BeneVap system is a forced evaporative system designed to reduce leachate volume by up to 95 %, meaning that large volumes of effluent are not required to be managed and discharged post-treatment. If successful, the BeneVap system will improve the resilience of the Copping Landfill to the effects of climate change through providing a sustainable treatment mechanism that is not subject to passive evaporation.

4 Part D – Summary of proposed management, mitigation and monitoring measures

The following summary tables outline the management, mitigation and monitoring measures committed to by the proponent for the Project.

Table 4-1- Management and mitigation measures

Reference number	Management, mitigation or monitoring measure	Project phase	EIS Section
Various			
Various MM 1	The existing site Operational Environmental Management Plan (OEMP), which captures all relevant existing operational phase management measures, will be updated to include any new operational permit conditions as a results of the Project. The document will be made available to the EPA upon request. The OEMP will be implemented throughout operation.	Operational	Section 3
Various MM 2	During the operational phase of the Project, the results of relevant environmental management and monitoring stipulated in this EER (and any resulting approval conditions) will be documented in Annual Environmental Reports to be submitted to the EPA within 3 months of the conclusion of the annual reporting period each year.	Operational	Section 3
Air Quality MM 1	Potentially dust generating material stockpiles, roads or excavated areas will be sprayed during periods of dry weather with water or a suitable dust suppressant as required.	Operational	Section 3.1.3
Air Quality MM 2	Existing speed restrictions will continue to be applied and adhered to for all internal roads to minimise dust generation. Vehicles accessing the site will adhere to the sign-posted speed limits on Blue Hills Road.	Operational	Section 3.1.3
Air Quality MM 3	Earth moving equipment will be regularly serviced and maintained to minimise exhaust emissions.	Operational	Section 3.1.3
Air Quality MM 4	Potentially dust generating activities on-site will be avoided during periods of dry, windy weather (where practicable).	Operational	Section 3.1.3
Air Quality MM 5	Daily cover will be applied to working cell faces to reduce odour emissions.	Operational	Section 3.1.3
Air Quality MM 6	A maximum working area of 2,000 m^2 will be opened on a working cell at any one time.	Operational	Section 3.1.3
Noise MM 1	Operation of noise generating machinery and equipment will be restricted to normal daytime operating hours, in accordance with the conditions of the existing EPN, namely: • Monday to Friday 7 am – 5 pm • Saturday 7 am - 4 pm • Public holidays (excluding Christmas Day and Good Friday) 7 am – 4 pm The site will be closed on Sundays.	Operational	Section 3.3.3
Noise MM 2	Low noise generating plant and equipment will be used where practicable.	Operational	Section 3.3.3

Reference number	Management, mitigation or monitoring measure	Project phase	EIS Section
Noise MM 3	Broadband reversing alarms will be utilised where practicable over traditional tonal alarms to minimise any nuisance noise generated.	Operational	Section 3.3.3
Noise MM 4	Equipment will be regularly serviced and maintained to minimise noise emissions.	Operational	Section 3.3.3
Noise MM 5	Where practical, machinery will be operated at low speed or power and be switched off when not in use, rather than left idling for prolonged periods.	Operational	Section 3.3.3
Noise MM 6	Trucks will be advised not to use exhaust brakes near residences on Blue Hills Road.	Operational	Section 3.3.3
Natural Values MM 1	Speed limits within the Project Site will be limited to 40 km/hr at all times to minimise roadkill.	Operational	Section 3.4.3
Natural Values MM 2	Truck drivers will be informed of the risks to roadkill of threatened fauna and will be instructed to report any roadkill incident on the way to or from the site. Any confirmed kills of listed fauna will be reported in the Annual Environmental Report for the site.	Operational	Section 3.4.3
Weeds, pests & pathogens MM 1	An updated Weed, Disease and Hygiene Management Plan will be developed and provided to the Director, EPA, within 6 months of project approval. The plan will be in general accordance with the Weed, Disease Planning and Hygiene Guidelines (DPIPWE, 2015) and include provisions for: • Weed control for areas of existing weed infestation where equipment will be required to work. • Hygiene protocols, including vehicle washdown (if warranted) prior to site entry/exit to avoid the spread of weeds and pathogens in general accordance with the Tasmanian Washdown Guidelines for Weed and Disease Control and Keep It Clean - A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens.	Operational	Section 3.5.3
Waste MM 1	All trucks transporting waste to the site must be appropriately covered to avoid wind-blown litter.	Operational	Section 3.6.3
Waste MM 2	The operation of the active landfill face within the cells will be restricted to a maximum area of 2,000 m^2, as far as reasonably practicable. At the end of each working day, a cover of clean fill material will be placed over the active landfill cell face.	Operational	Section 3.6.3
Waste MM 3	Acceptance of waste at the Project Site will cease an hour before the closure of the landfill, to allow adequate time to cover waste at the end of each day.	Operational	Section 3.6.3
Environmentally hazardous substances MM 1	All dangerous goods or environmentally hazardous materials will be stored in appropriately bunded containers within the construction compound(s), in accordance with relevant Australian Standards and state regulations.	Operational	Section 3.7.3
Environmentally hazardous substances MM 2	A register of dangerous goods and environmentally hazardous materials used on site will be maintained throughout operation. The register will be accompanied by the appropriate safety, storage, segregation and handling information (including Safety Data Sheets).	Operational	Section 3.7.3
Environmentally hazardous substances MM 3	Hydrocarbon and chemical spill kits will be stored on site and wherever dangerous goods and environmentally hazardous materials are used throughout the Project Site. Spill kits will also be stored in select vehicles.	Operational	Section 3.7.3

Reference number	Management, mitigation or monitoring measure	Project phase	EIS Section
Environmentally hazardous substances MM 4	All disposal of dangerous goods and environmentally hazardous materials will be undertaken in accordance with relevant Australian Standards and state regulations.	Operational	Section 3.7.3
Environmentally hazardous substances MM 5	Clean-up measures, reporting and notification procedures for equipment breakdowns and accidental releases will be incorporated in an Emergency Response Plan for the Project. This will include incident response in the event of fire, chemical release, or an explosion.	Operational	Section 3.7.3
Environmentally hazardous substances MM 6	All spills of dangerous goods or environmentally hazardous materials will be reported to the site supervisor.	Operational	Section 3.7.3
Environmentally hazardous substances MM 7	The site induction for all workers will include training in the use and disposal of all dangerous goods and environmentally hazardous materials to be used on site, as well as protocols to follow in the even to an incident involving these materials.	Operational	Section 3.7.3
Decommissioning and rehabilitation MM 1	A final Decommissioning and Rehabilitation Plan will be provided to the Director, EPA for approval within 12 months of the planned cessation of the Project Site as a whole.	Operational	3.12

Table 4-2 - Monitoring measures

Refence number	Aspect / EIS section	Monitoring commitment
Various MON 1	Various	Monitoring procedures for operational environmental controls are documented in the existing OEMP and will be implemented during the operational phase, including as a minimum: • Development of an online complaints register and weekly monitoring of the register. • Daily visual monitoring of active operational areas for dust and other visible emissions (e.g. wind-blown waste and visible water quality issues including high sediment loads or surface sheen). • Fortnightly audits of the physical site operational controls (including sediment and erosion control measures and waste management). Additional audits will be undertaken after extreme weather events. • Annual audits of all management measures set out in the OEMP. • Any non-conformance identified during inspections and audits will be documented, investigated, and resolved. • Audits will be made available to the EPA on request. Any non-conformance or incident with the potential for serious or material environmental harm will be reported to the Director, EPA within 24 hours.
Air Quality MON 1	Air quality	Landfill operating staff will monitor odour and dust levels on site and respond appropriately.
Water Quality MON 1	Water quality	The extensive Surface and Groundwater Monitoring Program already undertaken for the existing operations at the Project Site will continue for the Project.
Weeds, pests & pathogens MON 1	Weeds, pests & pathogens	Annual weed monitoring will be undertaken as part of the Operational Weed, Disease and Hygiene Management Plan, with results of management to be presented in the Annual Environment Reports for the site.
Waste MON 1	Waste	Regular monitoring and removal of litter will be undertaken along the perimeter fence and surrounding the Project Site.

5 Part E – Public and stakeholder consultation

5.1 Engagement undertaken to date

Public consultation has not been undertaken for the Project, based on the existing use of the site as a landfill.

Information relating to the Copping Landfill, such as monitoring reports and news articles, are regularly published on the SWS website. SWS also offer tours of the Copping Landfill to members of the public on request. In November 2022, SWS collaborated with the Mornington Park Waste Transfer Station and Landcare Tasmania, to deliver the 'Let's Explore Waste' program to school students. The program aims to educate students about waste management and minimising waste sent to landfill.

Engagement with the owner councils (Clarence City, Sorell, Tasman and Kingborough Councils), including updates on the Project, is undertaken at quarterly joint authority meetings.

5.2 Engagement proposed to be undertaken

SWS propose to continue the current engagement agenda, as outlined above, throughout the operation of the Project.

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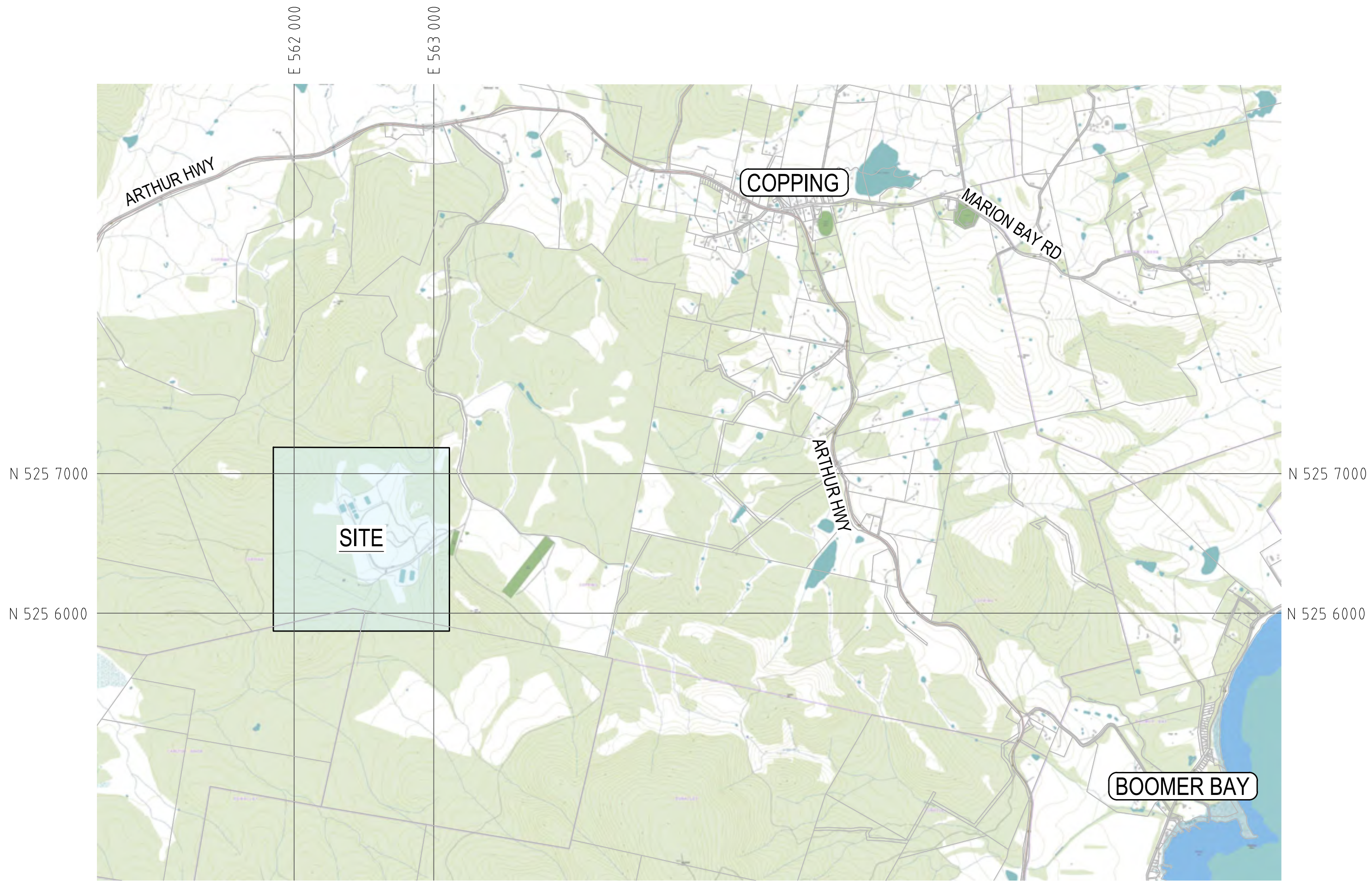
Appendix F Plans

COPPING LANDFILL
NEW CELLS 10 & 11



LOCALITY
SCALE 1:50000 (m)

DRAWING LIST

DRAWING NUMBER:	TITLE:	REVISION:
S-P.21.1810-01-CIV-DRG-1000	LOCALITY PLAN AND DRAWING LIST	0
S-P.21.1810-01-CIV-DRG-1001	QUALITY MANAGEMENT PLAN	0
S-P.21.1810-01-CIV-DRG-1002	QUALITY MANAGEMENT PLAN	0
S-P.21.1810-01-CIV-DRG-1003	QUALITY MANAGEMENT PLAN	0
S-P.21.1810-01-CIV-DRG-1011	SITE PLAN	0
S-P.21.1810-01-CIV-DRG-1101	CELL GENERAL ARRANGEMENT PLAN	0
S-P.21.1810-01-CIV-DRG-1102	LEACHATE COLLECTION SYSTEM PLAN	0
S-P.21.1810-01-CIV-DRG-1111	SITE SECTION	0
S-P.21.1810-01-CIV-DRG-1121	SITE CROSS SECTIONS	0
S-P.21.1810-01-CIV-DRG-1122	SITE CROSS SECTIONS	0
S-P.21.1810-01-CIV-DRG-1123	SITE CROSS SECTIONS	0
S-P.21.1810-01-CIV-DRG-1131	CELL TYPICAL CROSS SECTIONS	0
S-P.21.1810-01-CIV-DRG-1141	CELL TYPICAL DETAILS	0
S-P.21.1810-01-CIV-DRG-1142	CELL TYPICAL DETAILS	0
S-P.21.1810-01-CIV-DRG-1211	ROAD LONG SECTION	0
S-P.21.1810-01-CIV-DRG-1231	ROAD TYPICAL CROSS SECTIONS	0
S-P.21.1810-01-CIV-DRG-1232	ROAD TYPICAL CROSS SECTIONS	0
S-P.21.1810-01-CIV-DRG-1251	TYPICAL ACCESS ROAD SECTION AND DETAILS	0

REFERENCE FILES ATTACHED:

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED
ORIGINAL COPY ON FILE
"e" SIGNED BY
SIGNED
DATE

SCALE (PLOTTED FULL SIZE): AS SHOWN
SHEET SIZE: A3

500 0 500 1000 1500 2000
SCALE IN METRES - 1:50000

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CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: LOCALITY PLAN AND DRAWING LIST
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No.: S-P.21.1810-01-CIV-DRG-1000
REVISION: 0

Sep. 15, 22 - 12:06:09 Name: S-P.21.1810-01-CIV-DRG-1000.dwg Updated By: Geoff Tuck

EARTHWORKS QUALITY TESTING

GENERAL FILL

Item	Property	Standards	Frequency
Material is suitable for use as general fill	Fill is free of unsuitable material	Visual examination	Ongoing as fill material is won during the works
Fill has been adequately compacted	Density and moisture content of fill material	Control tests to AS1289.5.4.1 or AS1289.5.7 as applicable	Minimum of 3 tests per borrow pit used Take samples from discrete locations within the borrow pit.
		Compaction tests to AS1289.5.1.1 or AS1289.5.4.1 as appropriate	Minimum of 1 test per 1,000m³ placed and at least 1 test per layer of material placed.

COMPACTED CLAY LINERS

Item	Property	Standards	Frequency
Clay for borrow pit is suitable for use as a clay liner	Clay plasticity complies with specific limits	Undertake testing for Atterberg limits Liquid limit (AS1289.3.1.2) Plastic limit (AS1289.3.2.1) Plasticity index (AS1289.3.3.1)	1 per 1,000 m3 of compacted material (minimum of 4 tests per borrow pit used) Take samples from discrete locations within the borrow pit.
	Density and moisture content of clay material	Hilf rapid compaction method (AS1289.5.7.1) using standard compactive effort (AS1289.5.1.1 or AS1289.5.2.1)	Minimum of 3 tests per borrow pit used Take samples from discrete locations within the borrow pit.
	Clay can achieve a permeability of <1 x 10^{-9} m/s.	Falling head permeability test at the specified standard compaction (AS 1289.6.7.2)	Minimum of 3 tests per borrow pit used Take samples from discrete locations within the borrow pit.
Clay Placement Control	Compaction density achieves a minimum of 95% standard compaction	Density test using standard compactive effort (AS1289.5.1.1 or AS1289.5.2.1)	Minimum of 12 per Hectare for each layer of clay placed Minimum 12 tests total. Space test locations evenly over work area in a grid pattern
	Clay liner permeability < 1 x 10^{-9} m/sec.	falling head permeability of undisturbed sample - (AS1289.6.7.2)	Minimum of 5 per hectare for each layer placed Minimum of 5 tests total. Space test locations Evenly over work area in a grid pattern
		Percolation Tests on the completed surface of the clay layer (AS 1547)	Minimum of 5 per hectare for each layer placed Space test locations Evenly over work area in a grid pattern

REFERENCE FILES ATTACHED:

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED

ORIGINAL COPY ON FILE "e" SIGNED BY

SIGNED

DATE

SCALE (PLOTTED FULL SIZE) -

SHEET SIZE A3

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CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY

PROJECT: COPPING LANDFILL NEW CELLS 10 & 11

STATUS: ISSUED FOR TENDER

DRAWING TITLE: QUALITY MANAGEMENT PLAN SHEET 1 OF 3

DATUMS: AHD / MGA55, GDA20

CLIENT No.

DRAWING No. S-P.21.1810-01-CIV-DRG-1001

REVISION 0

Sep. 15, 22 - 12:06:12 Name: S-P.21.1810-01-CIV-DRG-1001.dwg Updated By: Geoff Tuck

Geofabric Clay Liners MQA

Tested Properties		Test Method	Test Frequency	Units	GCL Elcoseal x800	GCL Elcoseal x1000	GCL Elcoseal x2000
Hydraulic Properties	Hydraulic Conductivity	ASTM D5887	40,000m^2	m/s	3.5×10^{-11}	2.8×10^{-11}	3×10^{-11}
Bentonite Characteristics	Swell Index	ASTM D5890	40,000m^2	mL/2g	≥ 24	≥ 24	≥ 24
	Fluid Loss	ASTM D5891	40,000m^2	mL	≤ 15	≤ 15	≤ 15
GCL Components - Mass	Nonwoven Geotextile Mass per unit area	AS 3706.1	10,000m^2	g/m^2	220	220	220
	Bentonite Mass per unit area	ASTM D5993	2,500m^2	g/m^2	3,700	4,000	3,700
	Carrier/Composite Geotextile Mass per unit area	AS 3706.1	70,000m^2	g/m^2	110	110	320
	Geotextile configuration				W / NW5	W / NW	W+NW / NW
GCL - Mass	GCL total Mass per unit area @ 0% moisture content	ASTM D5993	2,500m^2	g/m^2	4,030	4,330	4,240
Strength Properties	Strip Tensile Strength	ASTM D6768	10,000m^2	kN/m	7	8	12
	CBR Strength	AS 3706.4	25,000m^2	N	1,400	1,600	3,500
	CBR Elongation	AS 3706.4	25,000m^2	%	10	15	30
GCL - Shear Strength Properties	Hydrated Peak Internal Shear Strength @ 10kPa Normal Stress	ASTM D6243	Periodic	kPa	30	30	35
	Hydrated Peak Internal Shear Strength @ 30kPa Normal Stress	ASTM D6243	Periodic	kPa	50	50	60
GCL Longitudinal Edge Treatment	Bentonite Impregnation - Width 300mm - Typical				Y	Y	Y
	Edge Sealing Performance	ASTM STP 1308	Periodic	m/s	2.5×10^{-11}	1.9×10^{-11}	2.4×10^{-11}
GCL Roll Dimensions	Standard Roll Dimensions (Width x Length)			m	4.7 x 45	4.7 x 35	4.7 x 30
	Typical Roll Mass (standard roll length)		(Weighed every roll)	kg	1,395	1,050	960
	GCL Spreader Bar Requirement				Heavy-Duty8	Heavy-Duty8	Standard9

Geotextiles MQA

Tested Properties		Test Method	Test Frequency	Units	Geotextiles						
					Bidim A14	Bidim A24	Bidim A34	Bidim A44	Bidim A64	Bidim A74	Bidim A84
Physical Properties	Pore Size (095)	AS 3706.7-2003	Per Formulation	µm	174	150	127	110	75	75	75
	Permittivity	AS 3706.9	Per Formulation	s^{-1}	3.20	1.80	1.65	1.20	0.90	0.60	0.55
	Coefficient of Permeability	AS 3706.9	Per Formulation	m/s x 10^{-4}	43	43	43	43	43	43	43
	Flow Rate @ 100mm Head	AS 3706.9	Per Formulation	l/m^2/s	320	180	165	120	90	60	55
Strength Properties	CBR Strength	AS 3706.4	25,000m^2	N	1,814	2,571	3,446	4,729	6,460	7,500	9,119
	Wide Strip Tensile Strength	AS 3706.2	Per Formulation	kN/m	9.0/9.0	14.0/14.0	18.5/18.5	26.5/26.5	37.5/37.5	43.5/43.5	52.0/52.0
	Wide Strip Toughness	AS 3706.2	Per Formulation	kJ/m^2	1.6/2.0	2.7/3.1	3.5/3.8	4.8/5.5	8.2/8.2	8.6/8.7	14.2/13.1
	Grab Tensile Strength	AS 3706.2	Per Formulation	N	600/600	850/850	1,210/1,210	1,850/1,850	2,620/2,620	3,010/3,010	4,000/4,000
	Trapezoidal Tear Strength	AS 3706.3	Per Formulation	N	240/240	345/345	440/440	590/590	800/800	1,065/1,065	1,200/1,200
	G Rating	Austroads	Per Formulation	N	1,300	1,900	2,510	3,500	5,100	5,550	7,600

Geomembranes MQA

Tested Properties		Test Method	MQC Frequency	Units	Geomembrane 2.00mm
Physical Properties	Density of Raw Material	ASTM D 792		g/cc	>0.932
	Melt Flow Index	ASTM D1238 (190° /2.16kg)	1 per batch	g/10min	<0.40
	Density of Geomembrane	ASTM D 792	90,000kg	g/cc	0.946 +/- 0.004
	Carbon Black Content	ASTM D 4218	Per roll	%	2-3
	Carbon Black Dispersion	ASTM D 5596	20,000kg	Category	CAT 1
	Dimensional Stability	ASTM D 1204 (100°C/1h)	Per day	%	+/- 1.5
	Low Temperature Brittleness	ASTM D 746	Per Formulation		No cracks
Endurance Properties	Stress Crack Resistance	ASTM D5397/ ISO18488[4]	90,000kg	h	>3,000
	Oxidative Induction Time (OIT)	ASTM D 3895/5885	90,000kg	min	>120
	Oven Aging at 85°, % retained after 90 days	ASTM D 5721	Per Formulation	%	>55
	UV Resistance HP OIT, % retained after 1600h	ASTM D 7238	Per Formulation	%	>75
	Oxidation at 85°	EN 14575	Per Formulation	%	<15
Mechanical Properties	Tensile Strength at Yield	ASTM D 6693 TypeIV	9,000kg	N/mm	35 (32)
	Elongation at Yield	ASTM D 6693 TypeIV	9,000kg	%	>13
	Tensile Strength at Break	ASTM D 6693 TypeIV	9,000kg	N/mm	64 (53)
	Elongation at Break	ASTM D 6693 TypeIV	9,000kg	%	800 (700)
	Tear Resistance	ASTM D 1004	20,000kg	N	>270
	Puncture Resistance	ASTM D 4833	20,000kg	N	>640

GENERAL (SAFETY)

The laboratory representative shall undergo a safety induction prior to entering the operational zone of the manufacturing facility. A document shall be provided to the laboratory representative showing the date on which the training occurred and the period of the validity of the training.

The laboratory representative shall wear PPE consisting of steel cap boots, long pants and long sleeved shirt, reflective vest (supplied by the manufacturer) and dust mask (supplied by the manufacturer), at all times while within the manufacturing facility.

SAMPLING PROCEDURE

The following sampling procedure shall be adhered to:

1. Samples shall be cut off the roll by the manufacturer's staff, in 300mm widths
2. The taped roll to be sent to site will be signed by the laboratory representative
3. The sample will be rolled up and packaged by the manufacturer's staff
4. The sample will be signed off by the laboratory representative
5. The sample will be placed on a pallet by the manufacturing staff

Upon completion of the shift/production run the pallet will be wrapped in cling film and packaging tape, the laboratory representative will sign on the packaging tape. When production recommences the tape will be removed by the laboratory representative prior to any additional samples being placed on the pallet. The manufacturer will not have access to the samples on the pallet.

DELIVERY OF SAMPLES

The manufacturer shall arrange for the delivery of samples to the nominated laboratory using a tail-lift truck, care should be taken to prevent damage to the signed wrapping covering the pallet.

REFERENCE FILES ATTACHED:

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
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PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: QUALITY MANAGEMENT PLAN SHEET 2 OF 3
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No.: S-P.21.1810-01-CIV-DRG-1002
REVISION: 0

Sep. 15, 22 - 12:06:15 Name: S-P.21.1810-01-CIV-DRG-1002.dwg Updated By: Geoff Tuck

Geotextiles CQA testing

Tested Properties	Test Method	Test Frequency	Units		Bidim A14	Bidim A24	Bidim A34	Bidim A44	Bidim A64	Bidim A74	Bidim A84
Mass per unit area	AS 3706.1	1 test per 2500 m^2 , including the first and last rolls (based on production order): minimum of two tests	g/m²	MARV	143	209	264	359	500	598	733
Grab tensile strength	AS 3706.2b	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	N	MARV	600/600	850/850	1,270/1,210	1,850/1,850	2,620/2,620	3,010/3,010	4,000/4,000
				Typ.	720/720	1,130/1,060	1,430/1,400	2,100/2,100	3,010/3,010	3,370/3,370	4,450/4,450
Trapezoidal tear strength	AS 3706.3	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	N	MARV	240/240	345/345	440/440	590/590	830/830	1,065/1,065	1,200/1,200
				Typ.	300/300	400/400	540/540	750/750	1,030/1,030	1,175/1,175	1,425/1,425
CBR (California bearing ratio) burst strength	AS 3706.4	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	N	MARV	1,750	2,500	3,400	4,650	6,400	7,300	9,000
				Typ.	2,000	2,800	3,700	5,000	6,950	7,900	9,600
Pore size	ASTM D6767	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	µm	Typ.	174	150	127	110	75	75	75
Permittivity	AS 3706.9	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	s^{-1}	Typ.	3.20	1.80	1.65	1.20	0.90	0.60	0.55

Geomembranes CQA testing

Tested Properties	Test Method	Test Frequency	Units	Geomembrane 2.00mm
Thickness	ASTM D5199 (smooth)	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	mm	2.0
Density	ASTM D792	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	g/cc	0.946+/- 0.004
Tensile Properties (yield/break strength, yield/break elongation)	ASTM D6693	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	N/mm; %	Tensile Strength at Yield; 35N/mm Average 32N/mm Min Elongation at Yield; ≥13% Tensile Strength at Break; 64 N/mm Average 53 N/mm Min Elongation at Break; 800% Average 700% Min
Puncture Resistance	ASTM D4833	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	N	≥640
Tear Resistance	ASTM D1004	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	N	≥270
Carbon Black Content	ASTM D1603 or ASTM D4218	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	%	2.0-2.5
Carbon Black Dispersion	ASTM D5596	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	Category	Category 1 or 2 Only
Stress Crack Resistance	ASTM D5397	1 test per 10,000 m^2 , or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last rolls (based on production order): minimum of two tests	hrs	≥3,000
Standard Oxidative Induction Time / High-pressure Oxidative Induction Time	ASTM D3895 / ASTM D5885	1 test per 10,000 m^2 , or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last roll (based on production order): minimum of two tests	mins	Std OIT ≥120 mins HP OIT ≥500 mins

Geofabric Clay Liners CQA testing

Tested Properties	Test Method	Test Frequency	Units		GCL Elcoseal x800	GCL Elcoseal x1000	GCL Elcoseal x2000
Mass per Unit Area	ASTM D5993	1 test per 2500 m^2 , including the first and last rolls (based on production order): minimum of two tests	g/m^2	MARV	N/A	4,330	N/A
				Typical	N/A	4,880	N/A
Bentonite Mass per Unit Area	ASTM D5993	1 test per 1250 m^2 , including the first and last rolls (based on production order): minimum of two tests	g/m^2	MARV	N/A	4,000	N/A
				Typical	N/A	4,500	N/A
Peel Strength	ASTM D6496	1 test per 1250 m^2 , including the first and last rolls (based on production order): minimum of two tests	N/m	Typical	N/A	360	N/A
Tensile Properties (machine direction)	ASTM D6768	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	kN/m	MARV	N/A	8	N/A
				Typical	N/A	11	N/A
CBR burst strengths	AS 3706.4	1 test per 5000 m^2 , including the first and last rolls (based on production order): minimum of two tests	N/m	MARV	N/A	1,600	N/A
				Typical	N/A	2,100	N/A
Fluid Loss	ASTM D5891	1 test per 1250 m^2 , including the first and last rolls (based on production order): minimum of two tests	mL	Typical	N/A	≤15	N/A
Swell Index	ASTM D5890	1 test per 2500 m^2 , including the first and last rolls (based on production order): minimum of two tests	mL/2g	Typical	N/A	≥24	N/A
Cation Exchange Capacity	Methylene blue method	1 test per 2500 m^2 , including the first and last rolls (based on production order): minimum of two tests	mEq/100g	Typical	N/A	70	N/A
Permeability	ASTM D5887	1 test per 10,000 m^2 , including the first and last rolls (based on production order): minimum of two tests	m/s	MARV	N/A	2.8×10^{-11}	N/A
				Typical	N/A	1.9×10^{-11}	N/A
Montmorillonite Content and Carbonate Content	CSIRO x-ray diffraction	1 test per 10,000 m^2 , including the first and last rolls (based on production order): minimum of two tests	%	Typical	N/A	70	N/A

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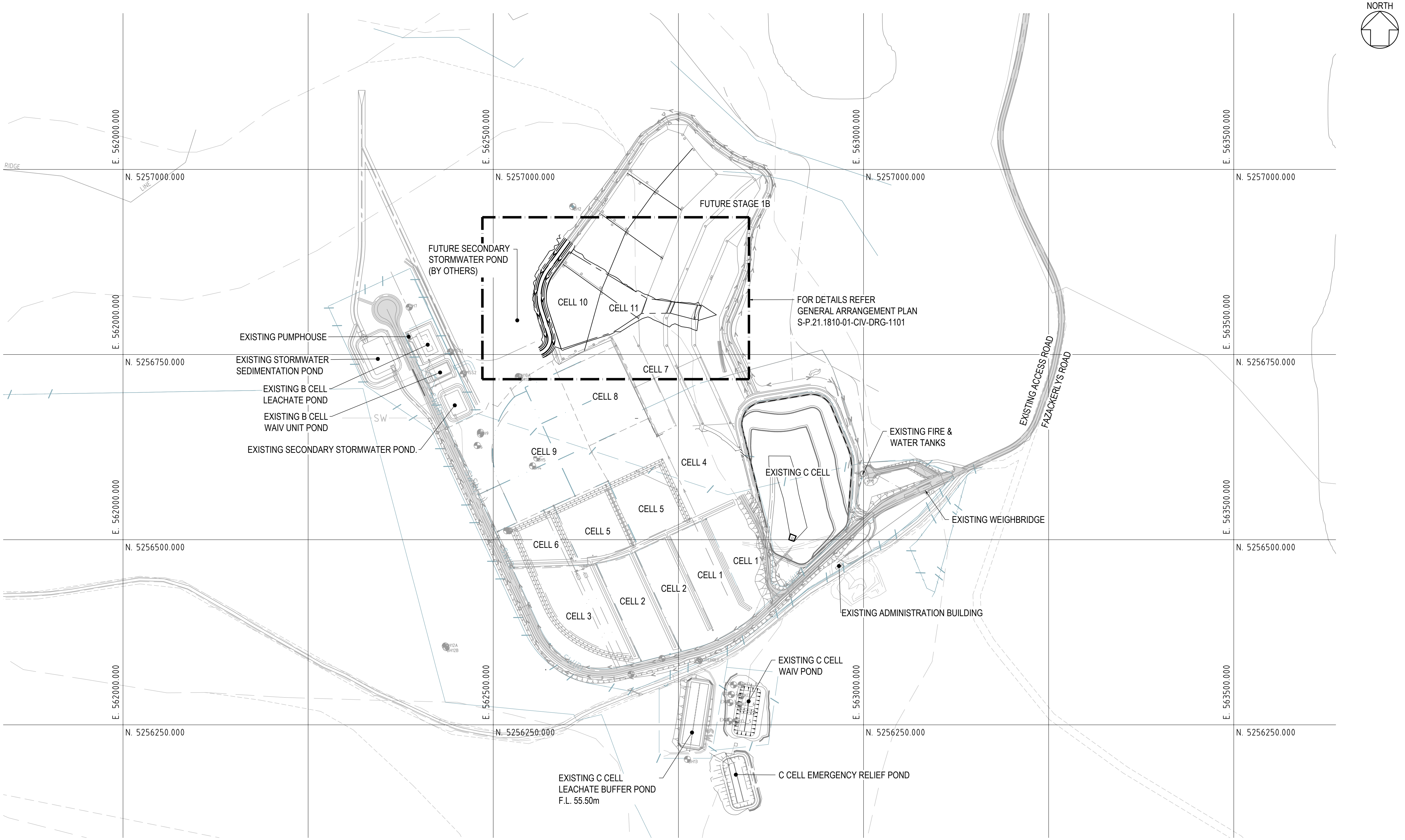

REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1110; S.P.21.1810-CIV-XREF-P.21.1116; S.P.21.1810-CIV-XREF-HB14356-X1500; S.P.21.1810-CIV-XREF-HB15447-X3011; S.P.21.1810-CIV-XREF-HB18339-P11; S.P.21.1810-CIV-XREF-1500

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SCALE (PLOTTED FULL SIZE) 1:5000
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50 0 50 100 150 200
SCALE IN METRES - 1:5000

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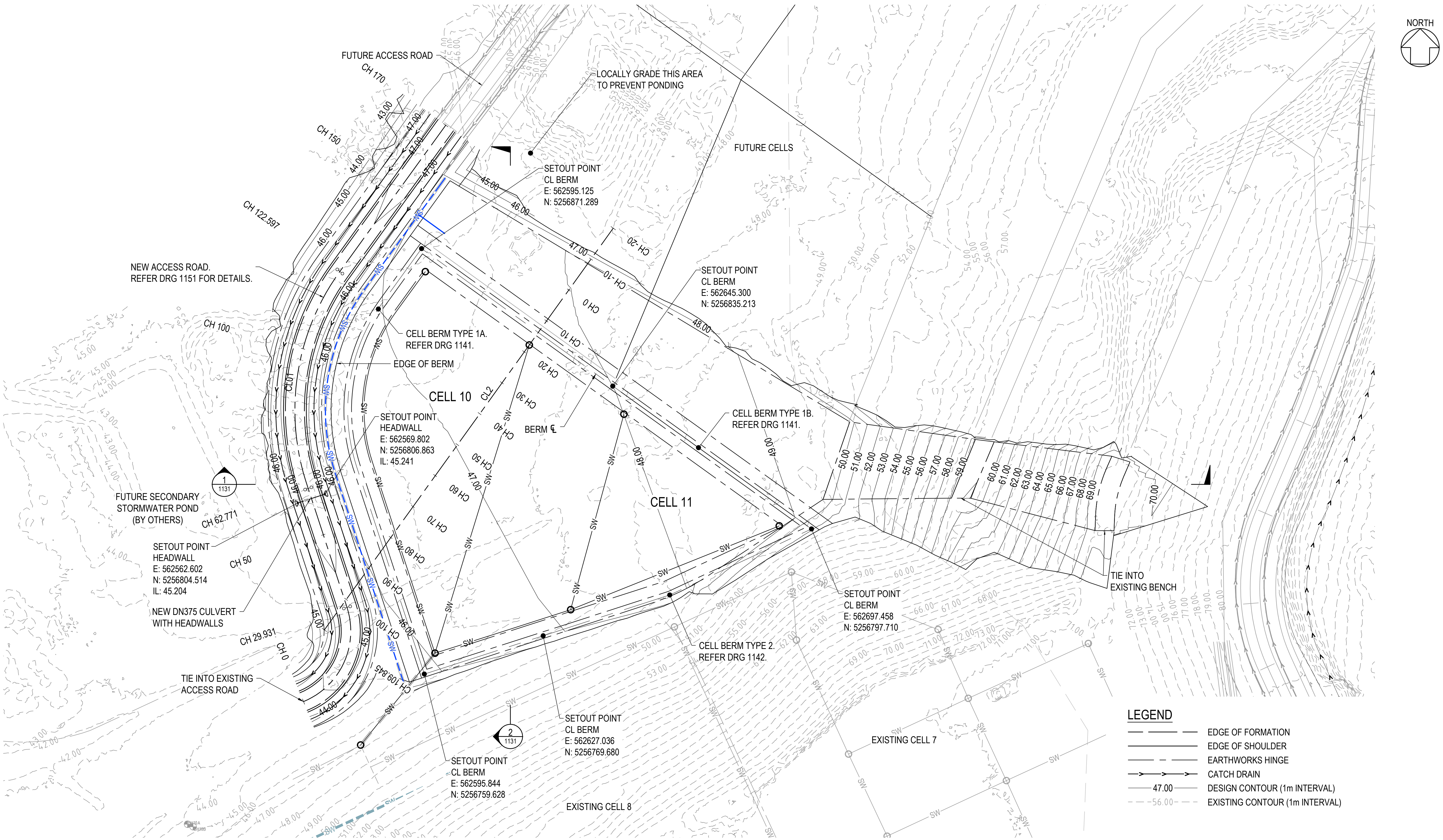
CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER
DRAWING TITLE: SITE PLAN
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1011
REVISION 0
Sep. 15, 22 - 12:06:24 Name: S-P.21.1810-01-CIV-DRG-1011.dwg Updated By: Geoff Tuck



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SCALE (PLOTTED FULL SIZE) 1:1000
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10 0 10 20 30 40
SCALE IN METRES - 1:1000

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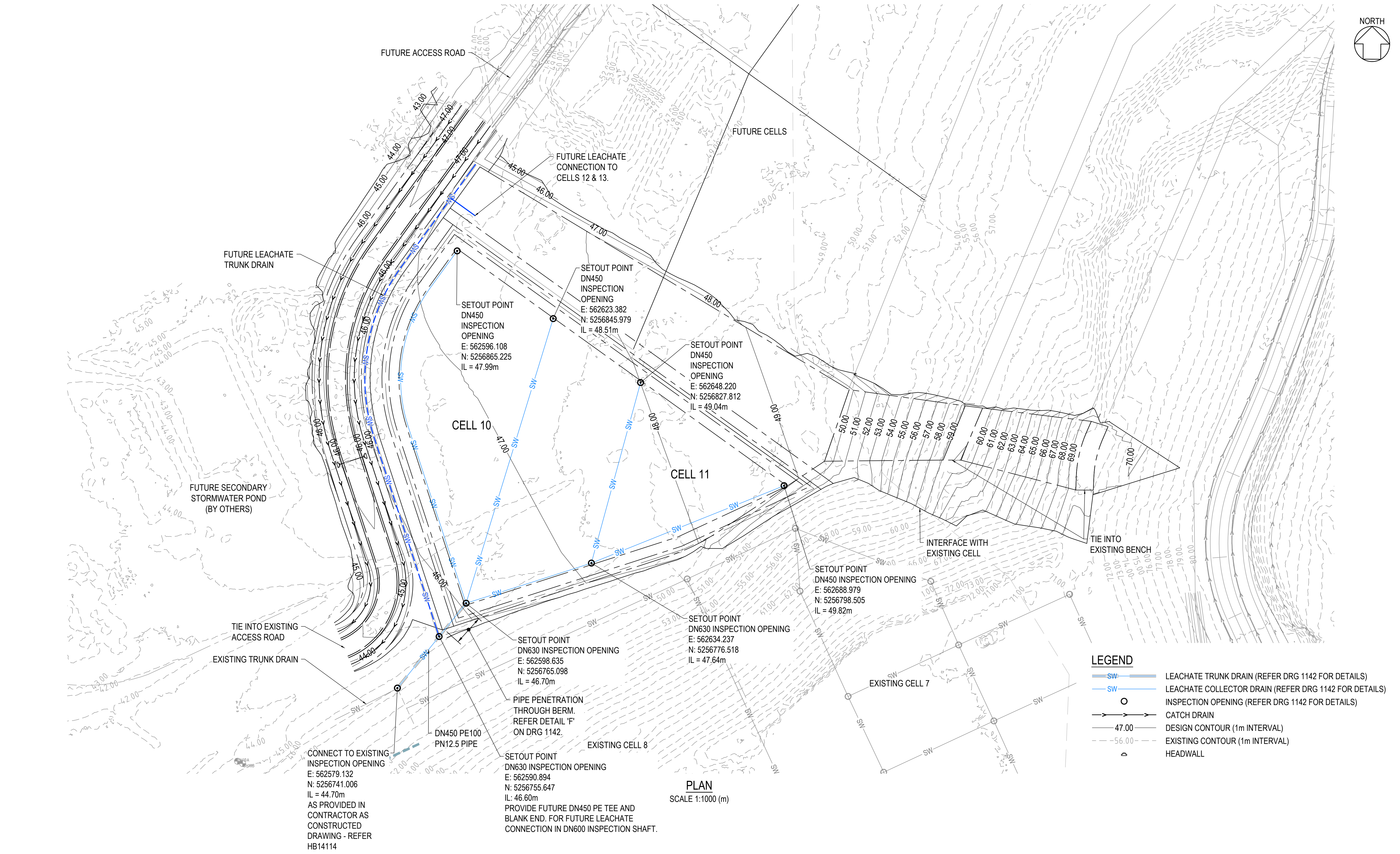
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: CELL GENERAL ARRANGEMENT PLAN
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1101
REVISION 0

Sep. 15, 22 - 12:06:33 Name: S-P.21.1810-01-CIV-DRG-1101.dwg Updated By: Geoff Tuck



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REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1110; S.P.21.1810-CIV-XREF-P.21.1116; S.P.21.1810-CIV-XREF-HB14356-X1500; S.P.21.1810-CIV-XREF-HB15447-X3011; S.P.21.1810-CIV-XREF-HB18339-P11; S.P.21.1810-CIV-XREF-1500; S.P.21.1810-CIV-XREF-1120; S.P.21.1810-CIV-XREF-1100; S.P.21.1810-CIV-XREF-1110_CAD

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SCALE IN METRES - 1:1000

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STATUS: ISSUED FOR TENDER

DRAWING TITLE: LEACHATE COLLECTION SYSTEM PLAN

DATUMS: AHD / MGA55, GDA20

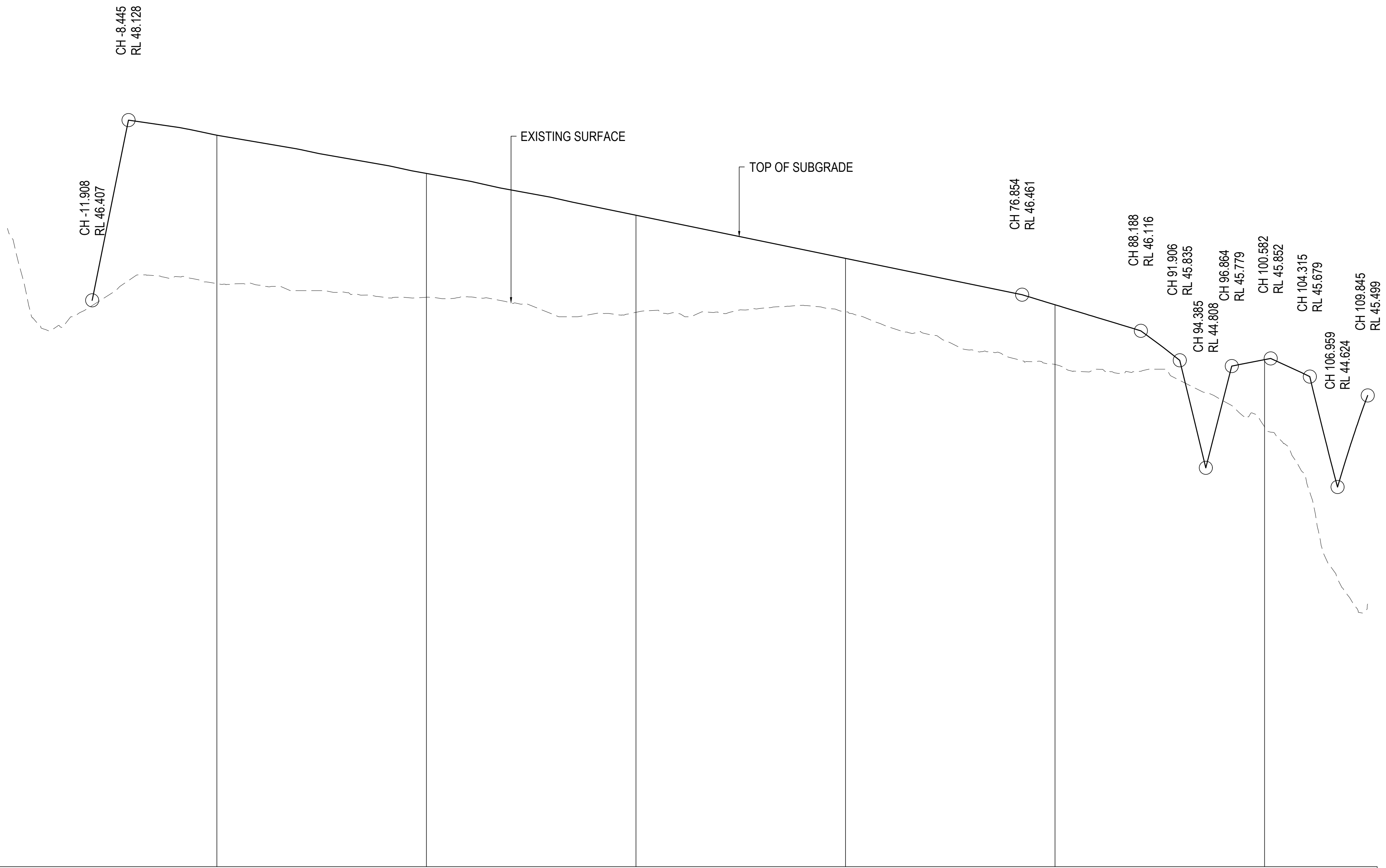
CLIENT No.

DRAWING No. S-P.21.1810-01-CIV-DRG-1102

REVISION 0

Sep. 15, 22 - 12:06:42 Name: S-P.21.1810-01-CIV-DRG-1102.dwg Updated By: Geoff Tuck

NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL
IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251



DATUM RL 41

VERTICAL ALIGNMENT																		
HORIZONTAL ALIGNMENT	L = 129.845																	
CUT / FILL	47.094			-1.418	-1.182	-0.927	-0.510		-0.570					-0.641				
DESIGN SURFACE LEVELS	0.000			47.984	47.618	47.220	46.808		46.365					45.841				
EXISTING SURFACE LEVELS	47.094			46.566	46.437	46.293	46.298		45.795					45.200				
CHAINAGE	-20.000	-11.908	-8.445	0	20	40	60	76.854	80	88.188	91.906	94.385	96.864	100	100.582	104.315	106.959	109.845

LONGITUDINAL SECTION CL2

REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1200-2

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SCALE IN METRES - 1:50 V
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SCALE IN METRES - 1:500 H

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PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: SITE SECTION CL2
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1111
REVISION 0

Sep. 15, 22 - 12:06:46 Name: S-P.21.1810-01-CIV-DRG-1111.dwg Updated By: Geoff Tuck

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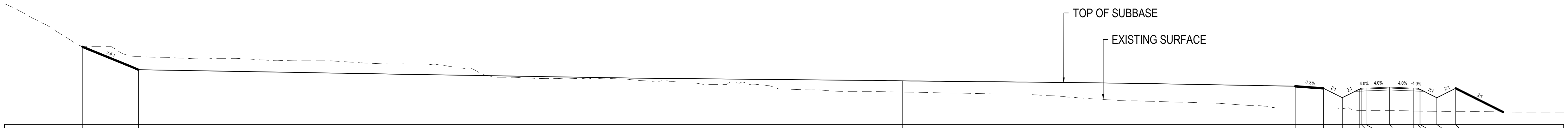
NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251



DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	51.250	51.264	-86.767
DNC	48.807	50.204	-80.824
CL2	47.627	46.437	0.000
IA-L-R	47.058	44.750	41.588
EH1-R	46.838	44.750	44.582
ID1-R	45.838	44.690	46.582
PV1-1	46.729	44.500	48.364
EV-R	46.838	44.500	48.582
ES-R	46.858	44.500	49.082
DNC	46.958	44.500	51.582
ES-L	46.858	44.428	54.082
EV-L	46.838	44.418	54.582
PV1-2	46.729	44.416	54.800
ID1-L	45.838	44.392	56.582
EH1-L	46.838	44.378	58.582
IA-L-L	44.334	44.336	63.589

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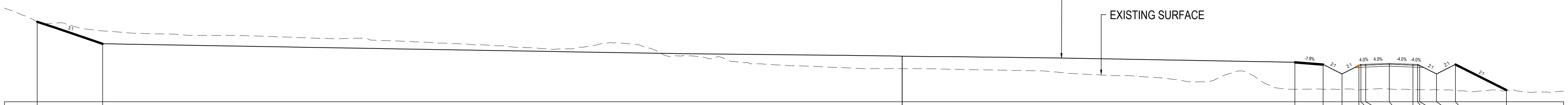

DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	51.449	51.419	-91.545
DNC	49.122	50.476	-84.606
CL2	47.812	46.500	0.000
IA-L-R	47.170	44.321	41.561
EH1-R	46.938	44.329	44.550
ID1-R	45.938	44.327	46.550
PV1-1	46.829	44.257	48.332
EV-R	46.938	44.271	48.550
ES-R	46.958	44.301	49.050
DNC	47.058	44.341	51.550
ES-L	46.958	44.270	54.050
EV-L	46.938	44.276	54.550
PV1-2	46.829	44.276	54.768
ID1-L	45.938	44.267	56.550
EH1-L	46.938	44.185	58.550
IA-L-L	44.237	44.189	63.951

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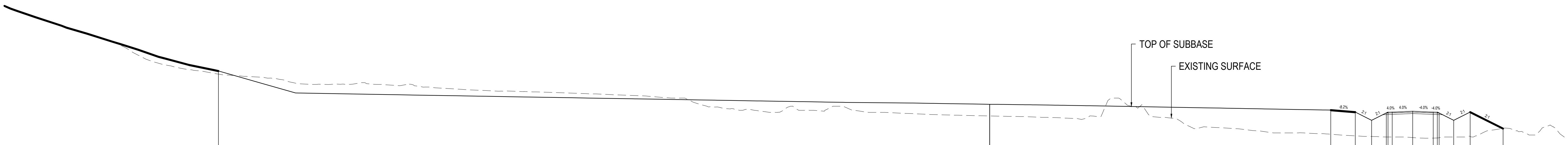

DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
DNC	52.043	51.663	-93.938
CL2	47.985	46.566	0.000
IA-L-R	47.282	44.341	41.535
EH1-R	47.038	44.146	44.518
ID1-R	46.038	44.064	46.518
PV1-1	46.929	44.002	48.301
EV-R	47.038	44.000	48.518
ES-R	47.058	44.000	49.018
DNC	47.158	43.939	51.518
ES-L	47.058	43.872	54.018
EV-L	47.038	43.889	54.518
PV1-2	46.929	43.916	54.736
ID1-L	46.038	44.000	56.518
EH1-L	47.038	44.069	58.518
IA-L-L	45.034	45.065	62.526

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REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1250-2

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CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

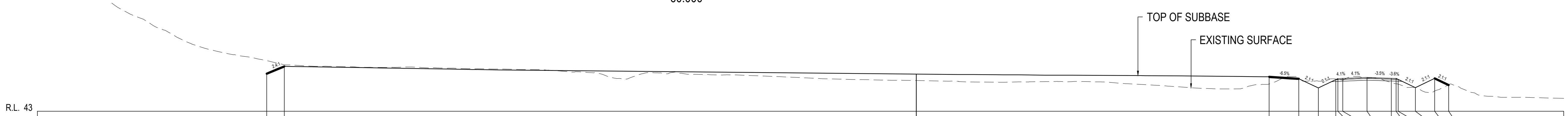
DRAWING TITLE: SITE CROSS SECTIONS SHEET 1 OF 3
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1121
REVISION 0

Sep. 15, 22 - 12:06:49 Name: S-P.21.1810-01-CIV-DRG-1121.dwg Updated By: Geoff Tuck

NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251

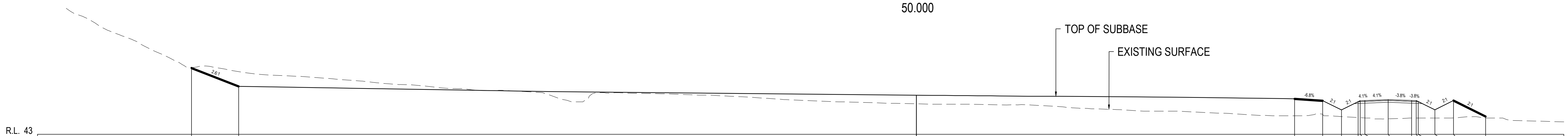
DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	46.667	48.003	-63.361
DNC	47.487	47.719	-61.238
CL2	46.808	46.298	0.000
IA-L-R	46.592	46.839	33.003
EH1-R	46.385	47.000	36.558
ID1-R	45.398	46.994	38.884
PV1-1	46.300	46.525	40.937
EV-R	46.410	46.441	41.187
ES-R	46.433	46.373	41.759
DNC	46.547	45.692	44.587
ES-L	46.459	45.647	47.396
EV-L	46.441	45.686	47.956
PV1-2	46.334	45.762	48.198
ID1-L	45.451	46.742	50.176
EH1-L	46.459	46.613	52.380
IA-L-L	46.692	46.692	52.889

60.000



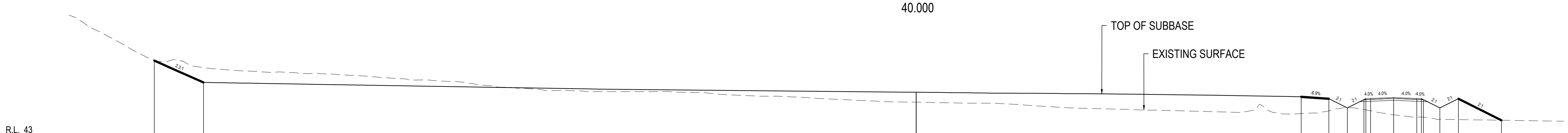
DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	47.062	48.468	-70.224
DNC	47.848	48.022	-68.317
CL2	47.014	46.317	0.000
IA-L-R	46.718	45.942	38.150
EH1-R	46.510	46.554	41.350
ID1-R	45.518	46.254	43.471
PV1-1	46.415	46.485	45.353
EV-R	46.525	46.459	45.582
ES-R	46.547	46.347	46.107
DNC	46.655	46.583	48.736
ES-L	46.563	46.103	51.354
EV-L	46.544	45.968	51.875
PV1-2	46.436	45.923	52.102
ID1-L	45.550	45.569	53.960
EH1-L	46.555	45.184	56.043
IA-L-L	45.827	45.881	57.561

50.000



DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	50.160	50.154	-78.361
DNC	48.177	49.762	-73.258
CL2	47.220	46.293	0.000
IA-L-R	46.835	45.000	40.891
EH1-R	46.627	45.138	43.928
ID1-R	45.630	44.913	45.952
PV1-1	46.524	44.803	47.756
EV-R	46.633	44.790	47.976
ES-R	46.654	44.759	48.481
DNC	46.758	44.669	51.006
ES-L	46.661	44.750	53.531
EV-L	46.642	44.750	54.035
PV1-2	46.533	44.750	54.254
ID1-L	45.644	44.750	56.049
EH1-L	46.647	44.768	58.064
IA-L-L	44.926	44.750	61.539

40.000



DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	50.853	50.863	-82.368
DNC	48.492	50.098	-77.042
CL2	47.434	46.357	0.000
IA-L-R	46.946	45.130	41.614
EH1-R	46.738	45.430	44.614
ID1-R	45.738	45.750	46.614
PV1-1	46.629	45.554	48.396
EV-R	46.738	45.522	48.614
ES-R	46.758	45.434	49.114
DNC	46.858	44.986	51.614
ES-L	46.758	44.750	54.114
EV-L	46.738	44.750	54.614
PV1-2	46.629	44.750	54.831
ID1-L	45.738	44.495	56.614
EH1-L	46.738	44.475	58.614
IA-L-L	44.409	44.409	63.271

30.000

REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1250-2

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
SIGNED
DATE

SCALE (PLOTTED FULL SIZE) 1:500
SHEET SIZE A3
5 0 5 10 15 20
SCALE IN METRES - 1:500

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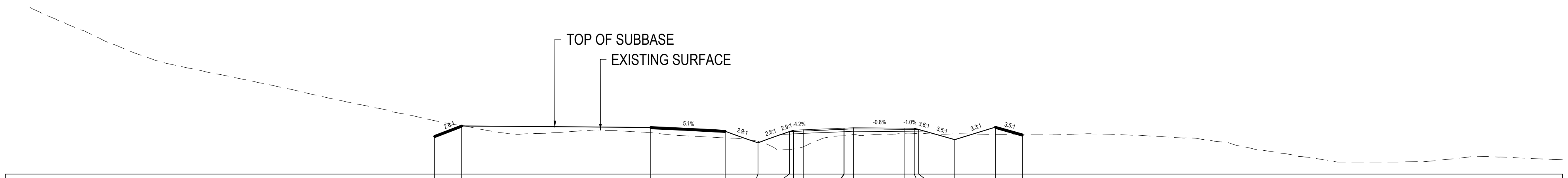
CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: SITE CROSS SECTIONS SHEET 2 OF 3
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1122
REVISION 0

Sep. 15, 22 - 12:06:53 Name: S-P.21.1810-01-CIV-DRG-1122.dwg Updated By: Geoff Tuck

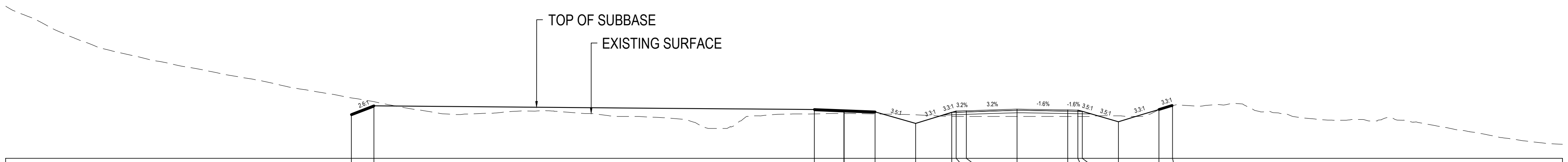
NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL
IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251



R.L. 42

DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	45.152	46.467	-34.180
DNC	46.025	46.060	-31.917
IA-L-R	45.892	45.463	-16.134
EH1-R	45.579	45.025	-9.927
ID1-R	44.618	44.744	-7.180
PV1-1	45.550	44.047	-4.553
EV-R	45.665	44.121	-4.216
ES-R	45.698	44.277	-3.408
CL2	45.841	45.200	0.000
DNC	45.874	45.306	0.795
ES-L	45.842	45.376	5.026
EV-L	45.834	45.389	5.873
PV1-2	45.730	45.412	6.241
ID1-L	44.879	45.367	9.258
EH1-L	45.918	45.313	12.643
IA-L-L	45.274	45.274	14.897

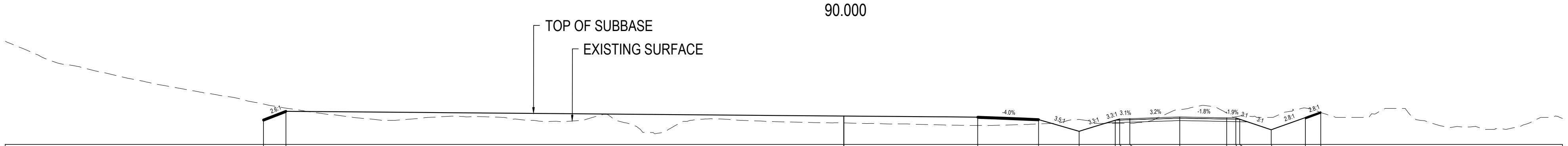
100.000



R.L. 42

DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	45.663	47.058	-41.131
DNC	46.390	46.740	-39.247
IA-L-R	46.082	45.715	-2.475
CL2	45.983	45.750	0.000
EH1-R	45.888	45.715	2.603
ID1-R	44.924	45.644	5.988
PV1-1	45.843	45.500	9.005
EV-R	45.955	45.500	9.374
ES-R	45.982	45.500	10.220
DNC	46.116	45.500	14.452
ES-L	46.050	45.500	18.683
EV-L	46.037	45.500	19.530
PV1-2	45.931	45.500	19.898
ID1-L	45.065	45.560	22.915
EH1-L	46.092	46.090	26.300
IA-L-L	46.439	46.440	27.443

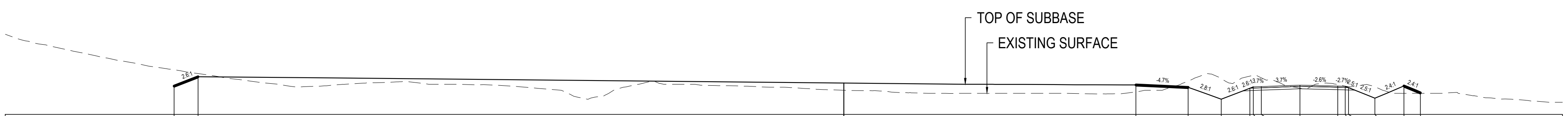
90.000



R.L. 44

DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	46.035	47.362	-48.445
DNC	46.756	47.022	-46.577
CL2	46.365	45.795	0.000
IA-L-R	46.271	45.577	11.184
EH1-R	46.070	45.711	16.260
ID1-R	45.097	46.081	19.645
PV1-1	46.013	45.750	22.663
EV-R	46.124	45.750	23.031
ES-R	46.151	45.750	23.883
DNC	46.285	46.900	28.053
ES-L	46.215	46.608	31.969
EV-L	46.200	46.306	32.728
PV1-2	46.094	46.354	33.054
ID1-L	45.221	46.250	35.687
EH1-L	46.239	47.023	38.546
IA-L-L	46.704	46.656	39.826

80.000



R.L. 44

DESIGN FEATURES	DESIGN LEVELS	EXISTING LEVELS	DESIGN OFFSETS
IA	46.351	47.698	-55.904
DNC	47.121	47.383	-53.908
CL2	46.602	46.002	0.000
IA-L-R	46.444	45.864	24.393
EH1-R	46.241	46.752	28.748
ID1-R	45.263	46.962	31.509
PV1-1	46.171	47.175	33.905
EV-R	46.282	47.242	34.193
ES-R	46.306	47.035	34.852
DNC	46.427	46.171	38.088
ES-L	46.346	46.475	41.243
EV-L	46.330	46.341	41.864
PV1-2	46.222	46.308	42.134
ID1-L	45.343	46.298	44.340
EH1-L	46.356	45.750	46.768
IA-L-L	45.793	45.750	48.139

70.000

REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1250-2

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
SIGNED
DATE

SCALE (PLOTTED FULL SIZE) 1:500 — SHEET SIZE A3
5 0 5 10 15 20
SCALE IN METRES - 1:500

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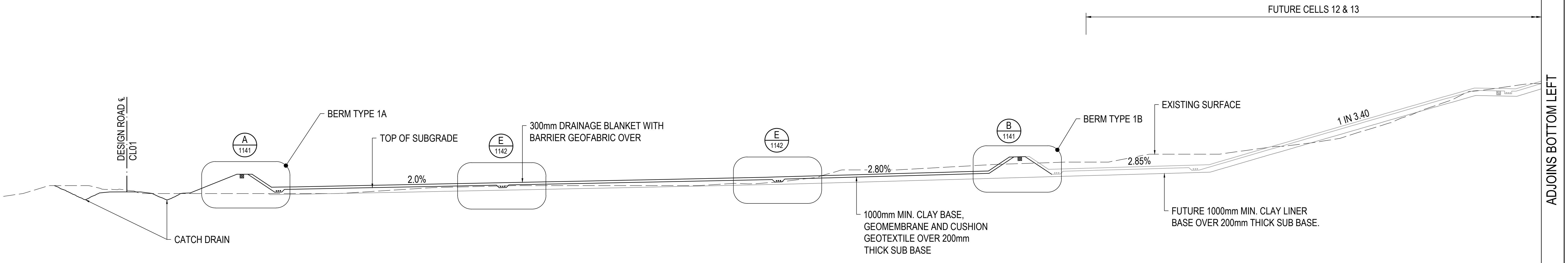
CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: SITE CROSS SECTIONS SHEET 3 OF 3
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1123
REVISION 0

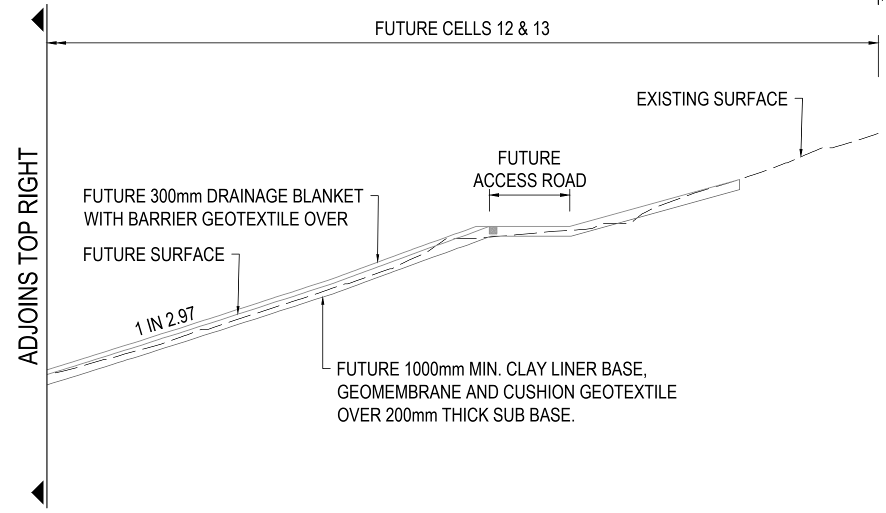
Sep. 15, 22 - 12:06:56 Name: S-P.21.1810-01-CIV-DRG-1123.dwg Updated By: Geoff Tuck

NOTE: COVER BOTH CELLS WITH 300 THICK GENERAL FILL OVER BARRIER GEOTEXTILE

NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251

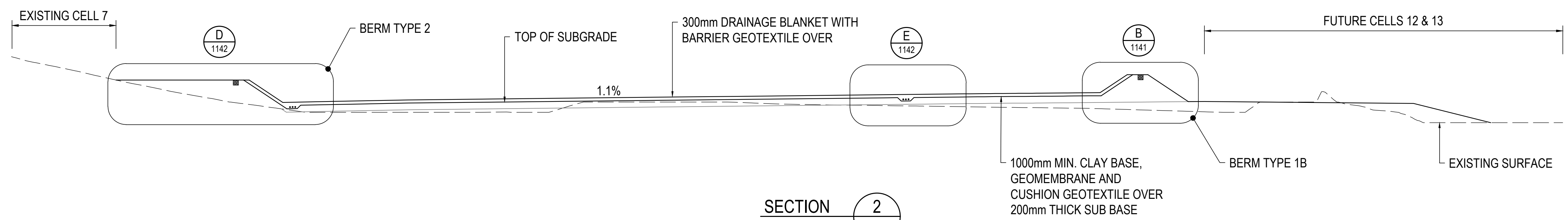


SECTION 1
1:500
1101



NOTE: FUTURE CELL FORMATION TO BE CONSTRUCTED UNDER THIS CONTRACT WITHIN THE LIMITS SHOWN ON THE CELL GENERAL ARRANGEMENT PLAN 1101.

NOTE: COVER BOTH CELLS WITH 300 THICK GENERAL FILL OVER BARRIER GEOTEXTILE



SECTION 2
1:500
1101

NOTE: FUTURE CELL FORMATION TO BE CONSTRUCTED UNDER THIS CONTRACT WITHIN THE LIMITS SHOWN ON THE CELL GENERAL ARRANGEMENT PLAN 1101.

REFERENCE FILES ATTACHED:

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
SIGNED
DATE

SCALE (PLOTTED FULL SIZE) 1:500
SHEET SIZE A3
5 0 5 10 15 20
SCALE IN METRES - 1:500

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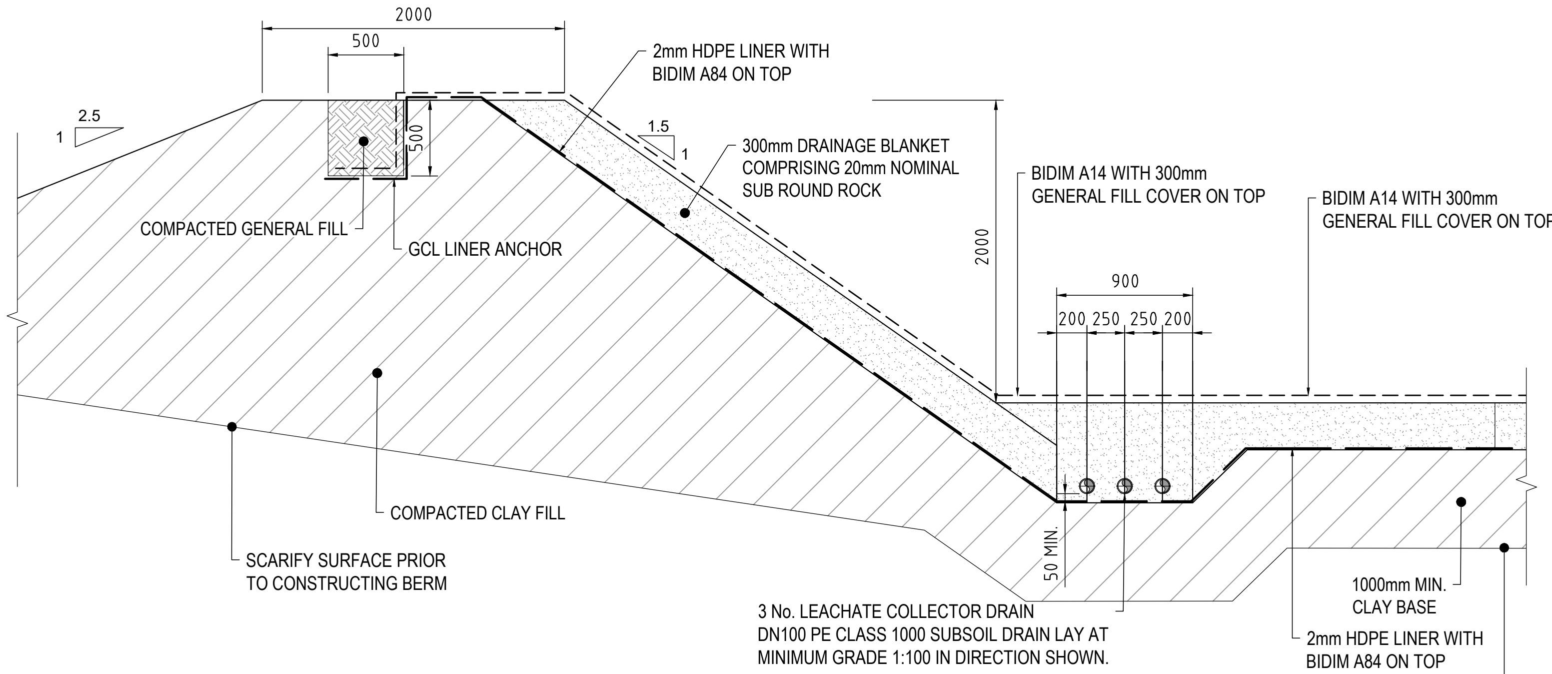
CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: CELL TYPICAL CROSS SECTIONS
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1131
REVISION 0

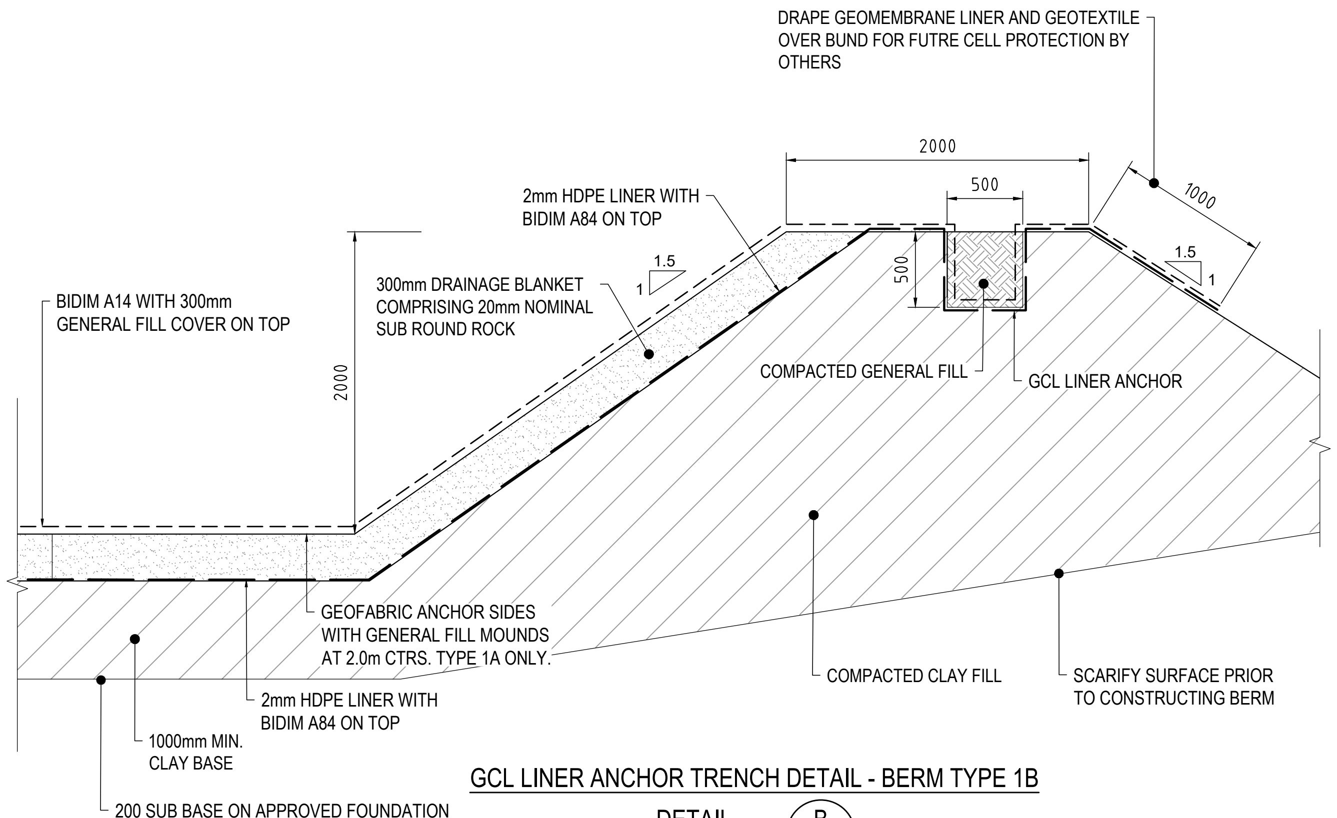
Sep. 15, 22 - 12:07:00 Name: S-P.21.1810-01-CIV-DRG-1131.dwg Updated By: Geoff Tuck

NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251



GCL LINER ANCHOR AND LEACHATE COLLECTOR DRAIN TRENCH DETAIL - BERM TYPE 1A

DETAIL A / -
1:50



GCL LINER ANCHOR TRENCH DETAIL - BERM TYPE 1B

DETAIL B / -
1:50

REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1115

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
SIGNED
DATE

SCALE (PLOTTED FULL SIZE) 1:50
SHEET SIZE A3
500 0 500 1000 1500 2000
SCALE IN MILLIMETRES - 1:50

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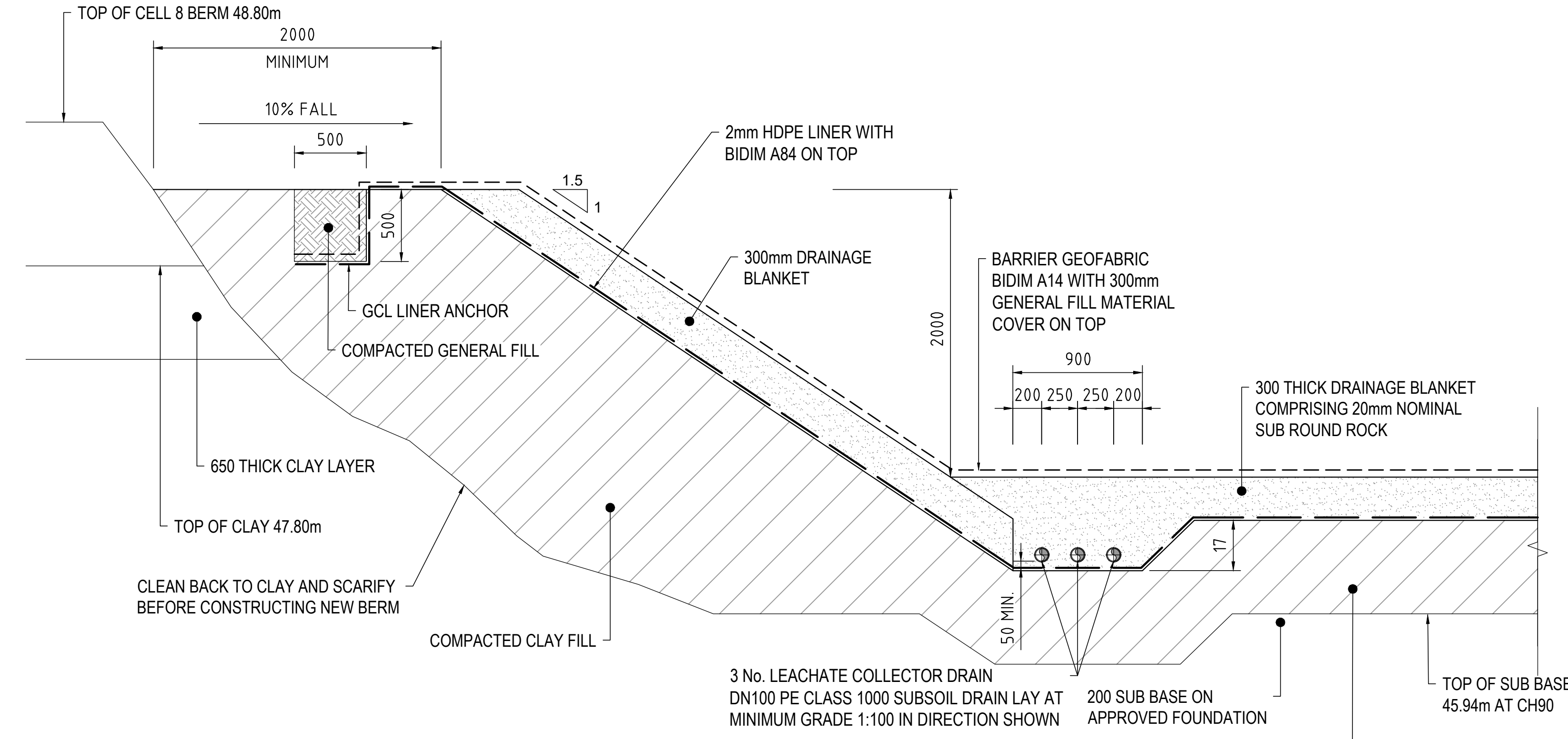
CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: CELL TYPICAL DETAILS SHEET 1 OF 2
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1141
REVISION 0

Sep. 15, 22 - 12:07:03 Name: S-P.21.1810-01-CIV-DRG-1141.dwg Updated By: Geoff Tuck

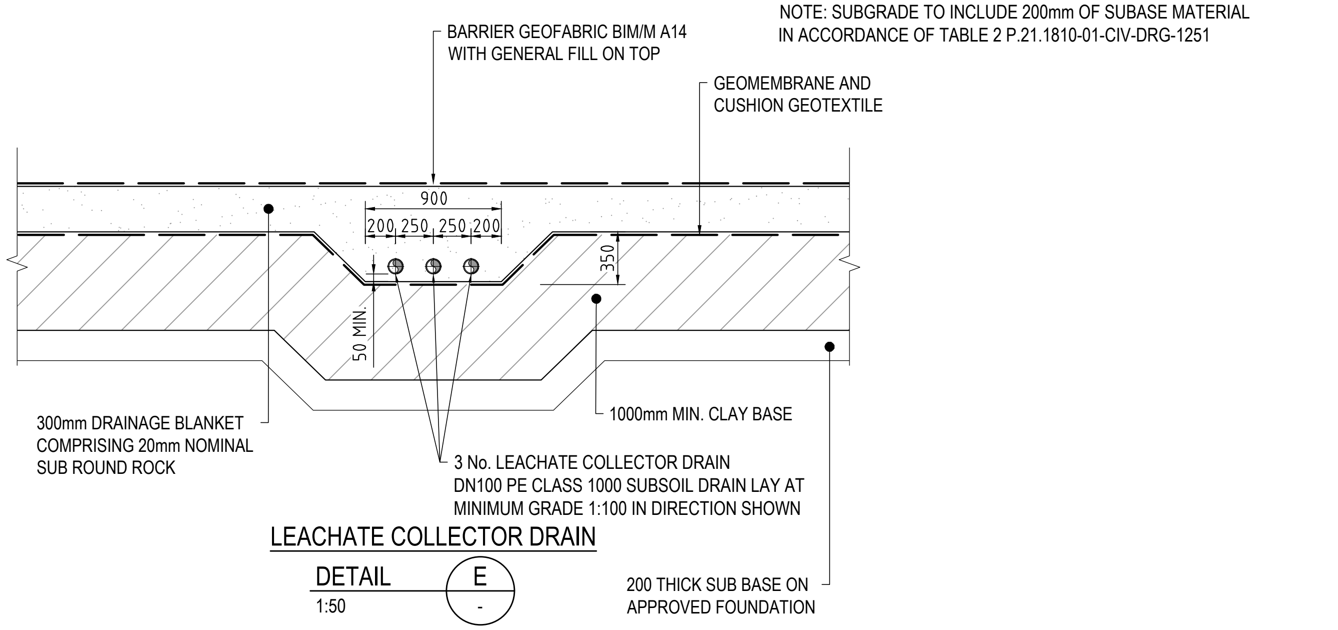
P&S FORM DRG-A3 REV - 8



GCL LINER ANCHOR AND LEACHATE COLLECTOR DRAIN TRENCH DETAIL - BERM TYPE 2

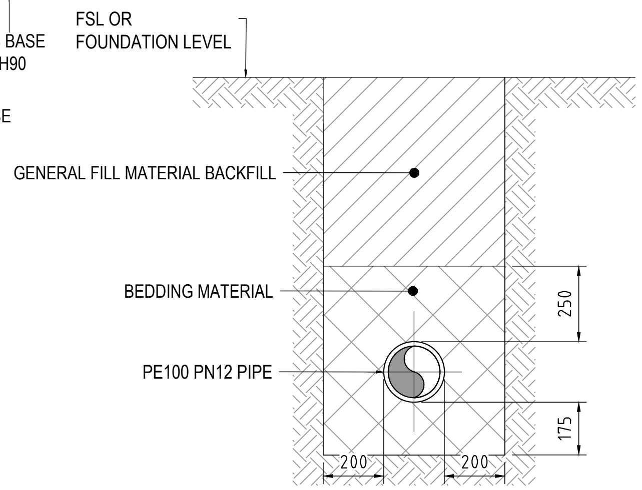
DETAIL D / -
1:50

NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251

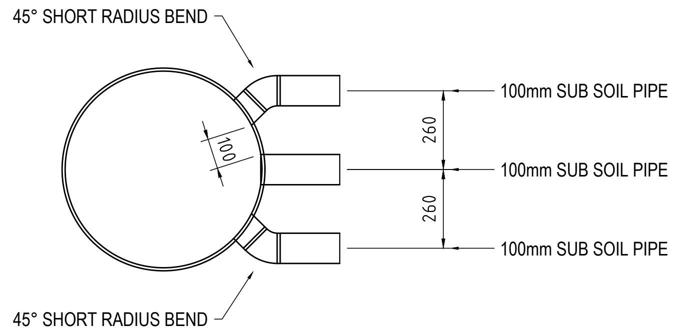


LEACHATE COLLECTOR DRAIN

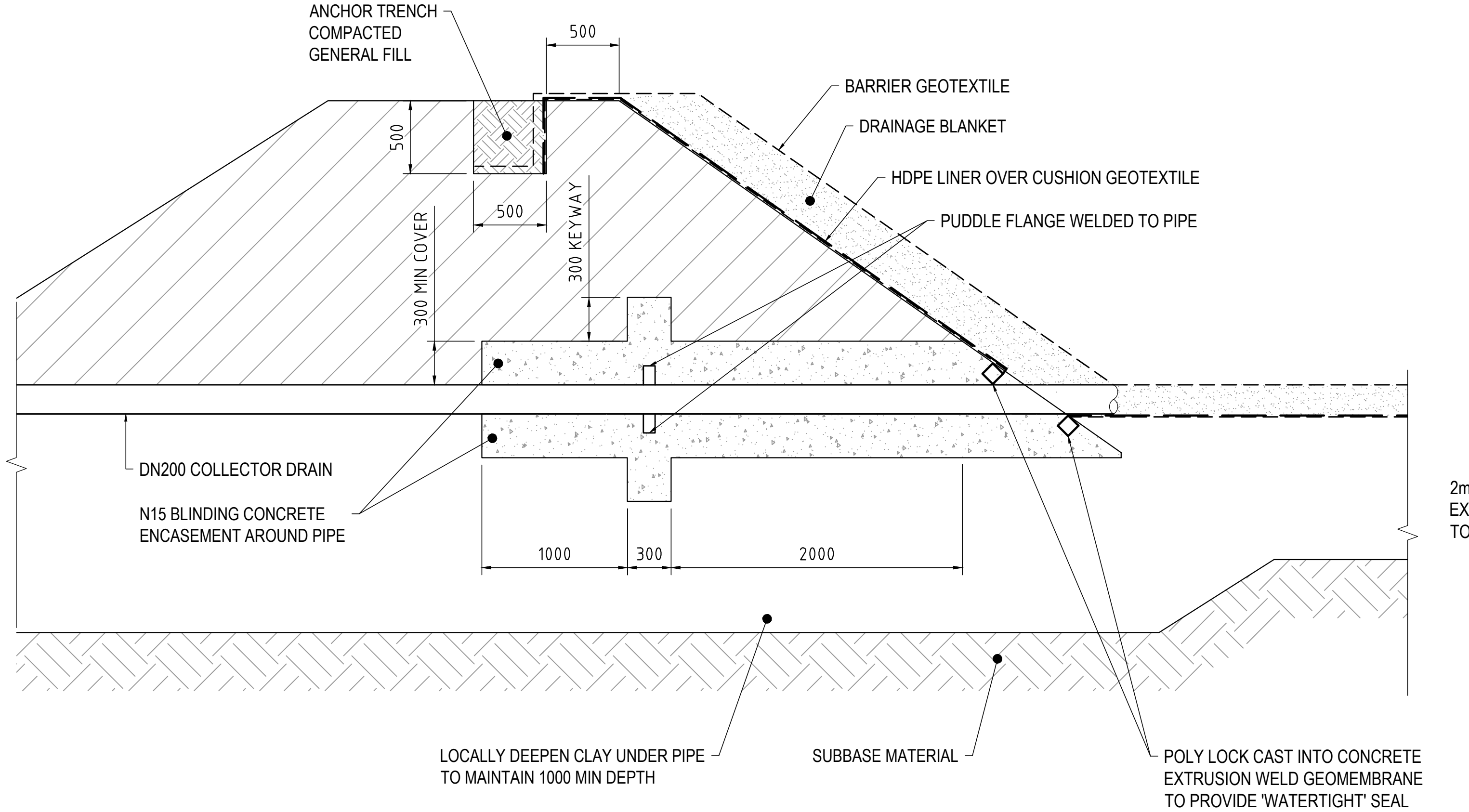
DETAIL E / -
1:50



LEACHATE TRUNK DRAIN TRENCH DETAIL
SCALE 1:25

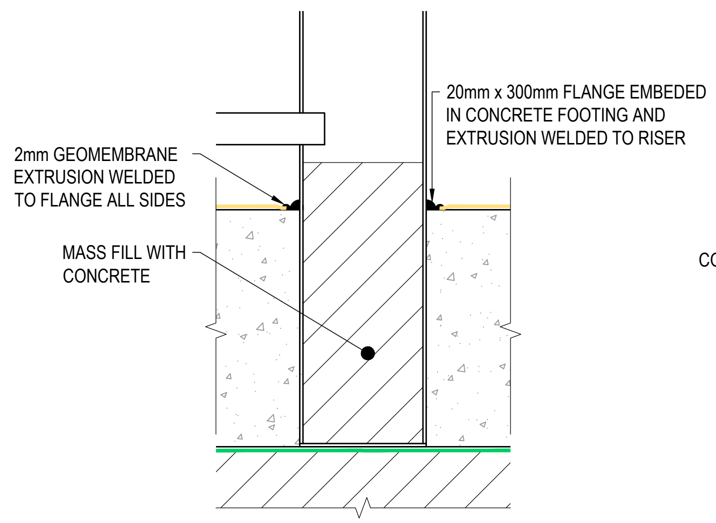


INSPECTION OPENING PLAN
SCALE 1:25

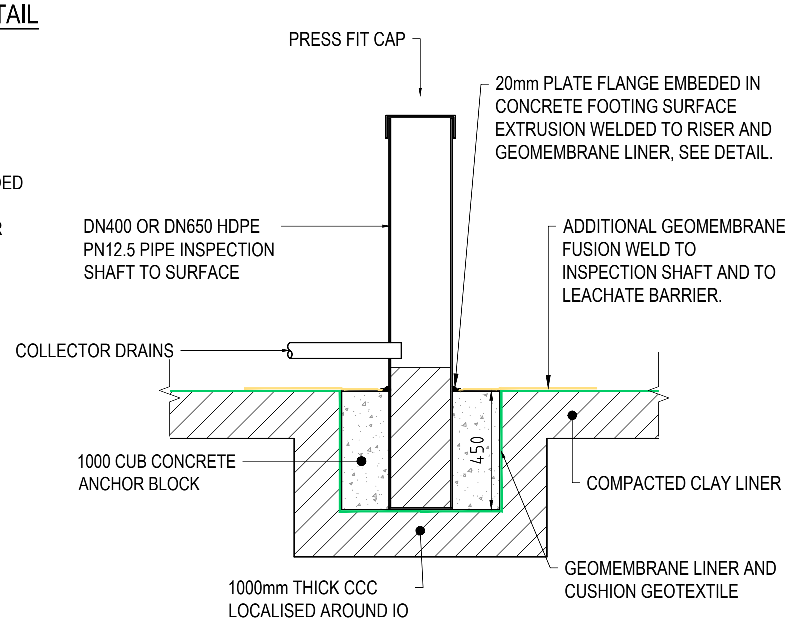


TYPICAL PIPE PENETRATION THROUGH AN EXTERNAL BERM

DETAIL F / -
1:50



TYPICAL INSPECTION OPENING DETAIL
SCALE 1:25



TYPICAL INSPECTION OPENING DETAIL
SCALE 1:50

REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1115

P&S FORM DRG-A3 REV - 8

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
SIGNED
DATE

SCALE (PLOTTED FULL SIZE): AS SHOWN
SHEET SIZE: A3

500 0 500 1000 1500 2000
SCALE IN MILLIMETRES - 1:50
250 0 250 500 750 1000
SCALE IN MILLIMETRES - 1:25

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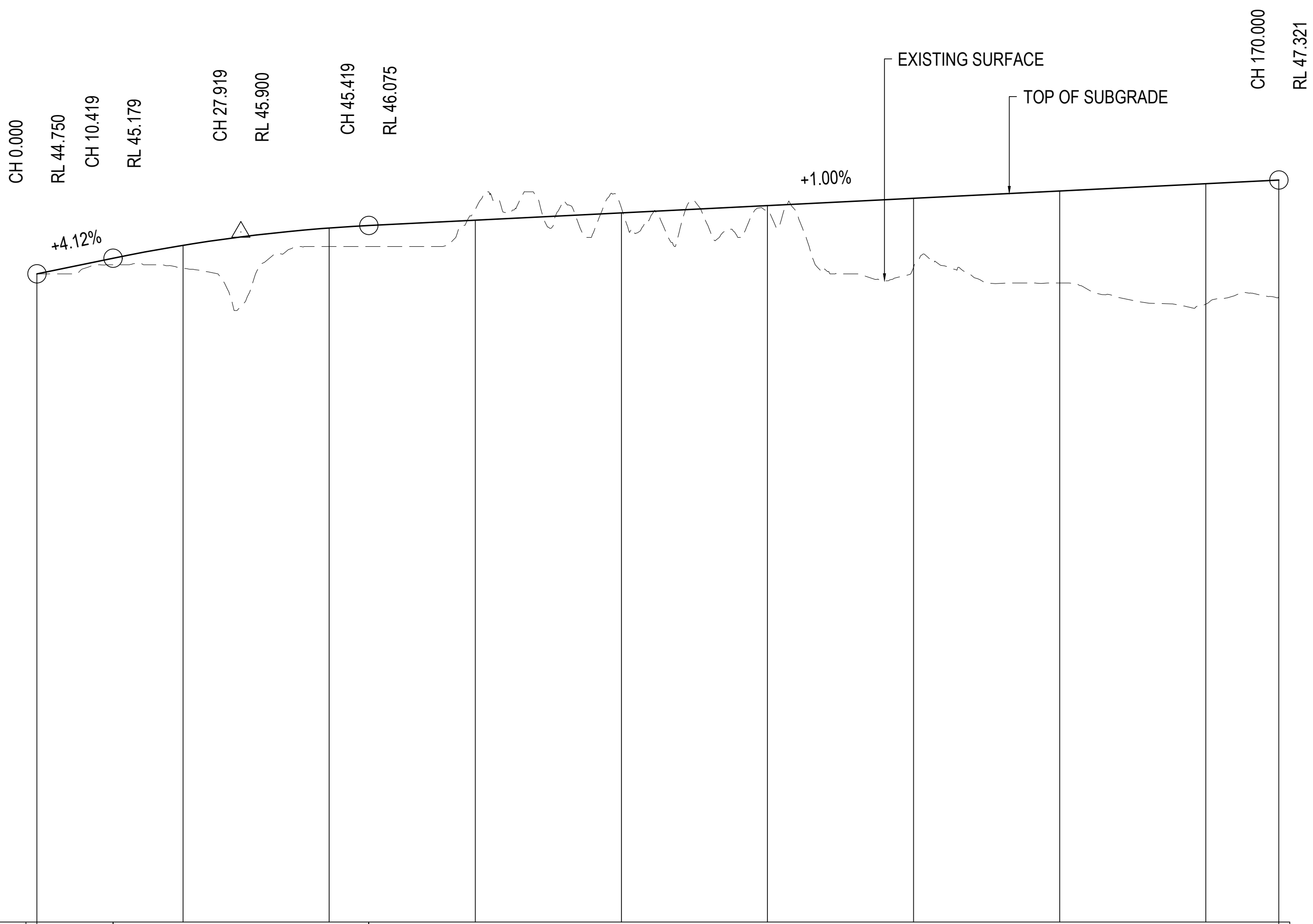
CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: CELL TYPICAL DETAILS SHEET 2 OF 2
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1142
REVISION 0

Sep. 15, 22 - 12:07:07 Name: S-P.21.1810-01-CIV-DRG-1142.dwg Updated By: Geoff Tuck

NOTE: SUBGRADE TO INCLUDE 200mm OF SUBASE MATERIAL
IN ACCORDANCE OF TABLE 2 P.21.1810-01-CIV-DRG-1251



DATUM RL 27

VERTICAL ALIGNMENT	G=4.12% L = 10.419; K = -11.221 L = 35.000; G=1.00% L = 124.581									
HORIZONTAL ALIGNMENT	R = 20.000 L = 29.931; L = 32.840; R = 62.082 L = 59.826; L = 47.403									
CUT / FILL	0.000	-0.620	-0.508	0.294	0.132	-0.121	-1.880	-2.521	-3.296	-3.213
DESIGN SURFACE LEVELS	44.750	45.533	46.008	46.221	46.421	46.621	46.821	47.021	47.221	47.321
EXISTING SURFACE LEVELS	44.750	44.913	45.500	46.514	46.553	46.500	44.941	44.500	43.925	44.107
CHAINAGE	0.000	10.419; 20; 27.919; 29.931	40; 45.419	60; 62.771	80	100	120; 122.597	140	160	170.000

LONGITUDINAL SECTION CL01

REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1200

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	ISSUED FOR TENDER	GMT	NB	RAC	15/09/2022

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
SIGNED
DATE

SCALE (PLOTTED FULL SIZE): AS SHOWN
SHEET SIZE: A3
SCALE IN METRES - 1:200 V (2 0 2 4 6 8)
SCALE IN METRES - 1:1000 H (10 0 10 20 30 40)

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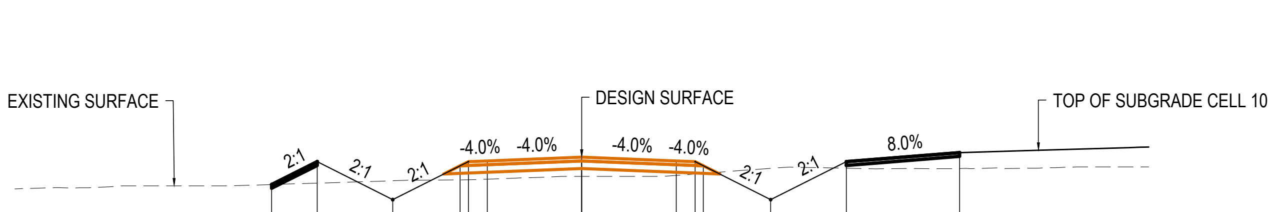
pittsh.com.au Phone 1300 748 874 ABN 67 140 184 309

CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL NEW CELLS 10 & 11
STATUS: ISSUED FOR TENDER

DRAWING TITLE: ROAD LONG SECTION CL01
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1211
REVISION 0
Sep. 15, 22 - 12:07:10 Name: S-P.21.1810-01-CIV-DRG-1211.dwg Updated By: Geoff Tuck

P&S FORM DRG-A3 REV - 8



R.L. 44

DESIGN FEATURES	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	45.285	45.888	44.888	45.779	45.888	45.908	46.008	46.008	45.908	45.888	45.779	44.888	45.888	46.128
EXISTING LEVELS	45.285	45.322	45.383	45.408	45.409	45.425	45.500	45.500	45.525	45.563	45.579	45.713	45.715	45.705
DESIGN OFFSETS	-8.206	-7.000	-5.000	-3.218	-3.000	-2.500	-0.000	-0.000	2.500	3.000	3.218	5.000	7.000	10.000

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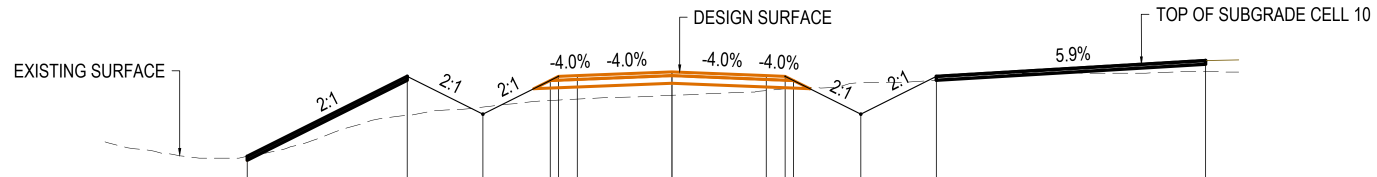

R.L. 42

DESIGN FEATURES	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	43.296	45.413	44.413	45.304	45.413	45.433	45.533	45.533	45.433	45.413	45.304	44.413	45.413	45.833
EXISTING LEVELS	43.296	44.380	44.601	44.775	44.787	44.814	44.913	44.913	45.039	45.090	45.100	45.249	45.309	45.544
DESIGN OFFSETS	-11.234	-7.000	-5.000	-3.218	-3.000	-2.500	-0.000	-0.000	2.500	3.000	3.218	5.000	7.000	14.122

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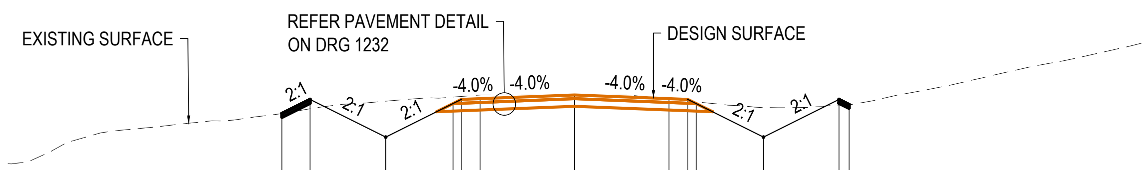

R.L. 42

DESIGN FEATURES	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	44.257	44.630	43.630	44.521	44.630	44.650	44.750	44.750	44.650	44.630	44.521	43.630	44.630	44.497
EXISTING LEVELS	44.257	44.383	44.586	44.693	44.710	44.748	44.750	44.750	44.640	44.590	44.568	44.416	44.481	44.497
DESIGN OFFSETS	-7.746	-7.000	-5.000	-3.218	-3.000	-2.500	0.000	0.000	2.500	3.000	3.218	5.000	7.000	7.267

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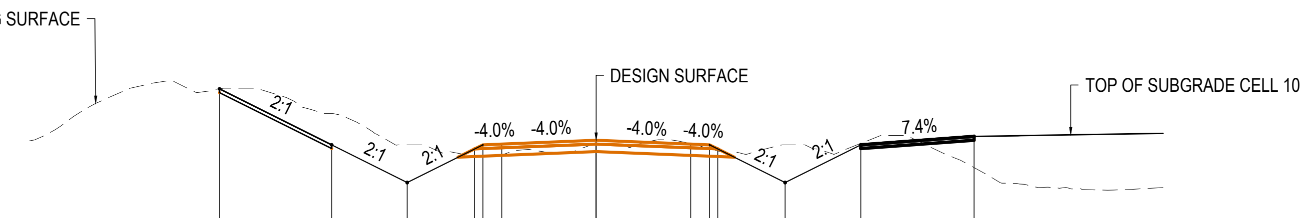

R.L. 44

DESIGN FEATURES	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	47.985	46.501	45.501	46.392	46.501	46.521	46.621	46.621	46.521	46.501	46.392	45.501	46.501	46.722
EXISTING LEVELS	47.985	47.329	46.500	46.191	46.194	46.239	46.500	46.500	46.533	46.389	46.337	46.500	46.537	45.897
DESIGN OFFSETS	-9.968	-7.000	-5.000	-3.218	-3.000	-2.500	-0.000	-0.000	2.500	3.000	3.218	5.000	7.000	9.999

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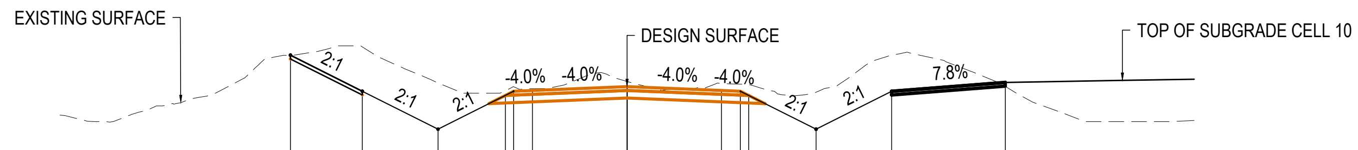

R.L. 44

DESIGN FEATURES	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	47.252	46.301	45.301	46.192	46.301	46.321	46.421	46.421	46.321	46.301	46.192	45.301	46.301	46.534
EXISTING LEVELS	47.252	47.473	46.519	46.311	46.423	46.366	46.559	46.559	46.508	46.489	46.481	46.276	47.254	46.432
DESIGN OFFSETS	-8.902	-7.000	-5.000	-3.218	-3.000	-2.500	-0.000	-0.000	2.500	3.000	3.218	5.000	7.000	10.004

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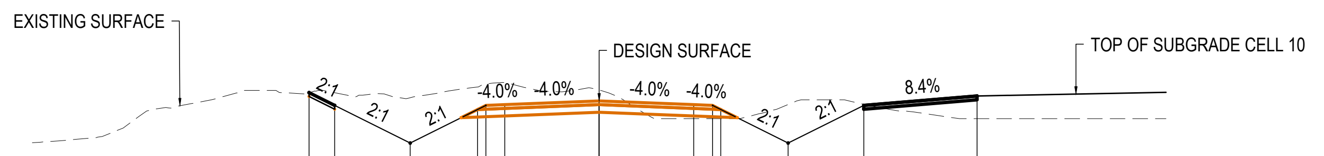

R.L. 44

DESIGN FEATURES	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	46.438	46.101	45.101	45.992	46.101	46.121	46.221	46.221	46.121	46.101	45.992	45.101	46.101	46.351
EXISTING LEVELS	46.438	46.438	46.305	46.591	46.674	46.704	46.514	46.514	45.750	45.750	45.750	46.126	46.134	45.750
DESIGN OFFSETS	-7.675	-7.000	-5.000	-3.218	-3.000	-2.500	0.000	0.000	2.500	3.000	3.218	5.000	7.000	9.998

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REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1250

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DATUMS: AHD / AMGA55, GDA20
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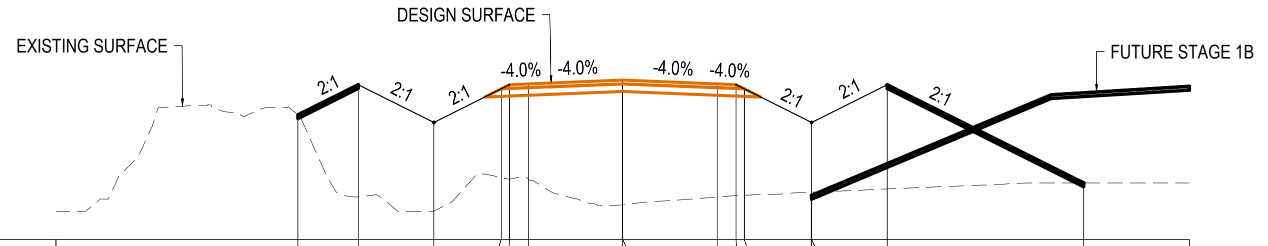
DRAWING No.: S-P.21.1810-01-CIV-DRG-1231
REVISION: 0

Sep. 15, 22 - 12:07:15 Name: S-P.21.1810-01-CIV-DRG-1231.dwg Updated By: Geoff Tuck



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DESIGN LEVELS	46.303	47.101	46.101	46.992	47.101	47.121	47.221	47.221	47.121	47.101	46.992	44.169	46.101	47.101	44.500
EXISTING LEVELS	46.303	44.131	43.753	44.644	44.600	44.607	43.925	43.925	44.128	44.163	44.175	44.259	44.259	44.341	44.500
DESIGN OFFSETS	-8.596	-7.000	-5.000	-3.218	-3.000	-2.500	0.000	0.000	2.500	3.000	3.218	4.991	5.000	7.000	12.202

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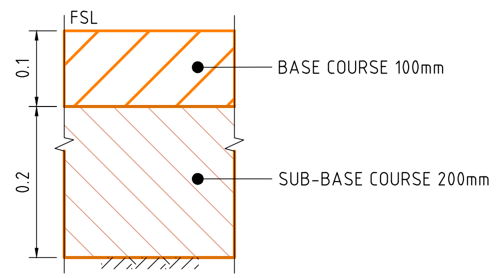

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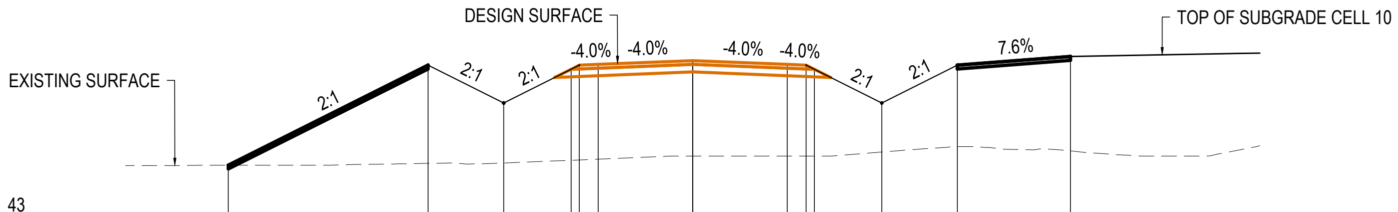

	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	44.259	46.901	45.901	46.792	46.901	46.921	47.021	47.021	46.921	46.901	46.792	45.901	46.901	47.128
EXISTING LEVELS	44.259	44.307	44.318	44.390	44.399	44.419	44.500	44.500	44.500	44.500	44.500	44.607	44.750	44.638
DESIGN OFFSETS	-12.283	-7.000	-5.000	-3.218	-3.000	-2.500	-0.000	-0.000	2.500	3.000	3.218	5.000	7.000	9.991

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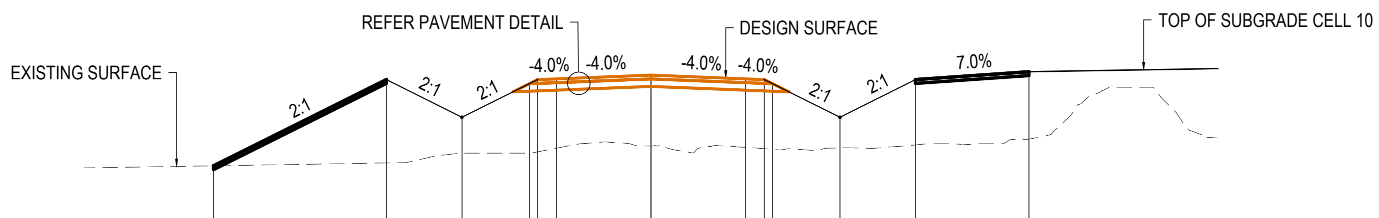

	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	44.414	46.701	45.701	46.592	46.701	46.721	46.821	46.821	46.721	46.701	46.592	45.701	46.701	46.910
EXISTING LEVELS	44.414	44.491	44.750	44.750	44.786	44.881	44.941	44.941	44.906	44.868	44.849	44.891	44.967	45.125
DESIGN OFFSETS	-11.573	-7.000	-5.000	-3.218	-3.000	-2.500	-0.000	-0.000	2.500	3.000	3.218	5.000	7.000	9.999

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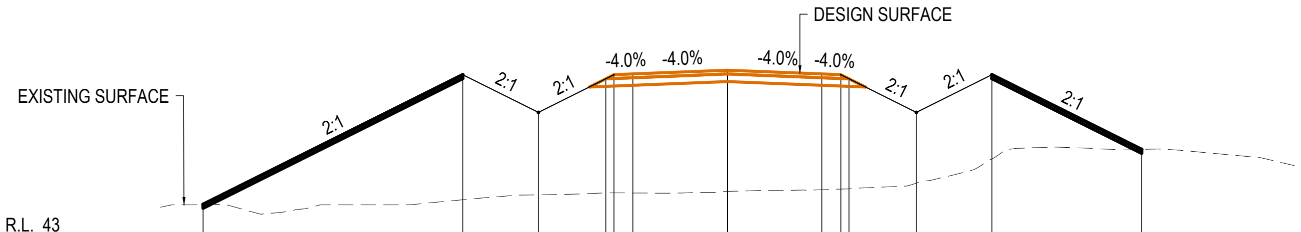

	IA-L-L	EH1-L	ID1-L	PV1-2	EV-L	ES-L	CL01	DNC	ES-R	EV-R	PV1-1	ID1-R	EH1-R	IA-L-R
DESIGN LEVELS	43.764	47.201	46.201	47.092	47.201	47.221	47.321	47.321	47.221	47.201	47.092	46.201	47.201	45.220
EXISTING LEVELS	43.764	43.886	44.017	44.066	44.067	44.066	44.107	44.107	44.151	44.168	44.175	44.326	44.971	45.220
DESIGN OFFSETS	-13.874	-7.000	-5.000	-3.218	-3.000	-2.500	-0.000	-0.000	2.500	3.000	3.218	5.000	7.000	10.962

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REFERENCE FILES ATTACHED: S.P.21.1810-CIV-XREF-1250

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DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1232
REVISION 0

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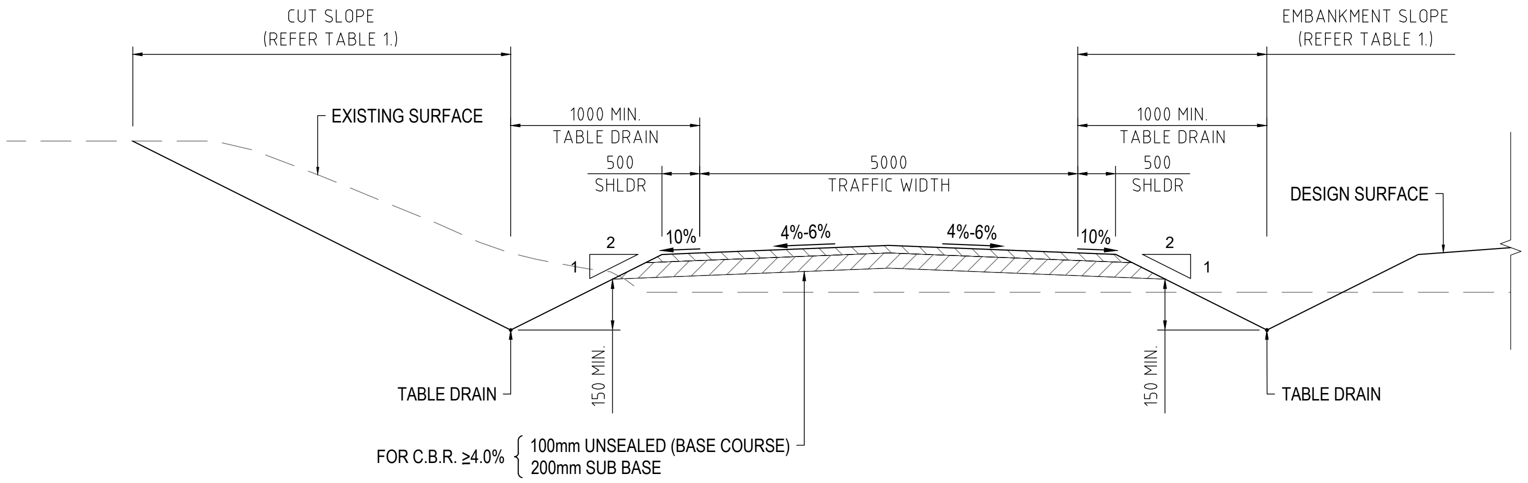

TYPICAL ACCESS ROAD CROSS SECTION

SCALE 1:100

TABLE 1

SOIL/ROCK TYPE	EMBANKMENT SLOPE		CUTTING SLOPE	
	VERTICAL	HORIZONTAL	VERTICAL	HORIZONTAL
SOLID ROCK	-	-	1.00	0.25
LOOSE ROCK	1.00	2.00	1.00	1.33
SAND	1.00	3.00	1.00	3.00
STIFF CLAY	1.00	1.00	1.00	1.00
SOFT CLAY	1.00	3.00	1.00	1.50

TABLE 2

PARTICLE SIZE DISTRIBUTION TO AS1289.3.6.1	SUB BASE	UNSEALED BASE COURSE
100mm	100%	
75mm	95% - 100%	100%
37.5mm	70% - 100%	90% - 100%
26.5mm		
19mm	52% - 100%	68% - 100%
9.5mm	40% - 100%	50% - 100%
4.75mm	30% - 100%	38% - 90%
2.36mm	22% - 75%	28% - 60%
0.425mm	12% - 40%	14% - 30%
0.075mm	6% - 26%	7% - 20%
GRADING LIMITS		
0.075 / 0.425mm	0.3 - 0.8	0.3 - 0.8
0.075 / 2.36mm	0.3 - 0.8	0.3 - 0.8
2.36 / 4.75mm	0.5 - 0.9	0.5 - 0.9
4.75 / 9.5mm	0.5 - 0.9	0.5 - 0.9
WET STRENGTH TO AS1141.22	GREATER THAN 50kN WITH A MAXIMUM VARIATION OF 45%	GREATER THAN 80kN WITH A MAXIMUM VARIATION OF 40%
MINUS 19mm SOAKED CBR TO AS1280.6.1.1	30 (SOAKED CBR TEST TO BE UNDERTAKEN WITH MATERIAL COMPACTED TO 95% DDR AND WITHIN 1% OF OMC, THEN SOAKED FOR FOUR DAYS PRIOR TO TEST. MATERIAL PASSING THE 53mm SIEVE BUT RETAINED IN THE 19mm SIEVE MAY BE REPLACED WITH AN AN EQUAL PORTION BY MASS OF THE MATERIAL PASSING THE 19mm SIEVE BUT RETAINED ON THE 4.75mm SIEVE. THE AMOUNT OF REPLACED MATERIAL, ON A DRY MASS BASIS, SHALL NOT EXCEED 25% OF THE PORTION PASSING THE 19mm SIEVE. PROVIDE DETAILS OF THE PERCENTAGE MATERIAL REPLACED.)	80 (SOAKED CBR TEST TO BE UNDERTAKEN WITH MATERIAL COMPACTED TO 95% DDR AND WITHIN 1% OF OMC, THEN SOAKED FOR FOUR DAYS PRIOR TO TEST. MATERIAL PASSING THE 53mm SIEVE BUT RETAINED IN THE 19mm SIEVE MAY BE REPLACED WITH AN AN EQUAL PORTION BY MASS OF THE MATERIAL PASSING THE 19mm SIEVE BUT RETAINED ON THE 4.75mm SIEVE. THE AMOUNT OF REPLACED MATERIAL, ON A DRY MASS BASIS, SHALL NOT EXCEED 25% OF THE PORTION PASSING THE 19mm SIEVE. PROVIDE DETAILS OF THE PERCENTAGE MATERIAL REPLACED.)
LIQUID LIMIT (LL) TO AS1289.3.1.1	MEAN - MAXIMUM 35 EACH SAMPLE - MAXIMUM 40	
PLASTICITY INDEX (PI) TO AS1289.3.3.1	MEAN - MAXIMUM 12 EACH SAMPLE - MAXIMUM 16	NOT LESS THAN 4 OR GREATER THAN 15
PI X % PASSING 0.425 SIEVE	MEAN - MAXIMUM 300 EACH SAMPLE - MAXIMUM 350	LESS THAN 300
COMPACTION CHARACTERISTICS DRY DENSITY RATIO	MINIMUM 96%	MINIMUM 98%
LAYER THICKNESS	MAXIMUM 200mm	MAXIMUM 175mm
TOLERANCES	LESS THAN 30mm BELOW OR 15mm ABOVE DESIGN SURFACE LEVEL	LESS THAN 10mm BELOW OR 15mm ABOVE DESIGN SURFACE LEVEL

REFERENCE FILES ATTACHED:

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DATE

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STATUS: ISSUED FOR TENDER
DRAWING TITLE: TYPICAL ACCESS ROAD SECTION AND DETAILS
DATUMS: AHD / MGA55, GDA20
CLIENT No.:
DRAWING No.: S-P.21.1810-01-CIV-DRG-1251
REVISION: 0
Sep. 15, 22 - 12:07:22 Name: S-P.21.1810-01-CIV-DRG-1251.dwg Updated By: Geoff Tuck

Appendix G Traffic impact assessment

Howarth Fisher and Associates
ACN 119 043 051
Structural, Civil and Traffic Engineering

Structural and Civil Engineering
Project Design and Management
Forensic Engineering and Structural Inspections
Research and Development Facilitators

Traffic Engineering
Traffic Management Studies and Traffic Impact Assessment
Expert Witness Representation
Road Safety Audits

Blue Hills Road

Traffic Impact Assessment Report

Prepared for
Southern Waste Solutions

Date
January 2023

Prepared by
Joanne Fisher

13 Willowdene Avenue
Sandy Bay, 7005
Tasmania
Australia

Phone +61 (0)3 6225 0619
Fax +61 (0)3 6225 0618
Email:info@howarthfisher.com

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Appendix A Development Plans
Appendix B Autotrack Paths

	Name	Signature	Date
Authorised by:	**Joanne Fisher**		**January 12th 2023**

1. Introduction

1.1 Client Details

This document has been prepared for the following:

Client Name:	Southern Waste Solutions
Address:	Blue Hills Road COPPING TAS 7174
Client Contact:	Mr Patrick Carroll

1.2 Project Details

The report is undertaken for the site at Blue Hills Road, Copping.

Blue Hills Road is the sole access road to the subject site and is a private road maintained by Southern Waste Solutions. Approximately 20% of the road is sealed and the remainder is a gravelled road. The Southern Waste Solutions site is located at the end of the road.

A copy of the proposed development plans can be found at **Appendix A.**

1.3 Traffic Impact Assessment

A traffic impact assessment (TIA) is a process of compiling and analysing information on the impacts that a specific development proposal is likely to have on the operation of the roads and transport networks and identify reasonable solutions to address these impacts. A TIA should not only include general impacts relating to traffic management but should also consider specific impacts on all road users, including transport modes such as bus, ferry, pedestrians and cycling networks as well as service and heavy vehicles and parking.

This TIA has been prepared in accordance with the Department of State Growth (DSG) publication, Traffic Impact Assessment Guidelines, August 2020. This TIA has also been prepared with reference to the:

- Austroads publication, Guide to Traffic Management, Part 12: Traffic Impacts of Developments, 28 April 2020.
- Roads and Maritime Services NSW, RTA, Guide to Traffic Generating Developments, 2002, NSW, RMS, TDT2013/04a.

- Australian/New Zealand Standards, AS/NZS 2890.1:2004, Parking facilities Part 1: Off-Street Car Parking.
- Australian Standards, AS2890.2:2018, Parking facilities Part 2: Off-Street commercial vehicle facilities.
- Australian/New Zealand Standard AS/NZS 2890.6:2009, Parking facilities Part 6: Off-street parking for people with disabilities.

Land use developments generate traffic movements as people move to, from and within a development. Without a clear understanding of the type of traffic movements (including cars, service vehicles, buses, taxis, bicycles, and pedestrians), the scale of their movements, timing, duration and location, there is a risk that this traffic movement may contribute to safety issues, unforeseen congestion, or other problems where the development connects to the road system or elsewhere on the road network. A TIA attempts to forecast these movements and their impact on the surrounding transport network.

A TIA must provide an impartial and objective description of the impacts and traffic effects of a proposed development. A full and detailed assessment of how vehicle and pedestrian movements to and from a development site might affect existing road and pedestrian networks if required. An objective consideration of the traffic impacts of a proposal is vital to enable planning decisions to be based upon the principles of sustainable development.

2. Scope of Consultancy

The scope of consultancy involves the following:

- Obtain background information and plans (traffic volume data, accident history, road parameters).
- Undertake a site visit.
- Assess trip generation rates associated with the proposed expansion (undertake surveys as required).
- Assess existing network constraints.
- Assess sight distance at accesses against the requirements of the AS2890.1:2004.
- Assess access provision in accordance with Tasmanian Planning Scheme - Sorell.
- Assess servicing requirements.
- Assess car parking layout against the requirements of the Tasmanian Planning Scheme - Sorell.
- Assess parking space requirements for all parking types.
- Run Autotrack path to analyse swept paths of all vehicle types utilising the facility.
- Address the performance criteria, if required.
- Document findings in a traffic impact assessment report.

3. Location of the Development

Figure 1 shows the location of the proposed development in the context of the surrounding street network.

Figure 1: Location of the development (source: Google Maps)

4. Existing Situation

4.1 Site Details

Southern Waste Solutions owns and operates a Land fill facility in Southern Tasmania at Blue Hills Road. Southern Waste Solutions is currently one of Tasmania's largest modern waste management facility networks, including Copping Landfill and Copping C-Cell, servicing 50% of Tasmania's population. Southern Waste Solutions operates six days per week, operating between the hours of 7am – 5pm Monday to Friday and 7am to 4pm Saturday and public holidays with the exception of Good Friday and Christmas Day. Blue Hills Road is a private road as indicated in the capture below:

Photograph 1: Showing the sealed section of Blue Hills Road.

4.2 Road Width

The existing access to the site is off Blue Hills Road. Blue Hills Road is typically ~7.5 metres wide in the vicinity of the site.

Photograph 2: Showing the gravelled road access to the Southern Waste Solutions site which is ~ 7.5metres wide.

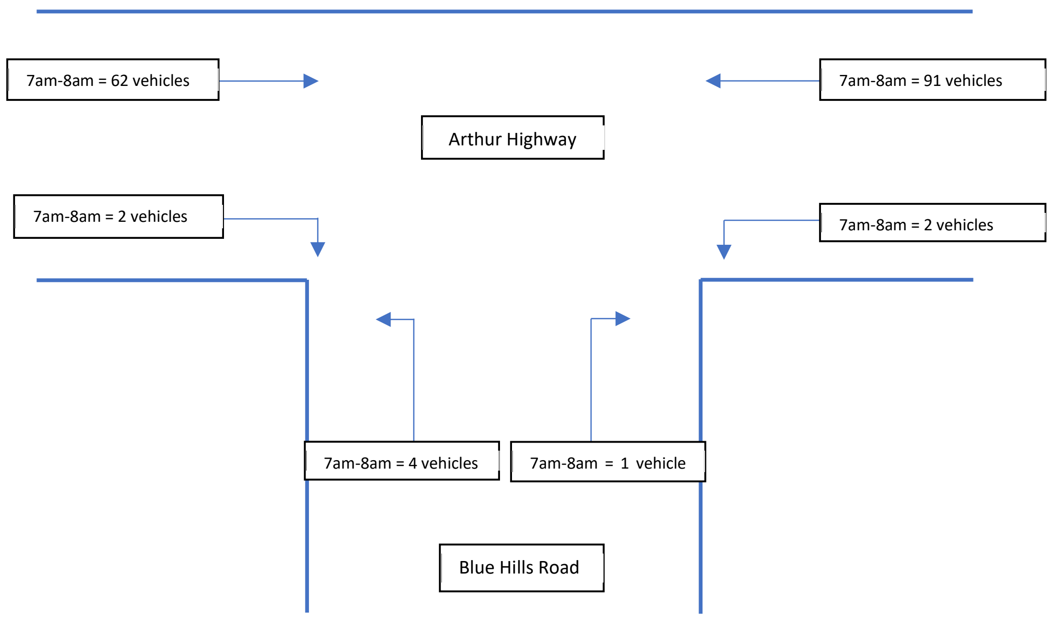
Arthur Highway in the vicinity of the intersection to Blue Hills Road is 10.2-metres wide, this comprises of a 3.1-metre westbound through lane, a 3.4-metre right turn lane and a 3.7-metre eastbound lane.

4.3 Traffic Volumes

To obtain an indication of the existing trip rates in the vicinity of landfill site along Blue Hills Road, Copping, Howarth Fisher and Associates undertook a traffic volume count at the intersection of Arthur Highway and Blue Hills Road on Tuesday, 13th December 2022, between 7am – 8am. These traffic volume counts represent the typical vehicle flow through the intersection, given they were taken during school term. Based on the data recorded during the traffic count, the Arthur Highway had a total of 152 vehicles, during the hour-long traffic count.

In line with standard traffic engineering practice the peak hourly traffic flows generally represent 10% of the daily traffic flows. The breakdown of the trips through the intersection is shown in the Figure 1 overleaf.

Figure 1: Turning Movement Counts at the Intersection of Blue Hills Road and Arthur Highway on Monday 13th December 2022.



4.4 Posted Speed Limits

The posted speed limit along Blue Hills Road, in the vicinity of the Southern Waste Solution landfill site is 40 km/hr. The posted speed limit along Arthur Highway, in the vicinity of the Southern Waste Solution landfill site, is 70km/hr.

4.5 Accident History

In line with standard traffic engineering practice, the accident history in the vicinity of the site for the past 5 years has been obtained from the Department of State Growth. The accidents have been summarised in the respective sections below.

4.5.1 Blue Hills Road

There have not been any reported accidents along Blue Hills Road in the vicinity of the site in the past 5 years.

4.5.2 Intersection of Blue Hills Road and the Arthur Highway

There has been one (1) accident at the intersection of Blue Hills Road and the Arthur Highway in the past 5 years. The accident was classified First Aid which included two (2) light vehicles. The cause of the accident was described as 'right through'.

4.5.3 Arthur Highway in the vicinity of the site

There have been nine (9) accidents which have occurred along the Arthur Highway in the vicinity of the Blue Hill Road intersection in the past 5 years. In terms of severity, the accidents were as follows:

- Two (2) were considered property damage only accidents.
- One (1) was classified as a serious accident.
- Five (5) were classified as minor accidents.
- One (1) was classified as a first aid accident.

Seven (7) out of the nine (9) accidents involved a single light vehicle, whilst the remaining two involved a collision between two (2) light vehicles. Given these were all light vehicle accidents, it is unlikely that these accidents were associated with the Southern Waste Solutions site.

Figure 2: Accident locations in the close vicinity of the Blue Hills Road / Arthur Highway intersection.

4.6 Proposed Development

The proposed development comprises of the expansion of the Copping Landfill site on Blue Hills Road, with the increase in height of existing cells, development of additional cells, and newly proposed internal access roads. The proposed development seeks to increase the approved dumping of the site from the current 150,000 tonnes to 200,000 tonnes per annum. The development plans are shown at **Appendix A**.

5. Assessment of Trip Generation

5.1 Existing Trip Rates

Howarth Fisher and Associates undertook a site visit on the Tuesday 13th of December 2022, to conduct a traffic volume survey during the morning peak period to and from the of Southern Waste Solutions site in Copping. There were nine (9) trips associated with the site in morning peak hour.

It has been advised by the South Waste Management Facility that the peak day and hour for trip generation occurs typically on a Tuesday between 7am – 8.30am. Howarth Fisher and Associates conducted the survey between on Tuesday 13th December 2022 between 7.10am and 8.10am to capture the worst-case scenario.

5.2 Proposed Trip Generation

Given the proposed development includes the expansion of the existing site, the traffic survey undertaken on the 13th of December 2022, forms a base line for the traffic flows associated with the size of the development. The development currently processes 150,000 tonnes of waste per annum, it is proposed that this will increase to 200,000 tonnes per annum as part of the proposed redevelopment. The intensification of trips has been calculated on a pro rata basis as shown in the table below.

Table 1: Existing and Proposed Trip Generation at Blue Hills Road, Copping.

Land Use	Trip Generation Rates	Total Requirement
Landfill Site Based on the current 150k tonnes of waste being processed on the site	*Existing trips*	**32 trips per day** **9 trips during the peak hour**[1]
Landfill Site Based on 200k tonnes of waste being processed on the site.	*Proposed trips*	**43 trips per day** **12 trips during the peak hour**

[1] Based on Howarth Fisher and Associates turning movement counts.

Based on a pro rata increase in the number of trips to the site there will be an estimated increase of 3 trips during the peak hour and an increase of 11 trips daily.

5.3 Tasmanian Planning Scheme – Sorell.

The increase in trip generation has been assessed in relation to the following clause of the Tasmanian Planning Scheme – Sorell.

A1.4

Vehicular traffic to and from the site, using an existing vehicle crossing or private level crossing, will not increase by more than:

(a) the amounts in Table C3.1; or

(b) allowed by a licence issued under Part IVA of the *Roads and Jetties Act 1935* in respect to a limited access road.

A1.5

Vehicular traffic must be able to enter and leave a major road in a forward direction.

Table C3.1 Acceptable increase in average annual daily traffic to and from the site (total of ingress and egress)

Location of vehicular traffic	Amount of acceptable increase in annual average daily traffic to and from the site (total of ingress and egress)	
	Vehicles up to 5.5m long	Vehicles longer than 5.5m long
Vehicle crossing on major roads and private level crossings	10% or 10 vehicle movements per day, whichever is the greater	10%
Vehicle crossings on other roads	20% or 40 vehicle movements per day, whichever is the greater	20% or 5 vehicle movements per day, whichever is the greater

Given there is an increase of more than 10% an assessment against the performance criteria has been undertaken.

Performance Criteria

P1

Vehicular traffic to and from the site must minimise any adverse effects on the safety of a junction, vehicle crossing or level crossing or safety or efficiency of the road or rail network, having regard to:

(a) any increase in traffic caused by the use;

(b) the nature of the traffic generated by the use;

(c) the nature of the road;

(d) the speed limit and traffic flow of the road;

(e) any alternative access to a road;

(f) the need for the use;

(g) any traffic impact assessment; and

(h) any advice received from the rail or road authority.

a) Any increase on traffic caused by the use;

There will be a proposed increase of 3 trips per peak hour and 11 trips daily. The increase in traffic will be predominantly by heavy vehicles given the use as a waste management facility. The current site processes 150,000 tonnes of waste per annum which will increase to 200,000 tonnes as part of the proposed upgrade.

b) The nature of the traffic generated by the use;

The largest vehicle which will be generated by the use is a 19 metre semi-trailer. A range of heavy vehicle, including 8.8 metre skip trucks, medium rigid vehicles and 12.5 metre heavy rigid vehicles would be used to service the site.

Most of the traffic would enter Blue Hills Road from the east and return to the east once waste has been dropped off at the site.

c) The nature of the road;

Blue Hills Road is a private road whose predominant function is to provide access to the land uses located along its length.

It is a no through road which terminates at the Southern Waste Solutions site.

d) The speed limit and traffic flow of the road;

Howarth Fisher and Associates have undertaken a traffic count along Blue Hills Road in the morning peak period (7am-8am). In line with standard traffic engineering practice peak hour flows typically (9 vehicles), represents 10% of the daily traffic volumes along Blue Hills Road in its entirety which typically reflect an annual average daily traffic flow of 90 vehicles per day.

The predominant inbound and outbound movement along the Arthur Highway into Blue Hills Road is from and to the east.

e) Any alternative access to a road;

Blue Hills Road provides the sole access to the site. There is no alternative access available.

f) The need for the use;

There is an increasing and growing demand for waste treatment associated with an increased market catchment and a general increase in waste.

g) Any traffic impact assessment; and

This report constitutes a traffic impact assessment report.

h) Any written advice received from the road authority.

There is no written advice received from the road authority.

6. Assessment of Parking

6.1 Existing Situation

There are currently 10 undesignated parking spaces associated with the existing site. There is significant room to provide dedicated parking in and around the main access where the main site offices are located.

6.1.1 Parking Requirements

Based on the requirements of the Tasmanian Planning Scheme - Sorell, an assessment has been made to determine the sites required parking spaces to comply with the requirements of the planning scheme. Southern Waste Solutions has advised that there will be maximum of six (6) people daily as well as a manager and four (4) contractors. Based on approximate measurements captured on google maps, the site in its entirety includes a total surface area of 250,000m^2.

Table 3: Parking requirements for the Recycling and Waste Disposal Site. Source: Tasmanian Planning Scheme – Sorell.

Land Use	Parking Rates	Total Requirement
Recycling and waste disposal (250,000m^2) (6 people daily + 1 manager + 4 contractors)	1 for each 500m^2 or site area + 1 space per employee.	**511 parking spaces**
TOTAL		**511 spaces**

6.2 Proposed Parking Provision

The existing car parking area has been marked up on the plans in Appendix A and represent that 14 parking spaces can be provided on site within the existing parking area. Given there are 14 parking spaces, out of the required 2,500 spaces, the development does not comply with the requirements of the State Planning Scheme - Sorell.

Given the size of the Southern Waste Solutions site the parking requirements are very high and unwarranted given the parking demand. The performance criteria as outlined below in the State Planning Scheme – Sorell have been addressed below:

P1.1

The number of on-site car parking spaces for uses, excluding dwellings, must meet the reasonable needs of the use, having regard to:

(a) the availability of off-street public car parking spaces within reasonable walking distance of the site;

(b) the ability of multiple users to share spaces because of:

(i) variations in car parking demand over time; or

(ii) efficiencies gained by consolidation of car parking spaces;

(c) the availability and frequency of public transport within reasonable walking distance of the site;

(d) the availability and frequency of other transport alternatives;

(e) any site constraints such as existing buildings, slope, drainage, vegetation and landscaping;

(f) the availability, accessibility and safety of on-street parking, having regard to the nature of the roads, traffic management and other uses in the vicinity;

(g) the effect on streetscape; and

(h) any assessment by a suitably qualified person of the actual car parking demand determined having regard to the scale and nature of the use and development.

a) *The availability of off street public car parking spaces within reasonable walking distance of the site;*

There is no off-street public parking in the vicinity of the site.

b) *The ability of multiple users to share spaces because of:*
   i) *Variations in car parking demand over time: or*

The parking demand will peak at 11 (which is the maximum number of staff at the site at any one time). The parking supply (14) within the site adequately caters to this requirement.

ii) *Efficiencies gained by consolidation of car parking spaces.*

Not applicable.

c) *The availability and frequency of public transport within reasonable walking distance of the site.*

There is no public transport available within reasonable walking distance of the site.

d) The availability and likely use of other transport alternatives.

Given that this is a waste facility, the primary users of the site will be waste vehicles dropping off rubbish and exiting the site without requiring a parking space. The parking spaces associated with the site will only be used by the workers and contractors on the site all of whom access the site via private vehicles. There are no visitors / members of the public permitted on site.

e) Any site constraints such as existing buildings, slope, drainage, vegetation and landscaping.

There are no site constraints, the size of the site is extensive and hence the calculated parking requirement is unwarrantedly high.

f) The availability, accessibility and safety of on street parking, having regard to the nature of the roads, traffic management and other uses in the vicinity.

There will be no requirement for on street parking given all the parking required can and will be provided on site.

g) The effect on streetscape.

The site is located at the end of a private unsealed road, the site is currently used as a waste treatment facility and there will be minimal impact on streetscape given much of the site cannot be seen from Blue Hills Road.

h) Any assessment by a suitably qualified person of the actual parking demand determined having regard to the scale and nature of the use and development.

The site is not open to the public, the maximum parking demand is a function of the maximum number of staff. The set out of parking spaces results in the provision of 14 spaces. There is significant amount of space on the site to provide any overflow of parking. There is a proposed maximum of 11 staff.

6.3 Dimensions and Manoeuvring

As outlined in the Tasmanian Planning Scheme - Sorell, the following parking bay dimensions are required. The parking set out has been designed in accordance with these requirements.

Table 5: Requirements for parking bay dimensions. Refer: Tasmanian Planning Scheme – Sorell

Table C2.3 Dimensions of Car Parking Spaces and Combined Access and Manoeuvring Space Adjacent to Parking Spaces

Angle of car spaces to manoeuvring space	Combined access and manoeuvring width	Car park widths	Car park length
Parallel	3.6m	2.3m	6.7m
45 degrees	3.5m	2.6m	5.4m
60 degrees	4.9m	2.6m	5.4m
90 degrees	6.4m	2.6m	5.4m
90 degrees	5.8m	2.8m	5.4m
90 degrees	5.2m	3m	5.4m
90 degrees	4.8m	3.2m	5.4m

6.4 Impact of the Development on On-Street Parking

Given that all the parking is supplied on site, the expansion of the landfill site will not impose an impact on on-street parking in the vicinity of the site.

6.5 Accessible Parking

In line with the Tasmanian Planning Scheme – Sorell requirements the : Number of Accessible Car Parking Spaces for People with a Disability is outlined below.

A1.2

Parking spaces provided for use by persons with a disability must satisfy the following:

(a) be located as close as practicable to the main entry point to the building;

(b) be incorporated into the overall car park design; and

(c) be designed and constructed in accordance with *Australian/New Zealand Standard AS/NZS 2890.6:2009 Parking facilities, Off-street parking for people with disabilities.* [S35]

Footnotes
[S35] Requirements for the number of accessible car parking spaces are specified in part D3 of the National Construction Code 2016.

In line with the requirements of the National Construction Code, there is a requirement to provide one (1) accessible parking bay for every 50 car parking spaces up to 1000, then one (1) for every 100 over 1000 parking spaces. Therefore, there is requirement to provide one (1) accessible parking bay to comply with the requirements of the State Planning Scheme – Sorell.

A copy of the accessible bay parking design which is in line with the Australian Standard can be found in the figure below:

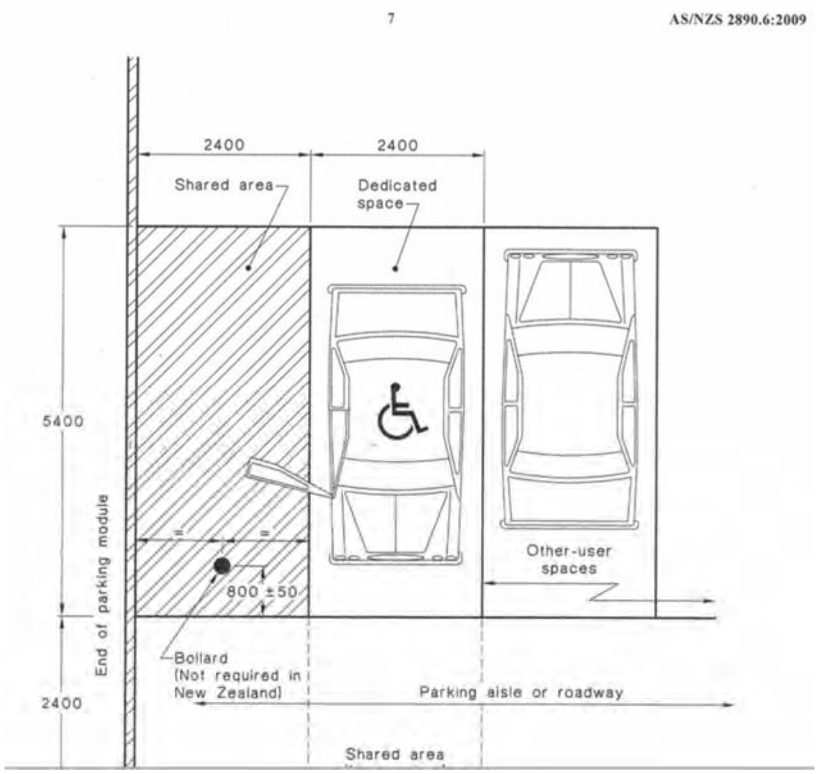


Figure 2.2 - AS2890.1: Off street parking – Example of an angle parking with shared area on one side only.

6.6 Bicycle Parking Requirements

As outlined in the Tasmanian Planning Scheme – Sorell , there is no requirement for bicycle racks to be provided at the facility given the site is not located in a general business zone or central business zone.

6.7 Motorcycle Parking

Given that no dedicated motorcycle parking is being provided on site , the performance criteria outlined in the State Planning Scheme – Sorell, has been addressed:

Table C2.4 Motorcycle Parking Space Requirements

Number of car parking spaces required for a use	Number of motorcycle parking spaces required for a use
0-20	No requirement
21-40	1 space
41 or more	1 space for every additional 20 car parking spaces required

C2.5.3 Motorcycle parking numbers

Objective:

That the appropriate level of motorcycle parking is provided to meet the needs of the use.

Acceptable Solutions	Performance Criteria
A1 The number of on-site motorcycle parking spaces for all uses must: (a) be no less than the number specified in Table C2.4; and (b) if an existing use or development is extended or intensified, the number of on-site motorcycle parking spaces must be based on the proposed extension or intensification, provided the existing number of motorcycle parking spaces is maintained.	**P1** Motorcycle parking spaces for all uses must be provided to meet the reasonable needs of the use, having regard to: (a) the nature of the proposed use and development; (b) the topography of the site; (c) the location of existing buildings on the site; (d) any constraints imposed by existing development; and (e) the availability and accessibility of motorcycle parking spaces on the street or in the surrounding area.

a) The nature of the proposed use and development;

Given the land use (notably a waste management facility), there is no requirement for motorcycle parking to be provided on site. Motorcycles can easily park in the car parking bays.

b) The topography of the site;

There is no on street parking and or public motorcycle parking in the vicinity of the site.

c) The location of existing buildings on the site;

The predominant mode of access to the site will be via truck. There will be car-based travel relating to staff access. Given the size of the staff, there will be available spaces for motorcycles to park in car parking spaces as and when required.

d) Any constraints imposed by existing development; and

Whilst there are no constraints caused by existing developments, there will be provision for motorcycles to park in standard car parking bays, given that the parking supply is going to exceed the maximum parking demand (based on the number of staff).

e) The availability and accessibility of motorcycle parking spaces on the street or in the surrounding area.

There are no motorcycle parking spaces in the vicinity of the site.

6.8 Layout of Parking Provision

The design and layout of the car parking complies with the intention of AS2890.1 and AS2890.2: Parking facilities given its location on the road network.

The design complies with the acceptable solution a) as outlined in clause C2.6.2 below, notably:

- i) It has a gradient in accordance with AS2890.
  ii) It provides for vehicles to enter and exit the site in a forward direction.
  iii)The parking area for light vehicles has an access width not less than the requirements in Table C2-2.
  iv) Have car parking space dimensions which satisfy the requirements in Table C2-3.
  v) Have the required access and manoeuvring space.
  vi) There are no issues with vertical clearance given the car park is at grade.
  vii) The car parking area will be line marked or spot marked to identify the parking spaces.

C2.6.2 Design and layout of parking areas

Objective:	
That parking areas are designed and laid out to provide convenient, safe and efficient parking.	
Acceptable Solutions	**Performance Criteria**
A1.1	**P1**
Parking, access ways, manoeuvring and circulation spaces must either: (a) comply with the following: (i) have a gradient in accordance with *Australian Standard AS 2890 - Parking facilities, Parts 1-6*; (ii) provide for vehicles to enter and exit the site in a forward direction where providing for more than 4 parking spaces; (iii) have an access width not less than the requirements in Table C2.2; (iv) have car parking space dimensions which satisfy the requirements in Table C2.3; (v) have a combined access and manoeuvring width adjacent to parking spaces not less than the requirements in Table C2.3 where there are 3 or more car parking spaces; (vi) have a vertical clearance of not less than 2.1m above the parking surface level; and (vii) excluding a single dwelling, be delineated by line marking or other clear physical means; or (b) comply with *Australian Standard AS 2890- Parking facilities, Parts 1-6.*	All parking, access ways, manoeuvring and circulation spaces must be designed and readily identifiable to provide convenient, safe and efficient parking, having regard to: (a) the characteristics of the site; (b) the proposed slope, dimensions and layout; (c) useability in all weather conditions; (d) vehicle and pedestrian traffic safety; (e) the nature and use of the development; (f) the expected number and type of vehicles; (g) the likely use of the parking areas by persons with a disability; (h) the nature of traffic in the surrounding area; (i) the proposed means of parking delineation; and (j) the provisions of *Australian Standard AS 2890.1:2004 Parking facilities, Part 1: Off-street car parking* and *AS 2890.2 -2002 Parking facilities, Part 2: Offstreet commercial vehicle facilities.*

6.9 Construction of Parking Areas

As per the acceptable solution, the proposed parking areas is existing, constructed with an all-weather pavement, is drained appropriately, and fully sealed.

C2.6.1 Construction of parking areas

Objective:	
That parking areas are constructed to an appropriate standard.	
Acceptable Solutions	**Performance Criteria**
A1	**P1**
All parking, access ways, manoeuvring and circulation spaces must: (a) be constructed with a durable all weather pavement; (b) be drained to the public stormwater system, or contain stormwater on the site; and (c) excluding all uses in the Rural Zone, Agriculture Zone, Landscape Conservation Zone, Environmental Management Zone, Recreation Zone and Open Space Zone, be surfaced by a spray seal, asphalt, concrete, pavers or equivalent material to restrict abrasion from traffic and minimise entry of water to the pavement.	All parking, access ways, manoeuvring and circulation spaces must be readily identifiable and constructed so that they are useable in all weather conditions, having regard to: (a) the nature of the use; (b) the topography of the land; (c) the drainage system available; (d) the likelihood of transporting sediment or debris from the site onto a road or public place; (e) the likelihood of generating dust; and (f) the nature of the proposed surfacing.

7. Assessment of Access

7.1 Existing Situation Access Width

The existing access to the site was measured to include a cross section width of 7.5-metres.

7.2 Planning Scheme Access Width Requirement

The access width has been designed to cater to the Australian Standards given the proposed car park will make provision for 14 spaces, notably less than 25 parking spaces which are accessed from a local road. There is a requirement for a combined entry and exit width between 3.0 to 5.5-metres. Given the site is utilised by heavy vehicles, the proposed cross section access width is 7.5-metres and will remain unchanged.

However, the design does not comply with the requirements of AS2890.2 – 2002 - Part 2: Off street commercial vehicle facilities. It should be noted that this standard has been superseded and the latest issue date is 2018 and reference is made to the latest version.

7.3 Australian Standard Requirement

7.3.1 Classification of Off-Street Car Parking Facility

In line with Australian Standard AS2890.1: Off-street car parking facilities the class of the proposed parking facility is determined from the table 1.1 below:

9 AS/NZS 2890.1:2004

TABLE 1.1

CLASSIFICATION OF OFF-STREET CAR PARKING FACILITIES

User class	Required door opening	Required aisle width	Examples of uses (Note 1)
1	Front door, first stop	Minimum for single manoeuvre entry and exit	Employee and commuter parking (generally, all-day parking)
1A	Front door, first stop	Three-point turn entry and exit into 90° parking spaces only, otherwise as for User Class 1	Residential, domestic and employee parking
2	Full opening, all doors	Minimum for single manoeuvre entry and exit	Long-term city and town centre parking, sports facilities, entertainment centres, hotels, motels, airport visitors (generally medium-term parking)
3	Full opening, all doors	Minimum for single manoeuvre entry and exit	Short-term city and town centre parking, parking stations, hospital and medical centres
3A	Full opening, all doors	Additional allowance above minimum single manoeuvre width to facilitate entry and exit	Short term, high turnover parking at shopping centres
4	Size requirements are specified in AS/NZS 2890.6 (Note 2)		Parking for people with disabilities

From Table 1.1, the type of the proposed parking facility is a user class 1 employee and commuter parking (generally, all-day parking).

Category of Access Driveway

In line with AS2890.1, *to determine access driveway widths and restrictions on their location along frontage road table 3.1 categorizes driveways according to –*

a) *the class of parking facility as shown in table 1.1;*

b) *the frontage road type, either arterial (including sub-arterial) or local (including collector):and*

c) *the number of parking spaces served by the access driveway.*

29 AS/NZS 2890.1:2004

TABLE 3.1

SELECTION OF ACCESS FACILITY CATEGORY

Class of parking facility (see Table 1.1)	Frontage road type	Access facility category				
		Number of parking spaces (Note 1)				
		<25	25 to 100	101 to 300	301 to 600	>600
1,1A	Arterial	1	2	3	4	5
	Local	1	1	2	3	4
2	Arterial	2	2	3	4	5
	Local	1	2	3	4	4
3,3A	Arterial	2	3	4	4	5
	Local	1	2	3	4	4

NOTES:

1 When a car park has multiple access points, each access should be designed for the number of parking spaces effectively served by that access.

2 This Table does not imply that certain types of development are necessarily suitable for location on any particular frontage road type. In particular, access to arterial roads should be limited as far as practicable, and in some circumstances it may be preferable to allow left-turn-only movements into and out of the access driveway.

In line with the requirements of the State Planning Scheme - Sorell, 2015, the access driveway is a category class 1 facility. The location of the access and egress points can be found on the plan at **Appendix A**.

7.4 Access Provision

The access provision is 7.5-metres wide and is therefore compliant with the requirements of the Australian Standard 2890.1 and the planning scheme for light vehicles.

7.5 AS2890.2: Off street commercial vehicle facilities

The design has been assessed against the requirements of the Australian Standard 2890.2: Off street commercial vehicle facilities in relation to access. However, AS2890.2: off street commercial vehicle facilities require there to be minimum two-lane access driveway width of 12.5-metres. The access is located at the termination of a road and there is not a standard access requiring vehicles to turn, the application of this access width requirement is therefore not applicable. The access is the same cross section width as the road and facilitates and enables commercial vehicles to access and enter without turning.

The design has been assessed against the access width and circulation road width requirements for commercial vehicles. Minimum roadway widths for straight sections of road are 3.5-metre for one way and two-way road widths are 6.5-metres wide as outlined in Table 3.1 (with widening through curves dependent upon the curve radius measured along the inside edge of the curve).

Given the access width is non-compliant the access has been assessed against the performance criteria of the Planning Scheme as outlined above:

Performance Criteria
P1 Design of vehicle access points must be safe, efficient and convenient, having regard to all of the following: (a) avoidance of conflicts between users including vehicles, cyclists and pedestrians; (b) avoidance of unreasonable interference with the flow of traffic on adjoining roads; (c) suitability for the type and volume of traffic likely to be generated by the use or development; (d) ease of accessibility and recognition for users.

a) The avoidance of conflicts between users including vehicles, cyclists and pedestrians;

There are stringent safety management procedures in place by the client to ensure that conflict is avoided. Each person who enters the site must be inducted onto the site and there is a requirement for pedestrians and other staff to wear high visibility jackets and for there to be a minimum distance of 10 metres between pedestrians and vehicles. There are dedicated parking areas near the site shed at the entrance and segregated weighbridge-controlled access for trucks entering the site. The access is 7.5-metres wide and is not open to the public. Given the location of the site on the network it is unlikely that there will be any pedestrian or bicycle traffic at this access from the external road network.

b) Avoidance of unreasonable interference with the flow of traffic on adjoining roads;

The major intersection with the Arthur Highway has been designed to avoid unreasonable interference with the flow of traffic. It should be noted that the access onto the Arthur Highway has been designed to accommodate the turning movements of a 19-metre semi-trailer entirely from the left lane without encroaching over the Arthur Highway centreline. Similarly, an 80-metre-long right turn lane with a 3.5-metre width exists to enable semi-trailers to turn into the site without impeding or impacting on westbound flows or requiring vehicles to cross the centre line. Blue Hills Road widens to 16 metres to accommodate the turning paths of the 19 metre semi-trailer.

c) *Suitability for the type and volume of traffic likely to be generated by the use or development;*

The access has been designed to adequately cater for the predominantly heavy vehicle traffic using the site. There are typically 32 truck movements to the site daily.

d) *Ease of accessibility and recognition for users.*

The access is easily recognisable and accessible for all road users.

7.6 Number of Accesses

The number of accesses has been assessed in line with the State Planning Scheme – Sorell.

C2.6.3 Number of accesses for vehicles

Objective:

That:

(a) access to land is provided which is safe and efficient for users of the land and all road network users, including but not limited to drivers, passengers, pedestrians and cyclists by minimising the number of vehicle accesses;

(b) accesses do not cause an unreasonable loss of amenity of adjoining uses; and

(c) the number of accesses minimise impacts on the streetscape.

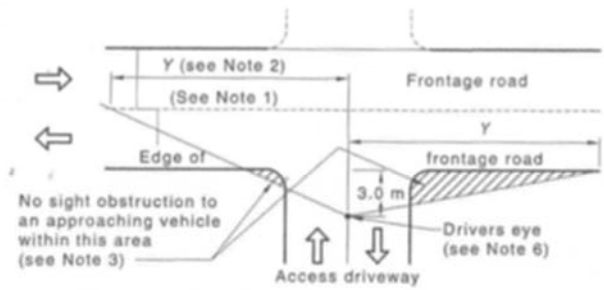
Acceptable Solutions	Performance Criteria
A1	**P1**
The number of accesses provided for each frontage must: (a) be no more than 1; or (b) no more than the existing number of accesses, whichever is the greater.	The number of accesses for each frontage must be minimised, having regard to: (a) any loss of on-street parking; and (b) pedestrian safety and amenity; (c) traffic safety; (d) residential amenity on adjoining land; and (e) the impact on the streetscape.

The number of accesses associated with the proposed development will remain the same and therefore this is in line with the acceptable solution.

8. Assessment of Sight Distance

8.1 State Planning Scheme – Sorell Requirements

The sight distance has been assessed in line with the provisions of the Tasmanian Planning Scheme - Sorell. In accordance with the Tasmanian Planning Scheme -Sorell the accesses must be designed in accordance with AS2890.1 and AS2890.2:2018 – Parking facilities – Off street commercial vehicle facilities. Both documents stipulate sight distance requirements, given the prevalence of truck movements at these accesses, the sight distances have been assessed against the more stringent requirements of AS2890.2:2018.



Frontage road speed (see Note 4) km/h	Distance (Y) along frontage road (see Note 5) m	
	5 s gap	8 s gap
40	55	89
50	69	111
60	83	133
70	97	156
80	111	178
90	125	200
100	139	222
110	153	244

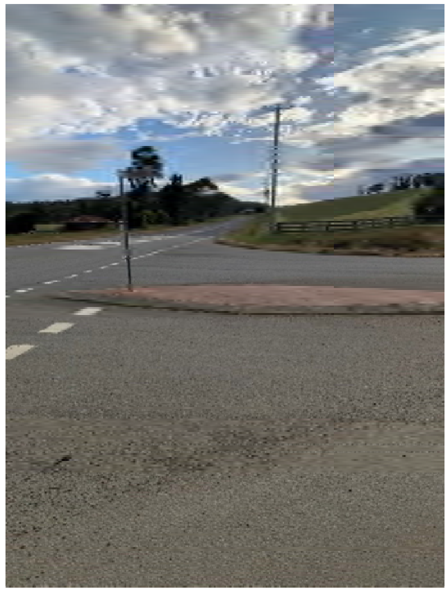
8.1.1 Access to the Site

Given the site is located at the end of Blue Hills Road subject to a 40km/hr speed limit, there is no issue with sight distance. There is a forward sight distance of more than 200-metres at the entrance as shown in the photograph overleaf:

Photograph 3: Forward sight distance from the access is in excess of 150 metres as shown in the photograph above.

The sight distance availability exceeds the requirements of *Acceptable Solution*, as required by the Tasmanian Planning Scheme – Sorell of 89 metres, given it is subject to speed limit of 40km/hr.

8.1.2 Arthur Highway / Blue Hill Road Intersection



Photograph 4: Sight distance to the east was measured to be in excess of 200-metres

Photograph 5: Sight Distance at the intersection of the Arthur Highway and Blue Hills Road was measured to the right (west) metres to be in excess of 200-metres.

The sight distance availability meets the requirements of *Acceptable Solution*, as required by the Tasmanian Planning Scheme – Sorell of 140-metres in both directions, given the frontage road is subject to a speed limit of 70km/hr.

9. Service Vehicles

The development application has been assessed in relation to service vehicle requirements as outlined below:

9.1 Tasmanian Planning Scheme - Sorell, 2015

In line with the provision of the Tasmanian Planning Scheme – Sorell.

C2.5.4 Loading bays

Objective:

That adequate access for goods delivery and collection is provided, and to avoid unreasonable loss of amenity and adverse impacts on traffic flows.

Acceptable Solutions	Performance Criteria
A1	**P1**
A loading bay must be provided for uses with a floor area of more than 1000m² in a single occupancy.	Adequate space for loading and unloading of vehicles must be provided, having regard to: (a) the type of vehicles associated with the use; (b) the nature of the use; (c) the frequency of loading and unloading; (d) the location of the site; (e) the nature of traffic in the surrounding area; (f) the area and dimensions of the site; and (g) the topography of the site; (h) the location of existing buildings on the site; and (i) any constraints imposed by existing development.

The site does not have a floor area given there are minimal actual building structures on the site. However, the site does not cater for waste moving equipment which operate internally within the site and 19 metre semi-trailers. The site has been designed to cater for commercial vehicles given the proposed land use will generate in the order of 43 truck (86 movements to and from the site per day).

Autotrack has been used to model the swept path of a 19-metre semi-trailer which will be the largest vehicle to utilise the site. It has been advised by staff at Southern Waste Solutions that there will be two 19-metre semi-trailer turning circles operating concurrently to fill a layer of waste. The turning movements of the semi-trailer will occur at different locations within the site.

The Autotrack paths included in **Appendix A** represent an arbitrary route which an ARV will follow on site. Given that the destination of the ARV is controlled by the proposed cell which is being developed, the exact route of ARVs within the site will not be consistent. The Autotrack paths shown in **Appendix A** provide evidence that two ARVS (19 metre semi-trailers) can enter and exit the site simultaneously whilst performing a single movement turn within a landfill site where it will dispose of its waste, and then finally return to Blue Hills Road.

10. Sustainable Transport

10.1 General

Given the land use of the site, the significant distance of the landfill site from the Arthur Highway and given the waste transfer stations serviced predominantly by trucks, the relevance of sustainable transport modes is not as predominant as for other land uses.

Nonetheless, there is a Tassielink bus service providing a link between Nubeena and Hobart. This service operates two early morning services and two evening bus services.

10.2 Pedestrian

C2.6.5 Pedestrian access

Objective:

That pedestrian access within parking areas is provided in a safe and convenient manner.

Acceptable Solutions	Performance Criteria
A1.1 Uses that require 10 or more car parking spaces must: (a) have a 1m wide footpath that is separated from the access ways or parking aisles, excluding where crossing access ways or parking aisles, by: (i) a horizontal distance of 2.5m between the edge of the footpath and the access way or parking aisle; or (ii) protective devices such as bollards, guard rails or planters between the footpath and the access way or parking aisle; and (b) be signed and line marked at points where pedestrians cross access ways or parking aisles. **A1.2** In parking areas containing accessible car parking spaces for use by persons with a disability, a footpath having a width not less than 1.5m and a gradient not steeper than 1 in 14 is required from those spaces to the main entry point to the building.	**P1** Safe and convenient pedestrian access must be provided within parking areas, having regard to: (a) the characteristics of the site; (b) the nature of the use; (c) the number of parking spaces; (d) the frequency of vehicle movements; (e) the needs of persons with a disability; (f) the location and number of footpath crossings; (g) vehicle and pedestrian traffic safety; (h) the location of any access ways or parking aisles; and (i) any protective devices proposed for pedestrian safety.

The parking area does not include a dedicated pedestrian facility. Therefore, the performance criteria have been addressed.

a) The site is not open to members of the public. The staff are regular uses of the car park and will be familiar with the circulation paths and functionality of the site.
b) The use is contained to staff and regular users of the site. There is no public access and there are strict safety protocols for pedestrian access within the site which all users are inducted into prior to attending the site.
c) There are only 14 bays provided.
d) The users will typically be long stay, low turnover users of the site associated with employee and staff movements.
e) An accessible access bay has been provided within the site to facilitate access for any staff member with mobility issues.

f) There are no footpath crossing and no footpaths located along Blue Hills Road.
g) This is a low speed environment where all pedestrians have to maintain stringent distances from vehicles and wear high visibility vests as part of the safety protocol.
h) The parking aisles and access ways are located in proximity to the site sheds and offices associated with the site.
i) As previously stated the site is subject to a series of pedestrian safety measures including pedestrian and vehicles being required to maintain a minimum distance, all staff and visitors being required to undertake a safety induction and the requirement for staff and visitors to wear safety equipment, including high visibility vests.

11. Conclusion and Recommendation

The proposed development has been assessed in relation to the following:

Trip Generation

The trip generation associated with the development has been calculated on a pro rata basis. Currently the site processes 150,000 tonnes of waste per annum. Because of the proposed redevelopment, it is proposed that this will increase to 200,000 tonnes.

Howarth Fisher and Associates undertook traffic counts on Tuesday 13th of December 2022 between 7am – 8am which typically represent worst case scenario flows. Given there will be an increase of 33.3% the trip generation will also be expected to increase by 33.3% on the current flows. Typically, there will be an anticipated maximum of 43 trips per day into and out of the site and 12 trips during the peak hour.

Parking

It has been advised that there will be a maximum of 11 staff working on the site at any given time. Based on the maximum staffing numbers, and the proposed 14 parking spaces, there is sufficient parking on site to cater for the maximum staff. However, given the State Planning Scheme – Sorell required 2,500 spaces, giving the size of the waste facility, the performance criteria have been addressed.

The parking area is fully sealed and drained and will be marked and dimensioned off in accordance with the acceptable solution

Access

The site access is 7.5 metres wide, which increases to include a 13-metre cross section internal road. The access width is significantly higher than the required 3.0 - 5.5-metre-wide requirement based on the AS/NZS2890.1:2004 for light vehicles. Given that the site is predominantly used by heavy vehicles, the access width has been assessed against the requirements of AS2890.2:Off street parking with commercial vehicles. The access is essentially a continuation of Blue Hills Road and although not compliant with the AS2890.2 provides a suitable and workable cross section for the service vehicles accessing the site, given there is no requirement to turn to and from the access (it is essentially a straight through movement). The performance criteria have therefore been addressed.

Sight Distance

Southern Waste Solutions is located at the end of Blue Hills Road and includes a forward sight distance of more than 200-metres.

The sight distance has also been measured along the Arthur Highway at the intersection with Blue Hills Road. The sight distance in both directions from the intersection was measured to be more than 200-metres. This is in line with the requirements of the Tasmanian Planning Scheme - Sorell.

Sustainable Transport

Buses/Coaches

The Southern Waste Solutions site is located 3.4-kilometres away from the Arthur Highway. There are Redline coach services to Carlton but no services extending to Copping.

Bicycle

There are no dedicated bicycle lanes on Blue Hills Road. Blue Hills Road includes a gravel cross section width of 7.5-metres. The 40 km/hr speed limit and the low traffic volumes, makes it conducive to cycling.

Pedestrians

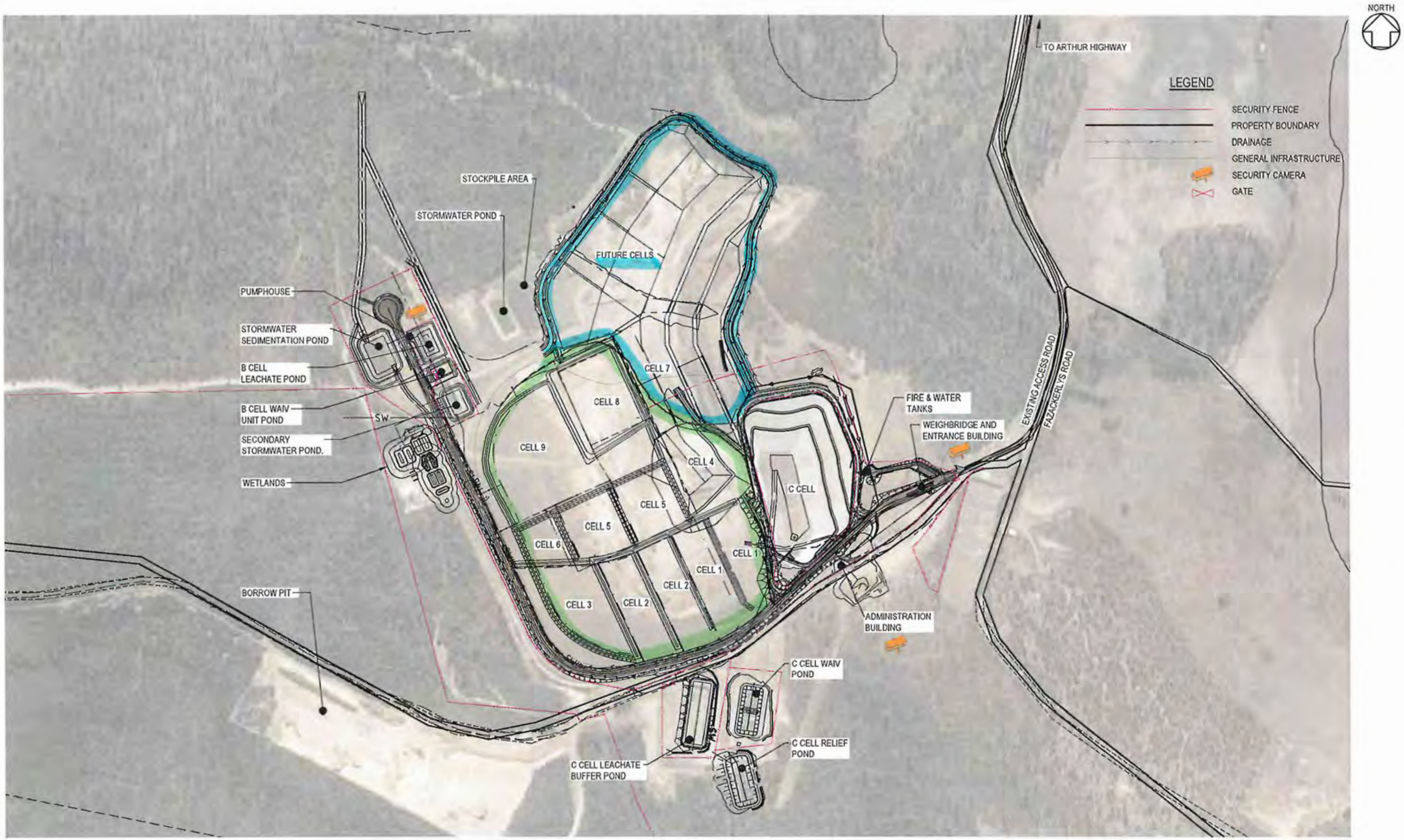
There is no dedicated pedestrian provision along Blue Hills Road. The site is located at some distance from any residential catchments.

Service Vehicles

The facility has been designed to accommodate the largest service vehicles which utilises the site, notably a 19metre semi-trailer. The Autotrack paths of a 19metre semi-trailer has been modelled using Autotrack and the swept path diagrams are located at **Appendix A** of this report. The Autotrack paths included in **Appendix A** of this report represent an arbitrary movement within the site. Given that the transport route of the ARV is dictated by the landfill site, the trip locations within the site will not be consistent. The Autotrack paths provide evidence that two ARVs can enter and exit the site simultaneously and navigate to the new cells via the existing service roads.

Appendix A

DEVELOPMENT PLANS



PLAN
SCALE 1:5000 (m)

Current Cells

REFERENCE FILES ATTACHED S.P.21.1810-CIV-XREF-1110 S.P.21.1810-CIV-XREF-P.21.1118 S.P.21.1810-CIV-XREF-HB14356-X1500 S.P.21.1810-CIV-XREF-HB15447-X3011 S.P.21.1810-CIV-XREF-HB18339-P11 S.P.21.1810-CIV-XREF-1500 S-P.21.1810-CIV-XRF-1850 S.P.21.1810-CIV-XREF-1111 S.P.21.1810-CIV-XREF-1112

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
0	APPROVED	BW	RC	RC	29/08/22

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
RC
SIGNED
DATE 07/09/2022

SCALE (PLOTTED FULL SIZE) 1:5000
SHEET SIZE A3

50 0 50 100 150 200
SCALE IN METRES - 1:5000

pitt&sherry
pittsh.com.au Phone 1300 748 874 ABN 67 140 184 309

CLIENT: COPPING REFUSE DISPOSAL SITE JOINT AUTHORITY
PROJECT: COPPING LANDFILL
-
STATUS: PRELIMINARY

DRAWING TITLE: SITE PLAN
DATUMS: AHD / MGA55, GDA20
CLIENT No.
DRAWING No. S-P.21.1810-01-CIV-DRG-1004
REVISION 0

Appendix B

AUTOTRACK PATHS

Howarth Fisher & Associates Pty Ltd

www.howarthfisher.com

SOUTHERN WASTE SOLUTIONS

BLUE HILLS ROAD, COPPING

TRAFFIC DRAWINGS

DRAWING No.	DRAWING NAME	REVISION No.
C1	COVER PAGE	2
P1	GENERAL ARRANGEMENT PLAN	2
P2	AUTOTRACK PATHS	2
P3	AUTOTRACK PATHS	2

Traffic
Civil
Structural
Industrial
Engineering

ISSUED FOR
FOR APPROVAL
PRINT DATE: Jan 13, 2023 - 12:15pm

PRELIMINARY - NOT FOR CONSTRUCTION

	ISSUE	BY	APPROVED	DATE
2	FOR DEVELOPMENT APPLICATION	GN	JF	13/01/2023

HOWARTH FISHER & ASSOCIATES
Pty Limited ACN 119 043 051
STRUCTURAL, CIVIL, TRAFFIC ENGINEERS
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SOUTHERN WASTE SOLUTIONS
BLUE HILLS ROAD, COPPING

COVER PAGE

SCALES NTS
DRAWN GN
DESIGN JF
ISSUE: 1
PROJECT NO. 22J665
DOCUMENT IDENTIFICATION -D-
DRAWING NO. C1

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A3

DO NOT SCALE OFF DRAWINGS

THESE DRAWINGS TO BE READ IN CONJUNCTION WITH DESIGN PLANS PREPARED BY ARCHITECT OR DESIGNER WHERE APPLICABLE

WARNING

BEWARE OF UNDERGROUND SERVICES

The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Worksafe Regulation 3.21.

DIAL 1100 BEFORE YOU DIG

	ISSUE	BY	APPROVED	DATE
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SOUTHERN WASTE SOLUTIONS

BLUE HILLS ROAD, COPPING

GENERAL ARRANGEMENT

SCALES 1:5000 @ A3
DRAWN GN
DESIGN JF
ISSUE: 2

PROJECT NO. 22J665
DOCUMENT IDENTIFICATION -D-
DRAWING NO. P1

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A3

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SOUTHERN WASTE SOLUTIONS
BLUE HILLS ROAD, COPPING

AUTOTRACK PATHS

SCALES	1:2000 @ A3
DRAWN	GN
DESIGN	JF
ISSUE:	2
PROJECT NO.	22J665
DOCUMENT IDENTIFICATION	-D-
DRAWING NO.	P2

A3

B99 Vehicle (Realistic min radius) (2004)

Overall Length	5.200m
Overall Width	1.940m
Overall Body Height	1.878m
Min Body Ground Clearance	0.272m
Track Width	1.840m
Lock-to-lock time	4.00s
Curb to Curb Turning Radius	6.250m

THESE DRAWINGS TO BE READ IN CONJUNCTION WITH DESIGN PLANS PREPARED BY ARCHITECT OR DESIGNER WHERE APPLICABLE

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SOUTHERN WASTE SOLUTIONS

BLUE HILLS ROAD, COPPING

AUTOTRACK PATHS

SCALES	1:250 @ A3	ISSUE: 2
DRAWN	GN	
DESIGN	JF	
PROJECT NO. 22J665	DOCUMENT IDENTIFICATION -D-	DRAWING NO. P3

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A3

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Southern Waste Solutions
Copping RDS

Proposed Landfill Expansion
(Stage 1B: Cells 10 – 17)

Hydrogeological Review

September 2021

Cover photo

Oblique Google Earth satellite image looking southeast over the Copping RDS April 2019. The proposed landfill expansion (Cells 10 – 17) is located at the central foreground.

Refer to this report as

Cromer, W. C. (2021). *Hydrogeological review, proposed landfill expansion (Stage 1B: Cells 10 – 17), Copping RDS.* Unpublished report for Southern Waste Solutions by William C. Cromer Pty. Ltd., 2 September 2021.

Use of this document

Summary

A conceptual hydrogeological model has been compiled for local-, intermediate and regional-scale groundwater flow directions beneath and adjacent to the proposed Stage 1B landfill expansion of Cells 10 – 17 at the Copping Refuse Disposal Site.

In February 2019 ten additional bores were added to the groundwater monitoring program at the site. Their logs have been reviewed and it has been shown that none of the four earlier hydrogeological models compiled in 2016 and 2018 required other than minor changes to account for the drilling.

Water table depths in twelve bores monitored seasonally in 2018 showed mostly little variation (range 0.07m – 5.16m; average 1.1m), but the annual variation increased with water table depth.

1 INTRODUCTION

1.1 Background

Southern Waste Solutions proposes to expand landfill operations at the Copping Refuse Disposal Site (CRDS).

The expansion (Stage 1B) is located immediately north of Stage 1A (now capped and closed) and C – Cell (operating) (Map 1 in Attachment 1).

In June 2021, the Tasmanian Environment Protection Authority (EPA) provided guidelines[1] for an Environmental Impact Statement; EIS) for the proposal. Section 6.1 (Key Issue 1: Water Quality and Leachate Management) of the Guidelines requires among other things:

- a map showing the location of any groundwater bores, and
- a conceptual groundwater model for regional and local aquifer flows, including seasonal variation and depth to groundwater, and direction of groundwater flow.

In July 2021 William C Cromer Pty. Ltd. (WCC) was engaged by consultants Pitt & Sherry to address these issues.

1.2 Previous hydrogeological modelling reports

Cromer and Brooker (2016[2]) compiled a conceptual hydrogeological model of the then-proposed C – Cell, and included a list of publications up to 2016 relating to geotechnical and hydrogeological studies for the CRDS.

Cromer (2018[3]) reviewed the 2016 conceptual model and the then-current groundwater monitoring program, commented on several hydrogeological issues raised by EPA, and recommended the retention of the existing group of monitoring bores, upgrading of some of them, and the addition of three others.

1.3 Purpose of this report

In addition to addressing the EPA requirements, this report also reviews the previous conceptual modelling in relation to ten additional monitoring bores installed in February 2019[4]. As with previous WCC reports, a section dealing with groundwater fundamentals is repeated, but with additional information explaining the relationship between groundwater flow systems and surface water catchments, and the conceptual groundwater travel times for local, intermediate and regional GFSs.

[1] EPA (2021). *Guidelines for preparing an Environmental Impact Statement for Category B Landfill Cells 10 – 17, Copping Landfill.* Prepared for Copping Refuse Site Joint Authority (Southern Waste Solutions), June 2021

[2] Cromer, W. C. and Brooker, J. K. (2016). Copping RDS: C Cell Hydrogeology – Data review, conceptual model and Stage 2 recommendations. Unpublished report for Southern Waste Solutions by William C. Cromer Pty Ltd, 1 February 2016. 26 pages.

[3] Cromer, W. C. (2018). *Copping RDS: Review of Groundwater Monitoring and Conceptual Groundwater Model.* Unpublished report for Southern Waste Solutions by William C. Cromer Pty Ltd, 24 August 2018. 38 pages.

[4] Drilling of these bores was supervised by Pitt & Sherry, who also logged the holes and presented copies of the logs to WCC for this report.

To review seasonal and longer fluctuations in water table elevations, reference has also been made to recent monitoring reports[5] by AquaSci.

It is expected that the current report will form part of the EIS, or be referenced by it.

2 HYDROGEOLOGY

2.1 Groundwater fundamentals

The interpreted geology of the CRDS and environs (Cromer, 2018; repeated unchanged as Map 1 in Attachment 2) comprises Triassic sedimentary rocks (sandstone interbedded with mudstone and shale) intruded by Jurassic dolerite. Several faults have been inferred.

Superficial Quaternary-age unconsolidated sediments include alluvial sand, silt, gravel and clay in valley floors, and colluvium (talus) of dolerite or mudstone/shale on steeper slopes.

The sandstone, mudstone, shale and dolerite are fractured hard-rock aquifers, where groundwater moves in secondary openings [6](joints, fault zones) between otherwise dry rock. The unconsolidated Quaternary sediments constitute an intergranular aquifer, in which groundwater moves in primary openings (voids between individual mineral grains).

Based on general hydrogeological principles, and observations over several years in on-site monitoring bores, at all scales the sediments and hard rocks in the general vicinity of the CRDS are regarded as a single, unconfined aquifer[7].

In such an environment, Figure 1 illustrates different components of the land-based part of the hydrological cycle[8] at the scale of a single catchment or smaller. Effective rain (precipitation less evapotranspiration) flows overland to surface streams, or infiltrates (at a rate determined by soil and rock permeability) through the unsaturated zone to the water table.

An important aspect of Figure 1 is the interconnectivity between surface water and groundwater.

The fundamentals of groundwater movement in an unconfined, gravity-driven groundwater flow system (GFS) similar to that in the vicinity of the CRDS are depicted schematically in Figure 2. Important points are:

- the hydraulic heads in recharge areas are relatively high and decrease with depth. In discharge areas, the energy and flow conditions are reversed; heads are low and increase with depth. In between, the throughflow is almost horizontal as shown by the steeply dipping equipotential lines.

[5]AquaSci (2019). *Copping RDS Surface & Groundwater Monitoring Program Annual Report, 2018.* Prepared for: Southern Waste Solutions January 2019, and AquaSci (2021). *Copping RDS Surface & Groundwater Monitoring Program Quarterly Sampling Event Report, March 2021.* Prepared for: Southern Waste Solutions April 2021.

[6] Secondary openings were formed later than the rock. Primary openings formed at the same time as the rock.

[7]Localised confined conditions may exist in the Quaternary sediments where low permeability beds or horizons exist.

[8] The *hydrological cycle* is the circulation of water in various phases through the atmosphere, over and under the earth, to the oceans, and back to the atmosphere. The cycle is solar-powered. Because water is a solvent it dissolves elements, and geochemistry is a fundamental part of the cycle, which is a flux for water, energy, and chemicals. Water enters the land-based cycle as precipitation; it leaves as surface streamflow (runoff) or evapotranspiration. The route which groundwater takes from a recharge point to a discharge point is a *flow path.*

- the concept of a groundwater flow system (GFS[9]) is fundamental to understanding groundwater conditions. Given the moderate relief of the area, it can be expected that the near-surface dominant groundwater flows to depths of a few tens of metres or so will be as local systems, with recharge on most elevated areas discharging to minor un-named watercourses. Some of the recharge will penetrate to depths of perhaps 50m or more, and will travel towards larger streams in the district. This scale of groundwater movement is regarded as intermediate.

- Still deeper groundwater infiltration results in regional systems discharging to major watercourses (eg Carlton River) and the coast.

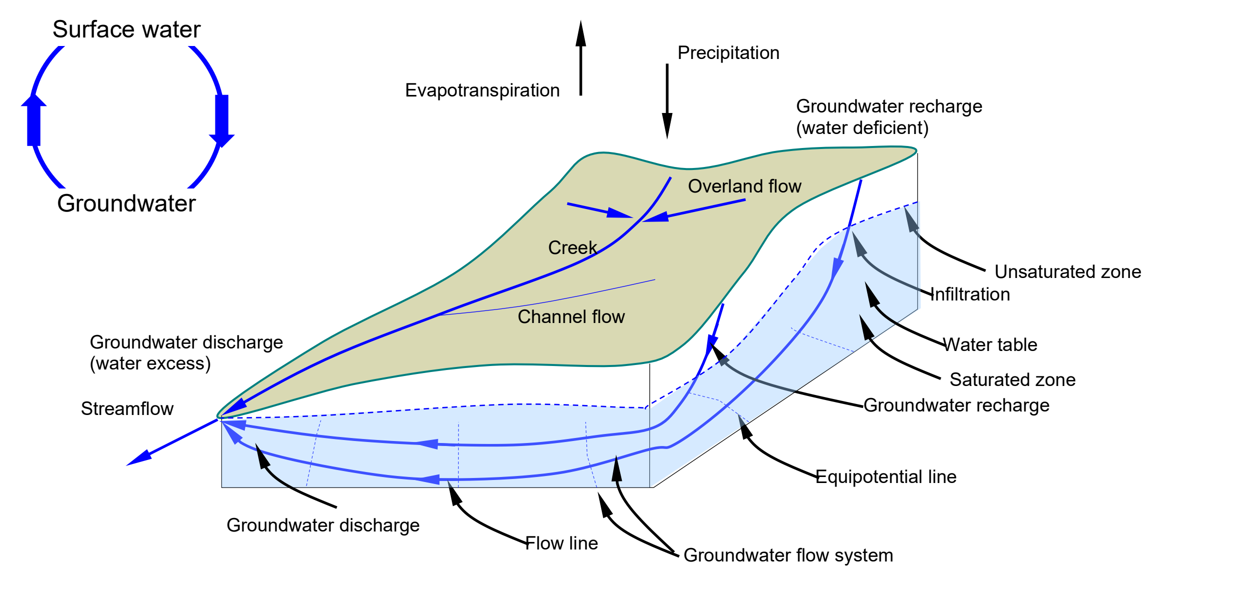


Figure 1. Aspects of the land-based hydrological cycle

2.2 Local, intermediate, and regional groundwater flow systems in the vicinity of the CRDS

Hocking *et al* (2005[10]) have studied groundwater and salinity issues in the Tasmania southern Midlands, and have recognised many local- and intermediate-scale GFSs. The authors' generalised scale of GFSs is shown in Figure 3, together with adopted response times for groundwater flow through each system.

The scale of GFSs depends on topography and geology, with local, intermediate and regional systems defined by the sizes of sub-subcatchments, subcatchments and catchments respectively of surface drainage systems[11].

[9] Sophocleous (2004) cited in Figure 2 defines a GFS as "a set of groundwater flow paths with common recharge and discharge areas. Flow systems are dependent on the hydrogeologic properties of the soil/rock material, and landscape position. Areas of steep or undulating relief tend to have dominant lo*cal flow systems* (discharging to nearby topographic lows such as ponds and streams). Areas of gently sloping or nearly flat relief tend to have dominant *regional flow systems* (discharging at much greater distances than local systems in major topographic lows or oceans)." A three-dimensional closed groundwater flow system that contains all the flow paths is called the *groundwater basin*.

[10] Hocking, M., Bastick, C., Hardie M., Dyson P. and Lynch, S. (2005). *Understanding Groundwater Flow Systems and processes causing salinity in the Southern Midlands and parts of the Clarence Municipalities.* NRM South and North and National Action Plan for Salinity and Water Quality, Tasmania. Report published by Southern Midlands Council.

[11] "CFEV River Section Catchments" (here called sub-subcatchments), subcatchments and catchments are shown as overlays on www.thelist.tas.gov.au.

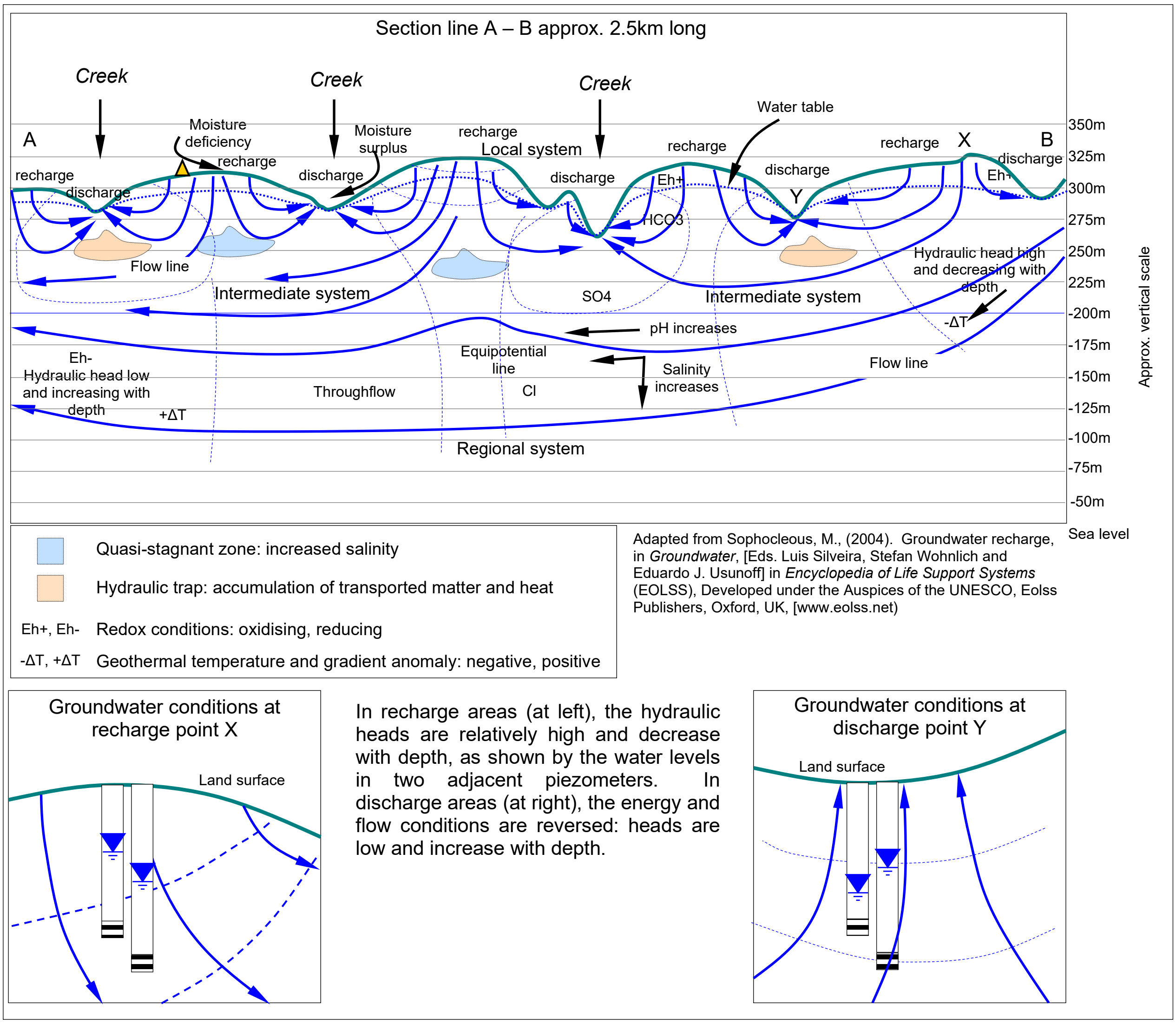


Figure 2. Fundamentals of groundwater hydrology in a gravity-driven groundwater system like that at and near the CRDS. Vertical exaggeration for the top section is about 5.

Accordingly, in the vicinity of the CRDS, the scale of local systems is reduced to nominally less than a kilometre or so, intermediate systems to 1 – 5km, and regional systems to >5km. The response times are similarly reduced in proportion, but these are only conceptual since they depend on bulk rock permeability and transmissivity which may change over orders of magnitude at all scales.

Map 2 in Attachment 2 depicts many surface water sub-subcatchments (all un-named) within the Upper Carlton Subcatchment (96km^2) and Lower Carlton Subcatchment (35km^2). The CRDS is wholly contained within a 205ha sub-subcatchment of the former.

Each sub-subcatchment defines and wholly contains a local GFS. At this scale, shallow groundwater flow is towards watercourses within each sub-subcatchment. Local groundwater flows are therefore in all directions. Intermediate-depth groundwater flows roughly north and northwest, and also southerly, beneath these minor watercourses to larger streams. It is inferred that still deeper regional groundwater flows southwesterly along the axis of the Carlton River valley, eventually to the coast.

Table 1 The geographical extent and response time of local, intermediate and regional scale GFSs

Category	Length of flow (km)	Response time (yr)
Local	<1km <5	<30
Intermediate	1 – 5km 5-50	30-100
Regional	>5km >50	>100

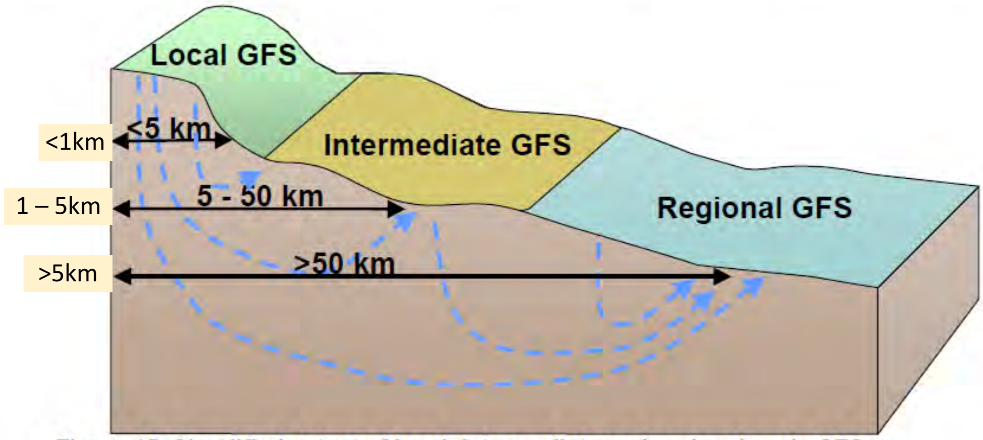


Figure 15 Simplified extent of local, intermediate and regional scale GFSs

Figure 3. [Figure 15 and Table 1 from Hocking *et al* (2005)]. The scales are based on mainland Australian conditions, and are not regarded as appropriate for the geological complexity and moderate relief in the vicinity of the CRDS. Suggested modified scales are superimposed on the Figure and Table. Response times are conceptual only, depending on aquifer permeability and transmissivity at all scales.

2.3 Groundwater monitoring bores at CRDS

Table 1 summarises the groundwater monitoring bores installed since the inception of the CRDS. Some have since been buried by landfill operations, and some at times have had insufficient water for sampling. Some have been abandoned and replaced by others. Approximately a dozen bores are now regularly monitored, including all ten new ones installed in February 2019.

Bore locations and cross section lines A – B and C – D (Cromer, 2016), A – B and C – D (Cromer, 2018), and X – Y (this report) are shown in Map 3 of Attachment 2.

It is noted that BH18A and BH18B are located not in the sub-subcatchment enclosing the CRDS, but in the adjoining one. Technically, therefore, the two bores cannot be upstream monitoring bores for landfill operations. But they are useful nonetheless in indicating background water quality.

2.4 Conceptual hydrogeological models

Five conceptual hydrogeological models have been compiled along various cross sectional lines since 2016 (Cromer 2016, 2018, this report). The first four models have been reviewed in the light of the additional ten monitoring bores installed since February 2019. Minor changes (addition of bores BH10C and BH10D) have been made to one of the 2018 models .

All models are presented in Attachment 3.

Table 1. Groundwater monitoring bores at CRDS.

Bore ID	Date drilled	GDA94 Easting	GDA94 Northing	Bore depth (mbg)	SWL Dec 2018* (mbg)	SWL March 2021** (mbg)	Summary log (depths in m)
BH1	Jul-96	562785	5256339	23.5	6.7	5.5	0-1.5 silty CLAY; 1.5-3.5 SILTSTONE (yellow/white); 3.5-23.5 carbonaceous SHALE (grey, green, black, etc)
BH2	Jul-96	562610	5256950	11.5	0.3	0.3	0-1.5 clayey SAND, sandy CLAY; 1.5-3.5 SANDSTONE (pale yellow/white); 3.5-11.5 carbonaceous SHALE (light grey, grey, green)
BH3	Jul-96	562211	5256447	20.8		6.6	0-1.5 silty SAND 1.5-3.5 silty CLAY; 3.5-7.5 silty SANDSTONE (pale yellow); 7.5-20.8 carbonaceous SHALE (light-dark grey)
BH4	Jul-96	562557	5256605	12.0			0-2.5 silty CLAY; 2.5-7.5 SANDSTONE (yellow); 7.5-10.5 carbonaceous SHALE (light-dark grey; green); 10.0-12 clayey SANDSTONE (grey)
BH5	Oct-01	562563	5256616	2.0			0-0.5 CLAY; 0.5-2 clayey SAND
BH6	Oct-01	562563	5256616	7.0			0-7 sandy CLAY, CLAY, SAND; some sandstone and siltstone clasts
BH7	Oct-01	562368	5256827	10.0	1.0	1.4	0-8 CLAY, sandy CLAY, Clayey SAND; some sandstone, shale and siltstone clasts; 8-10 hard black SHALE clasts
BH8A	Nov-10	562511	5256513	8.4			0-3.5 CLAY and silty CLAY; 3.5-6 sandy SILT; 6-8 silty SAND; 8-8.4 gravel
BH8B	Nov-10	562513	5256511	2.8			0-2.8 CLAY (moist)
BH9A	Nov-10	562486	5256650	6.9			0-4.5 CLAY; 4.5-5 gravelly sandy CLAY; 5-5.5 clayey sandy GRAVEL; 5.5-6.9 sandy GRAVEL;
BH9B	Nov-10	562486	5256650	2.9			0-2.9 CLAY (moist)
BH10A	Nov-11	562537	5256722	7.8	1.1		0-1.2 Silty CLAY; 1.2-c7 sandy CLAY; 7-7.8 SANDSTONE?
BH10B	Nov-11	562537	5256722	3	1.0		0-1.2 silty CLAY; 1.2-3.0 sandy CLAY
BH10C	Feb-19	562525	5256739	12.5		1.5	0-2 clayey SILT; 2-2.5 SAND; 2.4-4 SANDSTONE; 4-7 Carbonaceous SHALE; 7-12.5 SANDSTONE
BH10D	Feb-19	562521	5256744	7.0		1.0	0-1 clayey SILT; 1-2.8 Silty SAND; 2.8-4 SANDSTONE; 4-7 Carbonaceous SHALE
BH11	Not drilled						
BH12A	Jan-13	562440	5256362	21.6	3.3	3.4	0-0.5 SAND; 0.5-c. 3m silty CLAY; c. 3-c. 8 MUDSTONE/SILTSTONE (weathered; cream, grey, black); 8-21.6 silty CLAY grey, green;
BH12B	Jan-13	562440	5256362	5.5	3.5	1.6	0-0.5 SAND; 0.5-5.5 silty CLAY;
BH13	Jan-13	562771	5256209	13.5	7.0		0-13.5 silty CLAY; yellow brown, blue grey, minor black lignite at 11.5; mudstone clasts at 3.2
BH14A	Dec-15	562909	5256461	23	8.6	7.7	0-0.6 silty CLAY and clayey SAND; 0.6-1.4 SILTSTONE, grey1.4-2 clayey SAND ("fault zone"); 2-8 SANDSTONE, grey; 8-8.2 SILTSTONE dark grey; 8.2-23 SANDSTONE grey; mainly HW to 16 subhorizontal
BH14B	Dec-15			8.5			
BH15A	Dec-15	562830	5256570	24.9	14.5	14.6	0-24.9 DOLERITE; grey blue; strongly fractured 4.3-6, 10.3-11.3, 14.8-15.5,
BH15B	Feb-16	562830	5256570	9	11.6	12.8	0-9 DOLERITE; grey blue
BH16	Feb-16	562910	5256467	3.5			0-3.5 SANDSTONE (MW)
BH17	Feb-16	562913	5256504	23			0-23 DOLERITE (Fr)
BH18A	Feb-16	563011	5256605	35	34.6	34.9	0-35 DOLERITE
BH18B	Feb-16			19.5			
BH19	Feb-19	562659	5256278	8.5		3.9	0-1 Silty SAND; 1-2.2 Sandy CLAY; 2.2-3.8 Clayey SAND; 3.8-8.0 Silty CLAY (EW Triassic below 1m)
BH20	Not drilled						
BH21	Feb-19	562626	5256149	30.5		10.9	0-1 Silt; 1-2 Silty CLAY; 2-4.5 Clayey SILT; 18.5 Mudstone; 18.5-22 SANDSTONE; 22-4.5-10 Silty CLAY; 10-22 SANDSTONE; 22-27.5 SHALE;
BH22	Feb-19	562903	5256924	20.0		1.8	0-1 GRAVEL (Fill); 1-20 DOLERITE
BH23	Feb-19	562683	5256889	15.5		3.6	0-1.7 Silty CLAY: 1.7-4 Clayey SILT; 4-6 SANDSTONE; 6-10 SILTSTONE; 10-12 SANDSTONE; 12-15.5 SILTSTONE
BH24A	Feb-19	562381	5256675	12.5		1.6	0-0.3 Clayey SILT; 0.3-1.8 Silty CLAY; 1.8-3 Clayey SAND; 3-5 SANDSTONE; 5-5.5 SILTSTONE; 5.5-6.8 MUDSTONE; 6.8-12.5 SANDSTONE
BH24B	Feb-19	562381	5256674	3.6		2.2	0-0.3 Clayey SILT; 0.3-1.8 Silty CLAY: 1.8-3.6 Clayey SAND
BH25A	Feb-19	562425	5256561	9.5		2.4	0-0.4 Sandy SILT: 0.4-3.8 Clayey SILT; 3.8-5.5 MUDSTONE; 5.5-9.4 SANDSTONE; 9.4-9.5 SILTSTONE
BH25B	Feb-19	562423	5256563	3.5		ND	0-0.4 Sandy SILT; 0.4-3.5 Clayey SILT

Notes
mbg = metres below ground
SWL = standing water level; c. = approximately
* AquaSci (2019); ** AquaSci (2021)
Summary logs of bores drilled Feb 2019 from full logs supplied by Pitt & Sherry.

2.5 Seasonal water table variations

Quarterly water table depths of twelve bores (AquaSci 2019; Appendix D) showed mostly only minor seasonal variations in 2018 (Table 2). Eight of the twelve showed a seasonal variation of less than 0.5m. The average annual range across all twelve bores was 1.1m.

There is a strong direct relationship between depth to groundwater, and its annual variation (Figure 4).

Table 2. Groundwater monitoring bores at CRDS.

	Depths (mbg) to watertable					
	28/03/2018	20/06/2018	11/09/2018	5/12/2018	Average	Range
BH1	6.85	6.85	6.54	6.66	6.73	0.31
BH2	0.09	0.5	0.24	0.3	0.28	0.41
BH7	1.41	1.13	0.92	1	1.12	0.49
BH10A	1.2	1.18	1.01	1.05	1.11	0.19
BH10B	1.18	1.15	0.98	1.02	1.08	0.2
BH12A	3.32	3.34	3.38	3.31	3.34	0.07
BH12B	3.49	3.84	3.52	3.46	3.58	0.38
BH13	7.16	7.08	6.91	7.02	7.04	0.25
BH14A	8.35	7.44	7.47	8.57	7.96	1.13
BH15A	12.6	12.31	14.79	14.53	13.56	2.48
BH15B	10.64	10.03	12.31	11.57	11.14	2.28
BH18A	28.62	32.43	33.39	33.78	32.06	5.16
					Average	1.1

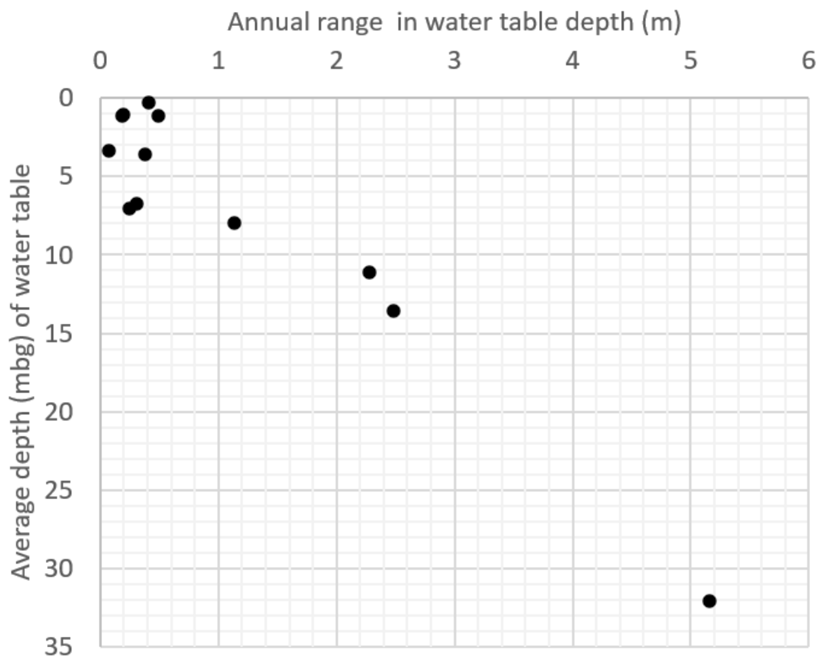


Figure 4 Groundwater depth vs its annual variation in 2018.

2.6 Estimated groundwater travel times

Table 3 characterises regional, intermediate and local groundwater flow systems with respect to rock and material types in the vicinity of the CRDS, assigns permeabilities[12], effective porosities, lengths of flow paths, and estimates rates of groundwater flow and the travel time within each groundwater system.

Estimated travel times for flow in local-scale, intermediate-scale and regional-scale systems are broadly in agreement with Figure 3. Depending mainly on the length of flow path and hydraulic gradient, groundwater travel times from recharge to discharge areas:

- for regional flow systems probably range from centuries to millennia,
- for intermediate flow systems probably range from decades to centuries, and
- for local systems probably range from years to decades.

3 CONCLUSIONS

The following conclusions are made:

- The addition of ten new bores to the groundwater monitoring system at CRDS has required only minor changes to the 2016 and 2018 conceptual hydrogeological models.
- An extra conceptual hydrogeological model has been added to the previous ones to further document inferred groundwater conditions beneath the proposed landfill expansion. Here, local-scale groundwater flow directions are westwards past and beneath monitoring bores BH23 and BH2. BH23 will eventually be buried.

[12] Fractured rock types (sedimentary rocks and dolerite) in Table 2 are assigned a permeability of 0.01m/day. There is limited data available for permeabilities generally in Tasmania. However, values of 0.01m/day have been obtained from testing in fractured rocks in western Tasmania (W. C. Cromer unpublished data). For intergranular materials, permeabilities possibly range from <0.0001m/day to >0.1m/day for clay to silty fine sand respectively. Some clay layers may act as confining layers. An "average" or "bulk" permeability of 0.005m/day seems reasonable. In any case, the flow rates and travel times in Table 2 are intended to be indicative only, and should not be relied upon to reflect actual conditions at any site.

Table 3. Regional, intermediate and local groundwater flow systems with respect to rock and material types in the vicinity of the CRDS, and estimated groundwater flow rates and travel times. The latter are indicative only.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Groundwater system	**Characteristics of flow paths**	**Aquifer**	**Example in the vicinity of CRDS**	**Aquifer permeability (m/day)**	**Head difference (m)**	**Length of flow path (m)**	**Hydraulic gradient**	**Flow volume (m3/day/ m2)**	**Flow volume (L/day/ m2)**	**Effective porosity**	**Flow rate (m/day)**	**Travel time (days; rounded)**	**Travel time (years; rounded)**	**Descriptor for travel time**
Regional	Irregular pathways through intersecting secondary openings	Fractured hard rock	Triassic sedimentary rocks and Jurassic dolerite	0.01	200	10,000	0.02	0.0002	0.2	0.01	0.02	500,000	1,400	"Centuries to Millennia"
Intermediate				0.01	100	5,000	0.02	0.0002	0.2	0.01	0.02	250,000	700	"Decades to Centuries"
Local				0.01	25	500	0.05	0.0005	0.5	0.01	0.05	10,000	30	"Years to Decades"
Local	Mostly laminar flow through intersecting primary openings	Intergranular sediments	Quaternary sediments	0.05	10	500	0.02	0.0010	1.0	0.01	0.10	5,000	10	

IMPORTANT: Inputs to this Table after Column 4 are rough estimates based on limited or no field data. Results should be treated with caution.

Notes for Columns

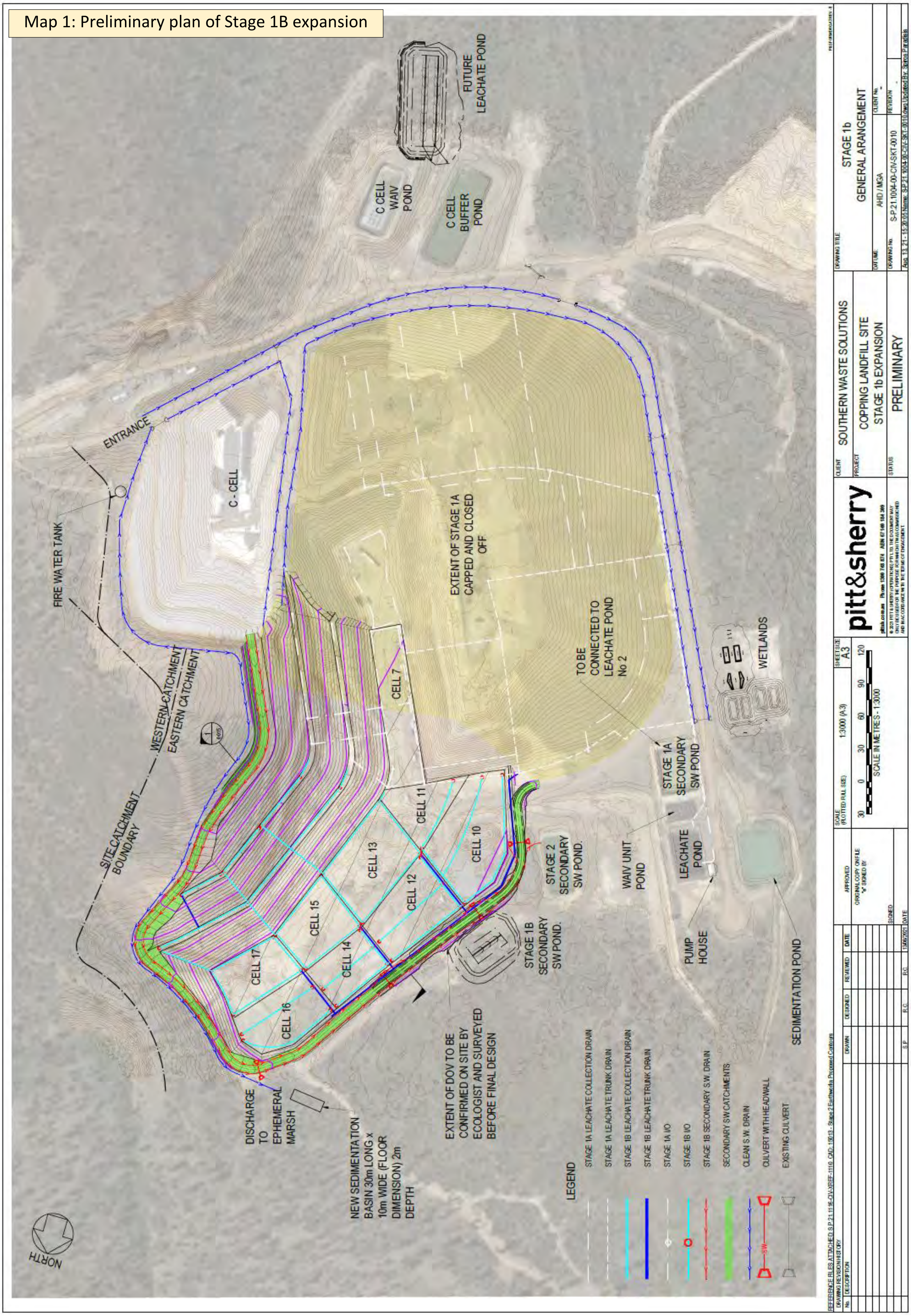
Column 1	Figures 2 and 3 in report; and Attachment 3 for hydrogeological cross sections
Column 2	Schematic, conceptual types of flow paths in the cross sections in Attachment 3
Column 3	Section 2 in report
Column 4	Interpreted geology, interpreted cross sections; logs of bore holes
Column 5	0.01m/day is fairly typical of fractured rock aquifers in Tasmania.
Column 6	Based on Attachment 3 cross sections
Column 7	Based on Attachment 3 cross sections
Column 8	Column 6 divided by Column 7
Column 9	From Darcy's Law: Flow volume = Column 5 x Column 8
Column 10	Column 9 x 1000. The flow through unit area of aquifer.
Column 11	Reasonable estimates
Column 12	Column 9 divided by Column 11
Column 13	Column 7 divided by Column 12
Column 14	Column 13 divided by 365

Attachment 1

(2 pages including this page)

Map 1. Preliminary plan of Stage 1B expansion (Cells 10 – 17). (Source: Pitt & Sherry; 13 Aug 2021)

Map 1: Preliminary plan of Stage 1B expansion



Attachment 2

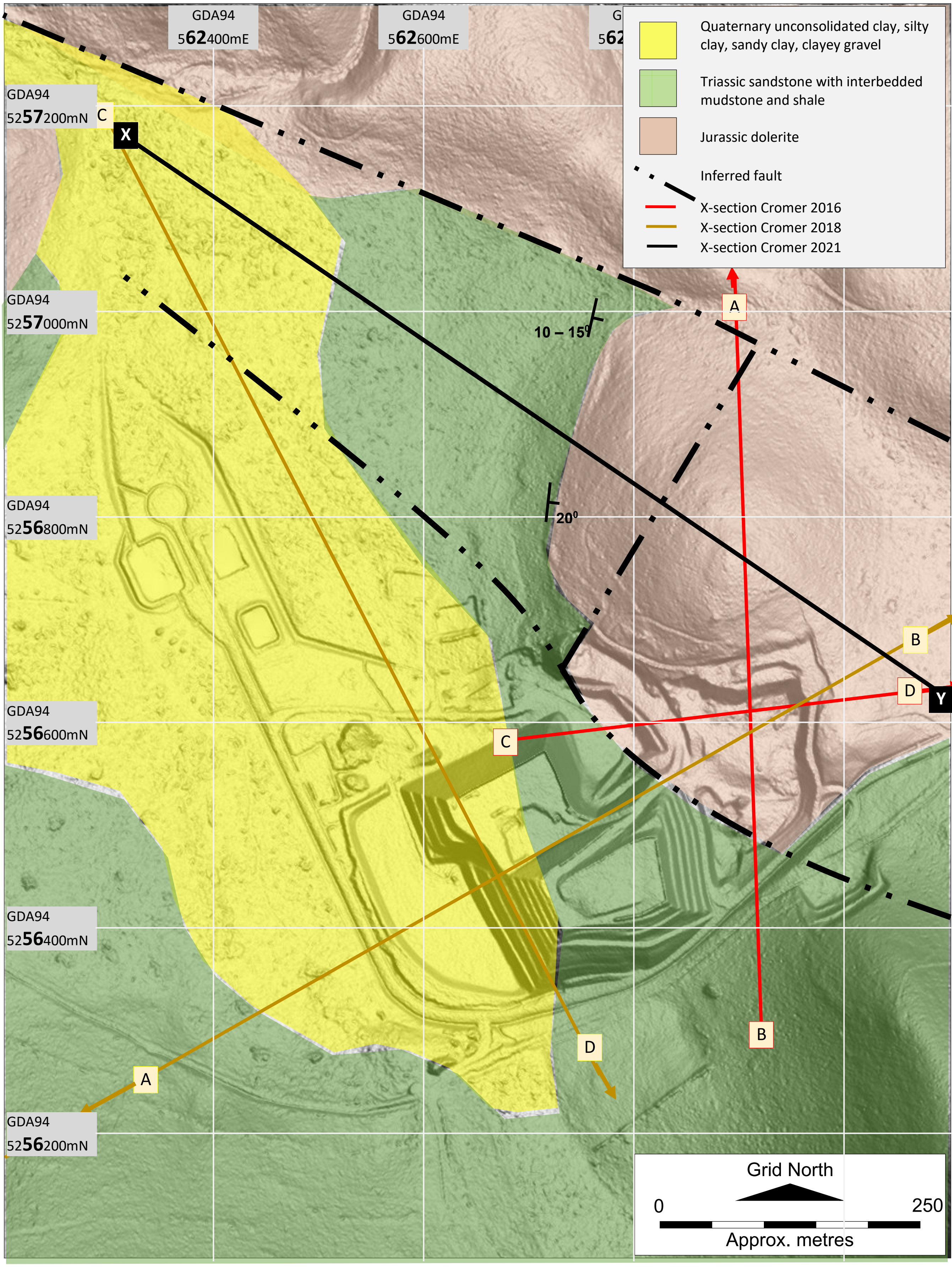
(4 pages including this page)

Map 1. Interpreted geology (Cromer, 2018) and locations of section lines for conceptual hydrogeological models (cross sections) in Attachment 3

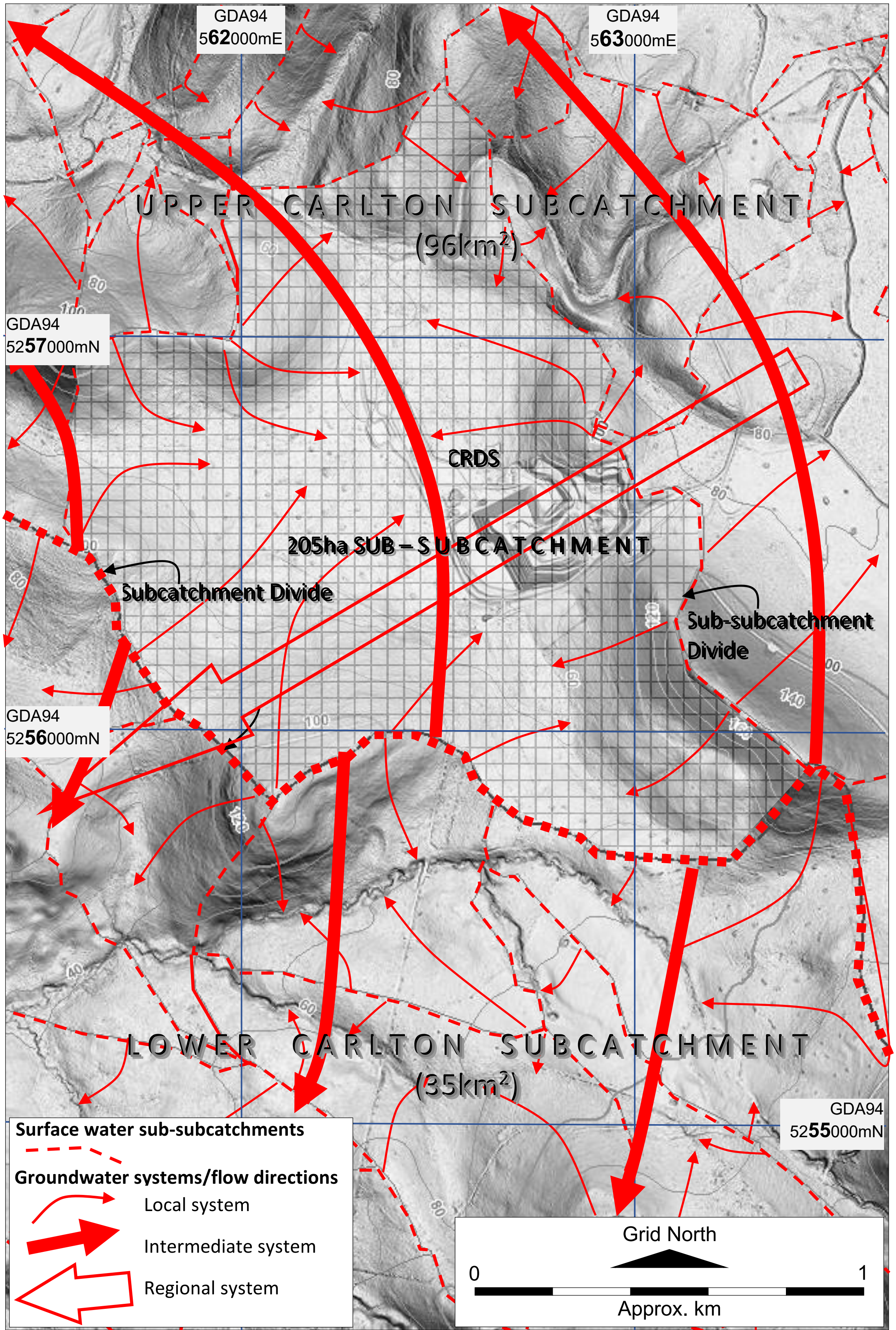
Map 2. Surface water subcatchments and sub-subcatchments, and inferred local- , intermediate- , and regional-scale groundwater flow directions in the vicinity of the CRDS

Map 3. Groundwater monitoring bores at the CRDS and locations of sections lines for conceptual hydrogeological models (cross sections) in Attachment 3

Map 1: Interpreted geology (Cromer 2018) and X-sections for conceptual hydrogeological models



Map 2: Inferred local-, intermediate- and regional-scale groundwater flow directions



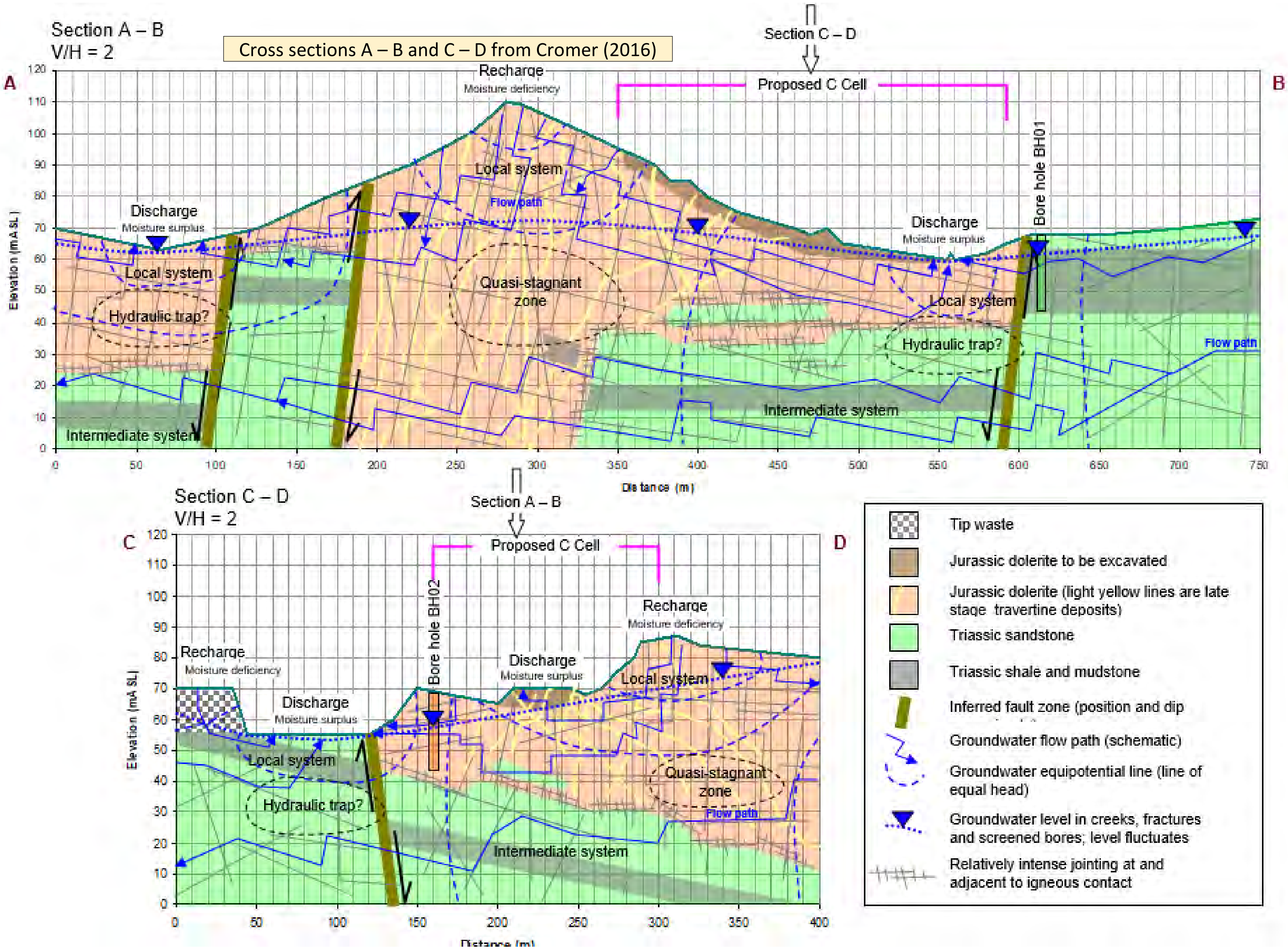
Sub-subcatchments are delineated by thin dashed red lines; subcatchments by thicker dotted red lines. Local, intermediate, and regional groundwater flow directions are inferred from site observations, groundwater levels in bores, and groundwater fundamentals. Local flow (arrowed thin red lines) is in small sub-subcatchments ("CFEV River section subcatchments" on www.thelist.tas.gov.au) in all directions, intermediate flow (arrowed thick red lines) is interpreted as north and northwest within the Upper Carlton Subcatchment (96m²) and south in the Lower Carlton Subcatchment (35km²), and regional flow (large open red arrows) is mostly southwest broadly along the axis of the Carlton River.

Map 3: Groundwater monitoring bores and X-sections for conceptual hydrogeological models

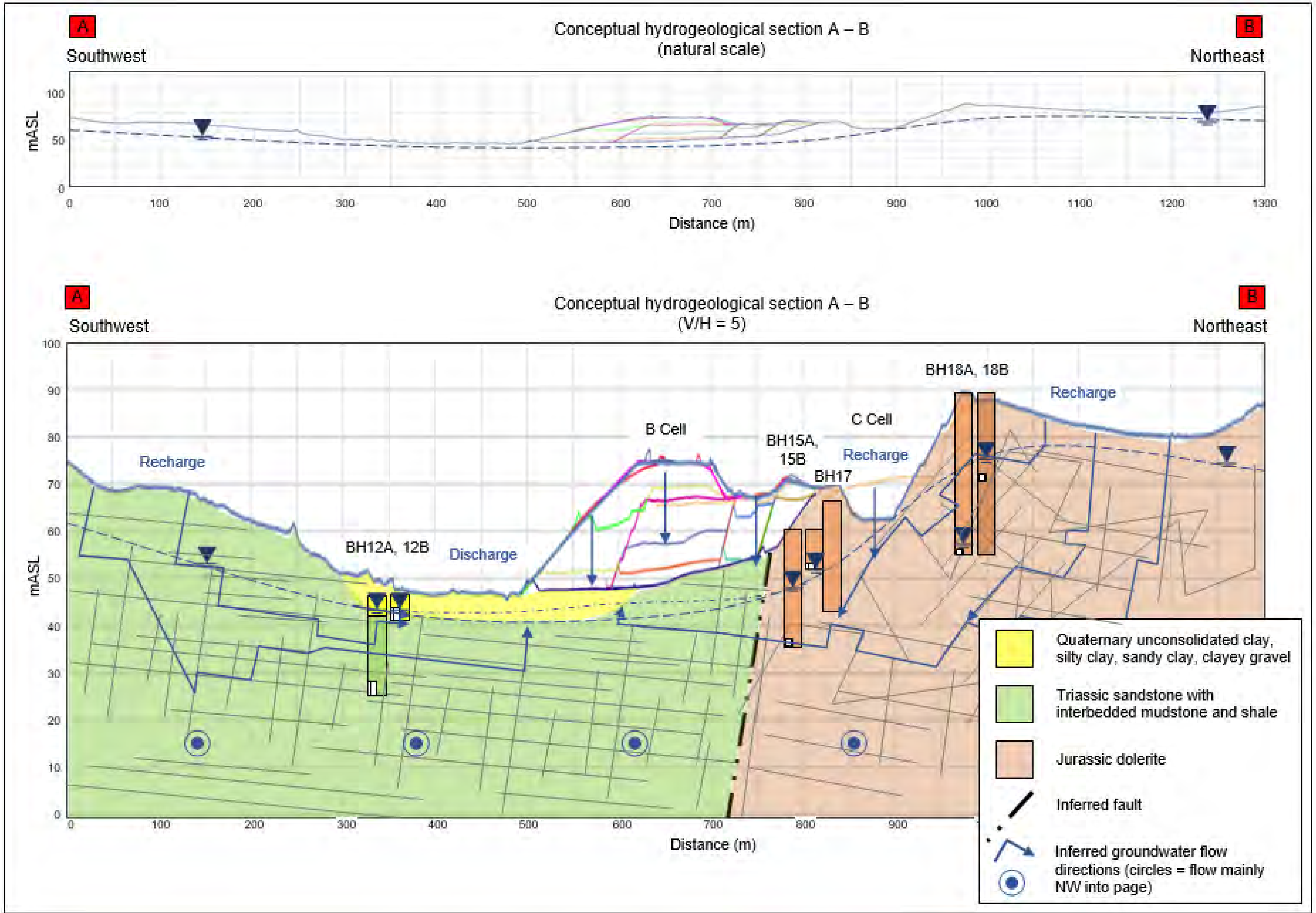
Attachment 3

(5 pages including this page)

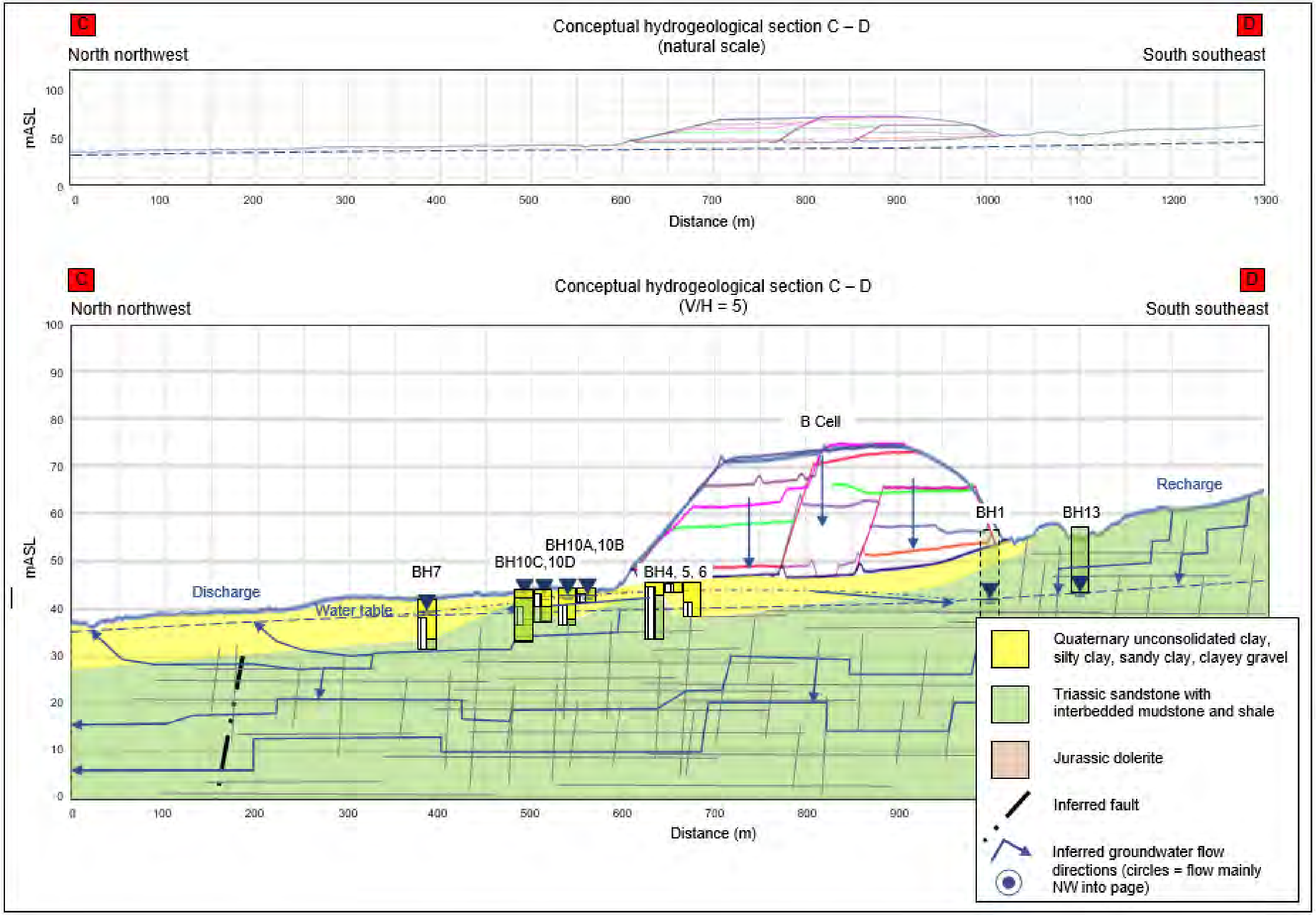
Conceptual hydrogeological cross sections (models)


Cross sections A – B and C – D from Cromer (2016)
Section A – B
V/H = 2
A
B
Section C – D
Proposed C Cell
Recharge
Moisture deficiency
Discharge
Moisture surplus
Local system
Flow path
Quasi-stagnant zone
Hydraulic trap?
Intermediate system
Bore hole BH01
Elevation (m AHD)
Distance (m)
Section C – D
V/H = 2
C
D
Section A – B
Bore hole BH02
Tip waste
Jurassic dolerite to be excavated
Jurassic dolerite (light yellow lines are late stage travertine deposits)
Triassic sandstone
Triassic shale and mudstone
Inferred fault zone (position and dip
Groundwater flow path (schematic)
Groundwater equipotential line (line of equal head)
Groundwater level in creeks, fractures and screened bores; level fluctuates
Relatively intense jointing at and adjacent to igneous contact

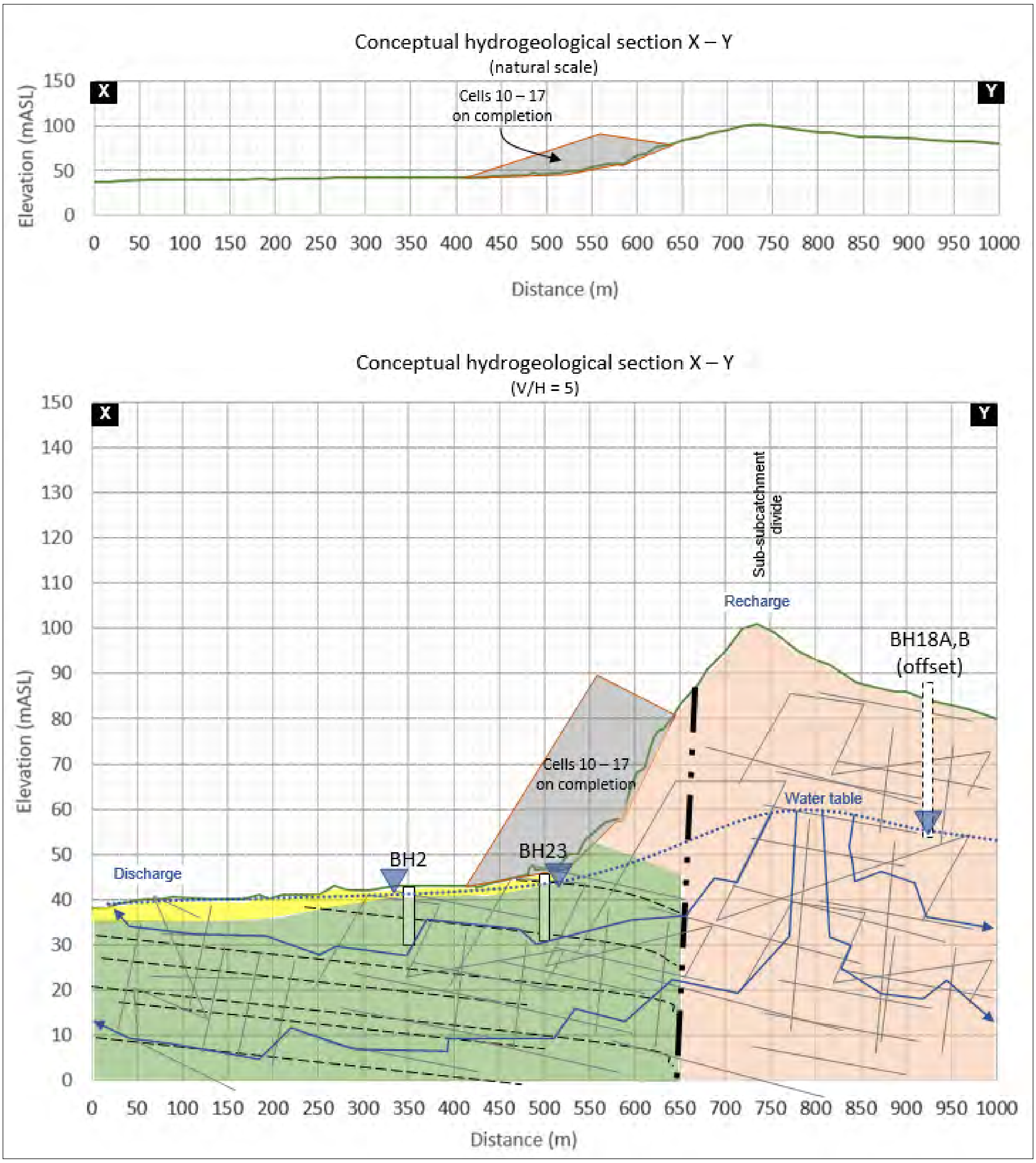
Cross section A – B from Cromer (2018)



Cross section C – D from Cromer (2018)



Cross section X – Y (this report)



AquaSci

Aquatic Ecology - Taxonomy - Water Quality

COPPING RDS SURFACE & GROUNDWATER MONITORING PROGRAM REVIEW, 2019

Prepared for:

Southern Waste Solutions

May 2019

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Cover Photo: Google Earth (Imagery 19 Jan 2018)
Copping Refuse Disposal Site.

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- Rob Casimaty (Pitt & Sherry)
- Mitchell Hedges (Syrinx)

Glossary and Acronyms

ADWG	Australian Drinking Water Guidelines
ANZECC	Australian & New Zealand Environment & Conservation Council
ARMCANZ	Agricultural & Resource Management Council of Australia & New Zealand
BH	Bore Hole (groundwater monitoring bore)
CLBP	C-Cell Leachate Balancing Pond (SS9)
CLBP-SP	C-Cell Leachate Balancing Pond Seepage Pit (SS8)
CMLP	C-Cell Main Leachate Pond (SS10)
CMLP-SP	C-Cell Main Leachate Pond Seepage Pit (SS11)
CRDS	Copping Refuse Disposal Site (=Copping RDS)
CRT	Carlton River Tributary – receiving waters for catchment including landfill (SS6 and SS7)
DPIWE	Department of Primary Industry, Water and Environment
EPA	Environment Protection Authority (Tasmania)
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NWQMS	National Water Quality Management Strategy
LOR	Limit of reporting
m bgl	Metres below ground level
mg/L	Milligrams per litre
µg/L	Micrograms per litre
PLP	Primary Leachate Pond (SS1)
PLP-LUP	Primary Leachate Pond Liner Underdrain Pit (SS4)
PSWP	Primary Stormwater Pond (SS3)
PSWPD	Primary Stormwater Pond Drain (SS5)
SSWP	Secondary Stormwater Pond (SS2)
SHH	Specific Hydraulic Head – standing water level in a bore
SGWMP	Surface and Groundwater Monitoring Program
SS	Surface Site (surface water monitoring site)
Al	Aluminium
As	Arsenic
BTEX	Benzene, Toluene, Ethylbenzene, Xylene = VOC
Cd	Cadmium
Cl	Chloride
COD	Chemical Oxygen Demand
CN	Cyanide (Total)
Cr	Chromium
Cu	Copper
DOC	Dissolved Organic Carbon
EC	Electrical Conductivity
E. coli	*Escherichia coli*
Fe	Iron
Hg	Mercury
K	Potassium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Ni	Nickel

TPH	Total Petroleum Hydrocarbons
OCP	Organochlorine Pesticides = Organochlorines (OC)
OPP	Organophosphate Pesticides = Organophosphates (OP)
Ortho-P	Orthophosphate or Reactive phosphate as P
PAH	Poly-aromatic Hydrocarbons
Pb	Lead
PCB	Poly-chlorinated Biphenyls
Redox	Reduction-Oxidation Potential
S	Sulphur
Se	Selenium
Soluble Metals	Metals present following 0.45 µm filtration and acidification; often used interchangeably with the term “dissolved metals”
TDS	Total Dissolved Solids = NFR (Non-filterable Residue)
Total Metals	All metals present, including those that are sediment bound. In turbid samples levels may be much greater than soluble metal levels. In clean samples, total and soluble (dissolved) levels may be similar.
TSS	Total Suspended Solids = SS (Suspended Solids)
TN	Total Nitrogen as N
TKN	Total Kjeldahl Nitrogen = oxidisable N = organic N + total ammonia
Total Ammonia	Total of all forms – ammonia + ammonium as N
TAN	Total Ammonia Nitrogen as N
TP	Total Phosphorus as P
V	Vanadium
VOC	Volatile Organic Compounds
Zn	Zinc
PFAS	Per & Poly-fluoroalkyl Substances (PFAS)
PFOS	Perfluorooctane sulphonic acid – known toxic PFAS
PFOA	Perfluorooctanoic acid – known toxic PFAS
PFHxS	Perfluorohexane sulphonic acid

1 Introduction

The Copping Refuse Disposal Site (henceforth referred to as the CRDS) is a Category 2 landfill (Tasmanian Landfill Sustainability Guide, DPIPWE, 2004), located near the township of Copping in south eastern Tasmania. Operations commenced in August 2001. A Category C Cell (referred to as the C-Cell) was constructed over 2017/18 and disposal of Level 3 waste commenced on 19 November 2018. The CRDS is managed by the Copping Refuse Disposal Site Joint Authority, trading as Southern Waste Solutions (SWS), a joint authority of the Clarence, Sorell, Kingborough and Tasman Councils. The CRDS Surface and Groundwater Monitoring Program (SGWMP) commenced on 9 October 2001, and has continued uninterrupted over the 17 years since that date. The most recent sampling event was completed by AquaSci in March 2019.

Currently, the CRDS SGWMP incorporates twelve surface water sites and twelve groundwater bores.

The CRDS SGWMP was previously reviewed in 2014 (AquaSci, 2014e). A range of recommendations have been implemented since that time, although others haven’t been to date. In that review it was recommended that program reviews be carried out each three years with the next review due in 2017/2018. The current review is in accordance with that recommendation.

In addition, the following developments and proposed developments within the site since the previous review all necessitate a re-examination of the CRDS SGWMP:

- Construction of the C-Cell and the commencement of waste disposal.
- A proposal for the expansion of the B Cells (10 – 17) to an area to the north of the current Cell 1 – 9 location.
- Issues relating to the program raised in a letter from the EPA (13 April 2018) as a result of the proposed B-Cell expansion.
- Request from the EPA (4 July 2018) to SWS for a “Review of groundwater and surface water monitoring results, with trends of potential contaminants going back as far as possible and including comparison with background results”.
- Recommendations from a *Review of Groundwater Monitoring and Conceptual Groundwater Model* (Cromer, 2018) resulting from the B-Cell expansion proposal (accepted by the EPA, 3 January 2019).
- The proposed construction of a leachate treatment wetland complex adjacent to the Primary Stormwater Pond (PSWP) – Treatment Wetland Pilot Trial (Syrinx, 2018a, b).

The purpose of triennial reviews was to ensure the CRDS SGWMP continued to achieve its goals in regard to modifications to the site and its operations as it has expanded over time.

The current review presents the outcomes of a thorough examination of all aspects of the surface and groundwater monitoring program. Inputs from several sources including Southern Waste Solutions, Pitt & Sherry and Syrinx Environmental as well as recent written reports e.g. Cromer (2018) are incorporated. All previous monitoring reports and reviews are listed in the references section of this report.

2 Review Scope

The scope of this review is summarised below. Groundwater issues are covered in more detail by Pitt & Sherry (2014) and particularly by Cromer (2018). The purpose of this review is to ensure that the water quality monitoring program continues to meet all of the requirements of the Landfill Sustainability Guide (DPIWE, 2004) and EPN 690/1 (DPIWE, 2004), in an efficient and effective manner, both now and into the future. It is intended that the recommendations of this review be discussed with the EPA. It is acknowledged that some amendments to the final program proposed may result from those discussions and a review of EPN 690/1 (including subsequent amendments) currently being undertaken by the EPA (C. Bell, Southern Waste Solutions, *pers. comm.*).

The scope includes:

- Summary of current water quality monitoring program and its development history.
- Program's compatibility with the Landfill Sustainability Guide (LSG) as well as EPN 690/1 (including amendments) and likely requirements of a new EPN to address proposed expansions to the site.
- Re-examination of recommendations from the 2014 program review not implemented to date.
- Parameters tested.
- Sampling frequency.
- Site locations and the rationale for the selection of each, including new sites where required.
- Sampling methodologies.
- Quality assurance.
- Reporting requirements and delivery.
- Recommendations made by Cromer (2018) concerning groundwater monitoring, accepted by the EPA (EPA, 3 Jan 2019).
- Issues concerning the program raised by a letter from the EPA to SWS, dated 13 April 2018.
- Implications for the program from the proposed expansion of the B-Cells (Cell 10 – 17) and the leachate treatment wetland pilot.
- Review of groundwater and surface water monitoring results as requested by the EPA (4 July 2018).
- Other issues including:
  - Site access.
  - Bore maintenance.
  - Water quality guidelines and leachate indicators.
  - Flow estimates.

- Work, health and safety.

- Contingency planning.
- Recommended improvements to the program and their compatibility with the Landfill Sustainability Guide, EPN 690/1 and amendments, as well as proposed expansions to operations at the CRDS.

3 Current Program and History

3.1 Aims

A key aim of the operation of the CRDS is to avoid any adverse impacts on water quality within groundwaters and the surface receiving waters of the tributary of the Carlton River (CRT) nearby. The primary source of contamination from landfills, including the CRDS, is leachate, although other potential sources exist for surface waters *e.g.* sediment.

A comprehensive water quality monitoring program is required to ensure that measures to avoid adverse water quality and ecological impacts are effective, to detect any adverse water quality impacts in a timely manner, and to allow early intervention to minimise and remove contamination should it be detected. Site location, sampling frequency and the suite of parameters tested all assist in the achievement of this goal.

The purposes of the CRDS Surface and Groundwater Monitoring Program (SGWMP) are to:

- Detect any contamination of groundwaters from leachate in a timely manner.
- Detect any contamination of the surface waters of the CRT in a timely manner.
- Identify contamination sources and facilitate the adoption of measures to remove these sources and minimise adverse impacts.
- Provide information relevant to the management of any releases of potentially contaminated waters from the CRDS site to the receiving environment.

It is stressed that the CRDS SGWMP is a monitoring program designed to fulfil the above aims. It is not designed to provide detailed studies of surface or groundwater systems, although a considerable amount of useful background information may be provided in this regard, particularly as some of the data sets collected extend over a period of up to 17 years. The data collected is also limited in that, with some exceptions, most sampling has been performed during ambient conditions and not during more extreme events. In addition, although some of the parameters measured are relatively coarse and not ideal for detailed water quality studies, they are adequate to achieve the aims of the monitoring program. The use of relatively coarse indicators as an initial screen is in accordance with ANZECC/ARMCANZ (2000) guidelines for aquatic ecosystem protection. In many cases, long term trends in the levels of parameters are more important than absolute values. Rises or falls in these parameters relative to historical ranges may indicate a need for further study, especially where they are known to be associated with the presence of leachate.

3.2 History

Copping Refuse Disposal Site (henceforth referred to as the CRDS) operations commenced in August 2001.

Water quality monitoring first commenced on 9 October 2001, and included seven surface sites (SS1 – SS7) and seven groundwater bores (BH1 – BH7). Groundwater sites included four bores constructed in 1996 (BH1 – BH4) as part of the original site Development Proposal and Environmental Management Plan (DPEMP) (Woodward Clyde, 1998) and three new monitoring bores (BH5 – BH7) constructed in 2001, prior to the commencement of the CRDS Surface and Groundwater Monitoring Program (SGWMP). BH3 was found to be damaged during the first sampling event, and removed from the program. This bore was decommissioned in 2013 but its location is still known to AquaSci. The Authority did not consider it necessary to monitor BH2, and it was also removed from the program following the February 2002 sampling event.

The seven surface sites and remaining five groundwater bores were monitored continuously from October 2001 until November 2012, when the active landfill cells expanded to cover the area containing BH4 – BH6 (Central Bore Cluster). These bores were decommissioned in 2013. Several other bores were constructed in 2011, principally to examine groundwater levels below the then proposed Cell 8/9 area. These included BH10A and BH10B, which were incorporated into the water quality monitoring program. The shallow BH10A and BH10B were initially located in bush east of the Secondary Stormwater Pond (SSWP), but with the expansion of the cell 8/9 area and clearance of bush around these bores to cater for debris from the January 2013 bushfires, they are now located at the northern edge of the now filled and capped cells 8 and 9, inside of the current access road.

Due to the expansion of the landfill cells and the construction of a leachate holding pond to the south of the original fence line, two additional surface sites (SS8, SS9) were added to the CRDS SGWMP in May 2013, as well as an additional groundwater bore (BH13). The latter was located upgradient of, but close to, the leachate holding pond. Until March 2019, this pond was designated Leachate Holding Pond 1 (LHP1). A further two bores (BH12A, BH12B) were constructed in January 2013 in the proposed leachate irrigation area, to the south-west of the landfill site. These were included in the monitoring program from May 2013.

The construction of a second leachate holding pond (LHP2) commenced in August 2014 to the east of LHP1. This pond (SS10) and its seepage pit (SS11) were added to the monitoring program from April 2015. From 2015 until 2017, LHP2 was used to store excess B-cell leachate. In 2017, the contents were moved to the Primary Leachate Pond and apart from some rainwater and a little residual leachate, the pond remained empty from mid-2017 until October 2018.

With the approval for the construction of a Category C waste landfill cell (C-Cell) additional groundwater bores were added to the program. As the location of BH2 was known to AquaSci personnel, this bore was examined in 2015 and found still to be operational. It was formally added to the monitoring program in March 2016 as a downgradient monitoring bore. Three other bore clusters were drilled in 2015, BH14A, BH14B, BH15A, BH15B and BH18A & BH18B. BH14A, BH15A, BH15B and BH18A are 50 mm diameter monitoring bores. These were added to the CRDS SGWMP in March 2016. BH14B and BH18B are small 25 mm diameter bores used for hydrological measurements only. These measurements are taken by AquaSci and reported when quarterly monitoring is performed, but are not formally part of the CRDS SGWMP.

As the construction of the C-Cell progressed and also B-Cell 4 adjacent to it, several alterations have been made to the BH14 and BH15 clusters with extensions to both as ground levels were raised in their vicinity. The BH14 cluster was raised by 2.6 m prior to the April 2017 sampling event. BH15 was buried in January 2017 and then extended vertically as the ground level was raised on several occasions by a total of 5.7 m, the last being prior to the September 2018 sampling event. During these construction activities, the collection of water samples from BH14A and BH15A was problematic for a range of reasons including a lack of the vehicle access required for pumping. These issues were resolved by the beginning of 2018 and all bores have been successfully sampled quarterly since March 2018.

With the completion of the C-Cell and the commencement of waste disposal on 19 November 2018, LHP2 now receives C-Cell leachate, the purpose for which it was originally constructed. Consequently, it is now referred to as the C-Cell Main Leachate Pond (CMLP). A WAIV (Wind Aided Intensified Evaporation) unit stands over the northern end of the pond (Appendix E).

In addition, Leachate was removed from LHP1 to the PLP in February 2019. Following cleaning, LHP1 will function as the C-Cell Leachate Balancing Pond, CLBP (C. Bell, SWS, Pers. Comm. March 2019).

Currently, the CRDS SGWMP incorporates twelve surface water sites (SS1 – SS11, SS14) and twelve groundwater bores (BH1, BH7, BH10A, BH10B, BH12A, BH12B, BH13, BH14A, BH15A, BH15B and BH18A). SS1 – SS7, BH1 and BH7 have been monitored continuously since the program commenced in 2001.

With the proposed expansion of the B-cells (Cells 10 – 17), a further 6 groundwater bores were drilled and construsted in February 2019 following recommendations within the Cromer (2018) conceptual groundwater model report (BH10C, BH10D, BH19, BH21, BH22, BH23). Although Cromer (2018) recommended the deepening of one of BH10A or BH10B to intersect Triassic sandstone bedrock, two new bores were drilled some 30 m further from the landfill cells, BH10C and BH10D. An additional 4 bores (BH24A, BH24B, BH25A, BH25B) were also drilled to monitor groundwater in the vicinity of a proposed leachate treatment wetland complex in the vicinity of the PSWP (Syrinx Environmental, 2018a, b).

It is likely water quality monitoring of these will commence in June 2019 once all-weather access is completed. These bores were developed by KMR Drilling on 12 and 19 February 2019 and BH1, BH2, BH14A, BH15A, BH15B (dry) and BH18A on 5 March

2019 (Pitt & Sherry, 2019). Water level measurements were taken from all of these new bores by KMR drilling on 20 February (Pitt & Sherry, 2019), and AquaSci personnel on 19 March 2019 as an addition to quarterly sampling.

As a result of the B-Cell expansion proposal, EPN 690/1 (including amendments) is currently under review by the EPA.

3.3 Monitoring Sites

The surface and groundwater monitoring sites sampled routinely and their locations are detailed in Tables 1 and 2, as well as Figure 1. Site photos for 18/19 March 2019 are presented in Appendix C.

In accordance with EPN 690/1, the twelve surface sites monitor:

- All leachate ponds (SS1, SS9, SS10).
- All leachate pond liner sumps (SS4, SS8, SS11).
- Discharge points from the landfill area (SS5).
- Upstream (SS6) and downstream (SS7) of the discharge point from the landfill to the CRT.
- Stormwater sediment ponds (SS2, SS3, SS14).

Table 1: Surface Water Monitoring Site Locations

Site	Description	Acronym	GPS Co-ordinates (GDA 94)
Surface Sites			
SS1	Primary Leachate Pond.	PLP	S42°50.358' E147°45.827'
SS2	Secondary Stormwater Pond (internal runoff from unused area and capped cells).	SSWP	S42°50.374' E147°45.840'
SS3	Primary Stormwater Pond.	PSWP	S42°50.338' E147°45.766'
SS4	Primary Leachate Pond Liner Underdrain Pit.	PLP-LUP	S42°50.331' E147°45.810'
SS5	Primary Stormwater Pond drain to marsh and the Carlton River Tributary (CRT).	PSWPD	S42°50.217' E147°45.741'
SS6	CRT 310 m upstream of discharge from Stormwater Pond and marsh (marsh creek); approx. 340 m upstream of SS7.	CRT-U/S	S42°50.102' E147°45.885'
SS7	CRT 25m downstream of discharge from Stormwater Pond and marsh (marsh creek).	CRT-D/S	S42°50.089' E147°45.709'
SS8	C-Cell Leachate Balancing Pond Seepage Pit	CLBP-SP	S42°50.581' E147°46.089'
SS9	C-Cell Leachate Balancing Pond (From April 2019) - formerly Leachate Holding Pond 1 (LHP1).	CLBP	S42°50.580' E147°46.104'
SS10	C-Cell Main Leachate Pond.	CMLP	S42°50.589' E147°46.150'
SS11	C-Cell Main Leachate Pond Seepage Pit.	CMLP-SP	S42°50.594' E147°46.147'
SS14	Secondary Stormwater Pond Seepage Pit	SSWP-SP	S42°50.394' E147°45.859'
*SS15	Marsh Creek	Marsh Ck	S42°50.016' E147°45.722'

* Not sampled routinely

The current twelve groundwater bores (Table 2) allow the monitoring of groundwater for the purposes of:

- Establishment of baseline water quality and natural variability over time across the CRDS site (all bores).

- Early detection of leachate contamination of groundwaters from B Cells (BH10A, BH10B).
- Monitoring of spread of potential B-Cell leachate plumes and effectiveness of mitigation measures (BH7, BH2)
- Detection of leachate contamination of groundwaters from the C Cell (BH14A, BH15A and BH15B close; BH2 further downgradient).
- Detection of contamination of groundwaters from leachate ponds (BH1, BH7 and potentially BH13).
- Monitoring of groundwater quality beneath the proposed leachate irrigation area (BH12A, BH12B).
- Establishment of baseline water quality upgradient of the CRDS site (BH13, BH18A).
- Monitoring of groundwater quality downgradient of the CRDS site (BH7, BH2).

The use of reference bores at Copping requires some comment. Water quality between bores is variable due to their different positions within the slow moving groundwater beneath the CRDS site. In some cases they may be located in different aquifers e.g. a perched aquifer rather than deeper groundwater *e.g.* BH15B. Cromer (2018) also noted EC varies with depth in some bores and it is likely that this will be the case for other parameters as materials leach through the soil profile. Hence, the reference bores (BH13 and BH18A) are useful only to the extent that gross changes across the groundwater overall are identified. In the past, for example, at times pH has risen in all bores during a sampling event, although pH was not the same in each bore. EC is elevated in all bores, but to different extents. Due to the slow groundwater movement (both vertically and horizontally), recharge takes months at least to move through the system and changes in water quality from recharge may occur at different times in different bores. In addition, water quality bores such as BH7 situated at the downgradient end of the system seem to be less affected by recharge events than those nearer recharge regions.

Direct comparisons made between bores need to recognise these limitations.

Table 2: Groundwater Monitoring Site Locations

Site	Description	Acronym	GPS Co-ordinates (GDA 94)
Groundwater Bores			
BH1	Leachate Holding Pond Bore: Original 23.5 m reference bore, constructed 1996; SE boundary of original site.	LHPB	S42°50.576' E147°46.099'
BH7	Primary Leachate Pond Bore: 10 m bore, constructed 2001; north-west of Primary Leachate Pond (downgradient).	PLPB	S42°50.315' E147°45.789'
BH10A	Near Cell 9 bore pair - deeper bore: 7.8 m bore, constructed 2011; located east of the Secondary Stormwater Pond downgradient of Cell 9 within active landfill area, at edge of access road.	NCBC-D	S42°50.366' E147°45.911'
BH10B	Near Cell 9 bore pair - shallow bore: 3 m bore, constructed 2011; located beside BH10A.	NCBC-S	S42°50.366' E147°45.911'
BH12A	21.6 m Irrigation Area Bore – Deep: constructed Jan. 2013.	IAB-D	S42°50.567' E147°45.948'
BH12B	5.5 m Irrigation Area Bore – Shallow: constructed Jan. 2013.	IAB-S	S42°50.567' E147°45.948'
BH13	13.5 m Southern Upgradient Reference Bore: constructed May 2013.	SUCB	S42°50.648' E147°46.089'
C Cell Groundwater Bores			
BH2	Downgradient Bore East/C Cell downgradient bore: 11.3 m, constructed July 1996, original survey bore; sampling discontinued in 2002; confirmed operational by AquaSci in 2014, sampling resumed March 2016.	CDB	S42°50.248' E147°45.970'
BH14A	C Cell SW bore – Deep: 24.1 m (50 mm diam.) WQ monitoring bore, SW corner of C Cell; constructed Feb. 2016; ground level raised prior to April 2017 event.	CSWB-D	S42°50.507' E147°46.188'
*BH14B	C Cell SW bore – Shallow: 11.3 m (25 mm diam.), same hole as BH14A; constructed Feb. 2016; hydrostatic parameters only.	CSWB-S	S42°50.507' E147°46.188'
BH15A	C Cell NW bore – Deep: 29.7 m (50 mm diam.) WQ monitoring bore, NW corner of proposed C Cell; constructed Feb. 2016; ground level raised on 3 occasions to Sept. 2018.	CNWB-D	S42°52.542' E147°46.143'
BH15B	C Cell NW bore – Shallow: 13.6 m (50 mm diam.) WQ monitoring bore, NW corner of C Cell; constructed Feb. 2016; ground level raised as for BH15A.	CNWB-S	S42°52.542' E147°46.143'
BH18A	C Cell Upgradient Reference Bore – Deep: 34.7 m (50 mm diam.) WQ monitoring bore, E of proposed C Cell; constructed Feb. 2016.	CURB-D	S42°50.430' E147°46.258'
*BH18B	C Cell Upgradient Reference Bore – Shallow: 19.3 m (25 mm diam.), same hole as BH18A; constructed Feb. 2016; hydrostatic parameters only.	CURB-S	S42°50.430' E147°46.258'

* Monitoring of hydrostatic parameters only; not part of CRDS SGWMP

Figure 1: Copping RDS Surface & Groundwater Monitoring Sites

3.4 Water Quality Parameters

The water quality parameters currently measured (December 2018) are summarised in Table 3.

Table 3: CRDS water quality monitoring parameters

Coppping RDS Surface Sites	
Parameter	**Units**
Group 1 (Quarterly)	
*Water temperature	°C
*pH	
*Electrical Conductivity (EC)	µS/cm
Total Dissolved solids (TDS)	mg/L
*Redox Potential	mV calomel
Chemical Oxygen Demand (COD)	mg/L
Total Suspended Solids (TSS)	mg/L
Alkalinity as $CaCO_3$	mg $CaCO_3$ / L
Total Nitrogen (TN)	mg N/L
Total Kjeldahl Nitrogen (TKN)	mg N/L
Ammonia (TAN)	mg N/L
Nitrate (NO_3)	mg N/L
Nitrite (NO_2)	mg N/L
Total Phosphorous (TP)	mg P/L
Orthophosphate (reactive) (Ortho-P)	mg P/L
Dissolved Organic Carbon (DOC)	mg/L
Total Cyanide (TCN)	mg CN/L
E. coli	orgs/100 mL
Group 2 (Six-monthly) + Group 4 (Annual)	
Metals-Total	
Same suite as soluble	mg/L
Metals-Soluble	
Aluminium (Al)	mg/L
Arsenic (As)	mg/L
Cadmium (Cd)	mg/L
Chromium (Cr)	mg/L
Copper Cu)	mg/L
Iron (Fe)	mg/L
Lead (Pb)	mg/L
Manganese (Mn)	mg/L
Mercury (Hg)	mg/L
Nickel (Ni)	mg/L
Selenium (Se)	mg/L
Vanadium (V)	mg/L
Zinc (Zn)	mg/L
Group 3 (Six-monthly)	
Major Ions	
Chloride (Cl)	mg/L
Sulphur (S)	mg SO_4/L
Magnesium (Mg)	mg/L
Potassium (K)	mg/L
Sodium (Na)	mg/L
Calcium (Ca)	mg/L
Group 4 (Annually)	
Organics	
Total Petroleum Hydrocarbons (TPH)	mg/L
BTEX (VOC)	mg/L
Polycyclic Aromatic Hydrocarbons (PAH)	mg/L
Organophosphate pesticides (OPP)	mg/L
Organochlorine pesticides (OCP)	mg/L
Polychlorinated Biphenyls (PCB)	mg/L
Per & Poly-fluoroalkyl Substances (PFAS)	µg/L

**Field Measurement*
V included Oct 2014; PFAS included Dec 2017
Total and soluble metals from Dec 2018

Copping RDS Groundwater Bores	
Parameter	**Units**
Hydrostatic	
Bore depth	m bgl
Groundwater depth	m bgl
Static hydraulic head	m
Group 1 (Quarterly)	
*Water temperature	°C
*pH	
*Electrical Conductivity (EC)	µS/cm
Total Dissolved solids (TDS)	mg/L
*Redox Potential	mV calomel
Chemical Oxygen Demand (COD)	mg/L
N/A	
N/A	mg $CaCO_3$ / L
Total Nitrogen (TN)	mg N/L
Total Kjeldahl Nitrogen (TKN)	mg N/L
Ammonia (TAN)	mg N/L
Nitrate (NO_3)	mg N/L
Nitrite (NO_2)	mg N/L
Total Phosphorous (TP)	mg P/L
Orthophosphate (reactive) (Ortho-P)	mg P/L
Dissolved Organic Carbon (DOC)	mg/L
Total Cyanide (TCN)	mg CN/L
N/A	
Group 2 (Six-monthly) + Group 4 (Annual)	
Metals-total	
N/A	
Metals-Soluble	
Aluminium (Al)	mg/L
Arsenic (As)	mg/L
Cadmium (Cd)	mg/L
Chromium (Cr)	mg/L
Copper Cu)	mg/L
Iron (Fe)	mg/L
Lead (Pb)	mg/L
Manganese (Mn)	mg/L
Mercury (Hg)	mg/L
Nickel (Ni)	mg/L
Selenium (Se)	mg/L
Vanadium (V)	mg/L
Zinc (Zn)	mg/L
Group 3 (Six-monthly)	
Major Ions	
Chloride (Cl)	mg /L
Sulphur (S)	mg SO_4/L
Magnesium (Mg)	mg/L
Potassium (K)	mg/L
Sodium (Na)	mg/L
Calcium (Ca)	mg/L
Group 4 (Annually)	
Organics	
Total Petroleum Hydrocarbons (TPH)	mg/L
BTEX (VOC)	mg/L
Polycyclic Aromatic Hydrocarbons (PAH)	mg/L
Organophosphate pesticides (OPP)	mg/L
Organochlorine pesticides (OCP)	mg/L
Polychlorinated Biphenyls (PCB)	mg/L
Per & Poly-fluoroalkyl Substances (PFAS)	µg/L

**Field Measurement*
V included Oct 2014; PFAS included Dec 2017
Soluble metals rather than total from Dec 2018

The water quality parameters currently measured are in accordance with the full list specified in Tables 4.4 and 4.5 of the LSG and Tables 1 and 2 of EPN 690/1. Since the previous program review (AquaSci, 2014; Pitt & Sherry, 2014), the following amendments have been made to the parameters measured:

- At the request of the EPA, vanadium was added to the metals analysed in October 2014.
- At the direction of SWS, PFAS were added to the group 4 parameters in December 2017, and are now completed annually during each June six-monthly event.
- December 2018:
  - Soluble as well as total metal levels were determined for all surface sites.
  - Soluble metal levels were analysed for all groundwaters sampled rather than total metal levels.

Two sets of sites are routinely sampled, surface sites and groundwater bores (Table 1). The parameters tested are grouped based on the nature of their influence on aquatic values and ecosystems, as is the sampling frequency for each group.

Group 1 (sampled quarterly) contains a range of fundamental physico-chemical parameters that widely affect ecological systems but apart from CN, generally are not in themselves toxic unless present in very high levels. They include basic parameters such as temperature, pH, salinity, nutrients, organic carbon, alkalinity and redox potential. Many of these may, however, affect the ecological impacts of other parameters e.g. pH affects metal solubility and hardness influences metal toxicity. These are examples of parameters referred to as "physico-chemical stressors" within the ANZECC/ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality. *Escherichia coli* (*E. coli*) is measured as an indicator of faecal contamination, and hence the potential risk from the presence of pathogenic micro-organisms.

CRDS leachate typically shows high nutrient, DOC, alkalinity and COD levels, and hence its presence may cause detectable changes in the levels of these parameters if present in receiving waters and groundwaters.

Group 2 (sampled six-monthly) contains a range of metals, some of which may be toxic if present in sufficient quantities. Although most are naturally derived from soil minerals, and may be common in natural systems (e.g. iron, aluminium and manganese), they may also be derived from landfill waste and hence present in leachate at elevated levels. Apart from the potential for toxicity, some are monitored because they may be indicative of leachate contamination of surface and groundwater systems in the vicinity of the landfill e.g. arsenic. Waters contaminated with leachate may travel off site and if present at concentrations likely to be toxic, potentially adversely affect surrounding ecosystems. Some metals may also become concentrated in the tissues of aquatic fauna (bioaccumulation). Metals are included in parameters referred to as "toxicants" within the ANZECC/ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality.

Group 3 (sampled six-monthly) contains most of the more common cations and anions generally found in natural waters, often referred to as major ions. Elevated levels or disturbances of the ratio in which the major ions are usually present may indicate the presence of leachate. They also contribute to factors such as hardness and hence may affect the toxicity of any metals present. Chloride is a conservative ion that may be used to trace leachate plumes in groundwater in some cases, although this may not be the case for the CRDS since the groundwaters are already saline.

Group 4 (sampled annually) contains several less common metals and a range of organic compounds such as hydrocarbons and pesticides that may be detected within the leachate of some landfills and adversely affect aquatic ecosystems if present above key levels. Some of these may be toxic and a small number may bioaccumulate within organisms and biomagnify through food chains. Apart for trace levels of oils/greases and rarely naphthalene, the only organics detected to date in CRDS leachate are PFAS of which, only PFOS levels exceed interim HEPA (2018) guidelines (AquaSci, 2018d).

In the case of metals, the LSG and EPN 690/1 do not specify whether total and/or dissolved metal levels should be determined, apart from iron where both are required for surface waters. In the past, for the CRDS surface sites where there is a long historical record of total metal levels, any increase occurring relative to historical levels would trigger the measurement of soluble metal levels. Hence, until September 2018, total metal levels were determined routinely as a screen, although soluble levels were also determined in some cases where further investigation has been required.

At the commencement of the program, the waters of the bores sampled were of low turbidity, and total metal levels were deemed an appropriate, if conservative measure of the level of metals potentially able to move with groundwater flows, as well as the presence of potential contamination from landfill activities. However, with the construction of new groundwater bores following 2011 as the site expanded, groundwater samples with high and variable turbidity have been encountered. In the case of these, total metal levels are predominantly determined by the amount of sediment present, rather than the level of metals present in the mobile phase or contamination levels from leachate. The previous program review (AquaSci, 2014) noted a re-examination of the use of total metals for groundwaters was warranted, and Cromer (2018) also raised this issue.

Consequently, during the December 2018 annual sampling event, both total and soluble metal levels were determined for surface waters and soluble metal levels for groundwaters. It is proposed that this continue into the future.

3.5 Sampling Frequency

Over the first three years of the monitoring program (2001 – 2004 inclusive), sampling was performed quarterly in accordance with the LSG and EPN 690/1. Group 1 parameters were sampled every quarter, Group 2 and 3 parameters each 6 months and Group 4 parameters annually. The LSG states that sampling should be completed quarterly for at least the first three years. After that, sampling frequency and the parameters tested may be varied if it can be demonstrated that the environmental risk posed is low and the changes are approved by the regulatory authority.

Following the 2001 – 2004 period of monitoring, an application was submitted to vary the frequency of sampling to six monthly based on the low environmental risk demonstrated by the data collected. An amendment to the EPN was issued on 4 February 2005 altering the required sampling frequency to six monthly (Environment Division, 2005). The list of parameters tested was not altered.

Due to the expansion of the CRDS footprint and potentially increased environmental risk, quarterly sampling was readopted in 2013. As was the case initially, Group 1 parameters are sampled quarterly, Groups 2 and 3 six-monthly and Group 4 annually, with the exception of arsenic, which has been sampled six-monthly due to elevated levels within leachate. Group 4 parameters are sampled as part of the December annual event, except for PFAS, which may be sampled at other times.

3.6 Reporting

Monitoring reports have been produced for each sampling event since October 2001, and detailed historical data matrices and time trended graphs have been maintained for all relevant parameters at all sites since that time. These are provided to Southern Waste Solutions (SWS) and the EPA electronically each quarter. From January 2019, all graphs have been provided in pdf format due to incompatibility issues between the various versions of Excel used by AquaSci, SWS and the EPA. Data matrices are provided in Excel format.

3.7 Flow Patterns

Information concerning surface water flow patterns has been collected over the period of monitoring from 2001 – 2018. This has covered a variety of rainfall regimes from wet years to drought.

When the CRDS commenced operations in 2001, the site was surrounded by an external stormwater drain which captured and diverted all off site stormwater to the Primary Stormwater Pond (SS3), a sediment settling pond. Runoff then flowed to the CRT via the PSWP drain (SS5) and a natural marsh. Internal stormwater, including that from the then unused cells, was diverted to the Secondary Stormwater Pond (SS2) to prevent any discharge to the receiving environment. With the expansion of the site, the stormwater drainage system has become more complex.

Natural surface drainage is shown in Figure 2. Surface runoff flows into the valley containing the CRDS from a range of sources to the east, south and west, through a marsh to the CRT, a small ephemeral stream flowing to the Carlton River. The marsh is also a natural saline groundwater discharge area.

With surface stormwater flows from within the landfill footprint captured within the Secondary Stormwater Pond (SSWP – SS2), any stormwater potentially contaminated by leachate has been contained on site. From late-2003 to mid-2007, the pond also received runoff from leachate irrigated onto the vegetated, unused landfill cells within the landfill footprint (ALS, 2010). This was discontinued in 2007, initially as a result of drought at that time, and later as a result of the presence of arsenic within the leachate.

Figure 2: Primary surface water flows in the vicinity of the CRDS

The exception to this was a controlled release of part of the contents of the SSWP to the PSWP drain following flash flooding on 9 April 2013 (Ecosure, 2013c), and an overflow event from the same pond during rainfall on 1 August 2014 (AquaSci, 2014c). The April 2014 discharge occurred in accordance with an EPA Emergency Authorization (EPA, 19 April 2013) under Section 34 of the Environmental Management and Pollution Control Act 1984. The leachate concentration within the pond was very low at that time, and the rate of release was controlled to ensure adequate dilution within the CRT and to minimise any impact on fauna within the marsh. Water quality monitoring was performed each day of the release (Ecosure, 2013d). The overflow on 1 August was limited in duration and monitoring indicated that sufficient dilution existed to mitigate any adverse impacts on the waters of the CRT (AquaSci, 2014c).

From 2013, it is likely that some stormwater runoff from the cleared area to the north of B cells has flowed directly to the marsh. This area was used for storage of debris from Dunalley, following the bushfires in January 2013. No waste is stored in that area currently, and it is remote from the active landfill cells and hence, leachate contamination. However, with the proposal to develop further B Cells in a section of that area (Pitt and Sherry, 2018) and a leachate treatment wetland complex in the vicinity of the PSWP, modifications to the stormwater system are likely.

Stormwater flows from the perimeter drains is captured by the Primary Stormwater Pond (PSWP) and/or the Primary Stormwater Pond Drain (PSWPD). Sediment is trapped in the pond and also within the drain, where flows have generally been low. A thick belt of the Common Spikerush *Eleocharis acuta* in the centre of the drain enhances this effect and also appears to reduce nutrient levels within flows passing through the drain. Further sediment is trapped within the marsh between the drain and the CRT, and little sediment appears to reach the CRT under normal rainfall conditions. Prior to the bushfires of January 2013, this area was thickly vegetated.

Inputs to the CRT also include runoff from the plantation area to the west of the landfill site. An additional drainage channel exists running parallel to and west of the PSWP drain to direct this drainage, and that from the valley to the south, around the PSWP to the marsh. Flows from this area enter the marsh principally at the downstream (northern) end of the PSWP drain, but also at various points along it. Groundwater discharges also occur within the marsh and to the drain when groundwater levels are high, as has been the case following the January 2013 bushfires. These inputs have been somewhat saline (circa 2,000 – 3, 500 µS/cm EC), since 2013. Vegetation has recovered naturally to some extent, but remains less well developed than prior to the 2013 bushfires.

Groundwater flow pathways are less understood, but information has been provided by Woodward-Clyde (1998), GHD (2010), Pitt & Sherry (2014), and more recently in detail by Cromer (2018). For detailed information, the latter report should be consulted as it provides the most recent and useful information. It also presents particularly useful profile views of the CRDS site showing the vertical location of existing bores within the various sediments and rock types (Attachment 8 of Cromer, 2018).

In summary, the site is underlain by Triassic sandstone and carbonaceous shales and mudstones. The higher ground consists of Jurassic dolerite and Triassic rocks. The lower parts of the valley are overlain by a thin, 2 - 3 m (but up to 8m) layer of sandy-clay Quaternary alluvial deposits, blending into very weathered siltstone, mudstone and sandstone bedrock (Pitt & Sherry, 2014; Cromer, 2018).

In the previous review (AquaSci, 2014c), it was concluded that a deeper aquifer on weathered sandstone appeared to flow below the landfill site to the marsh and the CRT from the higher areas surrounding it to the east, west and especially through the valley to the south (Woodward-Clyde 1998; Pitt & Sherry 2014). A shallower, unconfined aquifer on lignite appeared to be present above the deeper sandstone aquifer and, in places, shallow perched aquifers occur above this. Cromer (2018) noted that "At the scale of the RDS" there is only one aquifer, with temporary local perched local aquifers after rainfall. However, Table 6 of the report notes that BH4 and BH6 (Central Bore Cluster) were never monitored and that it could not be determined whether they were unconfined or confined. It appears that the relevant water quality monitoring data was not provided to the author. In fact BH4 and BH6 were monitored on 27 occasions from the commencement of monitoring in October 2001 until December 2011, although the results from the latter sampling event were anomalous due to damage as the landfill cells were expanded close to them. BH4, BH5 and BH6 were decommissioned in 2013 and are now buried under the landfill cells.

BH4 (11 m) was located within fractured sandstone bedrock and highly productive. It was one of the original 100 mm diameter survey bores (Woodward Clyde, 1998) along with BH1, BH2 and BH3. BH6 (7 m) was located within the overlying Quaternary sediments, with recharge slow and somewhat turbid. Water quality within the two bores consistently differed, indicating the presence of two essentially permanent aquifers at that point. Whether these were connected was not determined. Water quality BH7 further downgradient from these two bores showed features of both aquifers but was more similar to that of BH4 indicating mixing and only one aquifer at that site.

This does not change the overall conclusion made by Cromer (2018) that on the scale of the RDS, there is only one unconfined major aquifer, but it can be added that there appeared to be a shallower perched aquifer present at least from 2001 – 2011 below what are now the capped landfill cells. Whether this extends as far as BH10A and BH10B is unknown since these bores aren't deep enough to intersect the underlying fractured sandstone. The recently constructed BH10C and BH10D should reveal whether this is the case or not, as they have been constructed at similar depths to BH4 and BH6.

Monitoring bores are located in three sediment types, shallow silty and sandy clay Quaternary sediments (BH10A, BH10B, BH12B, the decommissioned BH5 and BH6), deeper fractured sandstone bedrock (BH13, BH1, BH12B, BH7 and the decommissioned BH4) and Jurassic dolerite on the eastern side of the site (BH14A, BH14B, BH15A, BH15B, BH18A, BH18B).

Groundwater flows appear to be slow, except in fractured sandstone and in some cases weathered dolerite (BH15A). Monitoring has shown that all groundwater is saline (EC 2,200 – 8,570 µS/cm), although EC is variable across the site. Cromer (2018) notes that this is a consequence of low recharge, long residence times in the aquifer and slow rates of groundwater movement. He also notes that in relatively unweathered dolerite and sandstone, groundwater is in fractured hard rock whilst it is intergranular in the valley floor alluvial sediments. The marsh appears to be a natural groundwater discharge area, with flows of both surface and groundwaters reaching the CRT via a small ephemeral creek (marsh creek). Groundwater also appears to enter the CRT directly upstream of SS7, but downstream of the SS6 reference site. Cromer (2018) shows groundwater flows clearly in the figure on p34 of his report in terms of both movement and geology.

3.8 Flows

During each sampling event, water levels are recorded for each pond and photographed. The presence of flows and depths within the CRT, the PSWP drain and over the PSWP spillway are also recorded. All sites are photographed to show water levels and flows at each sampling event and have been retained in a photographic database by AquaSci. These records extend back to the initial sampling event in October 2001.

3.9 Leachate Characterisation

Leachate from the landfill B-Cells is stored in the Primary Leachate Pond (PLP - SS1). Water quality data for leachate within the PLP on 4 December 2018 is presented in Table 4 below (organics omitted as not detected apart from greases at trace levels).

Table 4: Water Quality Data, SS1, December 2018

SS1 December 2018 Water Quality Data									
*Water temperature	17.1	°C		Total	Soluble				
*pH	7.9		Aluminium as Al	0.82	0.03	mg/L	Chloride as Cl	3,000	mg/L
*Conductivity	13,220	µS/cm	Arsenic as As	0.08	0.56	mg/L	Sulphur as SO_4	78	mg/L
TDS	6,900	mg/L	Cadmium as Cd	<0.0002	<0.0002	mg/L	Magnesium as Mg	330	mg/L
*Redox Potential	-83.6	mV	Chromium as Cr	0.068	0.044	mg/L	Potassium as K	160	mg/L
COD	1,200	mg/L	Copper as Cu	<0.001	<0.001	mg/L	Sodium as Na	2,200	mg/L
Total Suspended Solids (TSS)	76	mg/L	Iron as Fe	2.5	1.6	mg/L	Calcium as Ca	96	mg/L
Alkalinity as $CaCO_3$	3,000	mg/L	Lead as Pb	<0.001	<0.001	mg/L			
Total Nitrogen as N	420	mg/L	Manganese as Mn	0.62	0.4	mg/L			
Total Kjeldahl Nitrogen as N	420	mg/L	Mercury as Hg	0.18	<0.0001	mg/L			
Ammonia as N	370	mg/L	Nickel as Ni	0.039	0.12	mg/L			
Nitrate as N	<0.05	mg/L	Selenium as Se	0.049	0.003	mg/L			
Nitrite as N	<0.05	mg/L	Vanadium as V	<0.0001	0.032	mg/L			
Total Phosphorous as P	5.0	mg/L	Zinc as Zn	0.005	0.01	mg/L			
Orthophosphate (reactive) as P	1.5	mg/L							
DOC	380	mg/L							
Total CN as CN	0.017	mg/L							
E. coli	880	org/100mL							

Since the commencement of operations in 2001, the Copping RDS B-Cells leachate in the PLP has developed in three phases. Initially, there was a gradual increase in the levels of most parameters from 2001 till late 2005, followed by a rapid rise over 2006 and 2007 as a result of the 2006 – 2008 drought. The levels of a range of parameters have been stable since 2007, although somewhat variable depending on rainfall and other factors. These include EC (Figure 3), TDS, major ions Cr and Ni.

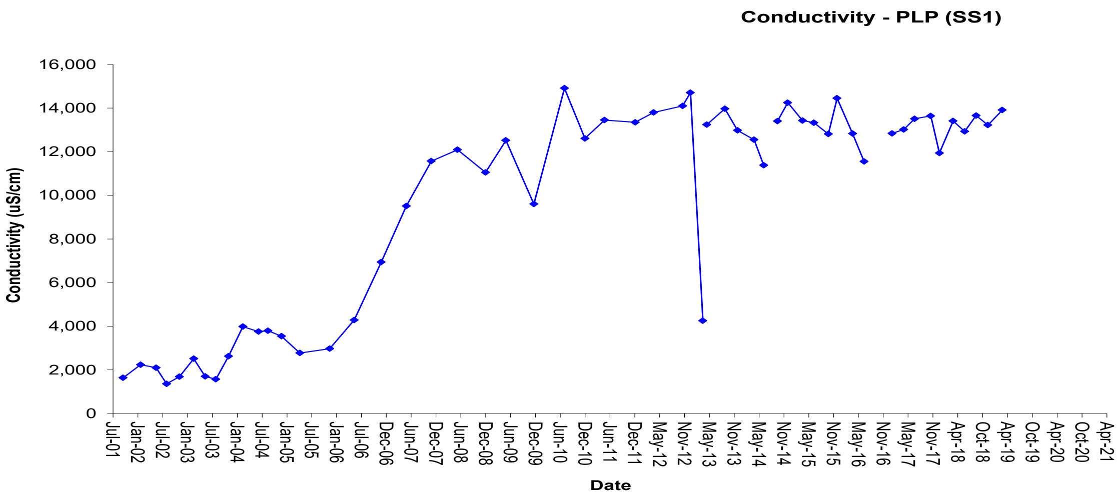

Figure 3: EC in the PLP (SS1) from 2001 - 2019

Other parameter levels have been relatively stable since 2011 including TP, Ortho-P, COD, TN (Figure 4), TKN, TAN, DOC, Zn and Pb.

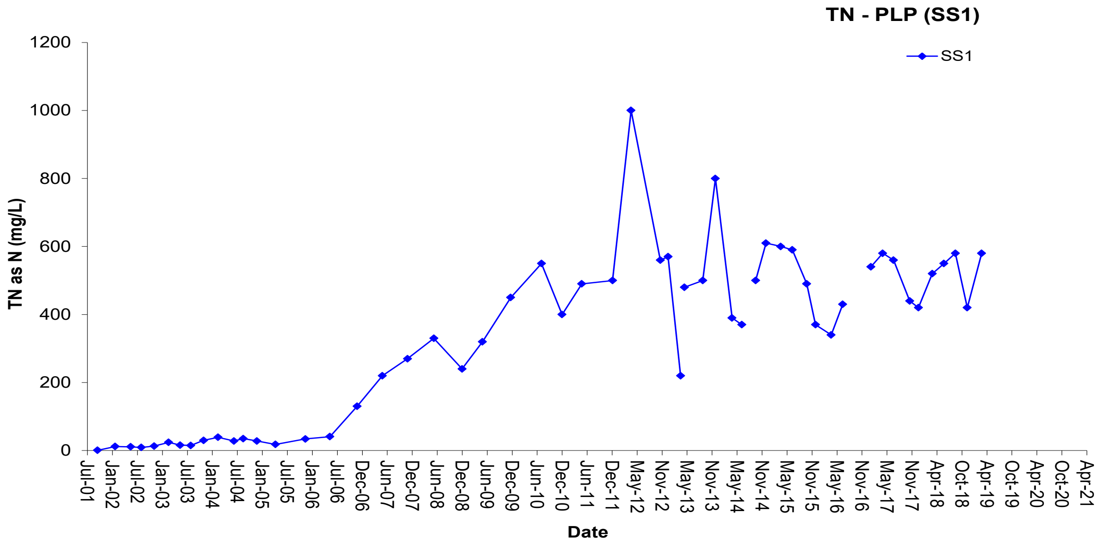

Figure 4: TN in the PLP (SS1) from 2001 - 2019

The levels of a few parameters appear to have continued to change gradually since 2013, although the level of several is highly variable between sampling events. These include gradual rises in the levels of TAN and Cl and gradual falls in the levels of DOC, Mg, Cr and V.

Arsenic was first detected in high levels in December 2012 (total As 4.6 mg/L). Levels have been highly variable since then, but have fallen over time. In December 2018, the total As level was 0.82 mg/L and the soluble level 0.56 mg/L. This trend is expected to continue as flows from the now capped cells containing the As waste reduce over time and contributions from active and new cells become more significant.

Total CN has been detectable since 2010 when the limit of reporting (LOR) was increased from 0.05 mg/L to 0.005 mg/L. It has been recorded above the LOR consistently since December 2013 with levels varying from 0.006 – 0.018 mg/L. Although these levels often exceed the ANZECC/ARMCANZ (2000) guideline for free CN (0.007 mg/L), under the conditions present in the PLP, most CN would be present as organic complexes and not free CN.

A large range of organics including VOC (BTEX), TPH(TRH), PCB, PAH, organochloride and organophosphate pesticides have been tested since 2001, but apart from traces of oils/greases and an occasional low level detection for naphthalene, these have remained undetected.

Per & Poly-fluoroalkyl Substances (PFAS) were detected within PLP leachate in both December 2017 (Sum PFAS 11.8 µg/L) and September 2018 (Sum PFAS 11.01 µg/L) (AquaSci, 2018a, d). Comparison with data provided for 27 Australian landfills by Gallen *et al*. (2017), revealed that PFAS composition within CRDS leachate was typical of similar Australian landfills and the levels low – moderate in comparison (AquaSci, 2018a). Perfluorooctane sulphonic acid (PFOS) compound levels exceeded the HEPA (2018) and interim ANZECC/ARMCANZ guideline value for slightly-moderate ecological systems (0.13 µg/L) in both December 2017 (0.42 µg/L) and September 2018 (0.55 µg/L) (AquaSci, 2018d).

CRDS B-Cell leachate is currently characterised by high EC, TDS, major ion, alkalinity TP and Ortho-P levels and very high COD, TN, TKN and TAN levels (nitrogen nutrients) with most N present as TAN and the remainder as organic-N. The levels of four metals consistently exceed the relevant ANZECC/ARMCANZ (2000) guidelines for ecosystem protection in surface waters, including As, Cr, Ni, V and Zn, although only marginally in the case of Zn. Since As and PFAS levels across CRDS surface and groundwaters not storing leachate are low or undetectable, the presence of elevated levels of these parameters in these waters would be a particularly useful indicator of leachate contamination.

3.10 Leachate Indicators

A range of chemical indicators are currently used to detect the presence of leachate within CRDS surface and groundwaters. These are based on the characterisation of B-Cell leachate and include:

- Increases in the modified Mulvey L/N ratio (K^++NH_4^++NO_x/Na^+)
- Levels of the modified Mulvey L/N ratio approaching or exceeding 0.1
- Increases in As levels (high in leachate, very low in native CRDS waters).
- Increases in Cr levels (very low in native CRDS waters, higher in leachate).
- Presence of PFAS (present in leachate, undetectable in native CRDS waters)
- Increases in a range of other parameters associated with leachate e.g. TAN, NO_x, COD, alkalinity, DOC, and K, especially in surface waters.

A number of changes occur when leachate breaks through to groundwater, such as increases in the levels of “leachate” cations such as potassium and ammonium relative to “native” cations such as sodium, calcium and magnesium. The ratio of the concentrations of these “native" “cations ions (or groups of these ions) are therefore known as leachate/non-leachate or L/N ratios. The use of L/N ratios is recommended where background groundwater salinity is elevated (Mulvey, 1997), as is the case at the CRDS. These are discussed further in Section 4.5 of this review.

Routinely, the modified Mulvey L/N ratio (K^++NH_4^++NO_x/$Na^{+)}$ and As levels are used as an initial screen as to whether leachate contamination may be occurring. If this is the case, other parameters indicative of leachate contamination are examined.

4 Program Review

4.1 Long-term Data Trends

To demonstrate that current CRDS operations had a negligible effect on the environment, in a letter to SWS (EPA, 29 June 2018) the EPA requested a "*Review of groundwater and surface water, with trends of potential contaminants going back as far as possible and including comparison with background results*". This section addresses this requirement.

Data matrices have been maintained for all sites over the entire period of monitoring in Microsoft Excel format and are provided to SWS and hence the EPA each monitoring event. Apart from Group 4 organics, long term data trending graphs have also been maintained for all parameters at all sites. These are also provided to SWS and the EPA each sampling event. As these are much too large to be included in this review, they are supplied separately in pdf format. A summary of long term trends is presented below for each monitoring site. Comments are limited for the newer C-Cell bores (BH14A, BH15A, BH15B and BH18A) due to their recent construction, with data sets comprising only seven sampling events and less for metals, major ions and organics.

Longer term water quality trends, particularly those at surface sites, have been determined principally by the following factors:

- Rainfall patterns.
- Drought.
- Major rainfall events e.g. April 2011, April 2013.
- Changes in pond function over time.
- Cell development including the number of cells, activity and capping.
- Construction activities.
- Leachate irrigation (SSWP – SS2).
- January 2013 bushfires.
- Sampling frequency.
- Sampling timing – usually ambient conditions, but at times influenced by major weather events.
- Evaporation.

4.1.1 Surface Sites

4.1.1.1 Primary Leachate Pond (SS1)

Since 2001, the PLP has stored leachate from the active and capped landfill B-Cells. The only exception to this was during the latter half of 2016 when the pond was relined. Over this period, the Secondary Stormwater Pond (SS2) was HDPE lined and used to store primary leachate. The development of the leachate within the PLP over time has been discussed in Section 3.9 of this report, as part of the leachate characterisation.

4.1.1.2 PLP Underliner Drainage Pit (SS4)

The PLP ULDP captures any leachate leaking from the PLP liner, condensation and seepage from rainfall from below the liner, and some groundwater. Water quality has varied somewhat over time depending on the influence of each of these factors. The capture system was renovated during the 2016 liner replacement. Since then, the contents appear to be principally shallow, saline groundwater. From 2013 to mid-2015, increases in total As, TN, TKN, TAN and nitrate were detected indicating low levels of leachate within the pit. This was attributed to a small amount of leakage due to damage to the upper sections of the liner during the bushfires, especially when leachate levels were high in the pond. Leakage was minimised at that time by maintaining low leachate levels in the PLP.

The levels of a range of parameters have been lower since relining including nutrients, DOC, COD and TSS. Soluble metal levels were very low in December 2018 and As was not detected.

A wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides have been tested since 2001, but apart from traces of oils/greases these have remained undetected. PFAS were not detected in September 2018.

4.1.1.3 Leachate Holding Pond 1 (SS9)

LHP1 was constructed in 2013 to store excess leachate and monitoring commenced in May that year. From 2013 to 2015, there was some movement of leachate between the PLP and LHP1, but since then leachate has remained within the pond. Rainfall (dilution) and evaporation (concentration) have both impacted on the composition of the leachate stored. Major algal blooms occur within the surface waters of the pond, especially in summer. Leachate was removed from the pond to the PLP in February 2019. Following cleaning, LHP1 will function as the C-Cell Leachate Balancing Pond (C. Bell, SWS, pers. comm., March 2019).

Until a period of heavy rainfall in June 2016, water quality within LHP1 was relatively stable with the levels of only pH, Ni, As and Cr gradually falling over time. As levels were significantly elevated (1.2 – 3.8 mg/L) as was the case in the PLP (1.3 – 4.6 mg/L) the source of leachate. Major changes occurred following the June 2016 rainfall. pH rose and remained higher (greater than 9) than prior to that date (below 9). EC, alkalinity, DOC, Mg, S, and As levels all fell markedly before rising again, but not to previous levels. TDS, COD, Cl, K and Na levels also fell in June 2016 but recovered fully later. TN, TKN, TAN, TP, Ortho-P and Ca levels fell markedly, and remained lower. Most parameters have shown seasonal (rainfall-evaporation) variability since then, with only Total Cr levels continuing to fall gradually.

As with the PLP, PFAS were detected in this pond in both December 2017 (Sum PFAS 14.2 µg/L) and September 2018 (Sum PFAS 10.3 µg/L). PFOS levels exceeded the relevant interim ANZECC/ARMCANZ guideline (0.13 µg/L) in both December 2017 (0.41 µg/L) and September 2018 (0.46 µg/L).

A wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides have been tested since 2013, but apart from traces of oils/greases these have remained undetected.

4.1.1.4 LHP1 Seepage Pit (SS8)

The LHP1-SP collects any seepage from the LHP1 liner including the area surrounding the liner. Seepage was detected only from the first sampling event in May 2013 until December 2014 after which there was insufficient water for sampling. The water present in the pit in May 2013 was of much better quality than the leachate in LHP1 and the source was probably rainwater runoff from the construction period. Water quality gradually deteriorated as the water level fell due to evaporation. The pit is currently dry.

4.1.1.5 Leachate Holding Pond 2 (SS10) (Now C-Cell Main Leachate Pond)

LHP2 was constructed in 2014 and used to store B-Cell leachate from June 2015 to June 2017. The leachate was then removed and from that date until November 2018, it contained only a little rainwater and residual leachate. Water quality within LHP2 over the 2015 to 2017 period closely matched that within LHP1 from which the leachate was pumped, except that parameter levels were a little lower as a result of some dilution from the rainwater that had collected in the pond prior to the addition of leachate.

A wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides have been tested since 2015, but apart from traces of oils/greases these have remained undetected

From November 2018, the pond has collected leachate and runoff from the C-Cell and is now known as the C-Cell Main Leachate Pond (CMLP). Only two sampling events have been performed since then (December 2018, March 2019).

4.1.1.6 LHP2 Seepage Pit (SS11)

The LHP2-SP was constructed at the same time as LHP2 and has always been dry.

4.1.1.7 Secondary Stormwater Pond (SS2)

The SSWP was constructed in 2001 as a clay lined pond to collect stormwater runoff from inside the landfill footprint. Since then, it has served this and a range of other functions, all affecting water quality. Consequently, the latter has been quite variable over the medium to long term.

Over the 2001 to 2003 period, the levels of several parameters increased very gradually as stormwater with dissolved and suspended materials collected in the pond. Evaporation/rainfall interactions impacted on these. These included pH, alkalinity, TN, TKN, TAN, TP, Ortho-P, DOC, K, Mg, total Cr and total Ni.

From 2004 to mid-2007, leachate from the PLP was irrigated onto the vegetated unused cells with runoff returned to the SSWP before being pumped back to the PLP. Over this 2004 and 2005 the levels of some parameters increased further including pH, EC, TDS, alkalinity, major ions (Cl, S, Na, Mg, K), alkalinity, TP, Ortho-P and total Ni.

The subsequent impacts on water quality within the SSWP occurred as the result of the 2006 – 2008 drought. Leachate irrigation was discontinued in mid-2007 as it was no longer required to reduce leachate volumes within the PLP. It was not resumed as arsenic was detected within the primary leachate from November 2012. The levels of many parameters increased further especially over 2007/08. These recovered somewhat over 2009/10 before rising back to 2007/08 levels over 2012/2013. Most parameter levels returned to 2006 levels over 2015, after which the contents of the pond were transferred to the PLP in preparation for the addition of an HDPE liner.

From May 2013 to November 2014, leachate from a leak in the side of one of the active cells was collected with other runoff within the pond and As levels were elevated over that period (0.032 – 0.4 mg/L). The leachate was captured within the pond and no discharged occurred to the receiving waters off site.

For the latter part of 2016, the pond contained primary leachate (October 2016 quarterly sampling event) whilst the PLP liner was replaced following damage from the 2013 bushfires. Leachate was returned to the PLP at the end of 2016, and the SSWP contained only a small amount of rainwater and some residual leachate over 2017/18. Sampling resumed in September 2018, although with difficulty since very little water has been present. The pond was completely dry in March 2019. When water is present, it principally consists of rainwater with low levels of residual leachate. The soluble As level (0.036 mg/L) was slightly higher than the ANZECC/ARMCANZ guideline (0.024 mg/L) in December 2018. PFAS were detected in low levels in September 2018 (Sum PFAS 0.7 µg/L). With normal rainfall and higher water levels, it is expected that dilution will reduce residual leachate concentrations below detectable levels.

A wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides have been tested since 2001, but apart from traces of oils/greases these have remained undetected.

4.1.1.8 Primary Stormwater Pond (SS3)

The PSWP was constructed prior to 2001 to capture off-site stormwater from the perimeter drains surrounding the CRDS site. It acts as sedimentation pond. Until mid-2005, water was allowed to drain through an outlet valve situated half way down the spillway. Hence, the water level in the pond was often very low, and parameter levels very variable. Following this date, the valve was closed and water allowed to flow over the spillway. Hence, water levels have been higher since that date. The waters of the pond have been very turbid from fine, suspended clay except for a brief period from April – October 2017 when the clay settled. This was due to an extended period of little rainfall and moderate EC.

The levels of most parameters within the PSWP were variable to highly variable over time, with few showing any long term increases or decreases. Total metal levels were correlated with TSS levels and the presence of fine clay. A small peak in total As concentration occurred in December 2011 (0.019 mg/L), which was lower than the ANZECC/ARMCANZ guideline for ecosystem protection (0.024 mg/L) This was attributed to sampling close to a significant rainfall event with the associated increased sediment input. pH has risen very gradually over time. Redox potential has been slightly lower after the water level in the pond was regulated by the spillway. COD and nitrate levels appear to be higher during periods of rainfall and the presence of birds on the pond. Moderate rainfall following dry periods *e.g.* April 2012 tend to result in increases in a range of parameters as materials are flushed into the pond from the stormwater drains. These include EC (and Cl, Na, Mg, K), alkalinity, TN, TKN, TAN, DOC, Cr and Ni.

PFAS were detected in very low levels within the pond in both December 2017 (0.11 µg/L) and September 2018 (0.07µg/L), indicative of trace level leachate contamination. The likely source of leachate was spray drift from the adjacent WAIV unit in operation over 2015 - 2018. It is likely levels will be lower when the next scheduled sampling event for PFAS occurs in June 2019 since the WAIV unit has been relocated to the CMLP. A reduced level of spray drift remains possible during high winds from the east and north east, especially if leachate levels within the PLP are high.

A wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides have been tested since 2001, but remain undetected.

4.1.1.9 Primary Stormwater Pond Drain (SS5)

The PSWPD leads from the PSWP spillway to a marsh. Stormwater flows from the PSWP through the drain and the marsh to the Carlton River Tributary (CRT) just upstream of SS7. It contains a belt of *Eleocharis acuta* and *Juncus* sp. in the centre, which acts to filter sediment from flows and remove nutrients. At times of low rainfall, it may be dry, as was the case in March 2019 (AquaSci, 2019b).

Until 2017, water quality within the drain usually reflected that of its major source, the PSWP, except that TSS and nutrient levels were usually lower. During drier times, water quality reflected evaporative processes with increasing EC, TDS, major ion and alkalinity levels. Total metal levels tended to become lower than those within the PSWP, presumably the result of sediment settlement.

Since the January 2013 bushfires and the removal of vegetation, at lower flows EC, TDS and major ion levels have been higher than those within the PSWP due to natural saline groundwater discharges to the drain. This trend has continued at somewhat higher flows since 2017 due to the discharge of saline groundwater to the stormwater system from the PLP-ULDP (SS4). Even at these times, however, the levels of these parameters have remained within their historical ranges within the drain.

Despite comprehensive testing for a wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides since 2001, none have been detected.

Trace levels of PFAS were detected within the drain in both December 2017 (Sum PFAS 0.09 µg/L) and September 2018 (Sum PFAS 0.02 µg/L). PFAS compounds appear to be a very sensitive indicator of even traces of leachate within the CRDS site. No PFAS was detected within the receiving waters of the CRT at either SS6 or SS7.

4.1.1.10 Carlton River Tributary – Upstream Reference Site (SS6)

The CRT is a small, ephemeral stream that receives drainage from the valley containing the CRDS after it has flowed through the marsh. Upstream, the CRT flows through a highly disturbed agricultural and plantation region.

The CRT contains two sites, the Upstream Reference Site (CRT-US), SS6 and the Downstream Site (CRT-DS), SS7. SS6 is located about 310 m upstream of where flows enter from the marsh via a small, temporary stream (marsh creek) and about 340 m upstream of SS7. It consists of an essentially permanent pool upstream of a rock sill across the stream. At least from 2001 – 2019, even when most of the rest of the CRT has been completely dry, the SS6 pool has retained some water. This situation applied in March 2019.

The levels of most parameters have been highly variable depending on rainfall, flows, the extent of dry periods and evaporative concentration. Several peaks in nitrate have occurred due to the latter and the use of the pool for drinking water by native animals. The application of fertilizer on plantations formerly located upstream also appears to have contributed at times. These were destroyed during the 2013 bushfires. Water temperature variability has increased since 2014, especially maxima. Most parameters show seasonal variability, based on rainfall. During drought EC, TDS, alkalinity and major ion levels rise and redox potential falls. Nutrient flushes occur with some rainfall events, particularly after dry periods.

Total metal levels generally have been low, apart from Cu, Al and occasionally Cr, which may slightly exceed the relevant ANZECC/ARMCANZ guidelines for ecosystem protection at times. However, apart from Mn and Fe, soluble metal levels have been very low and less than the Limit of Reporting (LOR) with none exceeding the guidelines.

Despite comprehensive testing for a wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides since 2001, none have been detected. PFAS were not detected in December 2017 or September 2018.

As SS6 is a reference site upstream of CRDS activities, all of these changes and trends are natural or the result of factors upstream.

4.1.1.11 Carlton River Tributary - Downstream Site (SS7)

SS7 is located approximately 30 m downstream of the marsh creek confluence with the CRT. At this point, the stream may dry out at times of low rainfall, both during summer/autumn and drought. This was the case in March 2019. The marsh creek carries all stormwater flows from the CRDS perimeter drains, the PSWP and the marsh. It also carries natural saline groundwater discharges occurring in the PSWPD and the marsh itself. Natural saline groundwater discharges also occur directly to the CRT upstream of SS7, even when the marsh creek is dry.

From 2001 to 2013, water quality at SS7 was generally very similar to that at SS6 upstream, except just prior to SS7 drying out when EC, TDS, major ions and alkalinity levels became higher than at SS6. SS7 was often dry during this period, especially from 2007 – 2009.

From 2013 to 2016 following the January 2013 bushfires, the influence of saline groundwater discharges from the marsh increased somewhat with more frequent instances of higher EC, TDS and major ion levels at SS7 than at SS6, without SS7 drying out. This trend was a little more marked from 2017 – 2018 as the result of the saline groundwater discharge from SS4 to the PSWPD (SS5), especially at times of low rainfall. This was exacerbated by the current drought in SE Tasmania (2014 – 2019).

Total metal levels have been similar to those at SS6 with Cu, Al and occasionally Cr, slightly exceeding the relevant ANZECC/ARMCANZ guidelines for ecosystem protection at times. As for SS6 though, apart from Fe and Mn, soluble metal levels have been very low and less than the Limit of Reporting (LOR) with none exceeding the guidelines. On occasion, Al levels have been a little higher at SS7 than SS6 due to higher TSS levels when the marsh creek was flowing.

Despite comprehensive testing for a wide range of organics including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides since 2001, none have been detected. PFAS were not detected in December 2017 or September 2018.

4.1.2 Groundwater Bores

Contamination of groundwater by leachate from the CRDS has not been detected in any bore since the commencement of monitoring in 2001.

Arsenic, PFAS and including VOC (BTEX), TPH (TRH), PCB, PAH, organochloride and organophosphate pesticides have not been detected in the groundwaters tested and are not discussed further. L/N ratios also did not indicate the presence of leachate in groundwaters.

Water quality within the groundwater bores tested was less variable than in surface waters and tended to reflect longer term weather patterns (drought vs wet periods) with seasonal variability in recharge superimposed on the longer term trends. Longer term rainfall patterns included above average and average rainfall from 2001 to 2005, drought from 2006 – 2008, high rainfall in 2009, especially June, followed by rainfall alternating between above average to below average levels from 2010 to 2013. The 2014 to 2018 period has been one of drought.

4.1.2.1 BH13 (13.5 m) – Southern Upgradient Reference Bore (SURB)

Water quality monitoring commenced at BH13 on 8 May 2013. The bore is upgradient of CRDS activities and located marginally within the fractured sandstone layer below the

CRDS (Cromer, 2018). It receives recharge from the south. Hence it is not affected by CRDS activities. The dominant trend was a marked rise in water level in autumn 2014 followed by a gradual return to the May 2013 level in December 2018. This rise was coupled with rises in EC, TDS, major ions, COD, TN, TKN, DOC TP and total Cu and Ni levels. Specific Hydraulic Head varied from 6.47 m (May 2013 and December 2018) to 7.70 m (April 2014).

4.1.2.2 BH1 (23.5 m) – Leachate Holding Pond Bore (LHPB)

BH1 is one of the original 100 mm diameter survey bores, constructed in 1996 (Woodward-Clyde, 1998). It is slotted along its entire length and penetrates through surface Quaternary sediments into the fractured sandstone below (Cromer, 2018). Groundwater flows are principally from recharge upgradient but it is located very close to the landfill cells. Monitoring commenced in October 2001. Some of the variability within parameter levels in this bore may be attributable to it intersecting groundwater at a range of levels within the aquifer below the CRDS.

Water levels reflect medium term drought/rainfall cycles, with seasonal fluctuations superimposed on these. There appears to have been a lag period of 3 – 4 months between significant periods of rainfall and resultant changes in water level and other parameters. Over the longer term, the water level rose in February 2002, fell gradually till May 2009 and rose again sharply in December 2009 following heavy rain in June that year. The water level has fallen gradually since then. SHH have varied from 14.75 m in February 2002 to 17.60 m in October 2016.

Longer term trends can be divided into three periods. The first was from 2001 across a wet period to (2006) or into (2007) the 2006-2008 drought. Although the levels of many parameters were very variable and seasonal variability could obscure longer term trends the following can be noted. DOC, Cl, Mg, S and K levels rose over that period, and pH, COD, TP, Total Cr, Cu, Fe, Pb, Ni and Zn levels fell. Although variable, EC, TDS, redox potential, TN, TKN, TAN, nitrate, nitrite and total Mn levels did not appear to rise or fall overall.

The second period extended from 2008 – approximately 2014, across an intermittently wetter period into the current drought. Cl, Mg, S, K and total Zn levels remained steady. pH, COD, TN, TKN, nitrite, total Cr, and Pb levels were lower than during the previous period but showed no increasing or decreasing trend. The TAN level rose across this period, and total Cu and Fe levels continued to fall. DOC and total Mn levels rose sharply and then fell gradually, whilst total Ni levels fell sharply, and remained low.

Over the third period, the 2014 – 2018 drought, variability within many parameters was reduced, presumably due to a lack of recharge. The levels of a range of parameters have remained lower than during previous periods including pH, COD, TN, TKN, TP, DOC and most total metals. Major ion levels, EC and TDS have remained similar to those during the 2008 – 2014 period.

Mn levels have reflected redox potential, showing falling levels to 2009 (0.37 - 0.023 mg/L), a marked rise in December that year (1.1 mg/L) followed by higher but falling levels since (down to 0.29 mg/L in December 2018). Redox potential fell sharply from December 2007 (-9.6 mV calomel) to December 2011 (-274 mV Calomel). Since then it has been variable but circa -150 mV.

4.1.2.3 BH7 (10.1 m) – Primary Leachate Pond Bore (PLPB)

BH7 was constructed in 2001 and serves both as a downgradient bore for the B-Cells and also to detect any leakage from the PLP to groundwater. Consequently, as the most downgradient bore on the CRDS site, it has the highest EC/TDS of the bores tested. A gradient of increasing EC exists from BH13 upgradient, through BH1, the decommissioned BH4 to BH7.

Water quality trends were very similar to those found in BH1, although parameter levels varied. EC, TDS, Cl, S, Na, Ortho-P and Mn levels were higher in BH7 then BH1, and TN, TKN, TP, K and Ca levels were lower. Redox potential and Mn levels remained very similar across the entire monitoring period 2001 – 2018.

4.1.2.4 BH10A (7.8 m) and BH10B (3.0 m) – Near Cell 9 Bore Cluster Deep/Shallow

BH10A and BH10B were constructed in 2011 close to the then active landfill cells. Their purpose is the early detection of any leakage of leachate from the cells to groundwater in their vicinity.

Water quality generally has been very similar in both bores, although the levels of some parameters have been higher in BH10A than 10B such as nitrate, TP and Ortho-P, whilst others have been lower including COD, TN, TKN, TAN, total Fe and several other total metals. The major difference noted was greater variability in parameter levels within the BH10B, especially over the 2011 – 2014 period of variable rainfall. This is attributable to the very shallow nature of this bore and rapid responses to local recharge. The levels of most parameters have fallen over time within both bores, but particularly over the 2011 – 2014 period.

4.1.2.5 BH12A (21.6 m) and BH12B (5.5 m) – Irrigation Area Bores Deep/Shallow

BH12A and BH12B are located to the west and upgradient of the landfill. They were installed in January 2013 to monitor groundwater in an area where irrigation of leachate was proposed. This has not occurred to date.

BH12B is located in shallow clay Quaternary deposits whilst the much deeper BH12A penetrates the underlying sandstone. Water quality differs in the two bores because of this. Hence, pH, EC, TDS, TAN, nitrate, Cl, Mg, Na, Ca and Mn levels were higher in BH12A whilst redox potential, DOC, S and total Ni levels were lower.

EC, TDS and Cl levels all rose over time within BH12A. EC rose slightly and pH fell over time within BH12B. Metal levels were generally low in both bores, but, as in H10A and BH10B, showed higher levels over the 2011 - 2014 period than after that. In both bores, the DOC level was lower from 2015 – 2018 than prior to this. Over the same period, redox potential and nitrate levels were higher than over 2011 – 2014.

4.1.2.6 BH2 (11.3 m) – C-Cell Downgradient Bore (CDB)

BH2 is one of the original 100 mm diameter CRDS survey bores constructed in 1996. Monitoring was discontinued in 2002 but, with the advent of the C-Cell, recommenced in March 2016. It serves as the C-Cell downgradient bore. Based on the limited data set available (10 sampling events overall, only 6 for metals, major ions and organics), EC, TDS, Cl, S, Mg, Na and Ca levels all appear to be falling over time (2016 – 2018).

4.1.2.7 C-Cell Bores (BH14A (depths), BH15A, BH15B and BH18A)

These bores were constructed in February 2016, as part of the development of the C-Cell. However, as a result of construction activities, they were not always accessible for sampling. BH18A is a very unproductive bore upgradient of the C-Cell. Productivity is so low that the bore cannot be purged prior to sampling. Even with water accumulating over a 3 month period, the volume available is barely sufficient for quarterly sampling and has never been adequate for the collection of organics samples.

BH14A, BH15A and BH15B are located to the south-west and north-west of the C-Cell respectively.

BH15B initially contained little or no water, but on occasion since then, has contained some low EC surface infiltration following rainfall (June, October 3016). Following extensive earthworks around it and BH15A, including several vertical extensions to the bores (total of 5.6 m), and the development of Cell 4 adjacent to it, it was found to contain adequate water for sampling again in September and December 2018. In September 2018, a pool of surface water surrounded the BH15 cluster, including runoff from the recently constructed and active Cell 4 adjacent to it. EC, TN, TAN, nitrate and DOC levels were all somewhat higher than those found in 2016, which was attributed to runoff from the edges of Cell 4 and also increased bird prevalence. The December 2018 results are anomalous as due to the low recharge, the bore could not be purged. The bore was essentially dry in March 2019. BH15B appears to be located in a temporary perched aquifer that forms only after rainfall.

BH15A is a deep (currently 29.7 m), productive bore located in weathered Jurassic dolerite. The groundwater sampled is saline (5,730 µS/cm in December 2018). Soluble metal levels appear to be low.

In summary:

- Leachate contamination has not been detected within the waters of the CRT.
- Leachate contamination has not been detected within the groundwaters below the CRDS.
- Nutrient rich water was detected in BH15B in September 2018, the source of which appeared to be rainfall related surface runoff from the edges of the adjacent landfill Cell 4, which was contaminated by bird faeces.

4.2 Parameter Suite

A reduction in the list of parameters tested is not recommended since the levels of a contaminant may remain low for long periods, but rapidly rise if conditions change. This was the case with arsenic in the PLP from November 2012. However, where there is a long history of non-detections, sampling frequency may be reduced, especially in sites less likely to be affected. The appropriateness of the measure used for metals and nutrients requires evaluation.

4.2.1 Metal Levels

The previous review (AquaSci, 2014e) recommended a re-examination of the use of total metal levels for both surface and groundwaters and Cromer (2018) has also indicated that for groundwaters, samples should be filtered prior to metal analysis.

The LSG and EPN 690/1 do not specify whether total and/or soluble metal levels should be determined, apart from iron where both are required for surface waters.

Total metal levels within surface waters represent a conservative measure of metal levels as they include all forms of the metals present. They comprise soluble metals, which are most likely to affect ecological systems as well as metals bound to sediment particles that are generally biologically less available, but may travel off site. The latter often become sequestered into bottom sediments. In waters of low turbidity or suspended solids there may be little difference between total and soluble metal levels. In the case of highly turbid waters, the majority of metals present in most waters would generally be associated with sediment.

The use of total metal levels as an initial screen in surface waters is in accordance with the ANZECC/ARMCANZ (2000) guidelines for aquatic ecosystem protection, which note that relatively coarse indicators may initially be compared to the relevant guideline values, but if the guidelines are exceeded, further investigation of the nature of the metals present would be indicated. This would include the investigation of soluble metal levels, the derivation of hardness modified toxicity triggers and other analyses such as metal speciation.

It should also be noted that the ANZECC/ARMCANZ (2000) guidelines for aquatic ecosystem protection were derived based on non-turbid waters and soluble or dissolved metal levels based on filtered samples offer the most valid comparison with these guidelines. Nonetheless, even in this case, turbidity may affect soluble metal levels if clay particles are present smaller than the 0.45 µm filters used for the determination of soluble metal levels. This may be the case for samples from the PSWP (SS3), which usually contain high levels of very fine clay particles.

In the case of groundwaters, sediment bound metals are unlikely to move off site if left in situ. On the other hand, soluble metals are mobile and can move with groundwater, thus potentially affecting off-site ecological systems. This would include surface waters influenced by groundwater discharges or groundwater that is abstracted for agricultural use. The latter is unlikely in the vicinity of the CRDS due to the saline nature of the groundwater present.

At the commencement of the monitoring program, the waters of the CRDS bores sampled were of low turbidity, and total metal levels were deemed an appropriate, if conservative measure of the level of metals potentially able to move with groundwater flows, as well as the presence of potential contamination from landfill activities. However, with the expansion of the site post 2011 and the establishment of new groundwater bores, groundwater samples with high and, more importantly, variable turbidity have been encountered. In the case of these, total metal levels are predominantly determined by to the amount of sediment present, rather than the level of metals present in the mobile phase or potentially, contamination levels from leachate. Consequently, the determination of soluble metal levels would provide a more appropriate measure of metal levels within groundwaters. It should be noted, however, that even when metal levels in source leachate are high, soluble levels in the associated groundwater plumes may be low due to sorption processes (Christensen *et al*., 1994).

In December 2018, both total and soluble metal levels were determined for surface waters and soluble metal levels for groundwaters. The measurement of both total and soluble metal levels for seems to be of limited value since it will depend of variable suspended solids levels, which could be measured directly as TSS or turbidity. As turbidity is variable, no true relationship between total and soluble metal levels could be established.

4.2.2 Nutrient Parameters

As with metals, nitrogen and phosphorous nutrients may bind to sediment to varying degrees, especially phosphorous. In the case of surface sites, since total levels rarely differ markedly between the SS6 and SS7 CRT sites, there is little reason to add filtered or dissolved levels to the parameter suite. In addition, total levels are a more appropriate measure of the nutrients moving off site as, under certain conditions such as low pH, sediment bound nutrients may be re-mobilised. However, in groundwaters, as with metals, filtered levels are a more appropriate measure of nutrient levels as sediment does not move off site unless waters are abstracted. Again, as with metals, little would be gained from the measurement of both dissolved and total nutrient levels for a period to establish the relationship between the two, due to the variable TSS found in Copping Bores.

In summary, it is recommended that the following changes be made to the current program:

- Determine total and soluble metals for all surface sites.
- Determine soluble metal levels for groundwaters.
- Filter groundwater nutrient samples on sampling.

It is acknowledged that field filtration will be required, which will add to field sampling time. This may also be problematic for some very turbid samples, even using expensive (circa $800), filtration apparatus with a large filter head and a hand pump. A commonly used option is to use syringe filters which are cheaper but due to the small size of the filters, in practice their use is limited to waters of relatively low turbidity. A number CRDS samples are moderately to highly turbid and this may render the use of syringe filters impractical. In addition, the latter are environmentally costly as an entire syringe and one or more filters are required for each sample filtered, and then discarded. Where field filtration is not practical, samples can be filtered within the laboratory prior to analysis, although this is less desirable due to transit times (up to 24h).

4.3 Sampling Frequency

Where a parameter tested has rarely been detected, or levels have remained very low or relatively steady for the entire period of monitoring (over eighteen years in the case of the CRDS), a case may be made to reduce the frequency of sampling. This is justified by the very low environmental risk these parameters pose, at least at some sites. In the event that the level of any of these parameters begins to rise or alter outside normal historical limits, it is implicit that more frequent monitoring would be resumed/adopted and reasons for the change identified. This was the case for arsenic which was monitored on an annual basis, but once detected in significant levels, on a six-monthly basis.

4.3.1 Group 1 physico-chemical parameters

Group 1 parameters (Table 3) are currently measured quarterly for both surface and groundwaters. As these parameters are highly variable in surface waters, this interval appears appropriate. However, in the case of groundwaters, the levels of these parameters are more stable and due to the slow movement of the groundwater below the CRDS, change over a longer time frame. In addition, only a few of the more useful indicators of leachate breakthrough are tested *e.g.* total ammonia. Other indicators such as major ions (and L/N ratios) and potentially metals such as arsenic are measured 6-monthly.

There seems to be a strong case to reduce groundwater bore monitoring to six-monthly for all bores except those close to the landfill cells (inner ring). Leachate has not been detected at any bore sampled to date, and as noted by Mulvey (1997), once detected at the inner bores, may take years to reach the outer bores.

As precaution, the internal ring of bores (those close to the cells) could remain on a quarterly monitoring cycle to ensure the rapid detection of any leachate breakthrough. The parameter suite tested for these should be increased to include the Group 2 and 3 parameters (major ions and metals), which incorporate the other useful leachate indicators. This would currently include BH10A, BH10B, BH14A, BH15A and BH15B or potentially from June 2019, BH10C, BH10D, BH23, BH14A, BH15A and BH15B.

4.3.2 Group 3 parameters - metals

In the past, most metals have been analysed on a six-monthly basis but others (As, Hg, Se) on an annual basis. With the detection of high levels of As in CRDS leachate in

November 2012, this metal was also analysed on a six-monthly basis. However, metals are analysed by the analytical laboratory as a complete suite with only those required by the client reported. In addition, once a set number of metals are reported, there are no further charges for additional metals. Hence, even though several metals such as Cd are rarely detected or detected at very low levels, there would be no cost saving from reducing the sampling frequency for these.

It is recommended that all metal analyses required for the CRDS SGWMP be reported each six-months, including those previously reported only annually, as was the case for the December 2018 annual sampling event.

Although the levels of some metals in storages containing leachate (As, Cr, Ni, V, Zn) are elevated and variable, the current six-monthly sampling frequency seems adequate to account for this variability. Discharges to the environment do not occur from these storages.

4.3.3 Group 3 parameters – major ions

Major ion levels have been monitored at all sites six-monthly for the duration of the SGWMP (Table 3). In relation to leachate contamination, the relative levels of these are as important as absolute levels, which vary between site as do EC, TDS and other parameters dependant on their levels. Currently, the cations Na, Mg, K and Ca are measured along with the anions Cl and S. The other major ion within CRDS groundwaters was found to be bicarbonate (Woodward Clyde, 1998). This was confirmed at all current bores in December 2018, with the measurement of alkalinity (total, bicarbonate and carbonate) in all groundwater samples (AquaSci, 2019a).

The current 6-monthy sampling frequency appears adequate but as bicarbonate may prove a useful leachate breakthrough indicator with groundwaters, it is recommended that alkalinity (total, bicarbonate and carbonate) be added to the groundwater parameter suite. Total alkalinity is currently measured only for surface waters.

4.3.4 Group 4 parameters - organics

Apart from PFAS, Group 4 organics parameters (TRH, VOC, PAH, PCB, organophosphate and organochloride pesticides) have rarely been detected at any surface or groundwater site apart from trace levels of TRH (oils and greases) and naphthalene in the leachate ponds. On the basis of the extensive temporal data set and the lack of detections, there seems little reason to continue to routinely sample for these unless they were detected within CRDS leachate. Therefore, it is recommended that routine annual sampling for Group 4 organics be performed only for the leachate ponds (SS1, S9 and SS10). If these compounds are detected within leachate, then the sampling of other sites should be reconsidered.

PFAS testing has only been performed twice over two years, with consistent results between events. This has shown the presence of these compounds within the B-Cell leachate ponds, but only traces in two other sites. The current annual sampling regime seems adequate to detect their presence, variability in levels and distribution across the

CRDS site. The lack of data and their apparent suitability as a leachate indictor suggests any decrease in sampling frequency would be inadvisable at present for surface sites and the inner ring of groundwater bores. However, unless detected in the latter, there seems to be little reason to sample the outer bores for these compounds.

4.3.5 Proposed Leachate Treatment Wetlands

Appropriate parameters for the treatment wetlands have not been determined as yet, but as part of the CRDS SGWMP, they are likely to include the Group 1-3 suite currently monitored for other CRDS sites. Unless Group 4 organics have been detected within leachate, there seems little point in sampling for these compounds. As PFAS have been detected within leachate, these compounds should be sampled annually as for other CRDS surface and inner groundwater bore sites.

4.4 Site Locations

The location of sites is determined by the requirements of the Landfill Sustainability Guide (DPIWE, 2004) and EPN 690/1 (and amendments) as noted in Section 3.3 of this report.

The LSG notes that surface water sites should be located:

- In the leachate ponds and leachate pond liner sumps. Leachate must be monitored to establish its quality and assess suitable management options.
- At points upstream and downstream of the landfill in any receiving waters.
- At the points of discharge from the landfill.
- Stormwater sediment ponds.

The LSG also notes that groundwater bore locations should include:

- At least one bore upgradient of the landfill site to provide background water quality data.
- At least two monitoring bores in close proximity to the landfill, with more at:
  - Larger sites.
  - Sites with longer operating lives (>10 years).
  - Sites with a high risk of contamination.
- At least one bore downgradient of the landfill.

The current sites fulfil all of these requirements. However, the points below should be considered, several of which were also noted during the previous program review (AquaSci, 2014):

- With several flow sources entering the marsh apart from landfill stormwater, a sampling site (SS15) within the marsh creek draining to the CRT would provide useful information concerning the quality of combined flows from all of these sources prior to entry to the CRT upstream of site SS7. Comparisons with water quality within the PSWP (SS3) and PSWP drain (SS5) would allow the contributions from sources not related to the landfill to be assessed. These would include natural rainfall runoff within the marsh, naturally saline groundwater discharges and flows from the plantations to the west of the landfill. Sampling would only occur when flows were present (as distinct from static pools). Once two years would be adequate and practical for this purpose, sampling for Group 1 – 3 parameters, although this may not be possible in times of drought.

- Neither of BH10A and BH10B are deep enough to intercept the deeper sandstone aquifer (i.e. BH4 has not been replaced). As part of the previous review, it was recommended that BH10B be deepened to circa 11 m to intersect the deeper sandstone layer. Cromer (2018) also recommended that these bores be deepened. In February 2019 two replacement bores were drilled (BH10C, BH10D) approx. 30 m further from the cells at the depths recommended by Cromer (2018).
- Since BH10A (7.4 m) is closer to the landfill cells, is a productive bore and has an extended water quality record, it may be argued that it should be retained as part of the CRDS SGWMP rather than replacing it with the new BH10D (7.0 m), which is further away and of unproven productivity. The bore log suggests it may not be as productive.
- In that case, the physically separated BH10A (7.4 m) and BH10C (12.4 m) would constitute the near cell 9 bores, rather than BH10C and BH120D.
- BH13 alone does not appear to be adequate for upgradient monitoring. It is constructed adjacent to the earthen bank of CLBP and hence, is very close to it. Any leakage from the CLBP nearby may report to groundwater sampled by the bore. Ideally, a bore should be considered further upgradient and remote from CMLP and CLBP. It should extend to an equivalent depth to BH1 to sample the same position in the sandstone aquifer below. This would form the upgradient reference bore (or bore cluster) for the CRDS site into the future, and would be permanent. The suitability of the newly constructed BH21 for this purpose should be examined.
- Elevations (RL – m AHD) are required for BH7. They have been measured for all other bores, apart from those recently constructed in February 2019. Elevations are required to allow comparisons of groundwater levels across the bores sampled.
- Sampling of BH12A and BH12B should be re-evaluated as leachate irrigation is unlikely to occur. As the deeper BH12A may serve as an upgradient reference bore to the west of the current B-Cells, it is recommended sampling continue. However, there seems to be little reason to continue sampling the very shallow BH12B. Nonetheless, the bore should be retained in place in case of future uses of the site.

The location of additional sites into the future will depend on the progress of:

- Proposed expansion of B-Cells 10 – 17 to the north of the existing cells.
- Filling of B-Cell 7
- Treatment Wetlands Pilot Trial

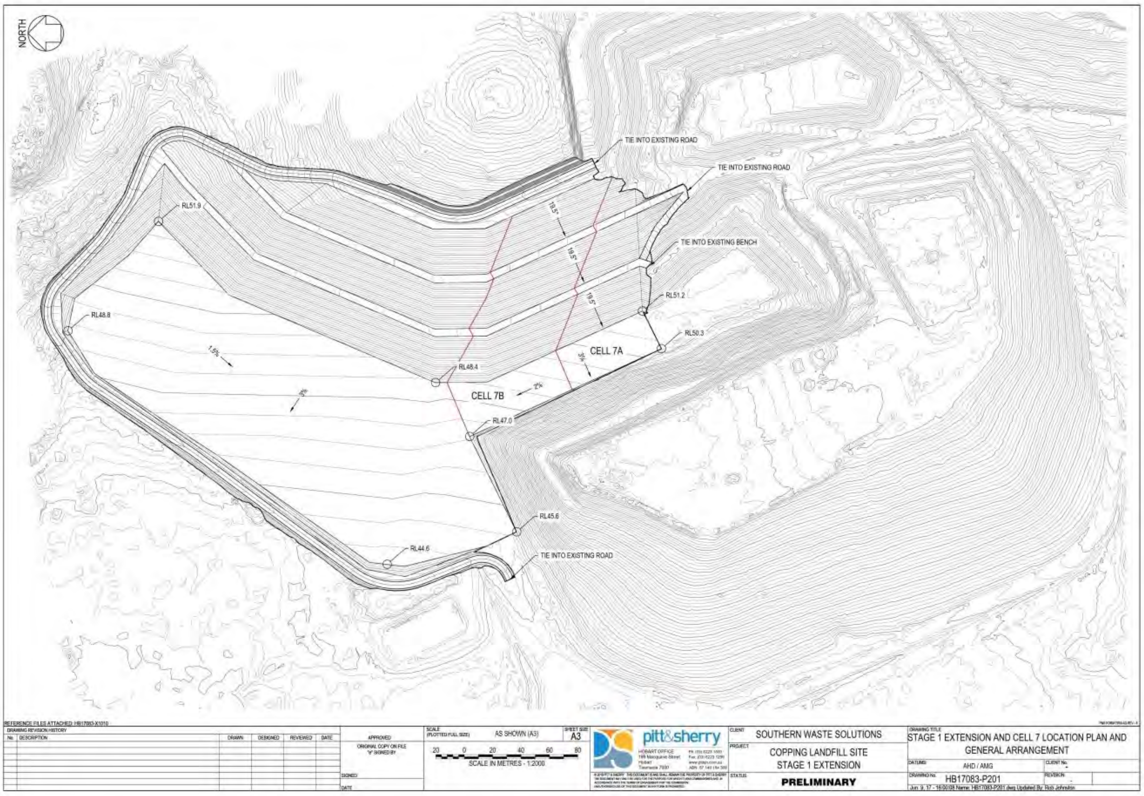

Figure 5: Proposed B-Cell expansion (Source: Pitt & Sherry, 2019)

It is unclear what additions to surface sites will be required for the B-Cell expansion (Figure 5) until further details are available, but the basic rationale is the separation of stormwater, groundwater and leachate. The expansion will require modifications to the stormwater system to ensure separation of external and internal stormwater, and to prevent turbid runoff entering the CRT. The following would require monitoring in accordance with the Landfill Sustainability Guide:

- Additional settling ponds, as for the current PSWP (SS3) and SSWP (SS2 and SS14).
- Any drains leading to the marsh and CRT (receiving environment) from external stormwater ponds, as is currently the case for the PSWPD (SS5).
- Any additional leachate storages, along with their seepage pits.

In essence, landfill groundwater monitoring consists of two rings of bores, a ring very close to the cells and other leachate sources, and an additional ring of bores further away, with reference bores upgradient of the cells (Mulvey, 1997). This principle has been followed in the past at Copping. The bores close to the cells or leachate storages are for the early detection of leachate breakthrough to groundwater should this occur, allowing the implementation of mitigation measures. The outer bores are to monitor the progress of any leachate plume, attenuation and the effectiveness of mitigation measures applied when breakthrough was detected. The siting of these bores relies on a good understanding of the groundwater system being monitored.

The Cromer (2018) conceptual groundwater model has provided this information and recommended the installation of a range of new bores, their locations and depths. This report was accepted by the EPA (EPA letter, 3 Jan 2019). From these recommendations, the following new bores were installed and developed in February 2019 (Figure 5):

- BH22 – 20 m deep reference bore upgradient to the east of the proposed expansion of the B-Cells (10-14).
- BH23 – 15.4 m deep monitoring bore close to proposed expanded B-Cells.
- Recommendation was that BH10B (2.9 m) be redrilled to the appropriate depth to sample deeper fractured sandstone, adequately replacing BH4 (11.4 m) now buried under the cells. Instead, two new bores established approximately 20 m further from cells BH10C (12.4 m) and BH10D (7.0 m), to replace BH10A and BH10B.
- BH19 – 8.4 m deep downgradient bore to monitor any leachate leakage to groundwater from the CMLP and CLBP.
- BH21 – 30.4 m deep reference bore located upgradient of BH19

These additional bores appear to satisfy all the LSG requirements for the monitoring of groundwater in the vicinity of the proposed B-Cell expansion into the immediate future. Over time, the proposed expansion is likely to extend from the current cells (Cell 7) northwards (N. Barta, Pitt & Sherry, pers. Comm., April 2019). It is likely BH23 will be decommissioned and buried under the cells and BH2 will undertake the role of a bore close to the landfill cells. An additional downgradient bore will be required at that time further downgradient, within the marsh. In addition, as the landfill cells extend to the northern end of the expansion footprint, an additional bore is likely to be required close to these cells near the marsh.

Details of all CRDS SGWMP groundwater bores are provided in Table 5, including those no longer in use and decommissioned.

Table 5: CRDS Groundwater Monitoring Bore Network, 2001 – 2019

Bore	RL (m AHD)	Depth (m)	Diam. (mm)	Slotted (m)	Construction Date Sediment Location	Recharge Rate	Comments/issues
BH13	57.5	13.5	50	10.5 - 13.5	Triassic sandstone encountered at 12.5 m on drilling, close to the bottom of the bore; probably lignite aquifer Constructed May 2013	Low	Upgradient reference bore following construction of LHP1 (now CLBP). EC is much lower than in BH1; shallow and water encountered at 12.5 m on drilling, very near bottom; barely penetrates the deeper aquifer flowing beneath CRDS and may not be representative of it; located very close to CLBP; water quality may not be comparable with BH1 and BH7 May not be an appropriate reference bore; consideration to be given to a deeper bore (cf BH1) located further upgradient from LHP1. May be useful as detection bore for potential leachate leakage to groundwater from LHP1.
BH1	56.95	23.5	100	1.0 – 23.5	Quaternary sediments and Triassic sandstone Original survey bore Constructed 1996	High	Original upgradient bore, but no longer the case as LHP1 (CLBP) constructed upgradient. Now CLBP downgradient bore; developed 5 March 2019.
BH3	49.40	20.6	100	1.0 – 20.6	Triassic sandstone	Unknown	Original survey bore; found to be damaged by pine roots first sampling event in 2001; not sampled; decommissioned 2013
BH4	45.24	12.0	100	1.0 - 12.0	Quaternary sediments & fractured sandstone aquifer (~10.5 m) Original survey bore Constructed 1996	High	Decommissioned in 2013 and now buried beneath Cell 9; original survey bore; most flow from fractured sandstone. With BH 6, one of two bores close to the landfill cells.
BH6	45.24	6.5	50	4.0 – 6.5	Quaternary sediments Constructed 2001	Low	Decommissioned and now buried beneath Cell 9. Water quality different to BH4. With BH 4, one of two bores sampling aquifers close to the landfill cells.
BH7	Unknown	10.0	50	4.0 – 10.0	Quaternary sediments and deeper Triassic sandstone. Constructed 2001	High	Over monitoring period (2001 – Dec 2011), water quality seemed to have similarities principally with BH4 but also BH6 for some parameters. PLP monitoring bore but also acts as a downgradient bore for the CRDS site.
BH10A	44.16	7.8	50	3.8 – 7.8	Quaternary sediments Constructed 2011	Medium	Water quality appears to be similar to BH6, which it replaces; too shallow to intersect sandstone sampled by BH4; increase in productivity and clarity over 2018 suggest may have accessed a sandstone fracture. Deeper of two near Cell 9 bore pair close to landfill cells. Evaluate whether to continue sampling or replace with BH10D

Bore	RL (m AHD)	Depth (m)	Diam. (mm)	Slotted (m)	Construction Date Sediment Location	Recharge Rate	Comments/issues
BH10B	44.12	3.0	50	1.0 – 3.0	Quaternary sediments Constructed 2011	Low	Very shallow bore; shallower of two near Cell 9 bore pair close to landfill cells. Decommission if not required for purposes other than water quality monitoring.
BH12A	47.09	21.6	50	18.6 – 21.6	Quaternary sand/gravel and fractured sandstone Constructed January 2013	Low-Medium	With BH12B, irrigation area bore west of CRDS; recharge from west
BH12B	47.18	5.5	50	4.0 – 5.5	Quaternary sediments (clay) Constructed January 2013	Low	Irrigation area bore; very turbid with high clay levels; very slow recharge. Recommended sampling cease, but bore be retained in place.

C-Cell Bores

BH14A	68.0	24.3	50	23.5 – 24.0	Triassic sandstone Constructed February 2016	Medium	Originally 21.5 m deep-GL raised just prior to April 2017 sampling event; Developed 5 March 2019; south-western corner of C-Cell (SW C-Cell bore).
BH14B	68.0	11.3	25	10.5 – 11.0	Triassic sandstone Constructed February 2016	N/A	Originally 8.9 m deep; GL raised just prior to April 2017 sampling event; Hydrological sampling bore only (no water quality); same hole as BH14A
BH15A	65.9	29.6	50	29.0 – 29.5	Jurassic dolerite Constructed February 2016	High	Originally 24.0 m; GL raised on three occasions, the last being just prior to the Sept 2018 sampling event; developed 5 March 2019; north-western edge of C-Cell (NW C-Cell bore).
BH15B	65.5	13.6	50	12.5 – 13.0	Jurassic dolerite Constructed February 2016	Very Low	Originally 8.4 m; GL raised on three occasions, the last being just prior to the Sept 2018 sampling event; located in a temporary perched aquifer fed by rainfall runoff; generally dry; located 1 m from BH15A.
BH18A	88.5	34.7	50	34.2 – 34.6	Jurassic dolerite Constructed February 2016	Extremely Low	Developed 5 March 2019; C-Cell upgradient reference bore,
BH18B	88.5	19.3	25	18.8 – 19.3	Jurassic dolerite Constructed February 2016	N/A	Hydrological sampling bore only (no water quality); same hole as BH18A.
BH2	43.8	11.5	100	1.0 – 11.5	Quaternary sediments and fractured sandstone Original survey bore Constructed 1996	Medium - High	Sampling discontinued in 2002; resumed in 2016 with the advent of the C-Cell; water encountered at 10.5 m on drilling near bottom); downgradient bore of eastern side of CRDS; developed 5 March 2019

Bore	RL (m AHD)	Depth (m)	Diam. (mm)	Slotted (m)	Construction Date Sediment Location	Recharge Rate	Comments/issues
New Bores Constructed February 2019 (Yet to be sampled)							
BH10C	Not measured	12.4	50	11.5 – 12.4	Constructed February 2019	Unknown	Replacement for shallow BH10B; deep enough to penetrate sandstone; one of Near Cell 9 Bores; located further from landfill cells than BH10B; developed March 2019; water quality sampling not commenced yet.
BH10D	Not measured	7.0	50	6.0 – 7.0	Constructed February 2019	Unknown	Replacement for BH10A (although BH10A fully functional); one of Near Cell 9 Bores; located further from landfill cells than BH10A; developed March 2019; water quality sampling not commenced yet. BH10A should be retained until it is known whether BH10D is equally productive; bore log and associated WL data (Pitt & Sherry, 2019) suggests not.
BH19	Not measured	8.4	50	5.5 – 8.4	Constructed February 2019	Unknown	C-Cell Buffer Pond monitoring bore; developed March 2019; water quality sampling not commenced yet.
BH21	Not measured	30.4	50	24.4 – 30.4	Constructed February 2019	Unknown	South-western upgradient reference bore; developed March 2019; water quality sampling not commenced yet. Suitability as southern upgradient bore for CRDS site to be considered.
BH22	Not measured	20.0	50	14.0 – 20.0	Constructed February 2019	Unknown	North-eastern upgradient reference bore; developed March 2019; water quality sampling not commenced yet. Cromer (2018) recommendation was a nested pair of bores, with one to 30 m depth; bore log and associated WL measurements (Pitt & Sherry, 2019) suggest BH22 is productive and may be suitable as a reference bore.
BH23	Not measured	15.4	50	9.4 – 15.4	Constructed February 2019	Unknown	Near new B-Cells bore; developed March 2019; water quality sampling not commenced yet.
BH24A	Not measured	12.4	50	8.4 – 12.4	Constructed February 2019	Unknown	Deeper of northern leachate treatment wetland bore pair; developed March 2019; water quality sampling not commenced yet.
BH24B	Not measured	3.6	50	1.0 – 3.6	Constructed February 2019	Unknown	Shallower of northern leachate treatment wetland bore pair; developed March 2019; water quality sampling not commenced yet.
BH25A	Not measured	9.5	50	6.5 – 9.5	Constructed February 2019	Unknown	Deeper of southern leachate treatment wetland bore pair; developed March 2019; water quality sampling not commenced yet.
BH25B	Not measured	3.5	50	2.0 – 3.5	Constructed February 2019	Unknown	Shallower of southern leachate treatment wetland bore pair; developed March 2019; water quality sampling not commenced yet.

RL = Relative Level of bore at ground level (m AHD) WL = Water Level BH = Bore Hole

The treatment wetlands pilot trial will be located just to the south of the PSWP and south west of the PLP (Figure 6). As they are located in a naturally wet area, it is likely stormwater drains will be required to divert external runoff around the wetlands to the PSWP or PSWPD. Presumably, water quality monitoring of the wetlands themselves will be required by Syrinx to ensure they function as required, although whether this will be performed as part of the CRDS SGWMP is undetermined at this time. Should this monitoring be integrated with the CRDS SGWMP, several new surface sites are likely to be required.

In February 2019, 4 shallow monitoring bores were installed on the site of these wetlands (Figure 6):

- Downgradient bore pair – BH24A (12.4 m deep) and BH24B (3.6 m)
- Upgradient bore pair – BH25A (9.5 m) and BH25B (3.5 m)

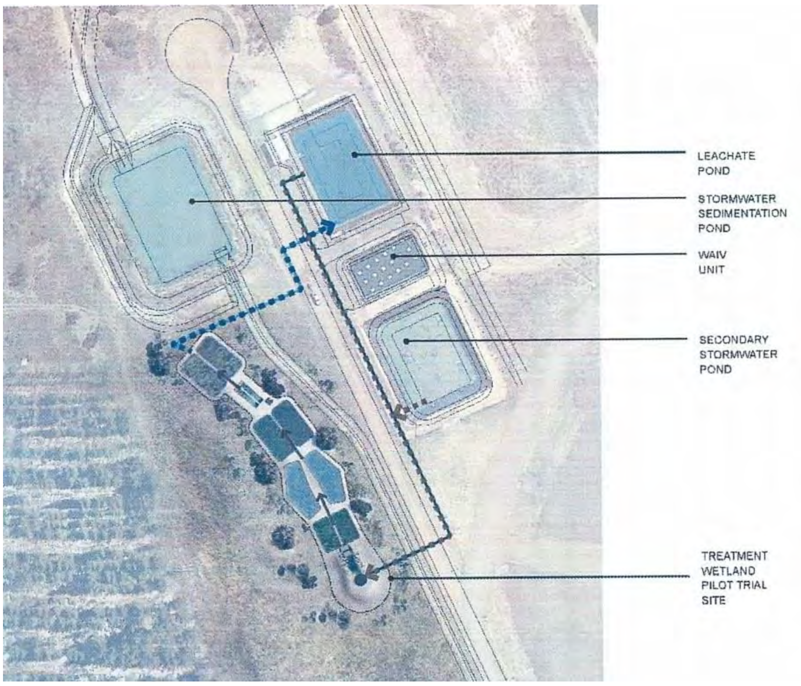

Figure 6: Proposed Pilot Leachate Treatment Wetland (Source: Syrinx, 2018)

Water level measurements made by AquaSci on 19 March 2019 suggest that sampling of the two shallow bores BH24B and BH5B for the full parameter suite required by the CRDS SGWMP may be problematic during drier times to the low volumes of water present. In both bores, the static hydraulic head was 1 m or less, which equates to a volume of approximately 2 L or less. Quarterly sampling (Group 1 parameters) requires approximately 1.4 L, six monthly sampling (Groups 1 – 3 parameters) 1.7 L and annual sampling 3.8 L per site (Groups 1 – 4 parameters). At wetter times, it is expected that water levels will be close to ground level with greater volumes available for sampling.

Figure 7: CRDS Surface and Groundwater Monitoring Sites, March 2019

Although organics (Group 4) sampling may not be possible at some events, it should be noted, that most of these compounds have rarely or never been detected at within CRDS leachate, and there seems little point in sampling for them. As noted earlier, PFAS sampling should be performed annually.

In summary, with the development of the proposed B-Cell expansion and treatment wetlands, the CRDS SGWMP will require additional sites to adequately perform its functions. In the case of surface sites, the exact nature of these is unknown at this time, but any additional sediment setting ponds and leachate storages will require monitoring as will any drains leading from sediment settling ponds to the external environment of the marsh and the CRT. The pilot leachate wetlands may also require monitoring at several new surface sites.

Based on Cromer's groundwater study (Cromer, 2018) and Syrinx requirements, additional bores have already been drilled, installed and developed to adequately monitor groundwaters into the immediate future. As landfill cells expand northwards in the future, BH23 is likely to be subsumed by the cells, and BH2 will become the near cell monitoring bore. An additional downgradient bore will be required within the marsh as the CRDS downgradient monitoring bore. With further spread to the northern end of the site an additional near cell bore(s) is likely to be required at that end of the site.

4.5 Leachate Indicators

The chemistry of landfill leachates is complex, and contamination of surface waters and the breakthrough of leachate into groundwater can be difficult to detect. Nonetheless, a number of changes are known to occur, such as increases in the levels of "leachate" cations such as potassium and ammonium relative to "native" cations such as sodium, calcium and magnesium. The ratio of the concentrations of these "native" "cations ions (or groups of these ions) may be indicative of the presence or absence of leachate, and are therefore known as leachate/non-leachate or L/N ratios. The use of ratios, rather than absolute values, allows comparisons between groundwaters with different total dissolved solids concentrations or salinity. The use of L/N ratios is recommended where background groundwater salinity is elevated (Mulvey, 1997), as is the case at the CRDS.

Leachate breakthrough forming a plume may occur in three phases (Mulvey, 1997):

- Phase 1 – bicarbonate and sulphate levels rise relative to the chloride level; calcium, magnesium and sodium levels rise relative to potassium and ammonium; these changes represent the displacement of native ions in front of the leachate plume, but their detection may be affected by soil type and other factors.
- Phase 2 – Biological oxygen demand, ammonium and potassium levels rise sharply and iron, zinc and the Mulvey L/N ratio rise.
- Phase 3 – pH may rise along with bicarbonate; sulphate, iron and zinc levels fall; ammonium, potassium and L/N ratio continue to rise.

In soil profiles of low permeability (clay), these phases may be distinct and well separated, but in more permeable substrates, much less so.

The fate and level of each leachate contaminant within groundwater is complex and depends on a range of factors (Christensen *et al*., 1994) including:

- Dilution.
- Biodegradation.
- Sorption.
- Dissolution.
- Precipitation.
- Volatilisation.
- Complexation.
- Ion exchange.
- Redox processes.

Landfill leachates vary in their composition. The CRDS B-Cell leachate has been characterised at various times over the duration of the monitoring program, including in this review (previous section). The purpose of this characterisation is twofold:

- To identify threats to the receiving environment in the event of leakage or a spill.
- To identify which parameters or combinations of parameters differ from native CRDS surface and groundwaters and therefore potentially be useful indicators of leachate contamination.

In the case of the CRDS, an extensive temporal body of data exists for a range of surface and groundwaters commencing from October 2001 and extending to March 2019 to date. This has provided a good understanding of natural variability at each site as well as the development of leachate over time allowing re-evaluation of the efficacy of the indicators used to detect leachate contamination and also the water quality monitoring program itself.

Various L/N ratios have been examined for PLP leachate over the duration of the CRDS SGWMP to reveal those likely to be most useful for the detection of leachate in other surface waters and particularly groundwaters, and equally importantly, those unlikely to be of use. The $K^{+}+NH_4^{+}+NO_x/Na^{+}$ ratio (modified Mulvey Ratio), is currently utilised for routine reporting as this proved to be sensitive for CRDS leachate in the past, and can be applied from the earliest sampling event in 2001. This modified ratio has been used rather than the Mulvey Ratio ($K^{+}+NH_4^{+}+NO_x/Mg^{2+}+Ca^{2+}+Na^{+}$) since the latter requires Ca levels, which were not determined until July 2010. Additionally, both ratios show very similar results for the 2010 – 2018 period and it has been possible to plot the changes in the modified ratio within the PLP from 2001 prior to waste disposal commencing to the present time (Appendix A).

This process has also been done for a range of other L/N ratios that may indicate the presence of leachate (Appendix A). Those showing little change as the leachate developed were unlikely to be useful as indicators of leachate contamination. Those showing large changes from uncontaminated conditions were much more likely to be useful (principally those involving changes in the levels of the leachate cations K^+ and NH_4^+.)

Changes from baseline values in the following L/N ratios are potentially useful indicators of leachate contamination:

- Cl^-/K^+ (decrease)
- Cl^-/NH^{4+} (decrease)
- Mg^{2+}/NH^{4+} (decrease)
- Na^+/K^+ (decrease)
- Na^+/NH^{4+} (decrease)
- Modified Mulvey Ratio - K^++NH_4^++NO_x/Na^+ (increase)
- Modified Mulvey Ratio - K^++NH_4^++NO_x/Mg^{2+}+Na^+ (increase)
- Mulvey Ratio - K^++NH_4^++NO_3/Mg^{2+}+ Ca^{2+}+Na^+ X 100 (increase)

Comparison with current groundwaters (Tables 6 and 7) reveals marked differences between leachate and uncontaminated groundwaters for 4/5 December 2018 as an example. The exception was BH15B (located in a temporary perched aquifer), which appeared to have received surface runoff with elevated nutrient levels from bird faeces and the active landfill B-Cell 4 adjacent to it. As the differences are great, these indicators should be sensitive enough to detect even moderate levels of contamination, as was the case with BH15B.

Any increase in the Mulvey Ratio or the modified version currently in use at a site would trigger an investigation as to the reasons for this, including leachate contamination. A decrease in the other ratios listed above may be used to confirm this. Significantly, Mulvey (1997) notes that changes in the relative ratios of native to leachate cations and anions may be first indicator of leachate breakthrough, preceding changes to background parameter levels. Typically the L/N ratio in groundwater leachate plumes is two orders of magnitude higher than native groundwater (Mulvey, 1997).

In addition to L/N ratios, soluble As levels are high in CRDS B-Cell leachate, but very low in all other surface and groundwaters. Any increase in soluble As levels at any site above natural variability may would be indicative of leachate contamination. Similarly, Cr levels are an order of magnitude higher in the PLP than at other sites not containing leachate and increases in this parameter at a site may provide evidence of leachate contamination. Nonetheless, it should be noted that high metal levels in leachate may not translate into high levels in groundwater leachate plumes due to their removal by sorption processes (Christensen *et al*., 1994).

PFAS analyses were performed in December 2017 and September 2018 for a suite of 21 compounds. PFAS were detected in leachate ponds (Sum PFAS 10.29 – 14.2 μg/L) but not in waters uncontaminated by leachate. In addition, very low levels were also detected in the PSWP (SS3) adjacent to the PLP, and traces in the PSWPD (SS5), suggesting these compounds may be a useful leachate indicator. PFAS were not detected in any bore apart from low levels in BH15B in December 2018. As noted above, this bore appears to have received rainfall related runoff from Cell 4 nearby.

L/N Ratios: Comparison Between Groundwaters (BH) and Leachate (SS1) 4/5 December 2018								
L/N Ratios	BH13	BH1	BH7	BH10A	BH10B	BH12A	BH12B	SS 1
Cl/K	375.0	366.7	700.0	700.0	666.7	300.0	166.7	18.8
Cl/NH_4^+	100,000	81,481	123,529	2,100,000	2,000,000	71,429	4,545	8.1
Mg/NH_4^+	16,667	14,074	19,412	280,000	280,000	5,238	295	0.9
Na/K	93	57	260	277	273	120	83	14
Na/NH_4^+	24,667	12,593	45,882	830,000	820,000	28,571	2,273	5.9
$K^++NH_4^++NO_x/Na^+$	0.011	0.018	0.004	0.004	0.004	0.008	0.012	0.241
$K^++NH_4^++NO_x/Mg^{2+}+Na^+$	0.006	0.008	0.003	0.003	0.003	0.007	0.011	0.209
$K^++NH_4^++NO_3/Mg^{2+}+ Ca^{2+}+Na^+$ X 100	0.496	0.553	0.219	0.238	0.244	0.576	1.055	20.183

Table 6: Leachate ratio comparisons – B-Cell groundwater bores and PLP leachate (SS1)

L/N Ratios: Comparison Between Groundwaters (BH) and Leachate (SS1) 4/5 December 2018						
L/N Ratios	BH18A	BH14A	BH15A	BH15B	BH2	SS 1
Cl/K	122.2	550.0	380.0	18.6	296.7	18.8
Cl/NH_4^+	5,500	5,789	135,714	765	890,000	8.1
Mg/NH_4^+	700	1,105	26,429	429	150,000	0.9
Na/K	54	145	80	21	87	14
Na/NH_4^+	2,450	1,526	28,571	882	260,000	5.9
$K^++NH_4^++NO_x/Na^+$	0.019	0.009	0.013	0.198	0.013	0.241
$K^++NH_4^++NO_x/Mg^{2+}+Na^+$	0.015	0.005	0.007	0.133	0.008	0.209
$K^++NH_4^++NO_3/Mg^{2+}+ Ca^{2+}+Na^+$ X 100	1.147	0.362	0.497	8.201	0.597	20.183

Table 7: Leachate ratio comparisons – C-Cell groundwater bores and PLP leachate (SS1)

With the commencement of the measurement of Ca in July 2010, the full Mulvey L/N ratio may be calculated. It is recommended that both the modified and full versions be calculated and tabulated for future events and for all events since July 2010, so that future potential trends may be viewed. Tabulated results for each site should be graphed against time for the periods data is available to better observe changes over time (*e.g.* Appendix A). These graphs can be updated as new data become available.

4.6 Sampling Methodologies

All water samples are collected in accordance with AS/NZS 5667:1998 (Standards Australia, 1998), the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000a) and, where relevant, instructions from the analytical laboratory. The Geoscience Australia Groundwater Sampling and Analysis – A Field Guide (Sundaram et al, 2009) was also consulted concerning groundwater sampling. This is in accordance with EPN 690/1 condition M1(b).

All sample bottles are provided by the analytical laboratory, Australian Laboratory Services, Environmental Division (ALS), Scoresby (t/a Water Ecoscience), Victoria. Samples collected are stored in eskies with freezer blocks for transport to ALS overnight by courier. All results are examined within 24 hours of receipt by AquaSci personnel and any apparent anomalies clarified with ALS immediately. This ensures that samples are still available for reanalysis, if required.

All samples are analysed by Australian Laboratory Services, Scoresby, which is NATA accredited for all of the analyses performed. This is in accordance with EPN 690/1 condition M1(a).

Depending on the recharge characteristics of the bore concerned, one of three strategies have been adopted:

- Water quality samples are collected from bores with high recharge rates (productivity) following the purging of approximately three times the standing bore volume and stabilisation of electrical conductivity within the pumping stream: BH1, BH2, BH7, BH15A
- Bores with lower recharge rates are purged fully of all groundwater a day before samples are collected: BH10A, BH10B, BH12A, BH12B, BH13, BH14A.
- Bores with extremely low recharge rates of weeks or even longer are not purged prior to sampling, but all water is removed with a bailer for water quality samples: BH18A, BH15B (when not dry).

New bores will be sampled using the most appropriate of these three strategies.

Due to the high clay content and relatively low volume of water present, the shallow BH12B is purged and sampled using a 1 m long bailer.

No alteration to current sampling methods is proposed.

4.7 Quality Assurance

As part of some water quality monitoring programs, quality assurance samples are collected in conjunction with samples from each site. These may include duplicate samples (two sets of samples from one site from the same container), field blanks (set of samples filled with deionised water in the field) and laboratory blanks. These are utilised to ensure contamination does not occur within the field or laboratory and that sampling and analytical methodologies are adequate.

To date, quality assurance samples have not been required within the CRDS SGWMP and are not specified within the LSG or EPN 690/1. All required sampling methodologies are adhered to and analytical results have been consistent across many years. All results are examined immediately they are received, and any anomalies are queried with the laboratory. In some cases, samples have been reanalysed to clarify apparent anomalies. It should be recognised that all analytical results will have some variability within the methodology, particularly where results are close to the detection limit (limit of reporting). Anomalous results have been rare.

Quality assurance samples are particularly useful where breakdowns in field sampling methodologies or laboratory procedures are likely, but will attract additional costs. Consistency in the results between duplicate samples and a lack of contamination in blanks adds confidence in the results obtained and that the methodologies followed are effective. However, the fact that small differences in results between duplicates may occur is not well understood, and a considerable amount of time may be spent 'explaining' minor differences in results that are not significant, particularly if results are available to the public. Breakdowns in sampling methodologies usually occur due to the use of untrained personnel or changes in personnel unfamiliar with the specific requirements of the sites sampled. This is unlikely since the same senior water quality consultant has performed this task since the inception of the program in 2001. Where present, field personnel assisting have been trained and supervised by that person at each event.

At this time, the addition of duplicate and other samples is not recommended on a regular basis, unless required by the regulator. However, the addition of a duplicate and a blank sample for example, once per year would confirm that field and laboratory procedures are effective. If problems are encountered, these samples could be collected more often. This would attract the additional cost for a full set of analyses and additional field time each time samples were collected.

4.8 Data Recording and Maintenance

Comprehensive data matrices have been maintained electronically in Excel format for each surface and groundwater monitoring site since monitoring commenced in 2001. These are updated once laboratory results have been received after each sampling event. Data for sites that are no longer sampled are maintained separately by AquaSci, and are available on request.

Temporal trended graphs of all Group 1 – 3 parameters for all surface and groundwater sites are maintained and updated each event in Excel format. All graphs use a standardised formatting system, which has been maintained since 2001. Where relevant, ANZECC/ARMCANZ guideline levels are also shown, although where parameter values are much higher or lower, they are omitted. With the advent of a range of new sites, and the use of several versions of Excel for older data sets, these graphs require revision *e.g.* which sites are grouped onto a single graph, and replotted in the latest version of Excel to simplify updating. Since January 2019, graphs have been forwarded to SWS each quarter in pdf format due to formatting incompatibilities between different versions of Excel used by AquaSci, SWS and the EPA.

Detailed, written reports are submitted each quarter (all reports are listed in the References, Section 6). Quarterly reports are generally submitted within one month of the receipt of the laboratory results, unless there are delays due results queries or reanalyses. These are submitted to Southern Waste Solutions in electronic form (pdf files). The format of these reports was agreed to by Southern Waste Solutions and the EPA (then the Environment Division) in 2005. These reports have been quite detailed in the past and despite recent changes to refine these, some simplification would be desirable. Quarterly reporting is not a requirement of EPN 690/1, and simplification of quarterly reports does not appear to require a modification of the EPN.

Written annual reports are more detailed and submitted to Southern Waste Solutions within two months of the receipt of the laboratory results. These analyse all results received over the previous year in the context of historical data trends and various water quality guidelines.

These are submitted to Southern Waste Solutions in electronic form (pdf files). As with quarterly reports, detailed historical data matrices and time trended graphs for each parameter tested at each site are submitted electronically in Excel or pdf format. This is in accordance with EPN 690/1, condition M2(h), which requires the submission of an annual interpretive report, together with analyte trend lines not later than three months after the conclusion of the relevant twelve month monitoring period.

4.9 Flow Estimates

Schedule 3 Section M1 (c) of EPN 690/1 notes that:

"All records of sampling and analysis (including an estimate of flow of effluent/water at the time of sampling) shall be retained for at least 3 years after the date of sampling and made available for public inspection upon request;"

It is unclear from the above specifically what flow estimates are required. As noted earlier, subjective estimates of flow and water levels are recorded at each site each sampling event and a photographic record maintained.

During unusual events, such as the April 2014 controlled discharge from the SSWP, more accurate flow estimates have been measured using a variety of methods based on cross sectional area, surface flow rates, water depths at pinch points and so on. Nonetheless, in the absence of structures such as V-notch weirs, actual flow rates cannot be measured. Several sites are available where such structures could be installed if required, for example within the CRT, marsh creek and PSWP drain.

Some clarification is required to determine the nature of flow estimates required by the EPN.

4.10 Other Items

4.10.1 Water Quality Guidelines

For the purposes of the ANZECC/ARMCANZ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), the CRT is classed as "freshwaters (flowing)" and its ecosystem as a moderately disturbed or Condition 2 ecosystem due to agricultural degradation, land clearing and forestry plantations upstream and downstream of the CRDS site. Table 8 presents existing ANZECC/ARMCANZ (2000) guideline threshold trigger values for ecosystem protection for the relevant parameters for slightly disturbed lowland river ecosystems (there are no guidelines for moderately disturbed systems), as well as various toxicant trigger values for metals for the protection of 95% or 99% of species. The recommended guidelines for waters used for agricultural purposes (ANZECC/ARMCANZ, 2000) are also included in the table as the waters of the Carlton River downstream are used for agriculture, as well as relevant Australian Drinking Water Guidelines (NHMRC/NRMMC, 2011) as these waters may potentially be consumed by humans, although this is unlikely.

It is stressed that the guidelines for ecosystem protection are specifically designed for flowing surface waters *i.e.* rivers and streams and it is invalid to apply them to wetlands or storages. In the case of the CRDS, these are the receiving waters of the CRT at sites SS6 and SS7.

Currently, there are no water quality guideline threshold values for groundwaters and groundwater protection strategies are poorly developed in Australia (ARMCANZ/ANZECC, 1995). The principal reason for monitoring groundwater at the CRDS site is to ensure that leachate does not enter and contaminate groundwater, and background water quality is not compromised. In the event that this did occur, the surface water guidelines may provide a useful baseline for the assessment of the risk of potential adverse impacts should groundwaters discharge to surface waters.

It is a requirement of the CRDS EPN 690/1 that groundwater quality be assessed against the ANZECC/ARMCANZ (2000) guidelines for surface water ecosystem protection. However, it should be noted that the baseline levels of many parameters within groundwaters may naturally exceed these guidelines *e.g.* electrical conductivity, and their application to groundwaters is questionable. In addition, potential impacts would depend on the resultant water quality within the receiving waters of the CRT following any groundwater inputs, which is where the guidelines are relevant and applicable. The application of other ANZECC/ARMCANZ (2000) guidelines for various agricultural uses *e.g.* stock water and irrigation would be valid if groundwaters were abstracted for these uses. However, this isn't the case in the vicinity of the CRDS, principally because of the elevated salinity of most groundwaters and the nature of land uses in the area e.g. plantation forestry.

When the CRT is flowing and can be sampled, the actual effects of all discharges are assessed through comparisons in water quality between SS6, the reference site upstream of the CRDS, and SS7, the test site downstream of the CRDS. Where differences are detected, the various ANZECC/ARMCANZ guidelines (*e.g.* ecosystem protection, irrigation and stock water) are applied to assist in the assessment of the likelihood of adverse environmental impacts. Where these are likely, further investigation is undertaken, including additional sampling.

If, as recommended, soluble metal levels are determined for all surface and groundwater sites, direct comparisons with the guidelines would be possible as they are based on soluble metal levels. If background soluble metal levels exceed the guideline values, locally derived guideline values may be derived.

Nonetheless, in the absence of locally derived guideline values, the ANZECC/ARMCANZ (2000) generic values provide a useful reference point for various toxicants and other parameters. Where background soluble levels exceed these values the aim should be to avoid any elevation of these background levels attributable to the landfill, in line with the current National Water Quality Management Strategy (NWQMS) approach.

For management purposes, to determine if any surface discharge from the landfill site to the CRT has the potential to be deleterious (whether or not discharge actually does occur), the levels of key parameters at surface sites may be compared to those at SS6, the upstream control site on the CRT, or with ANZECC/ARMCANZ guideline values. However, this is part of a risk assessment only and whether adverse ecological result will depend on a range of factors including attenuation and dilution. This can only be determined by the application of the guidelines to the receiving waters within the CRT itself.

Table 8: ANZECC/ARMCANZ (2000) Trigger Values for ecosystem protection and other relevant guidelines

Parameter	ANZECC/ARMCANZ (2000) Trigger Value Aquatic Ecosystems (Lowland Rivers)	ADWG (2011)	ANZECC/ARMCANZ (2000) Trigger Value Agricultural Waters
pH	6.5 - 8.0	6.5 – 8.5 (corrosion)	6 – 9
Conductivity (µS/cm)	125 – 2,200		<950 - <12,200 (s.d.)
TDS	-	600 (palatability)	<2,000 - <4,000 livestock (s.d.)
TN as N	0.5		25 – 125 STV, 5 LTV
Total Ammonia as N	0.02	0.5 (corrosion)	-
TP as P	0.05		0.8 – 12 STV, 0.05 LTV
Orthophosphate as P	0.02		--
Nitrate	0.04 NO_x	as NO_3 : 50 (infants) 100 (>3 months age)	<400 livestock (as NO_3)
Nitrite	0.04 NO_x	3 (as NO_2)	<30 livestock (as NO_2)
Total CN	0.007 (free)	0.08 (free)	-
E. coli (org/100mL)	-	100	<10 - <10,000 (use dependent)
Chloride	-		25 - >700 (foliar injury – s.d.)
Sulphur as $SO_4^=$	-	250 (sulphate)	<1,000 stock (sulphate)
Sodium (Na)	-	180 (aesthetic)	<115 - >460 (foliar injury - s.d.)
Potassium (K)	-	-	-
Magnesium (Mg)	-	-	<2,000 cattle
	Toxicant Trigger Value Freshwater		
Aluminium (Al)	0.055	0.2	-
Arsenic (As)	0.024 (AsIII) 0.013 (AsV)	0.01	2 STV, 0.1 LTV 0.5 – 5.0 livestock (s.d.)
Cadmium (Cd)	0.0002	0.002	0.05 STV, 0.01LTV 0.01 livestock
Copper (Cu)	0.0014	2	5 STV, 0.2 LTV <0.4 - <5 livestock (s.d.)
Chromium (Cr)	0.001 (Cr VI)	0.05 (Cr VI)	1 STV. 0.1 LTV 1 livestock
Iron (Fe)	-	0.3 (aesthetic)	-
Lead (Pb)	0.0034	0.01	5 STV, 2 LTV 0.1 livestock
Manganese (Mn)	1.9	0.5 (health) 0.1 (aesthetic)	10 STV, 0.2 LTV
Nickel (Ni)	0.011	0.02	2 STV, 0.2 LTV 1 livestock
Mercury (Hg)	0.00006 (inorganic) 99% sp. protection	0.001	0.002 STV and LTV 0.002 livestock
Selenium (Se)	0.005 (Total Se) 99% sp. protection	0.01	0.05 STV, 0.02 LTV 0.02 livestock
Vanadium(V)	0.006 (low reliability)	-	0.5 STV, 0.1 LTV
Zinc (Zn)	0.008	3	5 STV, 2 LTV 20 livestock

All units mg/L unless otherwise stated
STV = Short-term Irrigation Trigger Value (up to 20 years); LTV = Long-term Trigger Value (up to 100 years)
s.d. = species dependent – limit varies with species

4.10.2 EPA Letter 13 April 2018 – Piper Plots

It was suggested that "*The use of graphic Piper plots as a tool to analyse groundwater chemistry changes would be worthwhile adopting for analysis of groundwater (and leachate) around the Copping waste depot*." (EPA letter to SWS, 13 April 2018). Comer (2018) noted in response that the list of major ions analysed could be expanded to include all major ions to allow this, but that the data collected was inadequate to perform Piper plots currently or for past data.

Piper plots are one of a range of graphical methods (*e.g.* Collins and Schoeller Diagrams, Durov plots and more recently, a range of multivariate statistical methods) used to show the distribution of groundwater types (hydrochemical facies) using major ions. It is based on the grouping of major ions into "alkaline earths" (calcium and magnesium), "alkalis" (Na^+ and K^+), "weak acid" (HCO_3^-) and "strong acids" (Cl^- and $SO_4^=$). Groundwaters can be classified into groups such as Ca-HCO_3 waters, Na-Cl waters and so on.

A Piper plot allows the plotting of multiple samples on one diagram and is hence, a useful tool for groundwater surveys. However, it has the disadvantages of the data being normalised to percentages and they cannot easily accommodate groundwaters where other ions are important, as is the case for leachate contamination where ammonia and other nitrogen forms such as nitrate may be important. In addition, they are a relatively coarse tool used to classify broad water types rather than small changes in composition. Piper plots also require specific software to process the data and produce the graphical output.

A Schoeller diagram has the advantage that it can show multiple samples and absolute concentrations, as well as allow comparisons between various anions and cations. Schoeller diagrams can easily be plotted in readily available programs such as Excel. Additional ions can be added where necessary.

Piper plots and Schoeller diagrams are provided for CRDS groundwaters in Figures 8 and 10 for the original survey bores BH1 – 4 in 1996 (Woodward-Clyde, 1998) and Figure 9 and 11 for the current bores in December 2018 (BH1, BH7, BH10A, BH10B,BH12A, BH12B, BH13, BH14A, BH15A, BH15B and BH18A).

It can be seen that groundwaters for all CRDS bores are similar apart from the obvious outlier BH15B, which is located in a temporary perched aquifer, and is dry most of the time. BH12B differs somewhat from other bores also, although this is revealed more clearly in the Schoeller diagram.

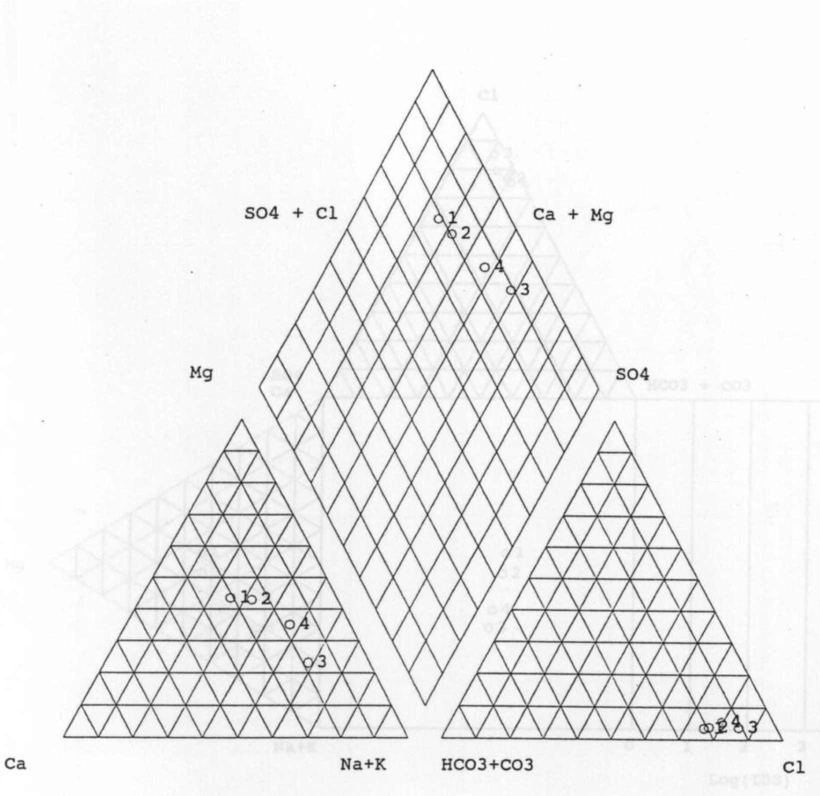

Figure 8: Piper Plot CRDS survey bores, 1996 (Source: Woodward-Clyde, 1998)

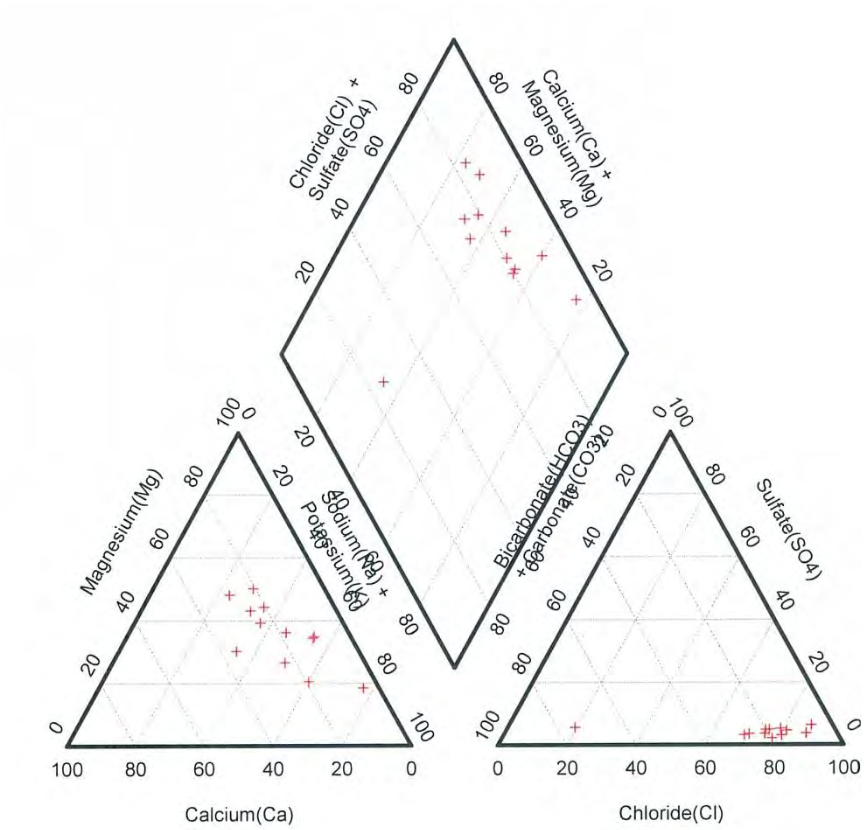

Figure 9: Piper Plot CRDS current bores, December 2018

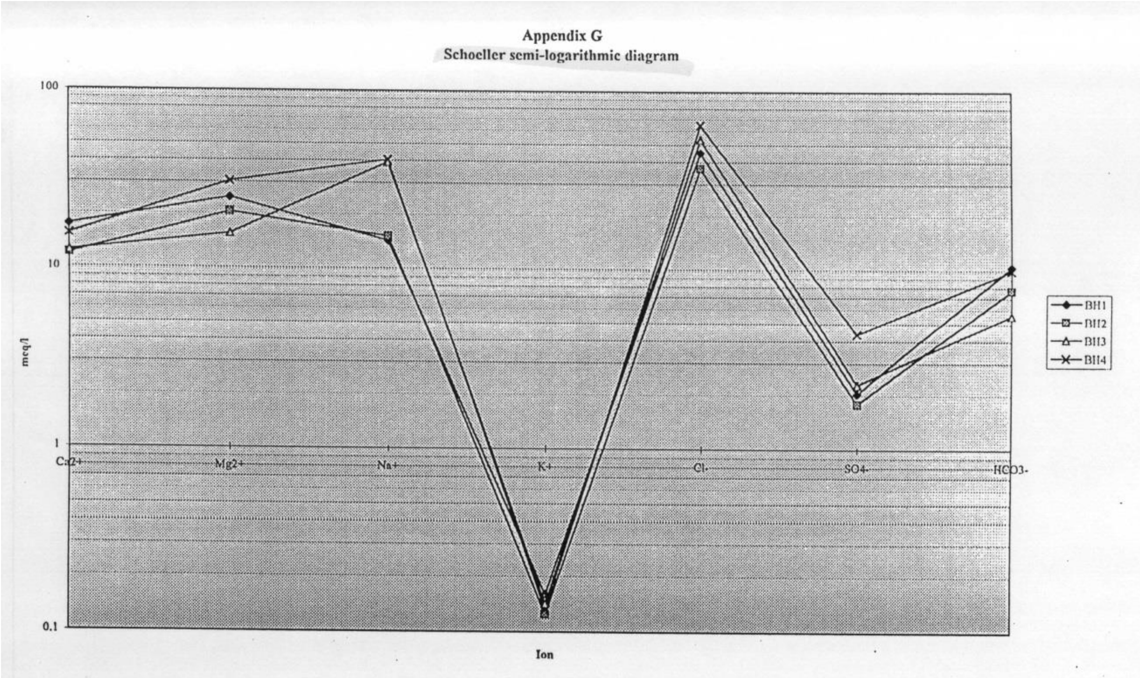

Figure 10: Schoeller Diagram, CRDS survey bores, 1996 (Source: Woodward-Clyde, 1998)

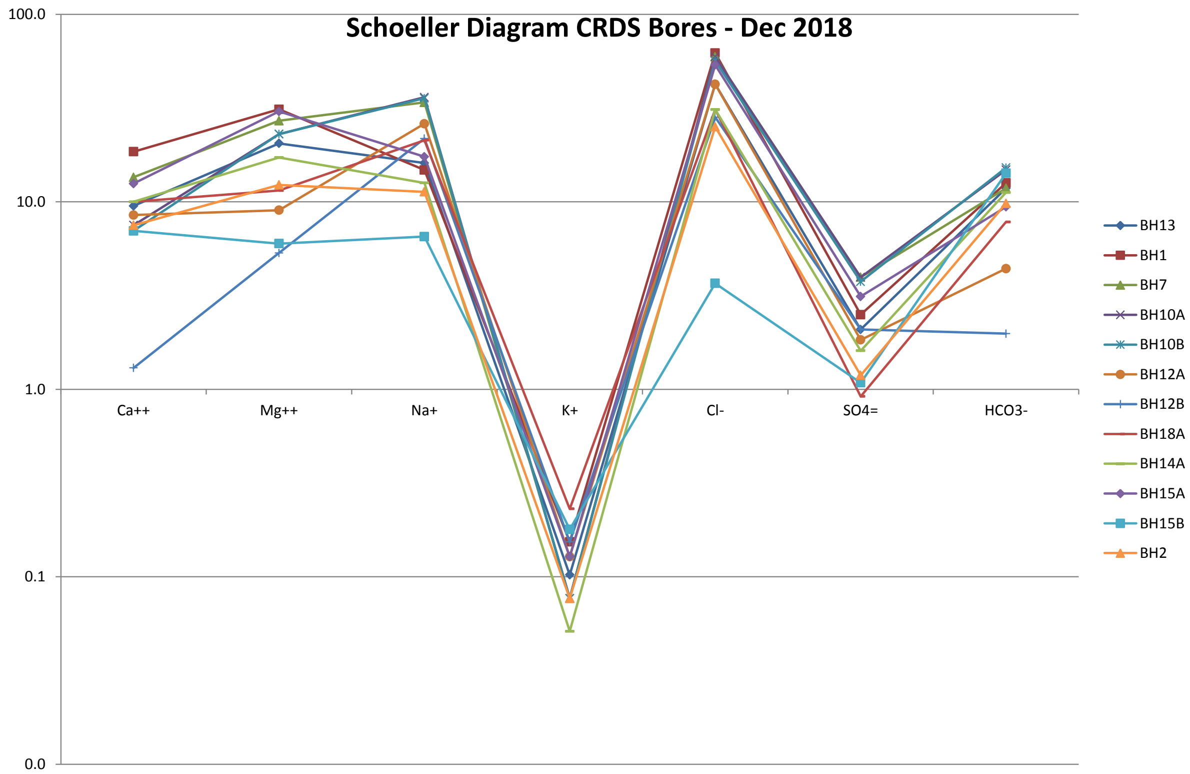

Figure 11: Schoeller Diagram, CRDS current bores, December 2018

Of the Piper plot and Schoeller diagram, the latter appears to be more useful in the CRDS context and is easier to produce. Nonetheless, both graphical representations of water quality are relatively coarse and although the Schoeller diagram may be useful after a significant leachate plume has been established, neither appears to be suitable for the detection of initial leachate breakthrough, where changes in water quality may be relatively small. In the case of the CRDS where groundwater remains uncontaminated, this is currently the highest priority. In addition, these diagrams have a spatial basis and do not usually account for temporal changes, although it may be possible to plot data for the same bore for a number of different dates.

The graphing of individual cation and anion levels and L/N ratios appears to be a more sensitive tool for the detection of small changes in key leachate related ions and their ratios, incorporating other important leachate ions such as ammonia and other nitrogen species (Figure 12).

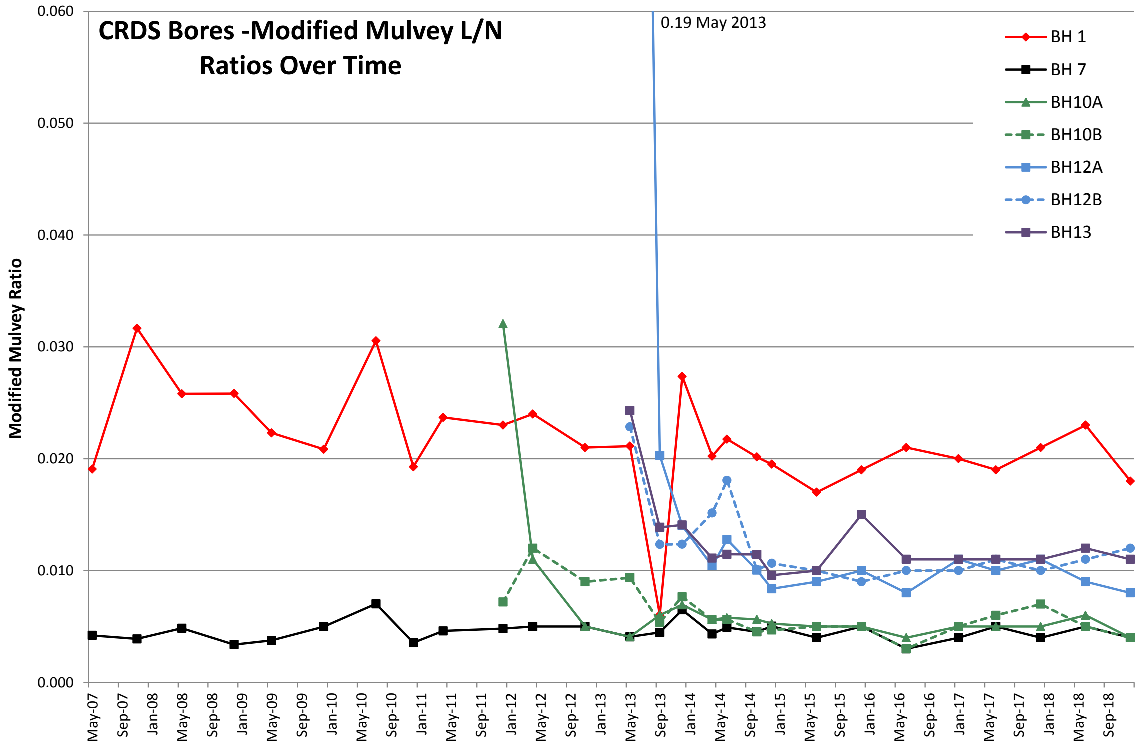

Figure 12: Modified Mulvey L/N ratio over time for CRDS bores

In summary, although Schoeller diagrams and Piper Plots may be useful when new bores are brought on line to examine their relationship to other Copping bores, the most sensitive and useful graphical tool for displaying groundwater quality changes relevant to the CRDS SGWMP *i.e.* leachate contamination, is temporal graphing of individual ion levels (currently performed every sampling event) and L/N ratios.

4.10.3 Site Access and Maintenance

Field sampling is currently conducted over a two day period, quarterly. In general, surface sites are sampled on day 1 and the slow recharge bores are purged. All bores are purged and sampled (BH1, BH7, BH15A, BH2) or sampled (BH10A, BH10B, BH12A, BH12B, BH13, BH14A, BH15B (if not dry), BH18A) on day 2. Sites are sampled in a specific order to maximise the number of sites sampled each day. With the addition of new sites due to the proposed B-Cell expansion and leachate treatment wetland, sampling will extend over three days from June 2019. The exact order cannot be determined until after the first sampling event, likely to occur in June 2019.

Access to a range of these sites requires access to the CRDS site and several sites are fenced with locked gates (*e.g.* the PLP, CLBS, BH14A, BH7). Since the previous program review (AquaSci, 2014), many site access issues have been addressed with all-weather 4WD tracks constructed to most sites, the provision of keys to the locked areas and the provision of locked gates through fences to provide safe access to a range of sites such as SS14 and BH1. This has reduced costly delays during sampling, particularly during annual events, which require the collection of a greater number of samples and a larger volume of water than quarterly or six-monthly events.

Initial access and final egress is via the weighbridge. A Dallas key has been provided for this purpose. This provides a record of entry and exit to and from the site and works well. In addition, on site Downer EDi personnel are notified on arrival and departure. On arrival, AquaSci personnel are advised of on-site conditions and any operations they need to be aware of. AquaSci has the mobile phone number of the senior Downer employee on site and notify him as well as SWS in advance of sampling dates.

Prior to the previous review, construction activities often damaged or interfered with sampling access tracks and infrastructure. This disturbance has been reduced or unavoidable since then.

With the advent of new sites including ten new bores and an unspecified number of new surface sites, all weather access will be required during and after construction as well as some improvements to current site access:

- Following the recovery of plant growth following the 2013 bushfires, a small walking track from PSWP spillway along the western side of the PSWP drain to SS5 has become overgrown. This requires the trimming of this vegetation by brush-cutter. This vegetation should be trimmed approximately once each year.
- Small foot tracks used to access both SS6 and SS7 on the CRT also require vegetation trimming. Heavy vehicles such as graders should not be used unless damage to the access track can be avoided.
- All-weather access tracks will be required to all new surface and groundwater sites.
- All new bores require a blue metal/rock pad around them to prevent soil/clay contamination during sampling.

- Where required, large rocks should be placed between bores and roads to prevent large vehicle access similar to BH15A.
- The access track to the PSWP and its drain has been used by large vehicles (presumably to turn around) and now has deep ruts. These should be flattened and the track access made inaccessible to large vehicles.
- Large vehicle access should be prevented to any of the all-weather 4WD tracks to sampling sites, especially that to the CRT; these are suitable only for light vehicles and are damaged by heavier vehicles. There is a tendency for the access to these to be damaged by heavy vehicles using them as turning circles, principally during construction activities when a range of external contractors are on site.
- Vegetation growing around BH7 should be kept trimmed down to facilitate sampling.
- The hinges on riser tops should be oiled from time to time. Sprays such as WD40 should be used with care to ensure none coats the bore caps and provides a source of contamination for samplers. Care should be taken that no lubricant enters any bore, or covers plugs.
- Rock pads around bores may require flattening from time to time, especially if used by heavy vehicles, although the latter should be prevented.
- Bores in active landfill areas should be surrounded by high visibility tape and access to their surrounding rock pads limited to prevent damage.
- As with current bores, any new bores in areas accessible to the public should have lockable caps. These should utilise the same key as current bores, which AquaSci has been supplied with.

4.10.4 Maintenance Responsibilities

Major maintenance such as vehicular access, roadworks, rock pads and so on would need to be completed by on site Downer EDi personnel between sampling events following direction by SWS, as required and when other duties permit.

Minor maintenance such as vegetation clearing around bores, along walking tracks and around surface sampling sites, lubrication of bore riser lids and locks and ensuring well plugs are present and functional could be performed by SWS personnel or by AquaSci personnel. A single day per year is likely to be required for these functions. Responsibility for these functions needs to be assigned.

Condition assessments should be prepared by AquaSci personnel during sampling as they use these assets most often and are most familiar with them. For sampling site and access tracks not within the active landfill area (and hence not visited routinely by on site Downer EDi or SWS personnel), AquaSci personnel should be available when required to familiarise Downer EDi or SWS personnel with what maintenance is required and where.

4.10.5 Work Health and Safety

Several WHS issues raised by AquaSci during the previous review have been addressed.

All AquaSci personnel complete the SWS site induction annually and all personnel are familiar with the site and its operations having sampled there at least several years, and in one case since the commencement of operations in 2001. AquaSci also has a WHS policy and SOPs covering activities on the CRDS site.

Downer personnel and SWS are notified when AquaSci personnel will be on site. Downer personnel are consulted in the site office on arrival so that AquaSci personnel are aware of activities at that time and any limitations on their activities. Downer personnel are also advised by phone on departure. In addition, AquaSci arrival and departure is logged by the weighbridge.

AquaSci holds the appropriate Public Liability, Professional Indemnity, Vehicle and Workers Compensation Insurances and certificates of currency.

There has never been a WHS incident involving AquaSci personnel on the CRDS site.

4.10.6 Event Sampling

Event sampling occurs in response to specific sets of conditions *e.g.* extreme rainfall. In some cases it is known that these events will occur, although not when but in other cases, events may be unpredictable.

AquaSci personnel are generally contactable at most times and water sampling equipment and sample bottles and so on are maintained in Hobart. This allows a rapid response where event sampling is required.

Some delays are unavoidable if sampling is required on a Friday or over the weekend as samples cannot be couriered to the analytical laboratory on these days. In these situations, samples are stored at 4 ^{o}C by AquaSci and couriered overnight to the laboratory on Monday. Some parameters may exceed the holding period for testing *e.g. E. coli* and therefore not be analysed. In the case of the CRDS, *E. coli* samples are not collected under these circumstances as they would not be analysed in any case.

4.11 Contingency Planning

Contingency planning allows rapid and efficient responses to unusual situations that are predictable in the sense that it is known they may well occur, but not when. A case in point was the extreme rainfall event of 9 April 2013. As such, it is possible to formulate responses in advance, so that management (including sampling requirements) is rapid, predetermined and efficient. This may include a response plan approved in principle by the EPA that can be activated almost instantly with a phone call or e-mail. Points of contact could be kept updated on a regular basis, including ‘out of hours’ contacts.

A hazard analysis and risk assessment for the CRDS site would identify the most significant risks and those that would benefit from the development of contingency plans.

It is suggested that contingency plans, incorporating water quality sampling where relevant, be developed for the following:

- Extreme rainfall events and flooding of various parts of the site.
- Leakage or overflows from storages including leachate ponds and stormwater ponds.
- Escape of stormwater from the active landfill area to the perimeter drains and potential movement off site.

Where possible, these should also incorporate points of contact with the EPA and other relevant personnel such as samplers and sets of pre-agreed processes (contingency plans) to allow rapid and appropriate responses to these events. This process avoids ad hoc responses, which may involve considerable delays and uncertainty. If discharges do occur, it is important that this happens when adequate dilution is available to minimise impacts.

Where possible, water quality monitoring during an event (rather than after) is an important part of these plans as it allows an assessment of actual rather than potential impacts, and the effectiveness of management actions. Where management actions are effective, it can be demonstrated to the wider community and regulators that impacts were avoided or minimised.

5 Conclusions and Recommendations

5.1 Conclusions

- The previous review of the CDS SGWMP was completed in 2014.
- A range of issues raised by that review have been addressed including:
  - Site access has been improved, and a range of WHS issues addressed.
  - At the request of the EPA, vanadium was added to the metals analysed in October 2014
  - At the request of SWS, PFAS were added to the group 4 parameters in December 2017, and testing was completed in December 2017 and September 2018.
- The current 2019 review is in accordance with the recommendation that program reviews be completed each three years.
- An examination of long term data trends from October 2001 to December 2018 revealed:
  - Leachate contamination has not been detected within the waters of the CRT.
  - Leachate contamination has not been detected within the groundwaters below the CRDS.
  - Nutrient rich water was detected in BH15B in September 2018, the source of which appeared to be rainfall related surface runoff from the edges of the adjacent landfill Cell 4, and contamination by bird faeces.
- CRDS B-Cell leachate is currently characterised by high EC, TDS, major ion, alkalinity TP and Ortho-P levels and very high COD, TN, TKN and TAN levels (nitrogen nutrients) with most N present as TAN and the remainder as organic-N. The levels of four metals consistently exceed the relevant ANZECC/ARMCANZ (2000) guidelines for ecosystem protection in surface waters, including As, Cr, Ni, V and Zn, although only marginally in the case of Zn. PFOA levels in leachate also exceeded the HEPA (2018) and interim ANZECC/ARMCANZ guideline value for slightly-moderate ecological systems during the two events it was sampled.
- The current location of surface sites meets all the requirements of the LSG and EPN 690/1.
- The current location of groundwater bores meets the requirements of the LSG and EPN 690/1.
- It is recommended the marsh creek be sampled once each two years when flowing, to ascertain the impact of inflows apart from those from the CRDS through the PSWP and drain.
- Although BH13 is useful to monitor leachate leakage from the adjacent CLBP, its proximity to this pond and lack of depth appear to render it unsuitable as an upgradient reference bore.

- The construction of a reference bore upgradient of BH13 should be considered. This bore should be of equivalent depth to BH1. The suitability of the newly constructed BH21 (30.4 m) to perform this task should be assessed.
- As irrigation of leachate is unlikely, sampling of BH12B should be discontinued. The bore should be retained however, in case it is required in the future. Sampling of the deeper BH12A should continue as it forms an upgradient bore for the western side of the CRDS aquifer.
- Since BH10A (7.4 m) is closer to the landfill cells, is a productive bore and has an extended water quality record, it may be argued that it should be retained as part of the CRDS SGWMP rather than replacing it with the new BH10D (7.0 m), which is further away and of unproven productivity.
- In that case, the physically separated BH10A (7.4 m) and BH10C (12.4 m) would constitute the near cell 9 bores, rather than BH10C and BH120D.
- Some clarification is required to determine the nature of flow estimates required by Schedule 3 Section M1 (c) of EPN 690/1.
- A reduction in the list of parameters tested is not recommended since the levels of a contaminant may remain low for long periods, but rapidly rise if conditions change.
- As discussed in the 2014 program review and later monitoring reports, It is recommended that:
    - Soluble as well as total metal levels be determined for all surface sites (as in December 2018).
    - Soluble metal levels be analysed for all groundwaters sampled rather than total metal levels (as in December 2018).
    - Nutrient samples be filtered for groundwaters.
- Since As and PFAS levels across CRDS surface and groundwaters not storing leachate are low or undetectable, the presence of elevated levels of these parameters in leachate may be useful indicators of leachate contamination in addition to the use of L/N ratios.
- Various L/N ratios have been examined for PLP leachate over the duration of the CRDS SGWMP to reveal those likely to be most useful for the detection of leachate in other surface waters and particularly groundwaters. The K^++NH_4^++NO_x/Na^+ ratio (modified Mulvey Ratio), is currently utilised for routine reporting as this proved to be sensitive for CRDS leachate in the past, and can be applied from the earliest sampling event in 2001. Other ratios are also examined where appropriate.
- With the commencement of the measurement of Ca in July 2010, the full Mulvey L/N ratio may be calculated. It is recommended that:
    - Both the modified and full versions be calculated and tabulated for future events.
    - The full Mulvey L/N ratio be calculated and tabulated for all events since July 2010 so that potential trends since then may be viewed.

- Tabulated results of the L/N ratios used should be graphed against time for each site for the periods data is available to better observe changes over time.

- It is recommended groundwater bore monitoring be performed six-monthly, rather than quarterly, except for the inner ring of bores. Leachate has not been detected at any bore sampled to date, and as noted by Mulvey (1997), once detected at the inner bores, may take years to reach the outer bores.
- As precaution, the internal ring of bores (those close to the cells) could remain on a quarterly monitoring cycle to ensure the rapid detection of any leachate breakthrough. The parameter suite tested for these should be increased to include the Group 3 parameters (major ions and metals), which incorporate the other useful leachate indicators. This would currently include BH10A, BH10B, BH15A and BH15B or potentially from June 2019, BH10C, BH10D, BH23, BH15A and BH15B.
- Although the levels of some metals in storages containing leachate (As, Cr, Ni, V, Zn) are elevated and variable, the current six-monthly sampling frequency seems adequate to account for this variability.
- The current 6-monthy sampling frequency appears adequate for metals and major ions in groundwaters but, as bicarbonate may prove a useful leachate indicator with groundwaters, it is recommended that alkalinity (total, bicarbonate and carbonate) be added to the groundwater parameter suite.
- On the basis of the extensive temporal data set and the lack of detections, it is recommended that the current annual sampling frequency for organics parameters (TRH, VOC, PAH, PCB, organophosphate and organochloride pesticides) be limited to the leachate ponds (SS1, SS9, SS10).
- If these compounds are detected in significant amounts within leachate, then the sampling of other sites should be reassessed.
- The lack of PFAS data and their apparent suitability as a leachate indictor indicate that the current annual sampling frequency should be maintained for all surface sites, the inner ring of groundwater bores, and the leachate treatment wetland bores. It should be discontinued for other bores unless detected at inner ring bores.
- Current reporting requirements are more than adequate to report water quality. Some simplification of quarterly and six-monthly reports would be desirable. All time trended parameter graphs should be supplied to SWS in pdf format by AquaSci to avoid incompatibility issues between the versions of Excel in use by those two organisations and the EPA.
- With the advent of new sites, graphing requirements should be re-examined and refined. This should include replotting using the most recent software to avoid compatibility issues between versions of Excel.
- Although Schoeller diagrams and Piper Plots may be useful when new bores are brought on line to examine their relationship to other Copping bores, the most sensitive and useful graphical tool for displaying groundwater quality changes relevant to the CRDS SGWMP *i.e.* leachate

contamination, is temporal graphing of individual ion levels (currently performed every sampling event) and L/N ratios.

- It is stressed that the ANZECC/ARMCANZ (2000) guidelines for surface water ecosystem protection are specifically designed for flowing surface waters *i.e.* rivers and streams, and it is invalid to apply them to wetlands or storages. In the case of the CRDS, these are the receiving waters of the CRT at sites SS6 and SS7.
- It is a requirement of the CRDS EPN 690/1 that groundwater quality be assessed against the ANZECC/ARMCANZ (2000) guidelines for surface water ecosystem protection. However, it is noted that the baseline levels of many parameters within groundwaters may naturally exceed these guidelines *e.g.* electrical conductivity, and their application to groundwaters is questionable.
- The location of additional sites into the future will depend on the progress of:
  - Proposed expansion of B-Cells 10 – 17 to the north of the existing cells.
  - Filling of B-Cell 7
  - Treatment Wetlands Pilot Trial
- With the proposed expansion of the B-cells (Cells 10 – 17), a further 6 groundwater bores were drilled and constructed in February 2019 following recommendations within the Cromer (2018) conceptual groundwater model (BH10C, BH10D, BH19, BH21, BH22, BH23).
- Although Cromer (2018) recommended the deepening of one of BH10A or BH10B to intersect Triassic sandstone bedrock, two new bores were drilled some 30 m further from the landfill cells, BH10C and BH10D. As BH10A (7.4 m) is closer to the landfill cells and a productive bore with an extended water quality record, it could be retained as part of the CRDS SGWMP. It would then be unnecessary to sample BH10D (7.0 m), which is further away.
- BH10A (7.4 m) and BH10C (12.4 m) would constitute the near cell 9 bores.
- BH10B (3 m) can be decommissioned when convenient.
- An additional 4 bores (BH24A, BH24B, BH25A, BH25B) were also drilled in February 2019, to monitor groundwater in the vicinity of a proposed leachate treatment wetland complex in the vicinity of the PSWP (Syrinx Environmental, 2018).
- These additional bores appear to satisfy all the LSG requirements for the monitoring of groundwater in the vicinity of the proposed B-Cell expansion into the immediate future.
- As landfill cells expand northwards in the future, BH23 is likely to be subsumed by the cells, and BH2 will become the near cell monitoring bore. An additional downgradient bore will then be required within the marsh as the CRDS downgradient monitoring bore. With further spread to the northern end of the site an additional near cell bore(s) is likely to be required at that end of the site.

- It is unclear what additions to surface sites will be required for the proposed B-Cell expansion until further details are available, but the basic rationale is the separation of stormwater, groundwater and leachate, with appropriate monitoring to ensure this occurs. This would include the monitoring of any additional sediment setting ponds, leachate storages and any drains leading from sediment settling ponds to the external environment of the marsh and the CRT.
- The proposed leachate treatment wetlands will also require monitoring to ensure they perform as designed during the pilot study.
- The current sampling schedule should be modified to include the changes agreed to and circulated to all relevant stakeholders to ensure the correct sites and parameters are sampled each event (*e.g.* provided in Appendix B).
- It is suggested that contingency plans, incorporating water quality sampling where relevant, be developed for the following:
  - Extreme rainfall events and flooding of various parts of the site.
  - Leakage or overflows from storages including leachate ponds and stormwater ponds.
  - Escape of stormwater from the active landfill area to the perimeter drains and potential movement off site.
- Where possible, these should also incorporate points of contact with the EPA and other relevant personnel such as samplers and sets of pre-agreed processes (contingency plans) to allow rapid and appropriate responses to these events.

5.2 Access/Maintenance

With the advent of new sites including ten new bores and an unspecified number of new surface sites, all weather access will be required during and after construction as well as some improvements to current site access:

- Following the recovery of plant growth following the 2013 bushfires, a small walking track from PSWP spillway along the western side of the PSWP drain to SS5 has become overgrown. This requires the trimming of this vegetation by brush-cutter. This vegetation should be trimmed approximately each year.
- Small foot tracks used to access both SS6 and SS7 on the CRT also require vegetation trimming. Heavy vehicles such as graders should not be used unless damage to the access track can be avoided.
- All-weather access tracks will be required to all new surface and groundwater sites.
- All new bores require a blue metal/rock pad around them to prevent soil/clay contamination during sampling.
- Where required, large rocks should be placed between bores and roads to prevent large vehicle access similar to BH15A.

- The access track to the PSWP and its drain has been used by large vehicles (presumably to turn around) and now has deep ruts. These should be flattened and the track access made inaccessible to large vehicles.
- Large vehicle access should be prevented to any of the all-weather 4WD tracks to sampling sites, especially that to the CRT; these are suitable only for light vehicles and are damaged by heavier vehicles. There is a tendency for the access to these to be damaged by heavy vehicles using them as turning circles, principally during construction activities when a range of external contractors are on site.
- Vegetation growing around BH7 should be kept trimmed down to facilitate sampling.
- The hinges on riser tops should be oiled from time to time. Sprays such as WD40 should be used sparingly and with care as it is difficult to ensure none coats the bore plugs and provides a source of contamination for samplers. Care should be taken that no lubricant enters any bore, or covers plugs.
- Rock pads around bores may require flattening from time to time, especially if used by heavy vehicles, although the latter should be prevented.
- Bores in active landfill areas should be surrounded by high visibility tape and access to their surrounding rock pads limited to prevent damage.
- As with current bores, any new bores in areas accessible to the public should have lockable caps. These should utilise the same key as current bores, which AquaSci has been supplied with.

Minor maintenance such as vegetation clearing around bores, along walking tracks and around surface sampling sites, lubrication of bore riser lids and locks and ensuring well plugs are present and functional could be performed by SWS personnel or by AquaSci personnel. A single day per year is likely to be required for these functions. Responsibility for these maintenance tasks needs to be assigned.

5.3 Recommended Changes to Current CRDS SGWMP

The following changes are recommended:

- Soluble as well as total metal levels be determined for all surface sites.
- Soluble metal levels be analysed for all groundwaters sampled rather than total metal levels.
- Nutrient samples be filtered for groundwaters.
- Sampling of BH12B should be discontinued. The bore should be retained however, in case it is required in the future. Sampling of the deeper BH12A should continue.
- The internal ring of bores (those close to the cells) should remain on a quarterly monitoring cycle to ensure the rapid detection of any leachate breakthrough. The parameter suite tested for these should be increased to

include the Group 2 and 3 parameters (major ions and metals), which incorporate the other useful leachate indicators. This would currently include BH10A, BH10B, BH14A, BH15A and BH15B or potentially from June 2019, BH10C, BH10D, BH23, BH14A, BH15A and BH15B.

- The leachate treatment wetland bores (BH24A, BH24B, BH25A and BH25B) be sampled quarterly as for the inner ring of bores.
- Other bores should be monitored six-monthly rather than quarterly.
- Should seepage pits reveal leakage from leachate ponds, bores close to and downgradient of these should also then be sampled quarterly. These include BH1, BH7 and BH19.
- Alkalinity (total, bicarbonate and carbonate) be added to the groundwater parameter suite to provide bicarbonate levels.
- The current annual sampling frequency for Group 4 organics parameters (TRH, VOC, PAH, PCB, organophosphate and organochloride pesticides) be continued for the leachate ponds (SS1, SS9, SS10), but not other sites.
- The PFAS annual sampling frequency be maintained until the next triennial review for all surface sites, groundwaters from the inner ring of bores and treatment wetland bores. For other bores, PFAS sampling should be discontinued.
- Sample the marsh creek once each two years when flowing.
- A resolution is required for the issue of whether the established and productive BH10A (7.4 m) is retained within the CRDS SGWMP or is replaced by the new BH10D (7.0 m), which is further away and of unproven productivity (bore log suggests it may not be as productive). If BH10A is retained, the physically separated BH10A (7.4 m) and BH10C (12.4 m) would constitute the near cell 9 bores, rather than BH10C and BH120D.
- BH10B can be decommissioned when convenient, if not required for purposes other than water quality monitoring.
- The construction of a reference bore upgradient of BH13 should be considered. This bore should be of equivalent depth to BH1. The suitability of the newly constructed BH21 (30.4 m) to perform this task should be assessed.
- Sampling of BH12B should be discontinued, but the bore should retained (not decommissioned) in case required in the future. Sampling of BH12A should continue.
- To establish baseline groundwater conditions, it is proposed the Leachate Treatment Wetlands bores BH24A, BH24B, BH25A and BH25B be sampled quarterly as for the inner ring of CRDS bores for Group 1-3 parameters. However, unless detected in leachate within the PLP, it should be unnecessary to sample for Group 4 organics.
- Current reporting requirements are more than adequate to report water quality but some simplification of quarterly and six-monthly reports would be desirable.

- All time trended parameter graphs should be supplied to SWS in pdf format by AquaSci to avoid incompatibility issues between the versions of Excel in use by those two organisations and the EPA.
- With the advent of a large number of new sites, graphing requirements should be re-examined and refined.
- Although Schoeller diagrams and Piper Plots may be useful when new bores are brought on line to examine their relationship to other Copping bores, the most sensitive and useful graphical tool for displaying groundwater quality changes relevant to the CRDS SGWMP *i.e.* leachate contamination, is temporal graphing of individual ion levels (currently performed every sampling event), some metal levels and L/N ratios.
- Tabulated results of the L/N ratios used for the detection of leachate should be graphed against time for the periods data is available, to better observe changes over time, as is the case with other parameters used for this purpose.
- The proposed expansion of B-Cells 10 – 17 to the north of the existing cells and the leachate treatment wetlands pilot trial will require additional surface and groundwater sampling sites.
- It is unclear what additions to surface sites will be required for these expansions until further details are available.
- With the proposed expansion of the B-cells (Cells 10 – 17), a further 6 groundwater bores were drilled in February 2019 and developed in March 2019 (BH10C, BH10D, BH19, BH21, BH22, BH23). These bores have been incorporated into the CRDS SGWMP and providing all-weather vehicular access has been provided, water quality sampling could commence in June 2019.
- An additional 4 bores (BH24A, BH24B, BH25A, BH25B) were also drilled to monitor groundwater in the vicinity of a proposed leachate treatment wetland complex in the vicinity of the PSWP. As with the new B-Cell bores, these bores have been incorporated into the CRDS SGWMP and providing all-weather vehicular access has been provided, water quality sampling could commence in June 2019.
- The current sampling schedule should be modified to include the changes agreed to and circulated to all relevant stakeholders to ensure the correct sites and parameters are sampled each event.
- Responsibility for these site maintenance and access tasks needs to be assigned.
- Contingency plans be developed for the following:
  - Extreme rainfall events and flooding of various parts of the site.
  - Leakage or overflows from storages including leachate ponds and stormwater ponds.
  - Escape of stormwater from the active landfill area to the perimeter drains and potential movement off site.

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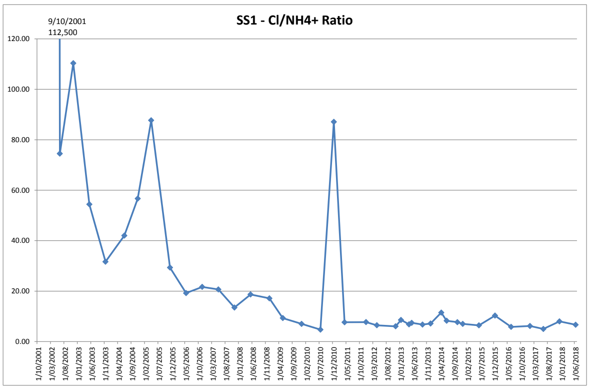
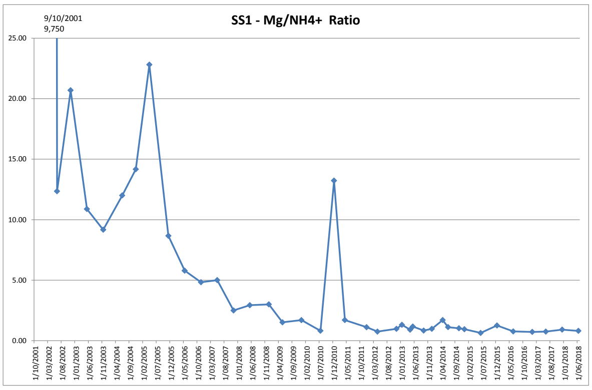
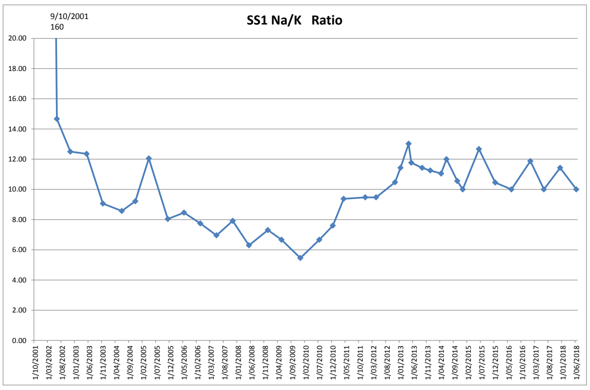
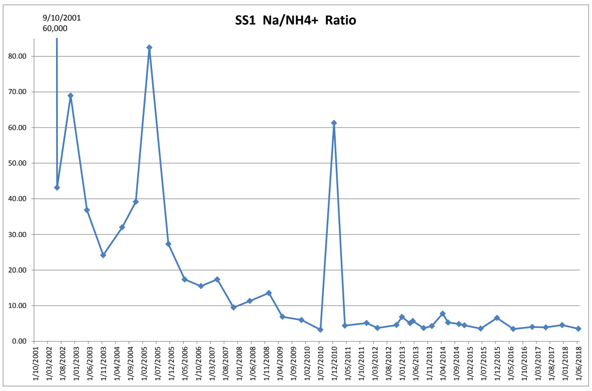
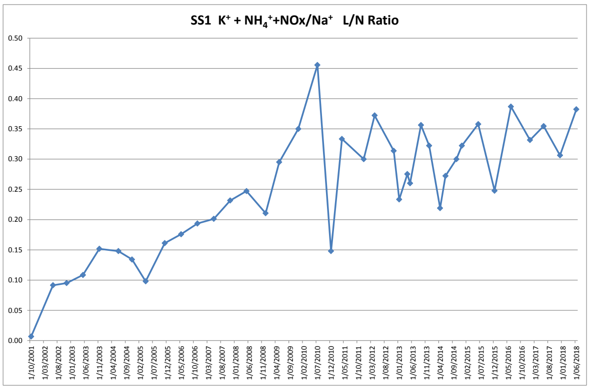
Appendix A: L/N Ratios – Time in SS1

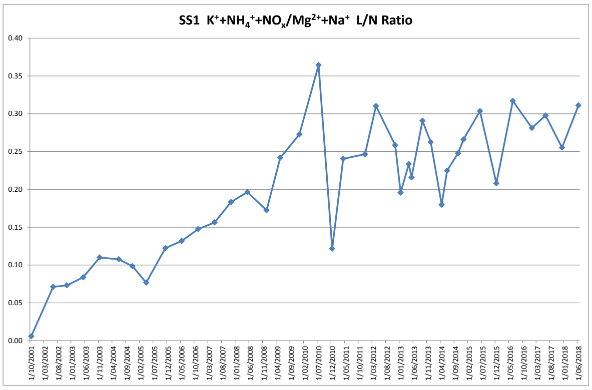

SS1 - Cl/NH4+ Ratio
9/10/2001
112,500

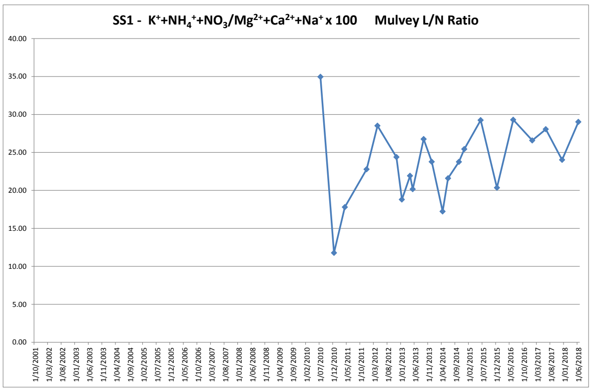

SS1 - Mg/NH4+ Ratio
9/10/2001
9,750


SS1 Na/K Ratio
9/10/2001
160


SS1 Na/NH4+ Ratio
9/10/2001
60,000


SS1 K+ + NH4+ +NOx/Na+ L/N Ratio


SS1 K+ +NH4+ +NOx/Mg2+ +Na+ L/N Ratio


SS1 - K+ +NH4+ +NO3/Mg2+ +Ca2+ +Na+ x 100 Mulvey L/N Ratio

Appendix B: Sampling Schedule

PROPOSED SAMPLING SCHEDULE for CRDS (2019 - 2020)									
Month	**Year**	**Event**		**Sites**	**Total Sites**	**Gp1**	**Gp2+3**	**Gp4**	**PFAS**
Mar	**2019**	Q	SS	All	12				
			BH	Near/LTW Bores	10				
Jun		S	SS	All	12				
			BH	**Near/LWT + 10A**	**11**				
			BH	Far/LP Bores	10				
Sep		Q	SS	All	12				
			BH	Near/LTW Bores	10				
Dec		A	SS	All (SS1, 9, 10 Gp 4)	12			**SS1, 9, 10**	
			BH	All bores	20				
Mar	**2020**	Q	SS	All	12				
			BH	Near/LTW Bores	10				
Jun		S	SS	All	12				
			BH	**Near/LWT + 10A**	**11**				
			BH	Far/LP Bores	10				
Sep		Q	SS	All	12				
			BH	Near/LTW Bores	10				
Dec		A	SS	All (SS1, 9, 10 Gp 4)	12			**SS1, 9, 10**	
			BH	All bores	20				

SITES	
Surface Sites (12)	SS1, SS4, SS2, SS14, SS3, SS5, SS6, SS7, SS9, SS8, SS10, SS11
Near Cell Bores (6)	BH10C, BH10D, BH14A, BH15A, BH15B, BH23
Far/Leachate Pond Bores (10)	BH1, BH2, BH7, BH12A, BH12B, BH13, BH18A, BH19, BH21, BH22
LeachateTreatment Wetland Bores (4)	BH24A, BH24B, BH25A, BH25B

Appendix C: Site Photos

SS1: Primary Leachate Pond (PLP)

SS4: PLP Underliner Drainage Pit

SS2: Secondary Stormwater Pond

SS14: Secondary SWP – Seepage Pit

SS9: C-Cell Leachate Balancing Pond

SS8: C-Cell LBP-Seepage Pit

SS10: C-Cell Main Leachate Pond

SS11: C-Cell MLP-Seepage Pit


SS3: Primary Stormwater Pond


SS5: Primary Stormwater Pond Drain


SS6: CRT Upstream Reference Site


SS7: CRT Downstream Site


Marsh Creek


BH13: Upgradient Reference Bore


BH1: CLBP Bore


BH7: PLP Downgradient Bore

BH10A, 10B: Active Landfill Cell Bores

BH12A, 12B: Irrigation Area Bores

BH18A, 18B: C-Cell Upgradient Reference Bore

BH14A, 14B: C-Cell SW Bores

BH15A, 15B: C-Cell NW Bores

BH2: C-Cell Downgradient Bore

BH10C, D: Active Landfill Cells Bores

BH21: SW Reference Bore

BH19: C-Cell Leachate Ponds Bore

BH22: NE Reference Bore

BH23: B-Cell Near Cell 7-14 Bore

BH24A, 24B: N Treatment Wetland Bores

BH25A, 25B: S Treatment Wetland Bores

Copping Landfill – Stage 2

NATURAL VALUES ASSESSMENT

14th September 2021
For Pitt and Sherry obo Southern Waste Solutions (PAS111)

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Summary

Southern Waste Solutions is seeking a permit for the expansion of the existing landfill site at Copping in southern Tasmania. The planned landfill area consists of an additional 7 landfill cells (cells 10 – 17) and is proposed to extend in a relatively minor way into native vegetation fringing the north of the site. To cap these additional landfill cells, a ~22-ha area to the west of the existing landfill is proposed to be cleared and used as a borrow pit. A field survey was conducted by North Barker Ecosystem Services to assess the potential impact of the proposal on natural values. This assessment forms part of the Environmental Impact Assessment for the proposal. The main findings of the assessment are as follows:

Vegetation

- One threatened native plant community occurs within the survey area. This community is listed as threatened under the Tasmanian *Nature Conservation Act 2002*: *Eucalyptus ovata* forest and woodland (DOV). This community is also listed under the EPBCA as *Tasmanian Forests and Woodlands dominated by black gum or Brooker's gum (Eucalyptus ovata / E. brookeriana)*.
- Impact to the DOV has been avoided.
- The only other native plant community is 0.92 ha of *Eucalyptus pulchella* forest and woodland (DPU). This loss is not significant at a local, regional, and state-wide scale.

Recommendations:

- A 30 m buffer from the development should be implemented to prevent damage to the DOV from edge effects. This will also ensure the proposed impact aligns with recommendations in the EPBC conservation advice for this community.
- Given the DOV buffer area is already cleared/impacted, native vegetation should be allowed to recolonise this buffer area and should be managed for weeds, especially given the prevalence of Spanish heath nearby.
- Ensure that the quality of water that may be drained from landfill to the DOV is not toxic to the vegetation and environment as this may impact the DOV.
- Prior to the commencement of works, the clearance area should be marked (either in situ and/or clearly on construction plans) and all contractor agreements should specify that works, vehicles and materials must be confined to within the designated clearance areas only.

Threatened flora

- No threatened plant species were recorded.
- No impact to threatened flora is anticipated to be present.

Threatened fauna and threatened fauna habitat

- A targeted den survey was conducted in the area proposed for landfill cells where there is a possibility of dens occurring. Accordingly, this search focussed on native habitat (the DVO and DPU) rather than the entirely cleared area of FUM. No potential burrows or dens of the Tasmanian devil or quolls were recorded.
- Scats of Tasmanian devil were recorded in the area proposed for the borrow pit and this area contains friable soils suitable for denning.
- The host plant for the threatened chaostola skipper was consistently recorded throughout the understory of the ~20 ha of FPU.

Recommendations:

- A den survey prior to the clearing of the area for the proposed borrow pit to ensure no burrows or dens that may be in use are destroyed during clearing.
- A survey of the area proposed for the borrow pit to assess the presence of chaostola skipper.
- The proposal will involve potential road upgrades and increases in traffic. It is understood that there will only be daytime use of the road network, so impact to carnivores is not expected; regardless, to mitigate potential increased likelihood of road mortalities the following should be observed:
    - Internal road use should be limited to daytime hours.
    - Speed limits ≤ 40 km/h should be applied to all internal roads during construction and operation.
    - Roadkill mortalities should be removed immediately upon location (to limit likelihood of predators being attracted to the carcass).

Weeds

- Three weed species declared under the Tasmanian Weed Management Act occur in the project area: Spanish heath, serrated tussock and slender thistle.

Recommendation:

- Develop a weed and hygiene management plan to manage the potential spread weeds to/from the site

Legislation

- Habitat for EPBCA listed fauna have been identified in the study area. Impact to habitat for these species is unlikely to result in significant impacts to Matters of National Environmental Significance (MNES) under the definitions under this Act. However, a survey for the skipper is required in the area proposed for the borrow pit to determine if that species is present.
- A permit to take is not likely required under the TSPA. However, if burrows or dens are found and will be destroyed and/or if skipper habitat is confirmed and will be impacted, a permit will be required and referral under the EPBC may be required.
- A 30 m wide corridor under the waterway and coastal protection code as defined in the Sorell Interim Planning Scheme 2015 occurs in the area proposed for the borrow pit. This area has been entirely transformed by forestry and it is our assessment that the proposal is able to meet the requirements of the code.
- The proposal does not conflict with the Permanent Native Forest Estate Policy.
- The proposal will not impact wetlands of international importance (RAMSAR wetlands) or areas or habitats of conservation significance.

Acknowledgments

Project management: Phil Barker

Field work and photographs: Richard White and Cameron Geeves

Report: Cameron Geeves and Richard White (reviewed by Phil Barker)

Mapping: Linda Drummond

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1 Introduction

1.1 Project details

Southern Waste Solutions is seeking a permit for the expansion of the existing landfill site at Copping in southern Tasmania. The planned extension landfill area consists of an additional 7 landfill cells (cells 10 – 17) and is proposed to extend in a relatively minor way into native vegetation fringing the north of the site. This area has been previously surveyed by North Barker in 2007[1] and in 2018[2]. To cap these additional landfill cells, a ~22-ha area to the west of the existing landfill is proposed to be cleared and used as a clay borrow pit.

North Barker Ecosystem Services has been engaged to undertake a natural values assessment of these areas (including a den survey for the area proposed to be impacted by the landfill cells).

The aim of this report is to provide information for the Environmental Impact Statement that will be used to assess the environmental aspects of the proposal. It includes recommendations for minimising environmental impact. The assessment focuses on flora and fauna habitat values of threatened species and vegetation communities.

1.2 Study Area

The existing landfill area is located off Blue Hills Road, Copping, (Figure 1), approximately 20 km east of Sorell. The land is zoned Utilities under the Sorell Interim Planning Scheme 2015 and is part of the Tasmanian South East bioregion[3].

The site contains two separate survey areas. The survey area containing the proposed landfill cells is located in a mostly highly disturbed area immediately north of the current landfill area (Figure 2). The clay borrow pit is located approximately 500 m southwest of the landfill (Figure 3). Altitude across the study area is between 40 and 100 m asl. The study area falls in the 600-800 mm rainfall zone.

1.3 Limitations

Due to seasonal variations in detectability and identification, there may be some species present within the study area that have been overlooked. To compensate for these limitations to some degree, data from the present survey are supplemented with data from the Tasmanian Natural Values Atlas[4] (NVA) and from an EPBC Protected Matters Report[5]. From these sources, all threatened species known to occur in the local area (5 km) are considered in terms of habitat suitability on site.

[1] North barker Ecosystem Services 2007
[2] North barker Ecosystem Services 2018
[3] IBRA7 - Commonwealth of Australia 2012
[4] DPIPWE 2021. Natural Values Report – nvr_1_26-Jul-2021.
[5] EPBC Protected Matters Report, 31/08/2021, ref#PMST_ZEVNVR.

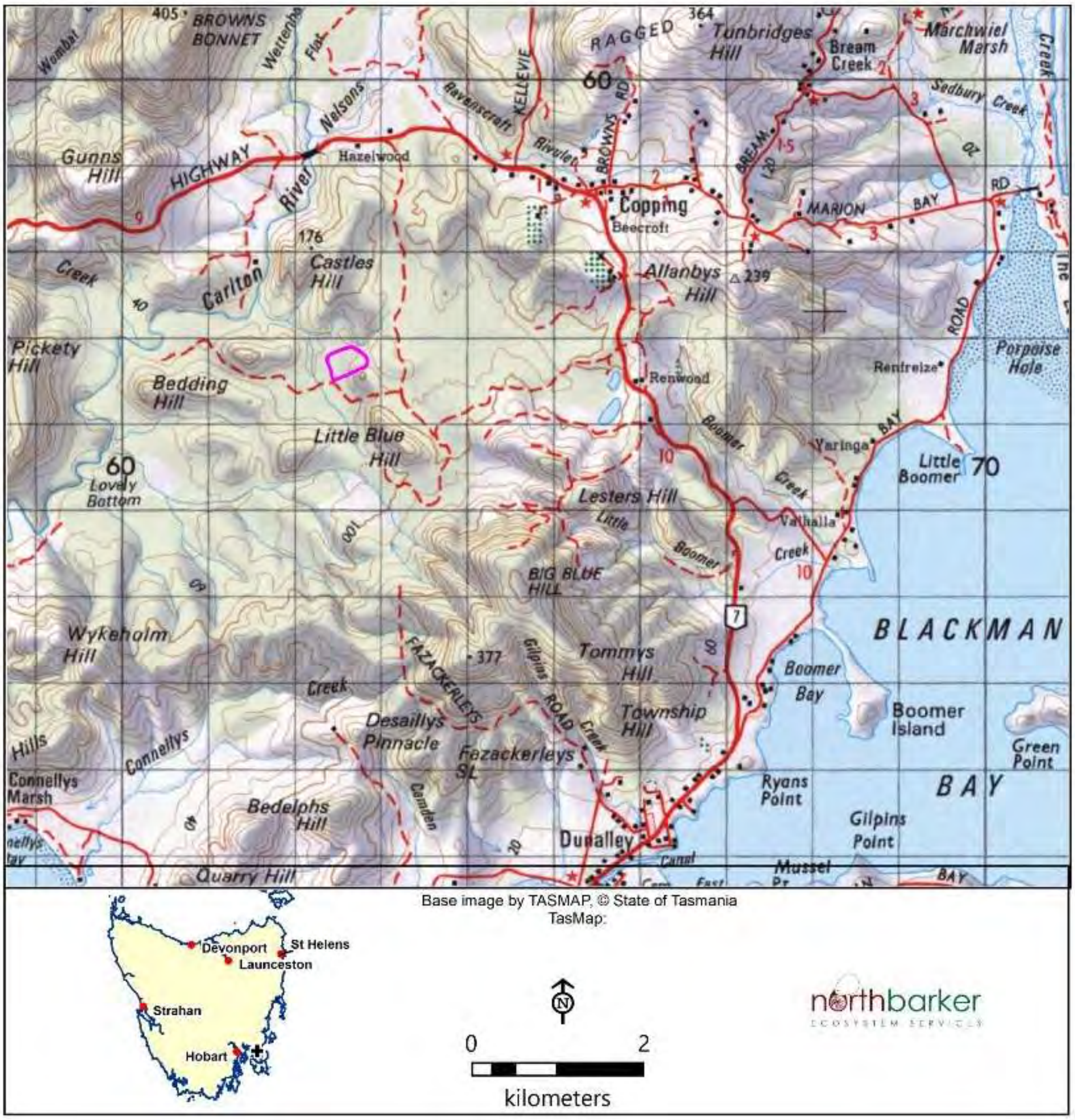

Figure 1 Southern Waste solutions landfill site

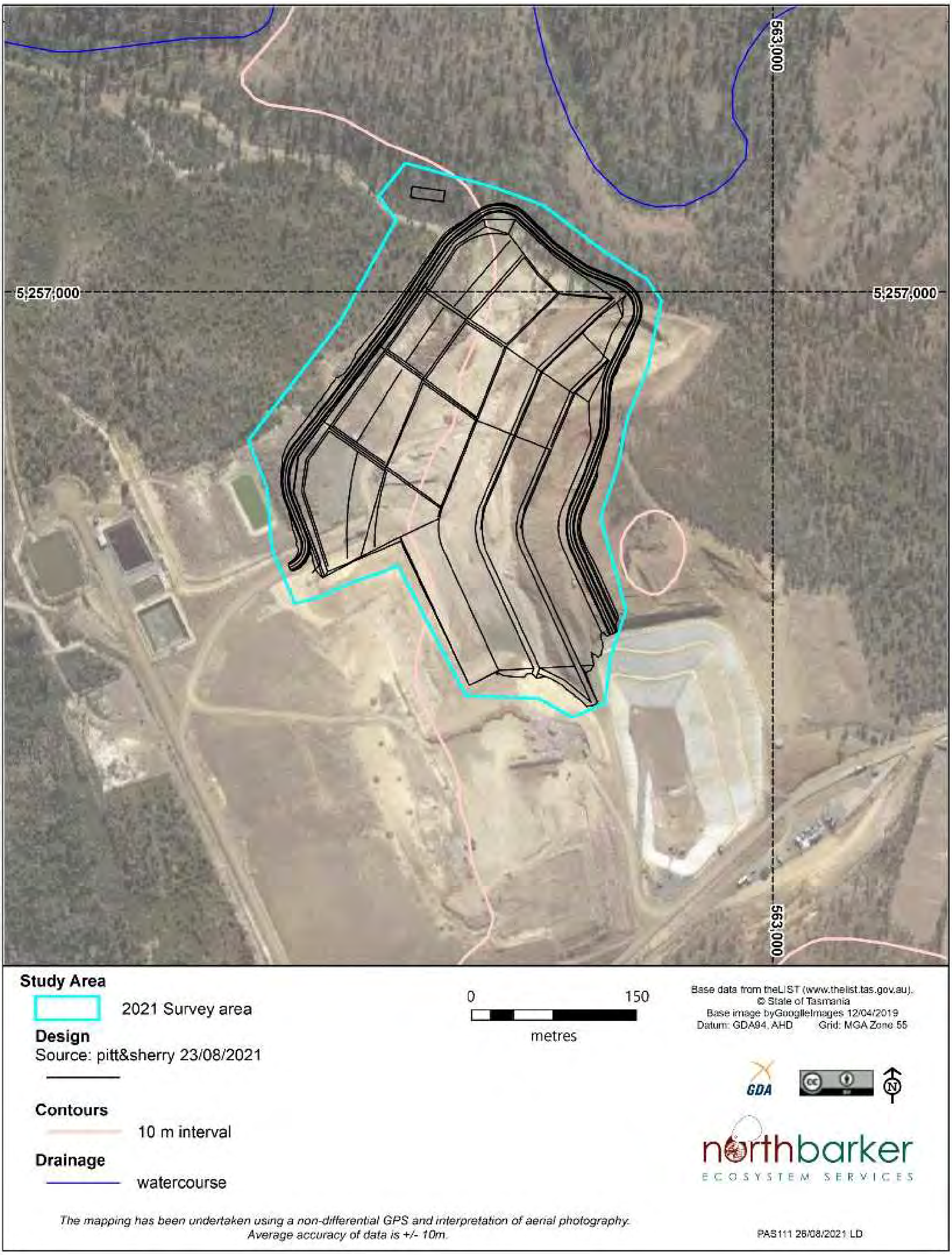

Figure 2 Survey area for new landfill cells

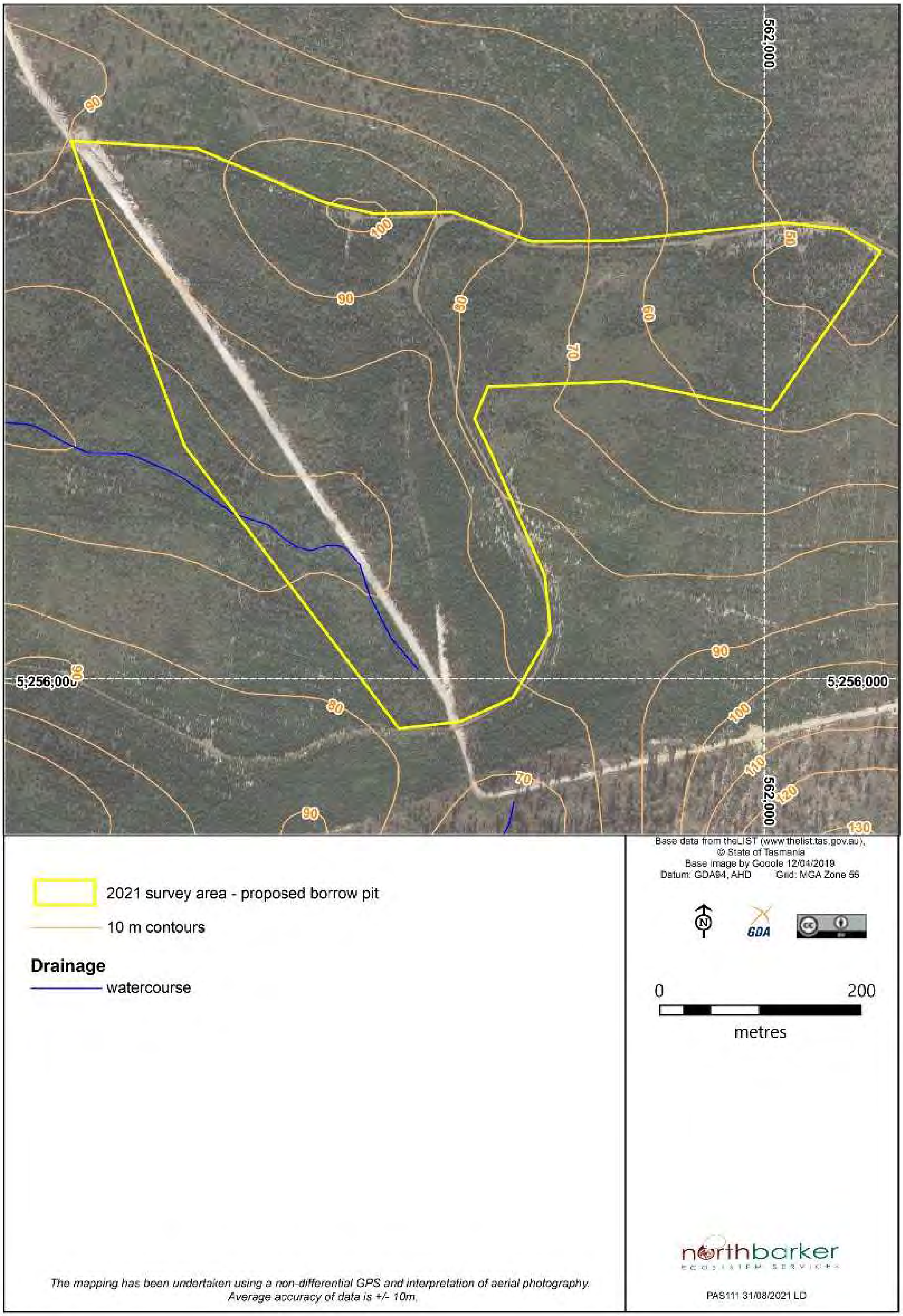

Figure 3 Survey area for the borrow pit

2 Botanical Survey and Fauna Habitat Assessment

2.1 Background Research

The following sources were used for biological records from the region:

- Natural Values Atlas - this Department of Primary Industries, Parks, Water and the Environment, Tasmania (DPIPWE) database includes biological records.
- EPBC Protected Matters Report – all matters of national environmental significance that may occur in the area or relate to the area in some way.
- TASVEG 4.0 Digital Data.

Findings are supported by the results of a previous 2018 survey for a larger area extending to the north and east of the current site[6].

2.2 Botanical survey

Field work was undertaken on foot by three ecologists on the 27th and 28th of July 2021. Vegetation was mapped throughout the area in accordance with units defined in TASVEG 4.0[7]. Plant species lists were compiled according to nomenclature within the current census of Tasmanian plant census[8], using a meandering area search based on the Timed Meander Search Procedure[9].

Any weeds and symptomatic evidence of plant pathogens were noted and assessed for implications for management.

This study does not consider non-vascular plants such as mosses and lichens.

2.3 Fauna Survey, Habitat Assessment and Pre-Clearance Survey

Observations of habitat suitability for fauna, as well as direct or indirect indicators of presence (*i.e.* sightings, scats, tracks, dens, *etc.*) were made concurrently with the botanical survey. Survey effort was focused on the areas outside the existing landfill site. Observations were recorded with a handheld GPS.

The area of vegetation surrounding the existing landfill and proposed new landfill cells has been previously surveyed and identified during a survey by NBES staff as potentially containing denning habitat for Tasmanian devil (*Sarcophilus harrisii*). Tasmanian devils are listed as endangered under both the *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA) and the *Threatened Species Protection Act 1995* (TSPA).

A pre-clearance den survey was conducted within the proposed area to be impacted for the new refuse cells on the 28th of July. The survey was conducted in accordance with the '*Guidelines for Natural Values Surveys - Terrestrial Development Proposals*', prepared by the Natural and Cultural Heritage Division of the Department of Primary Industries, Parks, Water and Environment (2015), and specifically for Tasmanian Devils, the '*Survey Guidelines and Management Advice for Development Proposals that may impact on the Tasmanian Devil (Sarcophilus harrisii) - A supplement to the 'Guidelines for Natural Values Surveys - Terrestrial Development Proposals*', prepared by the Natural and Cultural Heritage Division of the Department of Primary Industries, Parks, Water and Environment (2015).

Due to the labour-intensive nature of the DPIPWE Tasmanian devil den search protocol, the present survey was limited to the cells in this regard. It was proposed that if suitable habitat was encountered in the area for the borrow pit (which had not been previously surveyed,

[6] NBES 2018
[7] Kitchener and Harris 2013
[8] de Salas and Baker 2021
[9] Goff *et al.* 1982

unlike the area occupied by the proposed cells) that a pre-clearance survey would be carried out.

3 Results - Biological Values

3.1 Vegetation

The area occupied by the proposed landfill cells is comprised mostly of cleared land. Adjacent to the cleared area is an area of native vegetation, some of which narrowly overlaps with the project area (Figure 3). This vegetation is generally species poor and in places it is evident canopy trees are still recovering from the severe 2013 bushfires. This is particularly true for the *Eucalyptus ovata* woodland where the resprouting trees have lost their crowns.

The site of the proposed borrow pit consists almost entirely of pine plantation with a remnant heathy understory. One area of plantation has failed and has a significant native component and was thus mapped as regenerating cleared land.

Across both survey areas 5 TASVEG units were recorded, two of which are native vegetation communities:

- *Eucalyptus pulchella* forest and woodland (DPU)
- *Eucalyptus ovata* forest and woodland (DOV)
- regenerating cleared land (FRG)
- unverified plantations for silviculture (FPU)
- extra-urban miscellaneous (FUM).

Under the EPBCA, *Eucalyptus ovata* forest and woodland (DOV) is listed the critically endangered community *Tasmanian Forests and Woodlands dominated by black gum or Brooker's gum (Eucalyptus ovata / E. brookeriana)*. DOV is also listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA).

Table 1: Area of Vegetation Communities

TasVeg Code	Community	Total Area (ha)	Reservation status (State and Bioregional)
(DPU)	*Eucalyptus pulchella* forest and woodland	0.92	Well Reserved
(DOV)	*Eucalyptus ovata* forest and woodland	0.61	Threatened
(FRG)	Regenerating cleared land	0.31	N/A
(FPU)	Unverified plantations for silviculture	20.51	N/A
(FUM)	Extra-urban miscellaneous	10.23	N/A
	Total area mapped	32.59	

Distributions of TASVEG units within study areas for the proposed refuse cells and borrow pit area are presented in Figures 3 and 4. Floristics are presented in Appendix A, while each unit is described briefly below, with representative photos in Plates 1-5.

3.1.1 Eucalyptus pulchella forest and woodland (DPU) – Plate 1

This community is on a moderate slope, fringing the north-eastern perimeter of the cleared area immediately north of the refuse site. The canopy is at ~25 m and is sparse with evidence of dieback in places. The dominant canopy species is *Eucalyptus pulchella* with the occasional *E. viminalis* and *E. globulus.* The shrubby understory is dominated by *Acacia dealbata* regrowth for the 2013 fires. *Lomandra longifolia* is the dominant ground cover species. A notable patch of the highly invasive Spanish heath occurs. A community species list is given in Appendix A.

3.1.2 Eucalyptus ovata forest and woodland (DOV) – Plate 2

This community occupies the flat area north west of the perimeter of the cleared area immediately north of the refuse site. The eucalypts in this area were severely impacted by the 2013 bushfires; this is evident from the presence of regrowth trees, most of which are relatively short, averaging ~5 m in height. The understory has low species diversity and is dominated by *Leptospermum lanigerum* and *L. scoparium.* A community species list is given in Appendix A.

Under the EPBCA, *Eucalyptus ovata* forest and woodland (DOV) is listed the critically endangered community *Tasmanian Forests and Woodlands dominated by black gum or Brooker's gum (Eucalyptus ovata / E. brookeriana)*. DOV is also listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA).

3.1.3 Extra-urban miscellaneous (FUM) – Plate 3

This mapping unit covers the majority of the area proposed to be used for the new refuse cells. It consists of areas where quarrying and associated activities have occurred and contains no native vegetation. Due to the absence of natural values of any conservation significance this area was not surveyed in any detail.

3.1.4 Unverified plantations for silviculture (FPU) – Plates 4-6

This community occupies the vast majority of the area proposed for the clay borrow pit to the southwest of the refuse site. Although clearly a softwood pine plantation (*Pinus radiata*) and therefore mappable as FPS, this area is not included in the current Tasmanian Forest Group Plantation dataset and is therefore most accurately mapped as FPU. Historical images of this area show the entire footprint of the borrow pit area was converted to plantation (Plate 5)The plantation is reasonably young (~ 8 years old) with an overgrown understorey comprising a high proportion of native species, including occasional emergent eucalypt species. *Gahnia radula* is very common and there are a high proportion of heath species still present in the understorey including *Acrotriche serrulata, Leucopogon virgatus, Styphelia adscendens* and *Monotoca ericoides* (Plate 7). Despite the relatively high diversity of native species, the dominant species throughout is *Pinus radiata* and as this non-native canopy matures it is expected that the developing mat of shed pine needles will reduce this diversity.

3.1.5 Regenerating cleared land (FRG) – Plate 7

A small area of failed pine plantation in the eastern portion of the FPU is regenerating with a diversity of heathy shrub species including *Amperea xiphoclada, Epacris impressa, Aotus ericiodes and Leucopogon virgatus*. The area still contains pines, although at a much lower density than the surrounding area. Although this area is seemingly similar to its surrounds, because of the marked difference in size and density of the pines compared to the surrounding plantation, and the higher species diversity in the understory, this was mapped as a distinct community.

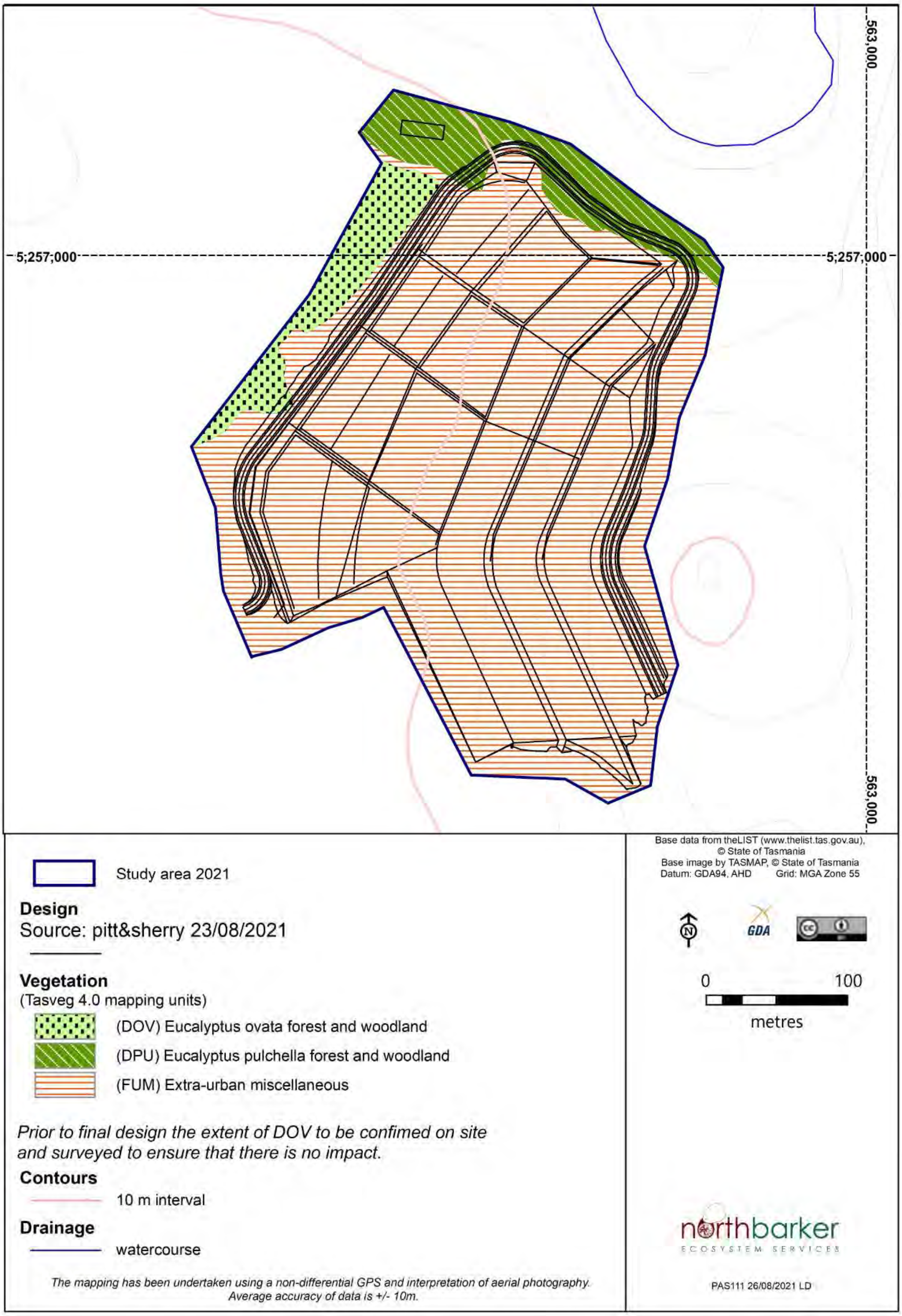

Figure 3: Distribution of TASVEG 4.0 units within the study area for the proposed new landfill cells

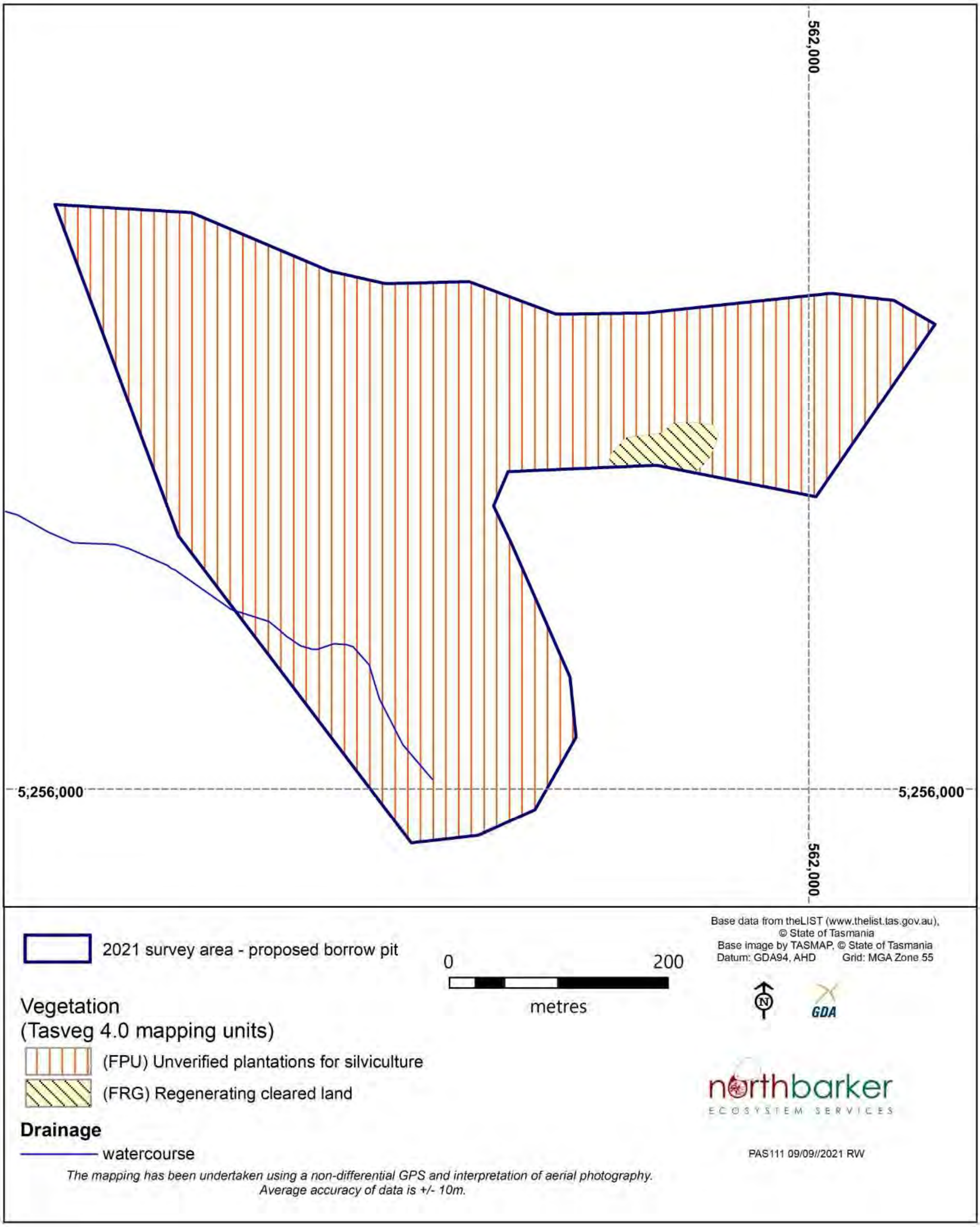

Figure 4: Distribution of TASVEG 4.0 units within the study area for the proposed borrow pit

Plate 1: ***Eucalyptus pulchella*** **forest and woodland in the study area**

Plate 2: ***Eucalyptus ovata*** **woodland on the western low-lying portion of the study area**

Plate 3: Typical FUM within area planned for the refuse cells.

Plate 4: Typical pine plantation found throughout the borrow pit survey area

Plate 5: Google earth image from 2011 showing the area proposed for the borrow pit (red outline) entirely converted to plantation

Plate 6: An open area in the plantation showing the high diversity of natives still present in places

Plate 7: FRG in proposed borrow pit survey area.

3.2 Vegetation reservation status

The most appropriate measure of reservation status (using JANIS criteria) relies on a 15% reserved target of extent prior to European settlement (pre-1750). Greater than 15% reserved is considered to meet the minimum reservation target. Reservation status for forest communities (DOV and DPU) are assessed against pre-European (1750) extent of vegetation[10]. Table 2 below shows current status for reservation for both communities at both a state-wide and bioregional level.

Table 2 Extent and reservation status of the native vegetation communities recorded in the study area

TASVEG Community[11] and extent in study area	State-wide	Bioregional
Eucalyptus ovata forest and woodland (DOV) 0.61 ha	Pre-1750 = 186,600 ha Currently reserved = 4,215 ha = 2.25% reserved CRITICALLY ENDANGERED (EPBCA)	Pre-1750 = 47,375 ha Currently reserved = 957 ha = 2.02% reserved CRITICALLY ENDANGERED (EPBCA)
Eucalyptus pulchella forest and woodland (DPU) 0.92 ha	Pre-1750* = 186,000 ha Currently reserved = 47,874 ha = 25% reserved Not threatened, well reserved	Pre-1750* = 173,690 ha Currently reserved = 46,336 ha = 26% reserved Not threatened, well reserved

[10] Knight 2012
[11] Harris & Kitchener 2005

3.3 Threatened flora

In total, 96 species of vascular plants were recorded during the field survey (Appendix B). No species listed as threatened under the schedules of the TSPA or EPBCA were recorded during this survey, or the 2018 survey. During the 2007 survey two species of threatened flora were recorded but these were in an area outside the present study area (*Scleranthus fasciculatus* and *Scutellaria humilis*).

No threatened flora species have been recorded within 500 m of the study area. Several threatened species have previously been recorded within 5 km of the site or have the potential to do so based on habitat mapping[12&13]. Most of the study area has been converted to forestry or cleared and there is limited native habitat in the study area suitable for threatened flora (0.92 and 0.61 of DPU and DOV, respectively). None of those species recorded within 5 km or predicted to occur based on distribution are considered likely to occur (Table 2).

Table 3: Flora species of conservation significance known within a 5 km radius of the study area, or predicted by habitat mapping[14&15]

Species	Status TSPA / EPBCA	Potential to occur if not observed	Observations and preferred habitat[16]
Boronia gunnii Gunn's boronia	Vulnerable / VULNERABLE	NONE	*Boronia gunnii* is strictly riparian in habitat, occurring in the flood zone of the Apsley, St Pauls, and Dukes rivers (where extant) and the Denison Rivulet and South Esk River (where presumed extinct) in rock crevices or in the shelter of boulders. The base substrate is always dolerite. No records within 5 km of the study area and predicted to occur on distribution only. No suitable habitat within the study area.
Caladenia caudata Tailed spider-orchid	Vulnerable / VULNERABLE	Very low	*Caladenia caudata* has highly variable habitat, which includes the central north: *Eucalyptus obliqua* heathy forest on low undulating hills; the north-east: *E. globulus* grassy/heathy coastal forest, *E. amygdalina* heathy woodland and forest, Allocasuarina woodland; and the south-east: *E. amygdalina* forest and woodland on sandstone, coastal *E. viminalis* forest on deep sands. Substrates vary from dolerite to sandstone to granite, with soils ranging from deep windblown sands, sands derived from sandstone and well-developed clay loams developed from dolerite. A high degree of insolation is typical of many sites. No records within 5 km of the study area

[12] DPIPWE 2021. Natural Values Report – nvr_1_26-Jul-2021.
[13] EPBC Protected Matters Report, 31/08/2021, ref#PMST_ZEVNVR.
[14] DPIPWE 2021. Natural Values Report – nvr_1_26-Jul-2021.
[15] EPBC Protected Matters Report, 31/08/2021, ref#PMST_ZEVNVR.
[16] Includes statements from Threatened Species Link summaries and note sheets

Species	Status TSPA / EPBCA	Potential to occur if not observed	Observations and preferred habitat[16]
			and predicted to occur on distribution only. While the DPU and DOV vegetation within the study area could broadly be considered as potential habitat for this species, this is a small area and given the paucity of records the likelihood of this species being present is very low.
Epacris virgata (Kettering) Pretty heath	Vulnerable / ENDANGERED	Very Low	*Epacris virgata* (Kettering) occurs among foothills in south-eastern Tasmania in dry sclerophyll forest on hilly terrain at elevations of 10-300 m above sea level, mainly on dolerite, though sometimes close to the geological boundary of dolerite and Permian mudstone. It is generally associated with grassy/heathy *Eucalyptus ovata* woodland/forest but is also occasionally found in grassy/heathy *E. pulchella* woodland/forest. There is a cluster of records 4.2 km to the north of the project area. This is a relatively distinctive species and is not likely to have been overlooked in the project area and is unlikely to occur.
Eryngium ovinum Blue devil	Rare / -	Very Low	*Eryngium ovinum* occurs in a range of lowland vegetation types most often on fertile heavy clay soils derived from dolerite. Vegetation types include open grasslands usually dominated by *Themeda triandra* (kangaroo grass), grassy forests and woodlands on slopes, ridges and broad flats, and roadside verges (representing remnant populations). There is a cluster of records 4.6 km t the west of the study area. Most of the project area is unsuitable for this species and it is not likely to occur.
Lepidium hyssopifolium soft peppercress	Endangered / ENDANGERED	Very low	The native habitat of *Lepidium hyssopifolium* is the growth suppression zone beneath large trees in grassy woodlands and grasslands (e.g., over-mature black wattles and isolated eucalypts in rough pasture). *Lepidium hyssopifolium* is now found primarily under large exotic trees on roadsides and home yards on farms. It occurs in the eastern part of Tasmania between sea-level to 500 metres above sea level in dry, warm, and fertile areas on flat ground on weakly acid to alkaline soils derived from a range of rock types. It can also occur on frequently slashed grassy/weedy roadside verges where shade trees are absent. While suitable dry soils in grassy woodland are present in the DPU, the habitat is not

Species	Status TSPA / EPBCA	Potential to occur if not observed	Observations and preferred habitat[16]
			optimal. This species has a narrow has an unusual distribution and is not likely to occur in the small area of native habitat in the study area.
Odixia achlaena Odixia	Rare / -	Very Low	*Odixia achlaena* occurs only on dolerite, mainly in dry eucalypt forest dominated by *Eucalyptus pulchella* on ridges and slopes. It has also been found in plantations. The nearest record is 4.3 km to the north of the study area and there are numerous additional records further north and west Kellevie. The DPU in the north of the study area is on dolerite and broadly suitable for this species. This is a relatively distinctive species and is unlikely to have been overlooked.
Pimelea flava Yellow rice flower	Rare / -	Very Low	*Pimelea flava* occurs in wet and dry sclerophyll forest and woodland and extends into hardwood and softwood plantations. It often occurs abundantly on disturbed sites such as in logged forest, firebreaks, powerline easements and road batters. There is a single record within 5 km from 1929. The study area is suitable for this species in places but this is a relatively distinctive species and is unlikely to have been overlooked.
Prasophyllum apoxychilum tapered leek-orchid	Vulnerable / ENDANGERED	Very low	*Prasophyllum apoxychilum* is restricted to eastern and north-eastern Tasmania where it occurs in coastal heathland or grassy and scrubby open eucalypt forest on sandy and clay loams, often among rocks. It occurs at a range of elevations and seems to be strongly associated with dolerite in the east and south-east of its range. No records within 5 km of the site and predicted to occur on distribution only. The habitat in the study area is broadly suitable for this species but dolerite is limited to a small area in the north of the study area. This species has a narrow distribution and the chances of it occurring in the small area of potentially suitable habitat is very low.
Pterostylis ziegeleri grassland greenhood	Vulnerable / VULNERABLE	Very low	*Pterostylis ziegeleri* is restricted to the east and north of Tasmania. In coastal areas, the species occurs on the slopes of low stabilised sand dunes and in grassy dune swales, while in the Midlands it grows in native grassland or grassy woodland on well-drained clay loams derived from

Species	Status TSPA / EPBCA	Potential to occur if not observed	Observations and preferred habitat[16]
			basalt. This species has not been recorded within 5 km of the study area and is predicted to occur on distribution only. Based on the lack of suitable habitat, it is highly unlikely to occur in the study area.
Scleranthus fasciculatus Spreading knawel	Vulnerable / -	Low	*Scleranthus fasciculatus* is only recorded from a few locations in the Midlands and south-east. The vegetation at most of the sites is Poa grassland/grassy woodland. *Scleranthus fasciculatus* appears to need gaps between the tussock spaces for its survival and both fire and stock grazing maintain the openness it requires. Often found in areas protected from grazing such as fallen trees and branches. There are two records in woodland ~720 m south east of the study area. Suitable grassy woodland in the project area is limited and this species is unlikely to occur and have been overlooked.
Scutellaria humilis Dwarf skullcap	Rare / -	Very Low	*Scutellaria humilis* is found in moist, shady places in the north-east and south-east of the State. Recent sites have been associated with rocky slopes and rises. A nearby population of > 10,000 plants, on Little Blue Hill 660 m from the study area, was recorded in the 2007 survey. Not recorded during the current survey and unlikely to have been overlooked.
Senecio psilocarpus swamp fireweed	Endangered / VULNERABLE	Very low	*Senecio psilocarpus* is known from six widely scattered sites in the northern half of the State, including King and Flinders islands. It occurs in swampy habitats including broad valley floors associated with rivers, edges of farm dams amongst low-lying grazing/cropping ground, herb-rich native grassland in a broad swale between stable sand dunes, adjacent to wetlands in native grassland, herbaceous marshland, and low-lying lagoon systems. No records of this species within 5 km of the study area. Habitat is suboptimal in the study area and this species is not likely to occur.
Thelymitra jonesii sky-blue sun-orchid	Endangered / ENDANGERED	Very low	*Thelymitra jonesii* is restricted to Tasmania, where it occurs in moist coastal heath on sandy to peaty soils and in *Eucalyptus obliqua* forest in deep loam soil over dolerite. No records of the species within 5 km of the survey area. Habitat in the study area is suboptimal and this species is not likely to occur.

Species	Status TSPA / EPBCA	Potential to occur if not observed	Observations and preferred habitat[16]
Vittadinia muelleri narrowleaf new-holland-daisy	Rare / -	Very Low	*Vittadinia muelleri* occurs in dry native grasslands and grassy woodlands particularly in open areas with lighter grass cover and patches of bare ground such as rock plates. It freely colonises disturbed sites such as roadside cuttings. It is widely dispersed through the Midlands and South East. There are records of this species > 4 km to the east of the study area near Boomer Bay. This species is not likely to occur in the small area of marginal habitat.
Xerochysum palustre swamp everlasting	Vulnerable / VULNERABLE	None	*Xerochrysum palustre* has a scattered distribution with populations in the north-east, east coast, Central Highlands, and Midlands, all below about 700 m elevation. It occurs in wetlands, grassy to sedgy wet heathlands and extends to associated heathy *Eucalyptus ovata* woodlands. Sites are usually inundated for part of the year. No records within 5 km of the survey area. Habitat in the study area is not suitable.

3.4 Weeds

Three species of weeds declared under the Tasmanian *Weed management Act 1999* were recorded from the site (Figure 5 and 6):

- Spanish heath (*Erica lusitanica*): occurs in the northern section of the area proposed for the landfill cells including a severe infestation in one area. It also occurs in scattered locations at the site for the proposed borrow pit.
- serrated tussock (*Nassella trichotoma*): this highly invasive species was recorded along road edge that forms the northern boundary of the proposed borrow pit.
- winged thistle (*Carduus tenuiflorus*): A single plant was recorded in the area of the proposed borrow pit; this is an annual species and it is expected that in summer plants will be more widespread that this single record suggests.

Plate 8: Spanish heath occurs as scattered plants within the study area.

Plate 9 Serrated tussock was found along the roadside of the western study area

Plate 10 Winged thistle (*Carduus tenuiflorus*) found in one location within the survey area for the borrow pit.

3.5 Plant Pathogens

No symptomatic evidence of cinnamon root rot fungus (*Phytophthora cinnamomi)* PC was recorded during the survey. However, a detailed PC assessment was not undertaken. The site falls within the bioclimatic range of PC and there are species present that are sensitive to the fungus.

3.6 Threatened fauna and threatened fauna habitat

No threatened fauna species were recorded during the survey. However, several Tasmanian devil scats were recorded on the roads within the area surveyed for the proposed borrow pit (Figure 5).

There were no visible tree hollows suitable for nesting of vertebrate species were observed during the survey.

It can be expected that wide ranging species with relatively broad ecological niches such as the Tasmanian devil may utilise the area for foraging and movements within their ranges. Table 3 below gives a description and comments on the likelihood of occurrence of species that have been previously recorded within 5 km of the site or have the potential to occur based on their core range boundaries.

3.6.1 <u>Tasmanian devil den survey</u>

The area of FUM is unsuitable for denning. The proposed clearance area associated with the DPU and the DOV was surveyed thoroughly (Figure 5); achieving coverage in excess of the 30 % visual survey coverage specified in DPIPWE's "*Survey Guidelines and Management Advice for Development Proposals that may Impact on the Tasmanian Devil (Sarcophilus harrisii): A supplement to the Guidelines for Natural Values Surveys - Terrestrial Development Proposals*". No potential dens or burrows were identified within this survey area. Similarly, no tracks, scats, or any other sign that could be attributed to devils was identified in this area. It is however possible that Tasmanian devil utilises this area, at least for foraging.

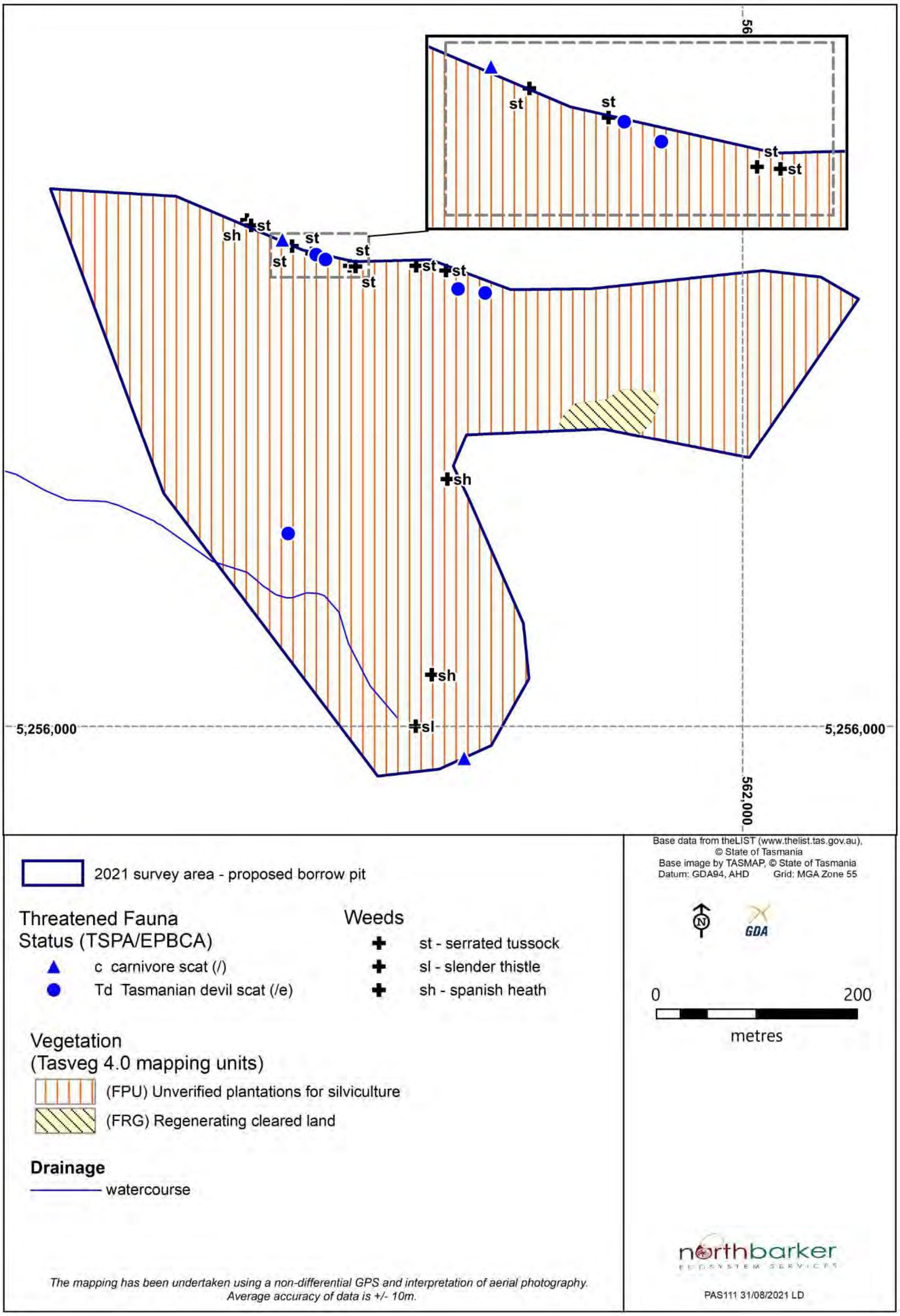

Figure 5: Distribution of TASVEG 4.0 units, weeds species and threatened fauna within the study area for the proposed borrow pit

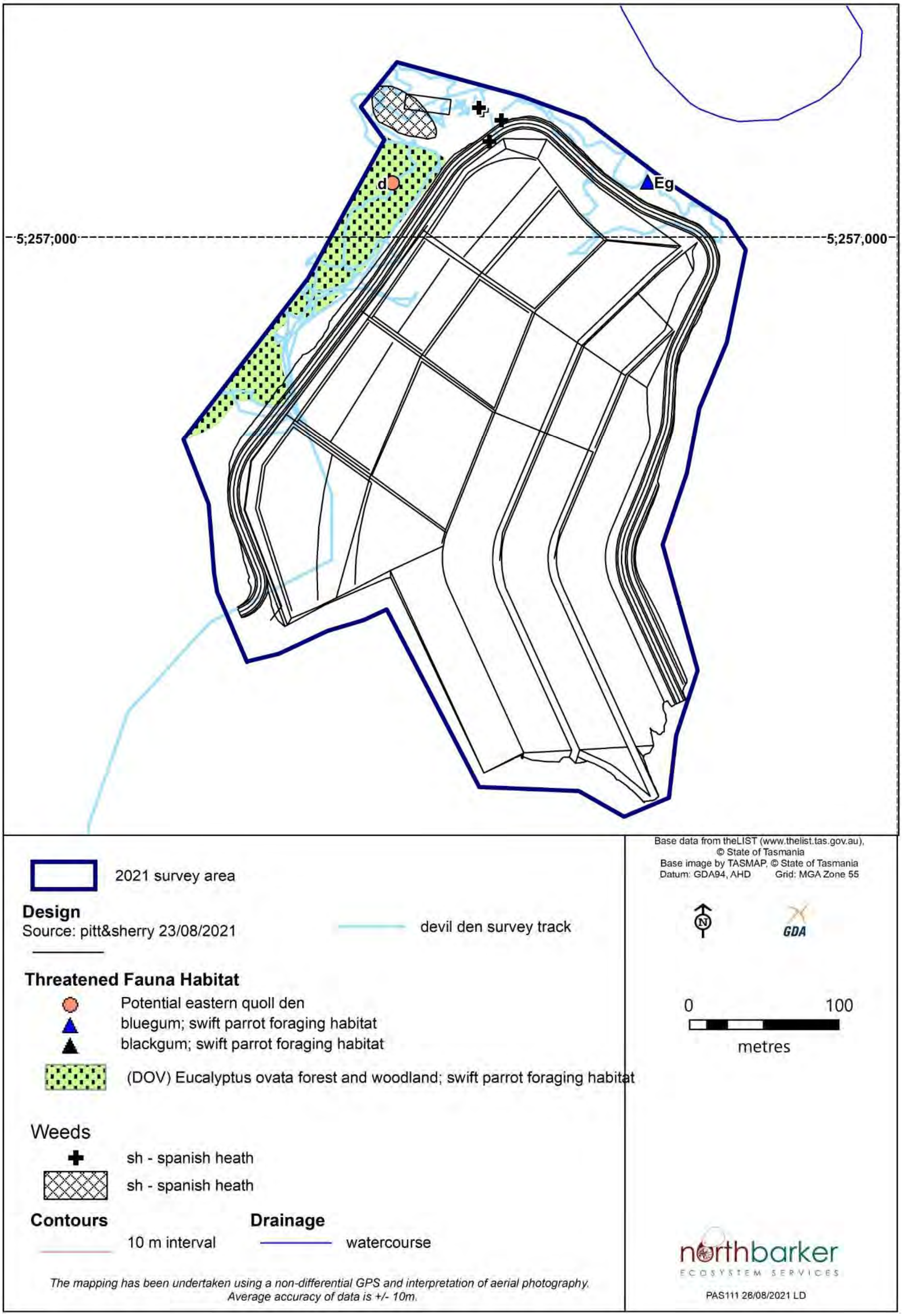

Figure 6: Threatened fauna habitat and weed species within the study area for the proposed new refuse cells

Table 4 Fauna species of conservation significance previously recorded, or which may potentially occur within 5 km of the survey area[17&18] (excluding marine and pelagic species as well as shorebirds and wetland birds that have no chance of occurrence).

Species	Status TSPA/ EPBCA	Likelihood of occurrence	Observations and preferred habitat[19]
BIRDS			
Accipiter novaehollandiae grey goshawk	Endangered / -	Foraging habitat: Low Nesting habitat: None	Inhabits large tracts of wet forest and swamp forest, particularly patches with closed canopies above an open understorey, and with dense stands of prey habitat nearby. In eastern Tasmania protected creekline support suitable nest trees. Mature trees provide the best nesting sites. Various species are utilised including blackwood, myrtle beech, eucalyptus and silver wattle. Not recorded within 5 km. This is a wide-ranging species and although the general area may form part of their hunting territory, the study area is not optimum foraging habitat and lacks the preferred nesting trees for this species.
Apus pacificus fork-tailed swift	- / Migratory	Low	An aerial insectivore occasionally recorded in Tasmania. Most records of the Fork-tailed swift are from Bass Strait Islands with fewer on mainland northern Tasmania. Almost exclusively an aerial species. Not recorded within 5 km and although it may fly over the project area this will be infrequent. Due to the almost exclusively aerial nature of this species it is very unlikely it will be impacted by the project.
Ardea ibis cattle egret	-/ Marine	None	This species occurs in tropical and temperate grasslands, woodlands and terrestrial wetlands. It uses predominately shallow, open, and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. It breeds mostly along the central eastern coast of Australia and not in Tasmania. Non-breeding individuals in Tasmania favour pasture and freshwater wetlands along the north coast and southeast. No suitable habitat in the project area.
Aquila audax subsp. *fleayi* wedge-tailed eagle	Endangered / ENDANGERED	Foraging habitat: Moderate Nesting habitat: None	This species nests in a range of old growth native forests and is dependent on forest for nesting. Territories can contain up to five alternate nests usually close to each other but may be up to 1 km apart where habitat is locally restricted. This eagle preys and scavenges on a wide variety of fauna including fish, reptiles, birds, and mammals. No viable nesting habitat will be impacted by the proposal. No nests are known within 500 m or within 1 km line of sight. The nearest known nest is around 2.5 km to the southeast. This is a wide-ranging species and may forage in the project area and

[17] EPBC Protected Matters Report, 31/08/2021, ref#PMST_ZEVNVR
[18] DPIPWE 2021, nvr_8_20-AUG-2021
[19] Bryant & Jackson 1999

Species	Status TSPA/ EPBCA	Likelihood of occurrence	Observations and preferred habitat[19]
			surrounds.
Ceyx azureus diemenensis Tasmanian azure kingfisher	Endangered / ENDANGERED	None	This species is found along rivers in the south, west, north, and northwest of Tasmania with outlying occurrences in the northeast, east, centre and Bass Strait islands. This species occurs in the forested margins of major river systems where it perches on branches overhanging rivers waiting for prey items such as small fish, insects, and freshwater crayfish to come down the river. This species nests in holes along the top of riverbanks. No suitable habitat for this species.
Haliaeetus leucogaster white-bellied sea-eagle	Vulnerable / Marine	Foraging habitat: Very low Nesting habitat: None	In Tasmania, this species is restricted to nesting within 5 km of coastlines, major estuaries, and inland lakes. They typically build nests in large eucalypt trees, much like the Tasmanian wedge-tailed eagle (*Aquila audax fleayi*), although their specific nesting requirements aren't as strict, such that they often nest in relatively small and exposed coastal trees (including [in a minority of cases] non-native species [e.g. Pinus radiata]), and are also known to nest occasionally on sea cliffs or even piles of rocks at ground level on islands lacking ground predators (e.g. Ninth Island). No suitable nesting habitat and the site is > 5 km from the coast or a suitable waterbody. Although this species may fly over the study area it is not likely to utilise the study area.
Hirundapus caudacutus white-throated needletail	-/VULNERABLE	Low to Moderate	This migratory species breeds in central and north-eastern Asia in Siberia, Mongolia, northern-eastern China, and northern Japan. It migrates south through eastern China, Korea and Japan spending its non-breeding season in eastern and south-eastern Australia including Tasmania. This species is almost exclusively aerial, occurring over most types of habitat with a preference to wooded areas, open forests, heathland and rainforests. This is a wide ranging but infrequently observed species in Tasmania. It may fly over the project area from time to time.
Lathamus discolor swift parrot	Endangered / ENDANGERED	Foraging habitat: One blue gum in the project area. The DOV is a future foraging resource. Nesting habitat: None	This species spends its winter in south-eastern mainland Australian before migrating to Tasmania in late winter/early spring to breed. During the breeding season, nectar from Tasmanian blue gum (*Eucalyptus globulus*) and black gum (*Eucalyptus ovata*) flowers is the primary food source for the species. These eucalypts are patchily distributed and their flowering patterns are erratic and unpredictable, often leading to only a small proportion of Swift Parrot habitat being available for breeding in any one year. Swift Parrots breed in tree hollows in mature eucalypts within foraging

Species	Status TSPA/ EPBCA	Likelihood of occurrence	Observations and preferred habitat[19]
			range of a flower source. There are 17 records of swift parrots within 5 km of the site. No hollows suitable for this species were recorded. A single blue gum occurs in the DPU that mat be used for foraging. The DOV is recovering from fire and the trees are < 5 m tall and typically in the 15-20 cm DBH range. With no trees > 40 cm in this area their potential as a foraging resource is limited[20].
Myiagra cyanoleuca satin flycatcher	-/MIGRATORY	Low	An interstate migrant, of which some of the population spends the summer breeding months in Tasmania. Widely distributed across forested environments but is sensitive to fragmentation and canopy thinning. Riparian habitats are preferred, and the species is infrequently recorded within regrowth and suburban environments. This is a wide-ranging but irregularly seen species and may occur within the study area from time to time.
Pardalotus quadragintus forty-spotted pardalote	Endangered / ENDANGERED	None	This species is endemic to Tasmania and occurs in only a few small areas within the State. It is relatively restricted to dry grassy forest and woodland along the east coast containing mature white gum (*Eucalyptus viminalis*). No suitable habitat within the study area.
Tyto novaehollandiae subsp. *castanops* Tasmanian masked owl	Endangered / VULNERABLE	Foraging habitat: Low Nesting habitat: None	Masked owls are a nocturnal species that favour the edges of dry forests, utilising nearby hollows ≥15 cm in diameter for nesting. Therefore, significant habitat for this species is limited to large eucalypts within dry eucalypt forest in their core range. Their core foraging habitat includes mature native forests and woodlands typically below 600 m altitude as well as mosaics of both native vegetation and agricultural patches. Although the general area may form part of a foraging territory, the borrow pit area is largely unsuitable and FUM is not likely to offer foraging opportunities. Foraging habitat is thus limited. There are no suitable hollow bearing nesting trees in the study area.
MAMMALS			
Dasyurus maculatus subsp. *maculatus* spotted-tail quoll	Rare / VULNERBALE	Foraging habitat: Low Denning habitat: Moderate	This naturally rare forest-dweller most commonly inhabits rainforest, wet forest, and blackwood swamp forest. It forages and hunts on farmland and pasture, travelling up to 20 km at night, and shelters in logs, rocks, or thick vegetation. Important habitat includes large patches of forest containing adequate denning sites and high densities of mammalian prey. One record within 5 km. The site is within the core

[20] Forest Practices Authority 2014

Species	Status TSPA/ EPBCA	Likelihood of occurrence	Observations and preferred habitat[19]
			range for the species but given the dry and highly transformed nature of much of the site, it ranges from unsuitable to suboptimal.
Dasyurus viverrinus eastern quoll	-/ENDANGERED	Foraging habitat: Moderate Denning habitat: Moderate	This species was previously widespread in mainland south-eastern Australia but is now restricted to Tasmania. Records from the Tasmanian Natural Values Atlas indicate that the eastern quoll occurs in most parts of Tasmania but is recorded infrequently in the wetter western third of the state. The species' distribution is positively associated with areas of low rainfall and cold winter minimum temperatures. Within this distribution, it is found in a range of vegetation types including open grassland (including farmland), tussock grassland, grassy woodland, dry eucalypt forest, coastal scrub, and alpine heathland, but is typically absent from large tracts of wet eucalypt forest and rainforest. There are seven records of this species within 5 km of the proposed site, the most recent from 1997. A single burrow was located in 2018 that may have belonged to this species. No burrows that may belong to this or any other threatened carnivore species were recorded in the present survey. It is possible that this species utilises the survey area. The most suitable habitat is the small area of DOV and DPU but it is possible the species ranges throughout.
Sarcophilus harrisii Tasmanian devil	Endangered / ENDANGERED	Foraging habitat: Present Denning habitat: Moderate	The Tasmanian devil occupies a wide range of habitats across Tasmania and exploits landscapes with a mosaic of pasture and forest with elevated prey densities and is attracted to roadkill hotpots with concentrated scavenging resource. Populations have declined substantially since the first observations of the infectious cancer Devil Facial Tumour Disease (DFTD). DFTD has now spread across much of Tasmania. The reduced population is also likely to be more sensitive to additional threats such as death by roadkill, competition with cats and foxes, and loss or disturbance of areas surrounding traditional dens where young are raised. The protection of breeding opportunities is particularly important for the species due to the mortalities from demographic pressures. A targeted den survey was conducted within the area of DPU and DOV proposed to be impacted. No dens, burrows or scats were detected in this part of the study area. During the survey of the area proposed for the borrow pit Tasmanian devil scats were detected along the roadsides. This area contains sandy, friable soils, and although no optimal denning habitat was observed it is possible this species utilises the area for denning.

Species	Status TSPA/ EPBCA	Likelihood of occurrence	Observations and preferred habitat[19]
Perameles gunnii eastern barred bandicoot	-/VULNERABLE	Moderate	This species inhabits grassy woodlands, native grasslands, and mosaics of pasture and shrubby ground cover favouring open grassy areas for foraging with thick vegetation cover for shelter and nesting. It has a widely dispersed range with concentrations in SE, NE and NW Tasmania and some areas of the State from where it is absent or in very low densities. It extends into the urban fringe where it can survive in large gardens and bushland reserves. It favours a mosaic of open grassy areas for foraging and thick vegetation cover for shelter and nesting. The site is within the core range for this species and there are 28 records within 5 km of the site. It is quite possible that this species occurs on the site with the small area of the DPU and DOV most suitable for this species.
FISH			
Prototroctes marina Australian grayling	Vulnerable / VULNERABLE	None	In Tasmania, the diadromous Australian Grayling has been found in northern, eastern, and western rivers. Little is known of the population size. The major threat to the species is the construction of barriers that prevent adult fish moving upstream and juveniles downstream. No suitable habitat.
AMPHIBIANS			
Litoria raniformis green and gold frog	Vulnerable/ VULNERABLE	None	The Green and Gold Frog (*Litoria raniformis*) is a large frog (up to 80 mm long) which occurs in Tasmania and south-eastern mainland Australia. Despite the name, its coloration varies considerably, but all adults have a pale green stripe down the middle of the back and turquoise thighs. In Tasmania, the species occurs in lowland areas in the south-east and north, breeding in permanent freshwater lagoons, generally with emergent vegetation. No suitable habitat.
REPTILES			
Pseudemoia pagenstecher tussock skink	Vulnerable / -	None	Occurs in *Poa* tussock grassland and *Themeda* grassland without trees. No suitable habitat.
INVERTEBRATES			
Antipodia chaostola chaostola skipper	Endangered / ENDANGERED	Low to moderate	The Chaostola skipper is restricted to dry forest and woodland supporting sedges of the Gahnia genus and occurs in isolated populations in south-eastern and eastern Tasmania. The host plant *Gahnia radula* (thatch saw sedge)

Species	Status TSPA/ EPBCA	Likelihood of occurrence	Observations and preferred habitat[19]
			was observed throughout the understory of the FPU vegetation, these plants were part of the understory of a high density of pine trees. There are no known occurrences of the chaostola skipper within 5 km. The nearest populations occur in the Meehan Range approximately 30 km west of the site and on a private land reserve at Little Swanport, over 50 km to the north. Regardless, given the host plant occurs throughout the area there is at least some chance the species may occur.
Lissotes latidens broad-toothed stag bettle	Endangered / ENDANGERED	None	This species occurs exclusively in south-eastern Tasmania and is restricted to 38 known sites between Orford and Copping, centred around Wielangta State Forest and on Maria Island. The broad-toothed stag beetle is known to occupy wet eucalypt forest dominated by *Eucalyptus obliqua, E. regnans and E. globulus.* Little is known about the population size of this species, but there are indications that it occurs at very low densities compared to other Tasmanian lucanids. Populations of the species appear to be highly separate and discreet. No suitable habitat within the areas surveyed.
Lissotes menalcas mount mangana stag beetle	Vulnerable / -	None	This occurs in southeast Tasmania including parts of the Wellington range, South Bruny and the Forester and Tasman Peninsulas. Confined to wet forest with large logs although much of potential habitat is unoccupied. No suitable habitat within the areas surveyed.

3.7 Conservation of Freshwater Ecosystem Values (CFEV)

Figure 6 illustrates the CFEV streams in proximity to the study area. The headwater of one stream, a tributary of the Carlton River is mapped within the southwestern part of the proposed borrow pit (Figure 9). The alignment of some parts of the stream overlaps a road. No stream was detected during the survey of this area. Given the survey was conducted during late winter it is expected that if this stream was ephemeral it would have been detectable if it existed within the survey area.

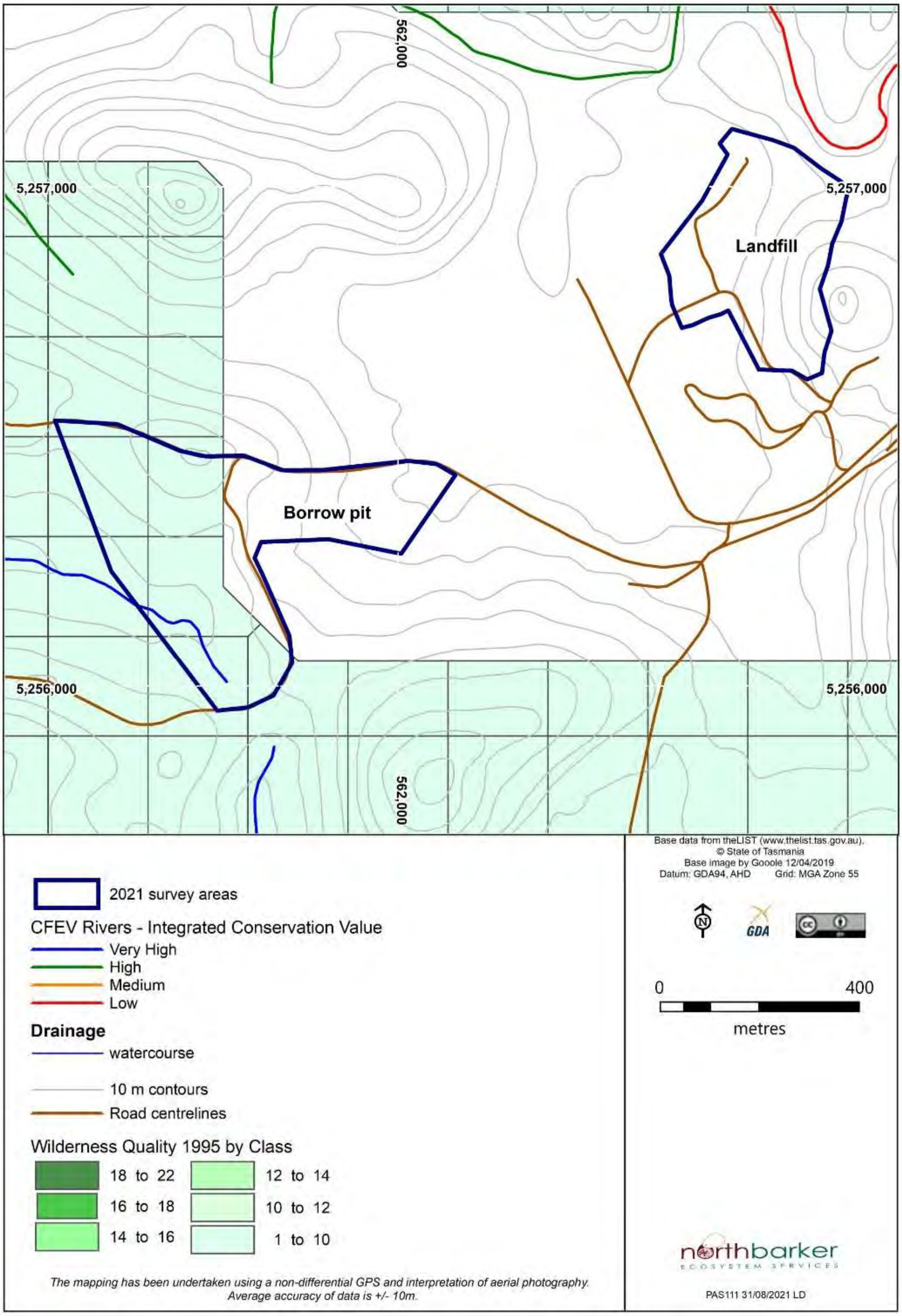

Figure 7 Shows both CFEV rivers and WHA Wilderness Quality (1995) in proximity to the study areas for the proposed refuse cells and borrow pit

3.8 Wilderness Value

The proposal does not occur within the Tasmanian Wilderness World Heritage Area. The survey area is considered to have no to very low wilderness quality.

3.9 Comprehensive, adequate, and representative Reserve (CAR) system

The study area is not associated with any reserves that form part of the Tasmanian Reserve Estate. The EPBC Protected Matters Search Tool[21] identifies 12 reserves within 5 km of the site the closest being private land with a conservation covenant < 1.5 km from the survey area.

3.10 Tasmanian Forest Practices Code 2015

There are no Wildlife Habitat Strips mapped for this area in the Tasmanian Reserve Estate.

3.11 Geoconservation

No recorded examples of geoconservation values are reported on the LIST nor apparently present within the study area.

3.12 Wetlands of international importance (RAMSAR wetlands) or areas or habitats of conservation significance

There are no wetlands of any importance in the study area and none will be impacted by the proposed development of the cells or the borrow pit.

There are no areas or habitats of conservation significance in the study area or likely to be impacted by the proposal, including designated conservation areas, areas relating to the requirements of international treaties (e.g. Japan-Australia and China-Australia Migratory Bird Agreements (JAMBA/CAMBA) and Ramsar (wetlands) Convention), or wetlands listed in A Directory of Important Wetlands in Australia.

4 Natural Values and Potential Impact

4.1 Vegetation

The field survey established that the study area contains one threatened native plant community, *Eucalyptus ovata* forest and woodland (DOV). This community is listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA) and the EPBCA as *Tasmanian Forests and Woodlands dominated by black gum or Brooker's gum (Eucalyptus ovata / E. brookeriana)*. It is understood that impact to this community will be entirely avoided.

The only other native vegetation community is DPU and the impact to 0.92 ha of this community is not significant.

4.2 Threatened flora

No threatened flora were recorded during the surveys and no impact to threatened flora species is expected.

4.3 Threatened fauna and threatened fauna habitat

4.3.1 Eastern quoll

In the NBES 2018 natural values survey a den was discovered within the DOV that was reported as potential eastern quoll habitat. This den was not relocated during the targeted den survey. Regardless, the record of this den is located in outside of the impact

[21] EPBC Protected Matters Report, 31/08/2021, ref#PMST_ZEVNVR.

area proposed for the new refuse cells. Given the availability of habitat for this species in the broader area, the loss of 0.92 ha of native habitat (the DPU) and 20.84 ha of modified habitat (the FPU and FRG) is not expected to have a significant impact on the carrying capacity for this species.

4.3.2 Tasmanian devil

Habitat for this species is widespread in the broader area and it is not apparent that the study area contains any obvious habitat elements (foraging or denning) that make the study area more suitable than the surrounding landscape. However, the site is utilised by Tasmanian devil, as evidenced by the presence of scats, and there will be a loss of habitat (~22 ha). Regardless, it is not expected that this loss will significantly impact the carrying capacity of the area for this species. No impact to denning habitat is expected in the area proposed for landfill cells. A dedicated pre-clearance den survey in the area proposed for the borrow pit is required to assess impact to denning habitat for this species in this area.

4.3.3 Eastern barred bandicoot

Although there is some potential for this species to occur, the most suitable area to be impacted is the DPU (0.92 ha). The loss of this scale of habitat is not significant.

4.3.4 Chaostola skipper

The area of FPU contains the host plant (*Gahnia radula*) for this species (20.53 ha). Although, the density of the host plant, and therefore the suitability of the habitat, varies throughout this community, most if not all of the area may be considered to offer potential breeding habitat for this species. A targeted survey for shelters of this species is required to assess if the area is utilised by the skipper.

4.3.5 Swift parrot

There is a single blue gum in the DPU that is a potential foraging resource for this species. If this area is cleared this tree will be lost. The loss of a single foraging tree will not have a significant impact on the species. The DOV is a potential future foraging resource; no impact to this community is proposed.

5 Recommendations for Avoidance and Mitigation

5.1 Threatened vegetation

- It is understood through communication with the project manager (Pitt & Sherry) that there will be no impact to the DOV.
- To prevent damage due to edge effects and to align with recommendations in the EPBC conservation advice for this community[22], a 30 m buffer from the development should be implemented.
- Given the DOV buffer area is already cleared/impacted, native vegetation should be allowed to recolonise this this buffer area and should be managed for weeds, especially given the prevalence of Spanish heath nearby.
- Ensure that the quality of water that may be drained from landfill to the DOV is not toxic to the vegetation and environment as this may impact the DOV.
- Prior to the commencement of works, the clearance area should be marked (either *in situ* and/or clearly on construction plans) and all contractor agreements should specify that works, vehicles and materials must be confined to within the designated clearance areas only.

[22] Commonwealth of Australia 2020 (see Section 2.44: Additional buffer zone around a patch)

5.2 Threatened flora

- No threatened flora species were recorded within the study area for this proposal.
- No mitigation is necessary based on the current proposal.

5.3 Threatened fauna and threatened fauna habitat

- Tasmanian devil scats were recorded along the roads in the area proposed for the borrow pit. There is some potential for denning habitat in this area. To manage risk of impact to this species, a pre-clearance survey of this area is recommended. A decommissioning process may be applied subject to results of the survey.
- Notably, the proposal will involve potential road upgrades and increases in traffic. It is understood that there will only be daytime use of the road network, so impact to carnivores is not expected; regardless, to mitigate potential increased likelihood of road mortalities the following should be observed:
  - Internal road use should be limited to daytime hours.
  - Speed limits ≤ 40 km/h should be applied to all internal roads during construction and operation.
  - Roadkill mortalities should be removed immediately upon location (to limit likelihood of predators being attracted to the carcass).
- *Gahnia radula* was consistently noted throughout the FPU understory. A pre-clearance survey of this area should be conducted to better assess and manage the potential for impact. This survey could be conducted concurrently with a den survey of the area.
- One mature blue gum that is emergent in the DPU is potential foraging habitat for the swift parrot. The current design of the landfill cells does not include impact to the area occupied by this tree. If possible, impact to this tree should be avoided, in which case impact to the tree protection zone (TPZ) should be minimised (ideally less than 10 % of the TPZ which is a 9 m radius).

5.4 Risks associated with scavenging

It is well-known that fauna and invertebrate species congregate near rubbish dumps to exploit food sources. This may be to forage directly on the organic waste at the site, or to prey on species attracted to the site; for example, waste on the site may attract rodents who in turn are preyed on by carnivores.

In terms of scavenging, the most obvious species likely associated with the Copping site are rats, silver and kelp gulls, forest ravens and potentially Tasmanian devils. A potential increase in foraging opportunities presented by the new cells may increase the prevalence of these fauna at the site. The scale of such an increase is however not expected to result in any significant risk to any native or threatened species or result in a significant 'knock on' effect that may negatively impact other native species. Regardless, coverage of waste can reduce fly propagation and pest animal issues[23]. Accordingly, organic waste that is likely to attract scavengers (especially food waste) should be covered to the extent practicable as soon as practicable.

Although, we understand the proposed cells are for category B waste (rather than more noxious, category C controlled waste), we are not aware of the characteristics of waste planned for the site and it's potential to pose a toxic risk to fauna; this is not considered here, nor are any methods to manage this risk.

[23] DPIPWE 2004

5.5 Weed and pathogens

Three declared weed species were identified during the survey. Spanish heath and serrated tussock are particularly vigorous invasives. A weed management and hygiene plan is recommended for the site. Weed management planning and hygiene should address the following areas:

1. A weed management plan should cover all relevant aspects of the control and management of declared weeds, including but not be limited to:
    - An overarching set of objectives and the context in which they are to be achieved;
    - An assessment of the potential impact of the introduction of weeds;
    - Strategies for managing weeds including their eradication within the study area;
    - Strategies for ongoing monitoring and control of weeds within the study area; and
    - Identification of appropriate herbicides for control and how they are to be used.

2. A hygiene plan can be developed as part of the Weed Management Plan to ensure there is no introduction of new 'declared' weeds or significant environmental weed species into the area, translocation of weeds within the study area or the import of existing Declared Weeds from outside the area. The hygiene plan should cover, but not be limited to:
    - Vehicle, machinery and equipment hygiene;
    - Washdown protocols when travelling between clean and contaminated areas;
    - Location and management of washdown areas and facilities, including management of effluent;
    - Maintaining logbooks detailing adherence to hygiene protocols for all contractors; and
    - Material hygiene (soils, gravel, plant material etc.) – ensuring that no materials contaminated with weed propagules (seed, propagative vegetative material) are imported into the study area.
    - The proponent should include periodic inspections for weeds and have measures in place to respond to any identified infestations.

6 Legislative Requirements

6.1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The EPBCA is structured for self-assessment; the proponent must indicate whether or not the project is considered a 'controlled action', which, if confirmed, would require approval from the Commonwealth Minister.

Habitat for EPBCA listed fauna have been identified in the study area including: wedge-tailed eagle, swift parrot, satin flycatcher, Tasmanian masked owl, spotted-tail quoll, eastern quoll, Tasmanian devil, eastern barred bandicoot. Impact to habitat for these species is unlikely to result in significant impacts to Matters of National Environmental Significance (MNES) under the definitions under this Act.

Chaostola skipper is also listed under this act. Potential habitat for this species will be impacted by this proposal and further surveying of the site is required to better understand the potential for impact and the associated risk of causing a significant impact to this species.

6.2 Tasmanian Threatened Species Protection Act 1995

Based on current knowledge of the site no Permit is required under this Act. However, if burrows or dens are found and will be destroyed and/or if skipper habitat is confirmed and will be impacted, a permit will be required.

6.3 Tasmanian Weed Management Act 1999

Three declared weed species were recorded from the study area:

- Spanish heath (*Erica lusitanica*)
- serrated tussock (*Nassella trichotoma*)
- winged thistle (*Carduus tenuiflorus*)

In the Sorell municipality, these weed species are classed as zone B weeds, therefore containment is the aim of the management plan and control if the declared weed impact negatively on threatened vegetation (such as the DOV). Appropriate construction hygiene should continue to be applied to avoid the introduction of other species listed under this Act or spread of declared weeds to areas without infestations. This may include machinery washdown following use at contaminated sites and before entering the site.

6.4 Sorell Interim Planning Scheme 2015

The current proposal is within the Utilities zone of the Sorell Interim Planning Scheme 2015. Natural values are not considered under these provisions of the Scheme.

There is a 30 m corridor on the mapped creek line in the area proposed for the borrow pit that under a Waterway and Coastal Protection Area overlay (E 11). The objective of the code is as follows:

E11.7.1 Buildings and Works
To ensure that buildings and works in proximity to a waterway, the coast, identified climate change refugia and potable water supply areas will not have an unnecessary or unacceptable impact on natural values.

The project cannot meet Acceptable Solution A1 so Performance Criteria P1 must be met:

P1

Building and works within a Waterway and Coastal Protection Area must satisfy all of the following:

a) avoid or mitigate impact on natural values;
b) mitigate and manage adverse erosion, sedimentation and runoff impacts on natural values;
c) avoid or mitigate impacts on riparian or littoral vegetation;
d) maintain natural streambank and streambed condition, (where it exists);
e) maintain in-stream natural habitat, such as fallen logs, bank overhangs, rocks and trailing vegetation;
f) avoid significantly impeding natural flow and drainage;
g) maintain fish passage (where applicable);
h) avoid landfilling of wetlands;
i) works are undertaken generally in accordance with 'Wetlands and Waterways Works Manual' (DPIWE, 2003) and "Tasmanian Coastal Works Manual" (DPIPWE, Page and Thorp, 2010), and the unnecessary use of machinery within watercourses or wetlands is avoided.

The site is an area of pine plantation and natural values are primarily limited to habitat for Tasmanian devil (foraging and potentially denning) and potentially chaostola skipper. A survey is required to determine the presence or otherwise of the skipper and this will inform any processes to manage/mitigate impact. Impact to Tasmanian devil can be mitigated with a pre-clearance survey; this will assist with avoiding impact to potential breeding habitat. Impact to foraging habitat is not considered necessary to mitigate.

Given the history of the site (i.e. entirely cleared for forestry) the aquatic/riparian values have been lost so provisions b) to i) are void.

6.5 Forest Practices Act

The clearance of forest for landfill is not exempt from the requirement of a Forest Practices Plan.

6.6 Tasmanian Regional Forest Agreement 1997

The loss of native forest in this project is up to 0.92 ha of DPU. This community is adequately reserved under the CAR system.

Broad scale clearance and conversion of more than 20 ha of forest is controlled under the Permanent Forest Estate Policy 2017. The Policy is given effect through the Forest Practices Authority's consideration of applications for Forest Practices Plans under the Forest Practices Act 1985. The Policy does not apply "*to the clearance and conversion of non-forest vegetation or planted vegetation such as commercial forest plantations or agricultural shelterbelts.*"

Accordingly, the policy would only apply to the clearance of native habitat of which the 0.92 ha of DPU is less than the 20 ha threshold for this policy.

Small scale clearance and conversion of native forest on public or private land is not limited by the provisions of clause 3.1 of this Policy.

3.1 Broad scale clearance and conversion of native forest on public or private land is not permitted as from the date of commencement of this version of the Policy.

Accordingly, the project does not conflict with the Permanent Native Forest Estate Policy.

7 Conclusion and recommendations

Southern Waste Solutions is seeking a permit for the expansion of the existing landfill site at Copping in southern Tasmania. The planned landfill area consists of an additional 7 landfill cells (cells 10 – 17) and is proposed to extend in a relatively minor way into native vegetation fringing the north of the site. To cap these additional landfill cells, a ~22-ha area to the west of the existing landfill is proposed to be cleared and used as a borrow pit. A field survey was conducted by North Barker Ecosystem Services to assess the potential impact of the proposal on natural values. This assessment forms part of the Environmental Impact Assessment for the proposal. The main findings of the assessment are as follows:

Vegetation

- One threatened native plant community occurs within the survey area. This community is listed as threatened under the Tasmanian *Nature Conservation Act 2002*: *Eucalyptus ovata* forest and woodland (DOV). This community is also listed under the EPBCA as *Tasmanian Forests and Woodlands dominated by black gum or Brooker's gum (Eucalyptus ovata / E. brookeriana)*.
- Impact to the DOV has been avoided.

- The only other native plant community is 0.92 ha of *Eucalyptus pulchella* forest and woodland (DPU). This loss is not significant at a local, regional, and state-wide scale.

Recommendations:

- A 30 m buffer from the development should be implemented to prevent damage to the DOV from edge effects. This will also ensure the proposed impact aligns with recommendations in the EPBC conservation advice for this community.
- Given the DOV buffer area is already cleared/impacted, native vegetation should be allowed to recolonise this buffer area and should be managed for weeds, especially given the prevalence of Spanish heath nearby.
- Ensure that the quality of water that may be drained from landfill to the DOV is not toxic to the vegetation and environment as this may impact the DOV.
- Prior to the commencement of works, the clearance area should be marked (either in situ and/or clearly on construction plans) and all contractor agreements should specify that works, vehicles and materials must be confined to within the designated clearance areas only.

Threatened flora

- No threatened plant species were recorded.
- No impact to threatened flora is expected.

Threatened fauna and threatened fauna habitat

- A targeted den survey was conducted in the area proposed for landfill cells where there is a possibility of dens occurring. Accordingly, this search focussed in native habitat (the DVO and DPU) rather than the entirely cleared area of FUM. No potential burrows or dens of the Tasmanian devil or quolls were recorded.
- Scats of Tasmanian devil were recorded in the area proposed for the borrow pit and this area contains friable soils suitable for denning.
- The host plant for the threatened chaostola skipper was consistently recorded throughout the understory of the ~20 ha of FPU.

Recommendations:

- A den survey prior to the clearing of the area for the proposed borrow pit to ensure no burrows or dens that may be in use are destroyed during clearing.
- A survey of the area proposed for the borrow pit to assess the presence of chaostola skipper.
- The proposal will involve potential road upgrades and increases in traffic. It is understood that there will only be daytime use of the road network, so impact to carnivores is not expected; regardless, to mitigate potential increased likelihood of road mortalities the following should be observed:
    - Internal road use should be limited to daytime hours.
    - Speed limits ≤ 40 km/h should be applied to all internal roads during construction and operation.
    - Roadkill mortalities should be removed immediately upon location (to limit likelihood of predators being attracted to the carcass).

Weeds

- Three weed species declared under the Tasmanian Weed Management Act occur in the project area: Spanish heath, serrated tussock and slender thistle.

Recommendation:

- Develop a weed and hygiene management plan to manage the potential spread weeds to/from the site

Legislation

- Habitat for EPBCA listed fauna have been identified in the study area. Impact to habitat for these species is unlikely to result in significant impacts to Matters of

National Environmental Significance (MNES) under the definitions under this Act. However, a survey for the skipper is required in area proposed for the borrow pit to better understand the potential impact to that species.

- A permit to take is not likely required under the TSPA. However, if burrows or dens are found and will be destroyed and/or if skipper habitat is confirmed and will be impacted, a permit will be required.
- A 30 m wide corridor under the waterway and coastal protection code as defined in the Sorell Interim Planning Scheme 2015 occurs in the area proposed for the borrow pit. This area has been entirely transformed by forestry and it is our assessment that the proposal is able to meet the requirements of the code.
- The proposal does not conflict with the Permanent Native Forest Estate Policy.
- The proposal will not impact wetlands of international importance (RAMSAR wetlands) or areas or habitats of conservation significance.

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9 Appendix A - Vascular Plant Species by Community

Site: 4 FPU

Grid Reference:	561672E, 5255997N
Accuracy:	GPS (within 10 metres)
Recorder:	Cameron Geeves
Date of Survey:	27 Jul 2021
Trees:	*Eucalyptus amygdalina, Eucalyptus obliqua, Eucalyptus viminalis subsp.*
Tall Shrubs:	*Acacia dealbata subsp. dealbata, Allocasuarina monilifera, Leptospermum scoparium, Oxylobium ellipticum*
Shrubs:	*Amperea xiphoclada var. xiphoclada, Bossiaea cinerea, Cassinia aculeata subsp. aculeata, Epacris impressa, Olearia ramulosa, Pultenaea juniperina, Styphelia ericoides*
Low Shrubs:	*Acrotriche serrulata, Aotus ericoides, Hibbertia procumbens, Hibbertia riparia, Leucopogon virgatus, Styphelia adscendens, Styphelia humifusa*
Herbs:	*Acaena novae-zelandiae, Acianthus pusillus, Chiloglottis sp., Euchiton japonicus, Geranium sp., Hydrocotyle hirta, Lagenophora gunniana, Oxalis perennans, Viola hederacea*
Graminoids:	*Gahnia grandis, Gahnia radula, Juncus pallidus, Juncus planifolius, Juncus sp., Lepidosperma concavum, Lepidosperma ensiforme, Lomandra longifolia, Schoenus apogon, Sporadanthus tasmanicus*
Grasses:	*Microlaena stipoides, Poa sp., Rytidosperma sp., Tetrarrhena disticophylla*
Ferns:	*Pteridium esculentum subsp. esculentum*
Climbers:	*Cassytha pubescens*
Weeds:	*Carduus tenuiflorus, Centaurium erythraea, Cirsium vulgare, Conyza canadensis, Erica lusitanica, Hypochaeris radicata, Leontodon saxatilis, Lysimachia arvensis, Pinus radiata, Plantago coronopus, Prunella vulgaris, Reseda luteola*

Site: 5 FRG

Grid Reference:	561863E, 5256304N
Accuracy:	GPS (within 10 metres)
Recorder:	Cameron Geeves
Date of Survey:	27 Jul 2021
Trees:	*Eucalyptus amygdalina, Eucalyptus viminalis subsp. viminalis*
Tall Shrubs:	*Acacia dealbata subsp. dealbata, Allocasuarina monilifera*
Shrubs:	*Amperea xiphoclada var. xiphoclada, Epacris impressa, Pimelea linifolia, Pultenaea dentata, Styphelia ericoides*
Low Shrubs:	*Aotus ericoides, Hibbertia procumbens, Leucopogon virgatus, Styphelia*
Herbs:	*Chiloglottis sp., Gonocarpus tetragynus*
Graminoids:	*Gahnia radula, Lepidosperma concavum, Sporadanthus tasmanicus*
Ferns:	*Pteridium esculentum subsp. esculentum*
Climbers:	*Cassytha pubescens*
Weeds:	*Pinus radiata*

Site: 6 DPU

Grid Reference:	562706E, 5257087N
Accuracy:	GPS (within 10 metres)
Recorder:	Fiona Walsh
Date of Survey:	28 Jul 2021
Trees:	*Acacia melanoxylon, Eucalyptus globulus subsp. globulus, Eucalyptus pulchella, Eucalyptus viminalis subsp. viminalis*
Tall Shrubs:	*Acacia dealbata subsp. dealbata, Acacia verticillata, Banksia marginata, Bursaria spinosa subsp. spinosa, Exocarpos cupressiformis, Leptospermum scoparium*
Shrubs:	*Bossiaea prostrata, Epacris gunnii, Epacris impressa, Leptomeria drupacea, Lomatia tinctoria*
Low Shrubs:	*Lissanthe strigosa subsp. subulata, Pimelea humilis, Styphelia humifusa*
Herbs:	*Acaena novae-zelandiae, Dichondra repens, Hovea heterophylla, Hydrocotyle sibthorpioides, Isolepis sp., Lagenophora stipitata, Oxalis perennans, Ranunculus lappaceus, Senecio linearifolius var. linearifolius, Senecio quadridentatus, Stylidium graminifolium*
Graminoids:	*Diplarrena moraea, Juncus pallidus, Juncus sp., Lepidosperma sp., Lomandra longifolia, Luzula sp., Typha sp.*

Grasses:	*Poa labillardierei, Poa sieberiana, Rytidosperma sp., Themeda triandra*
Weeds:	*Centaurium erythraea, Cirsium vulgare, Dactylis glomerata, Erica lusitanica, Hypochaeris radicata, Plantago coronopus*

Site: 7 DOV

Grid Reference:	562612E, 5256982N
Accuracy:	GPS (within 10 metres)
Recorder:	Fiona Walsh
Date of Survey:	28 Jul 2021

Trees:	*Acacia melanoxylon, Eucalyptus ovata var. ovata, Eucalyptus pulchella*
Tall Shrubs:	*Acacia verticillata, Leptospermum lanigerum, Leptospermum scoparium*
Shrubs:	*Bossiaea prostrata, Epacris gunnii, Epacris impressa*
Low Shrubs:	*Lissanthe strigosa subsp. subulata, Styphelia adscendens, Styphelia humifusa*
Herbs:	*Acaena novae-zelandiae, Dichondra repens, Lagenophora stipitata, Ranunculus lappaceus*
Graminoids:	*Diplarrena moraea, Empodisma minus, Lepidosperma sp., Lomandra longifolia, Schoenus apogon, Schoenus lepidosperma subsp. lepidosperma, Typha sp.*
Grasses:	*Poa labillardierei, Poa sieberiana, Rytidosperma sp., Themeda triandra*
Weeds:	*Centaurium erythraea, Cirsium vulgare, Dactylis glomerata, Hypochaeris radicata, Plantago coronopus, Plantago lanceolata*

10 Appendix B - Flora Species List

Status codes:

ORIGIN	NATIONAL SCHEDULE	STATE SCHEDULE
	EPBC Act 1999	TSP Act 1995
i - introduced	CR - critically endangered	e - endangered
d - declared weed WM Act	EN - endangered	v - vulnerable
en - endemic to Tasmania	VU - vulnerable	r - rare
t - within Australia, occurs only in Tas.		

Sites:

4	FPU - E561672, N5255997	27/07/2021	Cameron Geeves
5	FRG - E561863, N5256304	27/07/2021	Cameron Geeves
6	DPU - E562706, N5257087	28/07/2021	Fiona Walsh
7	DOV - E562612, N5256982	28/07/2021	Fiona Walsh

Site	Name	Common name	Status
	DICOTYLEDONAE		
	APIACEAE		
4	*Hydrocotyle hirta*	hairy pennywort	
6	*Hydrocotyle sibthorpioides*	shining pennywort	
	ASTERACEAE		
4	*Carduus tenuiflorus*	winged thistle	d
4	*Cassinia aculeata subsp. aculeata*	dollybush	
4 6 7	*Cirsium vulgare*	spear thistle	i
4	*Conyza canadensis*	canadian fleabane	i
4	*Euchiton japonicus*	common cottonleaf	
4 6 7	*Hypochaeris radicata*	rough catsear	i
4	*Lagenophora gunniana*	coarse bottledaisy	
6 7	*Lagenophora stipitata*	blue bottledaisy	
4	*Leontodon saxatilis*	hairy hawkbit	i
4	*Olearia ramulosa*	twiggy daisybush	
6	*Senecio linearifolius var. linearifolius*	common fireweed groundsel	
6	*Senecio quadridentatus*	cotton fireweed	
	CASUARINACEAE		
4 5	*Allocasuarina monilifera*	necklace sheoak	en
	CONVOLVULACEAE		
6 7	*Dichondra repens*	kidneyweed	
	DILLENIACEAE		
4 5	*Hibbertia procumbens*	spreading guineaflower	
4	*Hibbertia riparia*	erect guineaflower	
	ERICACEAE		
4	*Acrotriche serrulata*	ants delight	
6 7	*Epacris gunnii*	coral heath	
4 5 6 7	*Epacris impressa*	common heath	
4 6	*Erica lusitanica*	spanish heath	d
4 5	*Leucopogon virgatus*	common beard-heath	
6 7	*Lissanthe strigosa subsp. subulata*	peachberry heath	
4 5 7	*Styphelia adscendens*	golden heath	
4 5	*Styphelia ericoides*	pink beardheath	
4 6 7	*Styphelia humifusa*	native cranberry	
	EUPHORBIACEAE		
4 5	*Amperea xiphoclada var. xiphoclada*	broom spurge	
	FABACEAE		
4 5 6	*Acacia dealbata subsp. dealbata*	silver wattle	
6 7	*Acacia melanoxylon*	blackwood	
6 7	*Acacia verticillata*	prickly moses	
4 5	*Aotus ericoides*	golden pea	
4	*Bossiaea cinerea*	showy bossiaea	
6 7	*Bossiaea prostrata*	creeping bossiaea	
6	*Hovea heterophylla*	winter purplepea	
4	*Oxylobium ellipticum*	golden shaggypea	
5	*Pultenaea dentata*	swamp bushpea	
4	*Pultenaea juniperina*	prickly beauty	

	GENTIANACEAE		
4 6 7	*Centaurium erythraea*	common centaury	i
	GERANIACEAE		
4	*Geranium sp.*	native geranium	
	HALORAGACEAE		
5	*Gonocarpus tetragynus*	common raspwort	
	LAMIACEAE		
4	*Prunella vulgaris*	selfheal	i
	LAURACEAE		
4 5	*Cassytha pubescens*	downy dodderlaurel	
	MYRTACEAE		
4 5	*Eucalyptus amygdalina*	black peppermint	en
6	*Eucalyptus globulus subsp. globulus*	tasmanian blue gum	
4	*Eucalyptus obliqua*	stringybark	
7	*Eucalyptus ovata var. ovata*	black gum	
6 7	*Eucalyptus pulchella*	white peppermint	en
4 5 6	*Eucalyptus viminalis subsp. viminalis*	white gum	
7	*Leptospermum lanigerum*	woolly teatree	
4 6 7	*Leptospermum scoparium*	common tea-tree	
	OXALIDACEAE		
4 6	*Oxalis perennans*	grassland woodsorrel	
	PITTOSPORACEAE		
6	*Bursaria spinosa subsp. spinosa*	prickly box	
	PLANTAGINACEAE		
4 6 7	*Plantago coronopus*	buckshorn plantain	i
7	*Plantago lanceolata*	ribwort plantain	i
	PRIMULACEAE		
4	*Lysimachia arvensis*	scarlet pimpernel	i
	PROTEACEAE		
6	*Banksia marginata*	silver banksia	
6	*Lomatia tinctoria*	guitarplant	en
	RANUNCULACEAE		
6 7	*Ranunculus lappaceus*	woodland buttercup	
	RESEDACEAE		
4	*Reseda luteola*	weld	i
	ROSACEAE		
4 6 7	*Acaena novae-zelandiae*	common buzzy	
	SANTALACEAE		
6	*Exocarpos cupressiformis*	common native-cherry	
6	*Leptomeria drupacea*	erect currantbush	
	STYLIDIACEAE		
6	*Stylidium graminifolium*	narrowleaf triggerplant	
	THYMELAEACEAE		
6	*Pimelea humilis*	dwarf riceflower	
5	*Pimelea linifolia*	slender riceflower	
	VIOLACEAE		
4	*Viola hederacea*	ivyleaf violet	
	GYMNOSPERMAE		
	PINACEAE		
4 5	*Pinus radiata*	radiata pine	i
	MONOCOTYLEDONAE		
	ASPARAGACEAE		
4 6 7	*Lomandra longifolia*	sagg	
	CYPERACEAE		
4	*Gahnia grandis*	cutting grass	

4 5	*Gahnia radula*	thatch sawsedge	
6	*Isolepis sp.*	club rush	
4 5	*Lepidosperma concavum*	sand swordsedge	
4	*Lepidosperma ensiforme*	arching swordsedge	
6 7	*Lepidosperma sp.*	sword sedge	
4 7	*Schoenus apogon*	common bogsedge	
7	*Schoenus lepidosperma subsp. lepidosperma*	slender bogsedge	
	IRIDACEAE		
6 7	*Diplarrena moraea*	white flag-iris	
	JUNCACEAE		
4 6	*Juncus pallidus*	pale rush	
4	*Juncus planifolius*	broadleaf rush	
4 6	*Juncus sp.*	Rush	
6	*Luzula sp.*	luzula	
	ORCHIDACEAE		
4	*Acianthus pusillus*	small mosquito-orchid	
4 5	*Chiloglottis sp.*	bird orchid	
	POACEAE		
6 7	*Dactylis glomerata*	cocksfoot	i
4	*Microlaena stipoides*	weeping grass	
6 7	*Poa labillardierei*	silver tussockgrass	
6 7	*Poa sieberiana*	grey tussockgrass	
4	*Poa sp.*	poa	
4 6 7	*Rytidosperma sp.*	wallabygrass	
4	*Tetrarrhena disticophylla*	hairy rice-grass	
6 7	*Themeda triandra*	kangaroo grass	
	RESTIONACEAE		
7	*Empodisma minus*	spreading roperush	
4 5	*Sporadanthus tasmanicus*	branching scalerush	
	TYPHACEAE		
6 7	*Typha sp.*		
	PTERIDOPHYTA		
	DENNSTAEDTIACEAE		
4 5	*Pteridium esculentum subsp. esculentum*	bracken	