FLINDERS COUNCIL

Whitemark Landfill
EPN 7191/2

Review of Environment Management Plan and Remedial Site Works

justWASTE CONSULTING

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DOCUMENT RECORD

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GLOSSARY / ACRONYMS

Air Space	the volume of space on a landfill site to be filled with waste
Cap	a composite liner, intended to be a low permeable barrier which is laid down over the engineered landfill sites
Cell	a section of a landfill
EPN	Environmental Protection Notice
The Director	is the Director of Environmental Management appointed under section 10 of the EMPCA.
Inert Waste	materials that do not undergo environmentally significant physical, chemical or biological transformations and have no potentially hazardous content once landfilled.
Level 1 Activity	a small scale activity which may cause environmental harm and for which a permit is required under the Land Use Planning and Approvals Act 1993.
Level 2 Activity	a larger scale activity, as specified in Schedule 2 EMPCA.
Liner	a composite liner, intended to be a low permeable barrier which is laid down under engineered landfill sites.
Putrescible Waste	materials containing major components able to be decomposed by bacterial action. Such as household domestic garbage, food waste, paper, cardboard and green waste.
Residual	remaining after the greater part or quantity has gone.

1. Background

The Flinders Council owns and operates a putrescible landfill located at Whitemark. This facility is the only landfill in the Municipality.

The Whitemark Landfill is a level 2 facility licenced through Environment Protection Authority (EPA) Tasmanian under the following Environment Protection Notice (EPN);

- *Environment Protection Notice No. 7191/2.*

The EPN was issued to Council on 17 September 2007.

Waste delivered to the site is placed into two separate two main areas, putrescible and inert. Other waste materials such as clean fill, recyclables, green waste, animal residue and controlled wastes; including: asbestos, tyres, batteries, waste oil, clinical and related, medical sharps and quarantine waste, as per Council's EPN.

EPA Tasmania conducted a compliance audit on the 6th and 7th May 2013, including a site visit and Permit / EPN audit.

G9: Environment Management Plan (EMP) and review.

Condition G9: EMP and review states;

e) The EMP must be critically reviewed by a person responsible for the activity by 31st October 2010 and at 5 yearly intervals thereafter.

The EMP has not been critical reviewed since the Permit was issues in September 2007.

In addition, EPA has recommended Council include the following points to evaluate:

- The nature and environmental risks presented by the waste depot;
- Remedial works required to bring the waste depot into line with the *Landfill Sustainability Guide 2004* or the case to justify deviations from the Guide;
- The viability of recycling of various materials on Flinders Island; and
- The integrity of groundwater monitoring bores and their location in relation to the waste depot and the aquifer(s) that they intercept.

Council is also proposing to undertake significant remedial works at the waste depot, in relation to the inert waste area. Council will develop a project timeline and description and consult with EPA before engaging in such remedial works.

2. SITE DESCRIPTION

The Whitemark Landfill is located approximately seven kilometres North East of the township of Whitemark, address being: 419 Memana Road. Refer to figure 1 for the site location.

Figure 1: Site Map

Whitemark landfill site

2.1. Site Description

The Whitemark site consists of 35 ha of land. A mixture of putrescible and inert areas are designated along with resource recovery stockpile areas.

The site is set out in four distinctive areas:

- Putrescible landfill;
- Inert landfill;
- Resource recovery including tyres, whitegoods, E-waste, batteries, oil, scrap steel, tip shop; and
- Green waste stockpile.

Figure 1: Landfill Zones

Zone 1:	Resource Recovery areas;
Zone 2:	Inert landfill;
Zone 3:	Putrescible landfill

2.2. Site infrastructure

The site consists of the following infrastructure within the boundary:

- Machinery shed
- Resource recovery shed (tip ship)
- Gatehouse
- Hardstand area for resource recovery items
- Powerlines
- Internal road network
- Groundwater bores (3)

2.3. Waste volumes

The Whitemark landfill is permitted to accept 2,000 tonnes of waste to be disposed of on the land per year.

As documented in the 2014/15 Waste Quantities Report, the total waste quantities are provided below in table 1.

Table 1: Waste quantities

Year	Waste to Landfill (t)	Comparison to previous year (%)
2011/12	564	0
2012/13	481	-14.7
2013/14	686	+42.6
2014/15	612	-10.8

2.4. Hours of operation

The Whitemark site is currently open for the following hours:

Table 2: Opening hours

Day	Time
Monday	1.30pm – 4.30pm
Tuesday	7:00am – 10:00am
Wednesday	8.30am – 11.30am
Thursday	7:00am – 10:00am
Friday	1.30pm – 4.30pm
Sunday	1.30pm – 4.30pm

The site is closed on Public Holidays.

There are currently a series of bins at the front gate, which will be removed early in the next financial year. Bins may be replaced for peak periods such as the Christmas break.

Figure 2: Bins at the front of the Whitemark site (after hours access)

2.5. Vehicle Movements

During the 2014/15 financial year a total of 4,719 vehicles entered the site. These ranged from a standard car to a large duel axle truck. There are no kerbside collections offered to the Community, at this stage, therefore the community brings their own domestic waste to the site.

3. EXISTING ENVIRONMENT

3.1. Geology

The geology of the area is Quaternary sands, clays and gravels. The soils are deep, pale yellow and grey sands have developed on the dunes and ridges, while the duplex soils in the swales are mottled. Waterworn quartz grit is often found throughout the soil profiles on the low rises and ridges

3.2. Climate and Topography

The average annual rainfall for the area is 750 – 1000mm, spread relatively evenly throughout the year. Average slopes vary from 2 to 4 degrees and the site occurs in undulating plains.

3.3. Groundwater Monitoring

Groundwater monitoring at the Whitemark landfill occurs on a six monthly basis. Appendix 2 is the current monitoring report and analysis.

4. POTENTIAL EFFECT AND THEIR MANAGEMENT

4.1. Air Quality

Air emissions from the site are considered extremely low due to the vehicle movements and volume of waste disposed of. Air emissions include:

- Dust from roads and areas of bare soil
- Odours from the waste
- Emissions from equipment and vehicles
- Landfill gas (methane and carbon dioxide)

Whilst air emissions are considered extremely low, the prevalence of strong westerly winds at the site means any air emissions are usually dispersed to the east of the area.

Dust has the potential to cause an environmental nuisance if it is blown beyond the boundary of the landfill's activities. It can cause respiratory annoyance or problems, reduce visual amenity and fall out onto land or surfaces in other ownership, with the potential to soil clean surfaces and contaminate roof-collected water supplies, however no residential water collection exists within 500 metres of the disposal site and no complaints have been received. A large majority of roads on Flinders Island are gravel and therefore dust is well tolerated in general by the Community.

4.1.1. Avoidance and Mitigation

The following avoidance and mitigation measures will be implemented to minimise the generation of dust and emissions:

- Roads will be watered, if necessary, during hot, dry and windy conditions
- Existing vegetation will be maintained for windbreaks where possible

4.2. Surface water

Liquid waste is generated during landfill operations, specifically being:

- Leachate
- Storage area and run off
- Sediment loss

Surface water run off must maintain or in some circumstances enhance the quality of the surface waters downstream of the site.

Contaminated surface water has the potential to spread further into the surrounding natural environment, eventually entering into creek systems and livestock areas.

Sediment run off also has the potential to impact water quality of the creek system.

4.2.1. Avoidance and Mitigation

The following avoidance and mitigation measures will be implemented to minimise the risk of impact to surface water quality:

- Surface water drainage to consist of a series of cut off drains which divert runoff towards sediment traps / ponds
- Stormwater drain to divert water to Youngs Creek
- All sediment protection measures will be regularly inspected and maintained by site personnel

4.3. Ground water

The soil structure within the site is considered relatively permeable and impacts to groundwater and landfill activates have the potential to contaminate groundwater.

4.3.1. Avoidance and Mitigation

The following avoidance and mitigation measures will be implemented to minimise the risk of impact to groundwater:

- Groundwater monitoring will continue to be undertaken on a six monthly basis

4.4. Visual impacts

The landfill site is situated on a relatively flat parcel of land with had a low visual impact due to the distance from the roadside and the vegetation screening.

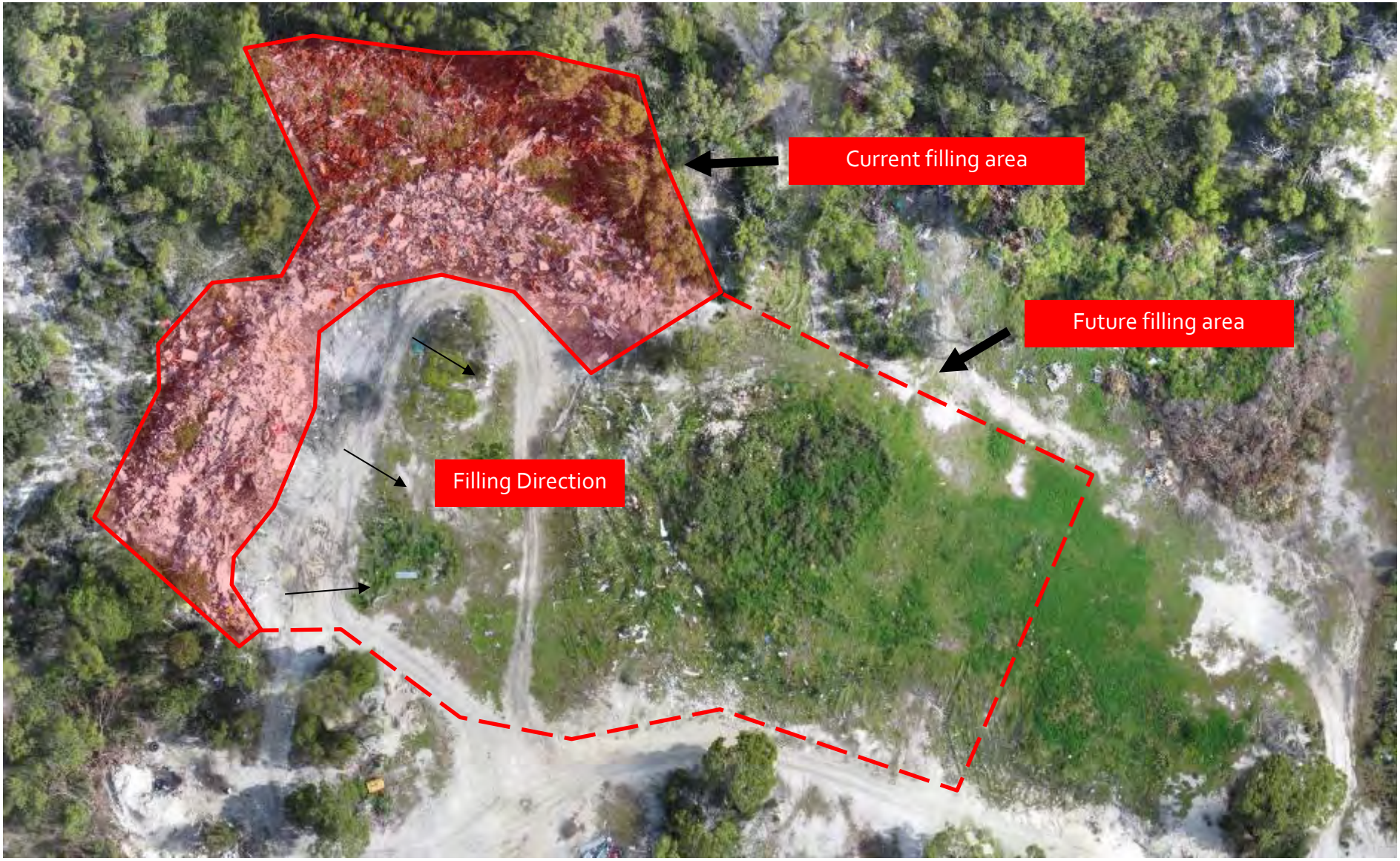
When onsite, the inert area of the site provides a visual impact based upon the filling design and lack of compaction and covering.

4.4.1. Avoidance and Mitigation

The following avoidance and mitigation measures will be implemented to minimise the risk of visual impact:

- Compaction and shaping of these areas will be conducted using Councils D6R Dozer. The lift will not exceed two metres high and work into the middle of the inert area. Cover material will be used from stockpiles onsite (Figure 3)

Figure 3: Inert area filling plan



4.5. Fire risk

The has been no formal fire management plan developed for the site.

Fire management planning at the site will be consistent with existing local fire authority requirements and public property management expectations. The main objectives of fire management at the site are to protect life and property, and the natural values of the landfill area and surrounds in the event of fire.

4.6. GCL Lined Cell (Putrescible waste)

In March 2010 an engineered landfill cell was constructed using an X1000 Geo-synthetic Clay Liner (GCL). For reasons unknown, the GCL cell was never used, although approved by EPA.

Due to the GCL being left uncovered to the elements Council engaged a consultant to inspect and test for the permeability qualities of the cell. The report by David Jolly indicates both the permeability test results as well as amended design options for future use. A copy of the report form Appendix 3 of this report.

Figure 4: Putrescible GCL Cell - March 2016

Concerns regarding this cell are:

- Original design quality;

- Leachate collection system at base of cell; and

- Overall size and shape of the cell with respect to the filling and achieving batters that would abide by the LSG.

4.6.1. Action plan for putrescible waste

Current practises do not meet all of the conditions of the EPN. This EMP review aims to highlight opportunities for improvement.

The current filling area is utilising a hole opened up by quarrying activities of many years ago. This area has an expected life of three years. Planning and design of the existing and future cells, including leachate capture is to occur under EPA approval.

Further consultation with EPA will occur until a satisfactory design is approved. Alternatively

4.6.2. The future

Flinders Council has completed a *Waste Management Strategy* that assesses waste management from a local perspective, including the management and disposal of putrescible waste. The main decision for Council is the disposal of regarding putrescible waste, with regard to best outcomes for the Community that satisfy all parties involved form an economic, social and environmental benefit.

Matters of consideration have included:

- Cape Barren Island waste;
- Recycling options;
- Separation & Segregation of waste;
- Management of 1 or multiple collection sites;
- Waste collection and transport;
- Value to the Community;
- Kerbside Collection;
- Off-Island Disposal; and
- Exposure to and control of costs.

Council has assessed various options for putrescible waste management intensely over the last 2 years and have continued to come to the conclusion that landfilling at the current Whitemark site is the best option.

Council is now working towards a long-term strategic approach to dispose of putrescent waste via approved landfill cells at the Whitemark site.

5. RECYCLING VIABILITY

Many items that are recycled elsewhere in Australia that are seen as either cost positive or cost neutral are potentially cost negative to the community on Flinders. Greater emphasis is to be placed on forming links with recycling opportunities or increasing on-Island initiatives.

Council has adopted a program of stockpiling materials with the aim of creating a volume that can meet a current market on scale.

Council currently separates and stockpiles:

- Whitegoods; -
- Ewaste;
- Glass bottles;
- Aluminium, cans;
- Tyres;
- Vehicle batteries;
- Engine oil;
- Scrap vehicles;
- Greenwaste;
- Concrete; and
- Steel, including fencing wire.

Figure 4: Stockpiles throughout the site.

Through the *Waste Management Strategy*, Council is investigating options for all waste materials. This includes recycling, reuse and stockpiling.

Council is investigating the waste streams that are able to be separated and stockpiled. This includes, but not limited to cardboard, co-mingled recyclables and plastic film.

6. EPN DOCUMENT REVIEW

A document review of the EPN and the *Landfill Sustainability Guide3, 2004 (LSG),* Along with various site inspections a full review of the licence conditions was carried out. Below are the main conditions of the licence and recommendations for continual improvement and issue of a new, Environmental Protection Notice (EPN).

6.1. Permit No. 7191/2 – Schedule 2

Environmental Conditions

Q1 Maximum Quantities

Licenced to accept 2,000 tonnes of waste, excluding clean fill. Currently 600 tonnes per annum accepted.

Q2 Landfill Area

The landfill is confined to Lot 1 (Attachment 1 of the EPN).

Q3 Permitted Waste Types

Materials that are not listed in Q3 are not accepted at the landfill.

Q4 Non-Permitted Waste Types

No liquid waste or hazardous waste not listed in Q3 is accepted at the Whitemark Landfill.

General Conditions

G1

The EMP from June 2004 that formed the basis for the issuing of the EPN has not been met. This is due to the current site still being filled due to the small volumes of waste materials accepted into the putrescible area.

G7 Annual Reporting

No Annual Reports have been provided to the EPA since the operation of the site. Council will commit to providing the EPA with an Annual Report for 2015/16 by 30 September 2016.

G8 Waste Date Reporting

Data reporting is provided to the EPA on an annual basis.

G9 Review of EMP

The EMP has not been critically reviewed since provided to Council. This document is the first time the EMP has been reviewed.

G10 Public Complaints Register

Complaints from the community in the past have resulted from illegal afterhours fires being lit.

No public complaints have been received to Council in the past twelve months.

Construction

C1 Commencement of Works

No new cells have been constructed.

C2 Leachate Barrier

No leachate barrier system is in place. . No leachate runoff has left the site as it is contained in a dam at the back of the putrescible area.

C4 Leachate Management

No leachate runoff has left the site as it is contained in a dam at the back of the putrescible area.

C5 Perimeter Drains

Perimeter drains are located throughout the site. No information on the design, mapping or ability on whether they have the capacity of a 24 hour, 1 in 20 year rainfall event.

C6 Sediment Ponds

Sediments traps and ponds are located throughout the site. There is no written maintenance program for cleaning.

Quality Assurance and Design Drawings

C8 Quality Assurance

No new cells have been designed or constructed. Council will abide by these conditions once a plan is developed for future waste management at the site.

Site Operations

SO3 Operations Manual

An Operational Manual is required for the site.

SO4 Site Security

The putrescible landfill area is surrounded by a 2.0 metre high fence. The other areas of the site are either not fenced or fenced by a low stock fence.

The entry to the site from the road is fenced and gated. The site cannot be accessed by other means when the main gate is locked due to dense vegetation on all other boundaries with private land.

SO5 Waste Emplacement

At present waste placement is different for the two areas:

Inert Area: Waste is placed onto the group and pushed up into a pile;

Putrescible Area: Waste is placed into the area by the public. Compacted and covered on a weekly basis.

SO6 Waste Cover

Cover is applied weekly to the putrescible area. Due to the qualities and the availability of machinery daily compaction and covering is difficult to achieve.

SO7 Waste Capping

Previous areas of the site have been capped and rehabilitated. A rehabilitation plan is required for the current areas.

SO10 Litter Management

Signage is erected throughout the site informing customers of where waste streams are to be disposed of.

Litter is managed through weekly site checks conducted by staff.

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SO12 Fire Protection

A fire management plan is to be developed and signed off by TAS Fire.

SO15 Recycling and Recovery of Waste Materials

Through the *Waste Management Strategy* Council is investigating and researching options for further resource recovery options.

These include cardboard, co-mingled recyclables and plastic film.

Hazardous Substances and Controlled Waste

H1 Records

Asbestos volume is recorded through the gatehouse upon receipt.

H5 Waste Tyres

Waste tyres are stockpiled.

Decommissioning and Rehabilitation Conditions

A rehabilitation plan is to be developed to comply with R1, R2 and R3 conditions.

Monitoring Bore Installation, Monitoring and Reporting

M1 Groundwater Bore Installation

There are three groundwater sampling bores located at the Whitemark Landfill.

No records are available on the borehole installation.

M2 Monitoring, Record Keeping and Reporting

Monitoring and reporting on the groundwater results is conducted six monthly and provided to EPA.

7. COMMENTS / COMMITMENTS

Following this review the Flinders Council would like to recommend the below list of comments / commitments.

7.1. Issuing of a new EPN

The Flinders Council seeks the issuing of a new EPN that will update the current EPN.

7.2. Separate Inert / Putrescible Cells

Council has developed an effective separation practise with the Community for inert and putrescible waste. With the costs of putrescible cell, Council will continue to fill these two separate areas.

7.3. Rehabilitation Plan

Council is to develop a Rehabilitation Plan for the progressive rehabilitation of the site. This Rehabilitation Plan is to be approved by the Director prior to works commencing. The Rehabilitation Plan will be designed in conjunction with an updated filling sequence plan for both the inert area and the putrescible area.

7.4. Operations Manual

Development of an Operations Manual within six months.

Operations are projected to change considerably as Council aims to tender for external management of the site. This will include the work of waste separation and segregation of waste as well as waste collection with the aim to improve services to community, improve costs and liability risk to Council and ensure compliance with EPN conditions.

7.5. Putrescible Landfill Cell

Council is to review, design, consult and seek approval a GCL landfill cell within the Whitemark landfill footprint.

Dialogue with the EPA is to follow once a draft design is available.

It is envisaged that the existing pre-approved GCL cell will be the first site to be utilised for putrescent waste disposal. Some modification are required. If EPA are accepting of Council's proposal to dispose of waste via this method, further details will be provided relating to the modifications to be undertaken to ensure it is suitable to receive waste.

The existing cell could then be utilised whilst future cells are designed for succession planning.

APPENDIX 1 – LIST OF RECOMMENDATIONS

Number	Condition	Recommendation
G7	Annual Review	Submit an Annual Report to the EPA 30 September 2016 and annually thereafter.
C5	Perimeter Drains	Study into the sites perimeter drain system, including mapping and compliance with a 24 hour, 1 in 20 year rainfall event.
C6	Sediment Ponds	Study into the sediment pond system, including mapping and capacity.
S03	Operations Manual	Develop an Operations Manual for the site. Including daily, weekly and monthly checklists.
S05	Filling Plan	Develop a filling plan for the inert and putrescible areas.
R1	Rehabilitation	Development of a Rehabilitation Plan, approved by the Director.

APPENDIX 2– GROUNDWATER REPORT

APPENDIX 3– EXISTING GCL CELL REPORT – DAVID JOLLY

FLINDERS COUNCIL

justWASTE CONSULTING

GROUNDWATER MONITORING REPORT

WHITEMARK, APRIL 2016

10TH MAY, AXIO

DOCUMENT RECORD

Version	Issued To	Date	Author	Approved
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CONTENTS

1. INTRODUCTION

The following summary discusses results obtained from groundwater monitoring carried out at Whitemark Refuse Disposal Site between October 2009 and January 2016. The summary is based on analytical results only and is limited in its interpretation as bore construction logs and monitoring event record sheets were not viewed in conjunction with the results. Result summaries are based on characterising the groundwater quality and identifying trends that may be resulting from the land use as a refuse disposal site.

An earlier report prepared by SEAM[1] states that three monitoring bores were installed in September 2008 by Taswide Geoservices and at the time bores were too dry to monitor. It was only following a rain event that bores were able to be sampled. The following 2010 monitoring event also indicated a relationship between a prolonged period of low rainfall and a corresponding reduction in aquifer recharge.

The direct relationship of rainfall and bore water levels indicates a close relationship between surface water influencing groundwater recharge in the area. Thus any above surface impacts are likely to appear in the bore water which is ideal for monitoring any potential impact of the refuse disposal site. Given the low potential yield of the bores it is unlikely the bores could be utilised for use (i.e, stock watering, and irrigation) other than for monitoring purposes.

The direction of groundwater flow is unknown however groundwater usually flows in the direction of least geological resistance and decreasing slope. It is likely groundwater bores 1 and 3 will flow northwards towards Youngs Creek and groundwater bore 2 may flow either north towards Youngs Creek or south west to a large dam. Bore 1 has been established as the background bore due to the assumed groundwater flow. Further the bore is located at a distance from the site with a significant vegetated area in between the active site and bore location.

The site has historically been used for low scale tin mining and quarrying.

The groundwater summary is based on seven groundwater sampling events:

- 30th October 2009 carried out by SEAM;
- 22th September 2010 carried out by SEAM;
- 19th February 2013 carried out by JustWaste;
- 29th January 2014 carried out by JustWaste;
- 30th October 2014 carried out by JustWaste;
- 5th June 2015 carried out by JustWaste; and
- 10th January 2016 carried out by JustWaste.

[1] Sustainable Environmental Assessment and Management [SEAM], 2011. *Whitemark Refuse Disposal Site EMP Review for Flinders Council.*

2. SITE MAP

3. WATER QUALITY GUIDELINES

The ANZECC Water Quality Guideline trigger values for toxicants for 95% protection of slightly too moderately disturbed freshwater systems have been adopted for both surface water and groundwater[2]. Trigger values are often used as an early warning mechanism to alert managers of a potential problem (the guidelines do not assess compliance and should not be used in this capacity). Whilst, there are no specific Protected Environmental Values (PEVs) for groundwater in Tasmania, the ANZECC & ARMCANZ (2000) guidelines recommend that the trigger values be applied to both surface water and groundwater. Different conditions and processes operate in groundwater compared with surface waters and these can affect the fate and transport of many organic chemicals.

The *National Environment Protection (Assessment of Site Contamination) Measure [*NEPM[3]] *1999* (amended 2013) is made under the *National Environment Protection Council Act 1994* and is given effect by individual legislation and guidelines in each state and territory. The goal is to establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, landowners, developers and industry. The outcome is to provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination.

The 2011 Australian Drinking Water Guidelines (ADWG[4]) Version 2.0 Updated December 2013 have been developed by the National Health and Medical Research Council (NHMRC) in collaboration with the Natural Resource Management Ministerial Council (NRMMC). The ADWGs are designed to provide an authoritative reference to the Australian community and the water supply industry on what defines safe, good quality water, how it can be achieved and how it can be assured. The guidelines have been developed after consideration of the best available scientific evidence and provide a framework for good management of drinking water supplies to ensure safety at point of use. They address both the health and aesthetic quality aspects of supplying good quality drinking water. These guidelines have been incorporated into this summary as a comparison only. It is not an expectation that the water quality at the site meet the ADWG criteria however, it is a useful reference.

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[2] Australia and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (ANZECC& ARMCANZ, 2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

[3] National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended May 2013), *Schedule B1- Guideline on Investigation Levels for Soil and Groundwater, Table 1C Groundwater Investigation Levels (Fresh Waters).*

[4] National Health and Medical Research Council (NHMRC). *Australian Drinking Water Guidelines 6, 2011- Version 2.0 Updated December 2013.*

4. GROUNDWATER RESULTS SUMMARY

4.1. Monocyclic Aromatic Hydrocarbons (MAH)

Benzene, Toluene, Ethyl-benzene and o,m&p Xylene (abbreviated as BTEX) are generally associated with petroleum contamination. Results for the three groundwater bores at all sampling time were all below the laboratory limit of reporting (LOR) indicating no detection of petroleum impact from refuse disposal activities.

4.2. Total Petroleum Hydrocarbons (TPH)

Light TPH fractions (C_6-C_9) such as petrol are highly volatile, whereas heavier fractions (C_{10}-C_{40}) such as diesel, oil and grease are progressively less volatile.

- In 2014, 40ug/L for the C_{29}-C_{36} fraction was detected in bore 1.
- This was reduced to below 40ug/L in 2015 but recorded as 110ug/L in January 2016.
- Both bore 2 and 3 recorded level below 40ug/L in 2014 and 2015.
- However, but bore 2 and 3 mimicked the trend from bore 1 with large increase in 2016, recording 69 and 100ug/L respectively.
- All 2016 record are within the THP C_{15}-C_{28} fractions.

Considering the noticeable increase in al bore for the 2016 sample a site investigation looking to identify any potential spills is recommended. The NEPM recommended level for reporting is 100ug/L. The detection of the TPH in all bores pose a question of bore 1s viability as a control bore.

4.3. Polynuclear Aromatic Hydrocarbons (PAH)

PAH primarily is produced from the incomplete combustion of organic sources such as wood burning or biofuels. As particle pollution concentrations can be high in proximity to roads.

There were no results detected above the laboratory LOR for any of the sampling events in any of the bores or the leachate sample. The laboratory LOR of <0.5ug/L is above the ADWG limit of 0.01ug/L, so results could be above the ADWG limit. However, given that the bore water and leachate pond is not utilised for drinking purposes; this should not be concerning.

4.4. Organochlorine Pesticides (OCP)

OCPs includes 13 types of pesticides that are toxic to human, animal and specifically toxic even in low concentrations to most aquatic life.

There were no results detected above the laboratory LOR for any of the sampling events in any of the bores or the leachate sample. Many of the Laboratory LOR levels were greater than the guideline values. Thus if the LOR had been lower, positive results exceeding guideline levels may have been obtained. It is suggested that in future sampling events the laboratory is requested to lower their LOR to the appropriate guideline level where possible.

4.5. Metals

Heavy metals include arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn) and mercury (Hg). Heavy metal contamination is typically caused by a variety of industrial operations and processes.

It is difficult to compare the sampling events carried out by SEAM and JustWaste as SEAM analysed for dissolved metals and JustWaste analysed for total metals. NEPM guidelines for metals are provided as dissolved and ANZECC and ADWG are for comparison to total metals. The Flinders Council EPN outlines the monitoring parameters from the *Landfill Sustainability Guide 2004* which refers to the ANZECC guidelines. These parameters are in accordance with the *State Policy Water Quality management 1997*. Metals should thus be measured as a total rather than dissolved.

It should also be noted that the LOR for some values are is higher than the guideline value, indicating that an exceedance is possible but unknown. This is the case for example for Cr, Cu and Pb. Prior to further testing the values of all metals should be reviewed.

The presence of high chromium, copper and zinc in all groundwater bores, including the control bore 1, is likely to be a result of the natural background geology. Further, due to the large distance between bores it is unlikely the refuse disposal site could have an impact that far reaching. However, concentrations of these metals should be monitored closely for any increase in results especially if one bore displays result very different from others.

Iron concentrations were generally high in all bores, with the background bore 1 having concentrations ranging between 6.5-15mg/L, with the highest record in 2016. Bore 2 had a high record from the 2009 sample at 67.4mg/L but has since decreased to 9mg/L in 2016. October 2009 sampling result of 67.4mg/L is likely to be representative of impact from the disposal site, given that the following sampling event carried out in September 2010 the iron result was 0.413mg/L. Bore 3 has an iron concentration range similar to Bore 1, 0.085-14.7mg/L.

Mercury was not detected above laboratory LOR in any bore during any monitoring event.

4.5.1. Summary from Bore 1:

- Chromium exceeded ANZECC guidelines in all sampling event 2006-2016, gradually increasing to the highest recorded value in 2016.

- Copper exceedance of ANZECC and NEPM Groundwater Investigation Levels (GILs) in September 2010. Between 2013-2015 the values were low but 2016 recorded the highest value jet.

- Manganese exceedance of ADWG in October 2009 but then declined and has remained low.

- Zinc exceedance of ANZECC and NEPM at all sampling events with the highest recorded value in 2016.

4.5.2. Summary from Bore 2:

- Arsenic exceedance of ANZECC guideline in February 2013 and January 2014. Arsenic level has since continuously decreased.

- Chromium exceedance of ANZECC guidelines in all seven sampling events; and exceedance of ADWG during February 2013, January 2014 and October 2014 sampling events.

- Copper exceeded ANZECC and NEPM GILs during 2009, 2010 and 2013 monitoring events. The laboratory is required to lower the LOR to determine if the sample results are continuing to exceed guideline limits.

- Manganese exceedance of ADWG in October 2009 but has since continuously decreased.

- Nickel exceedance of ADWG in October 2009; exceedance of ANZECC and NEPM GILs in February 2013 and October 2014. The 2016 result is below all guides recommended value.

- Lead exceedance of ANZECC, NEPM GILS and ADWG in all sampling events. October 2014 and June 2015 values were below ADWG guideline value.

- Zinc exceedance of ANZECC and NEPM during all monitoring events. Zinc concentrations have been consistently high. The 2016 result is the highest recorded since 2009.

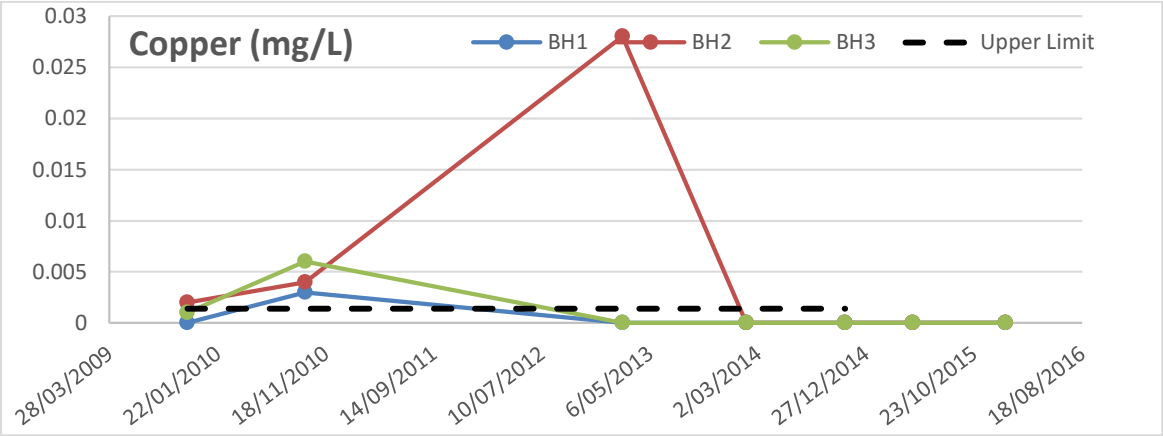
4.5.3. Summary from Bore 3:

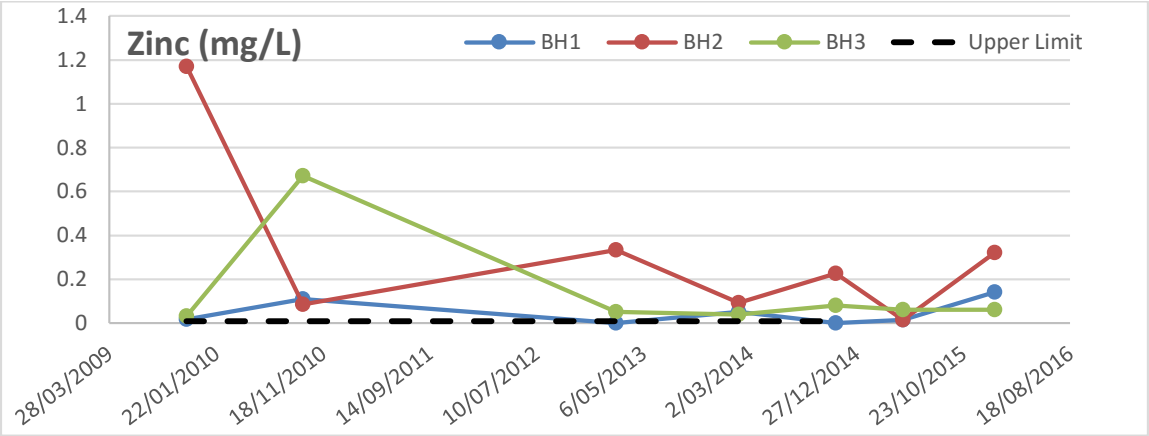
- Chromium exceedance of ANZECC guidelines during sampling events between 2009-2013 but has since decreased with the lowest recording in 2016.

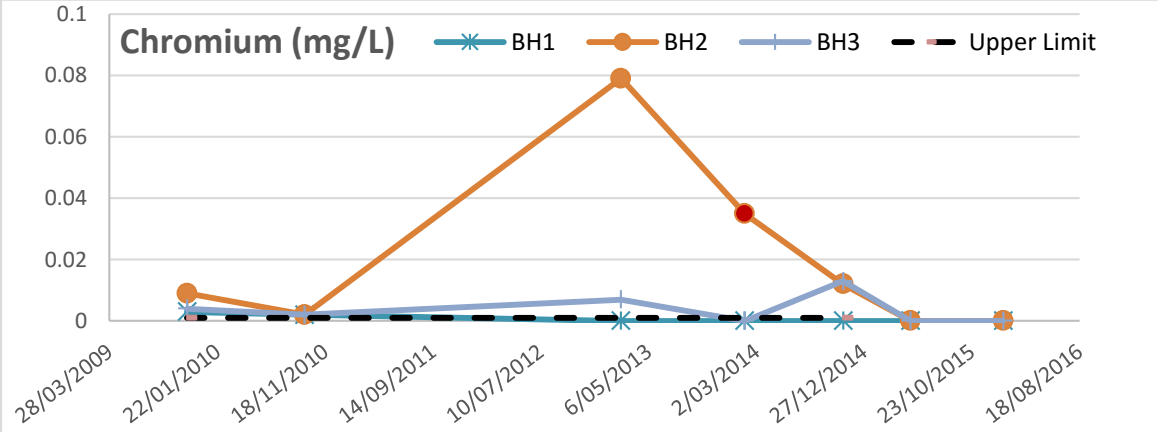
- Copper exceedance of ANZECC and NEPM GILs in September 2010 but has since decreased with the lowest recording in 2016.

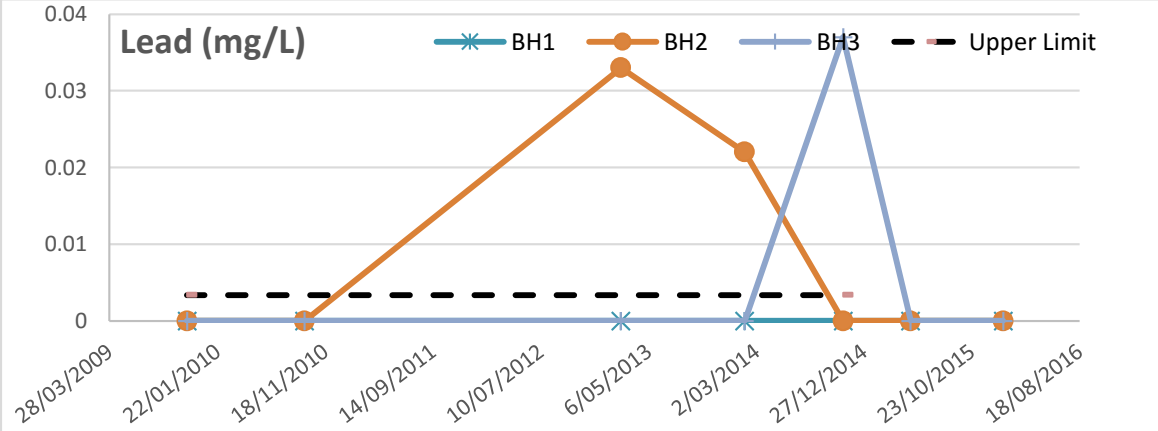
- Lead exceedance of ANZECC, NEPM GILS and ADWG in October 2014.

- Zinc exceedance of ANZECC and NEPM GILS during all monitoring events.


Copper (mg/L)
BH1
BH2
BH3
Upper Limit
0.03
0.025
0.02
0.015
0.01
0.005
0
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016

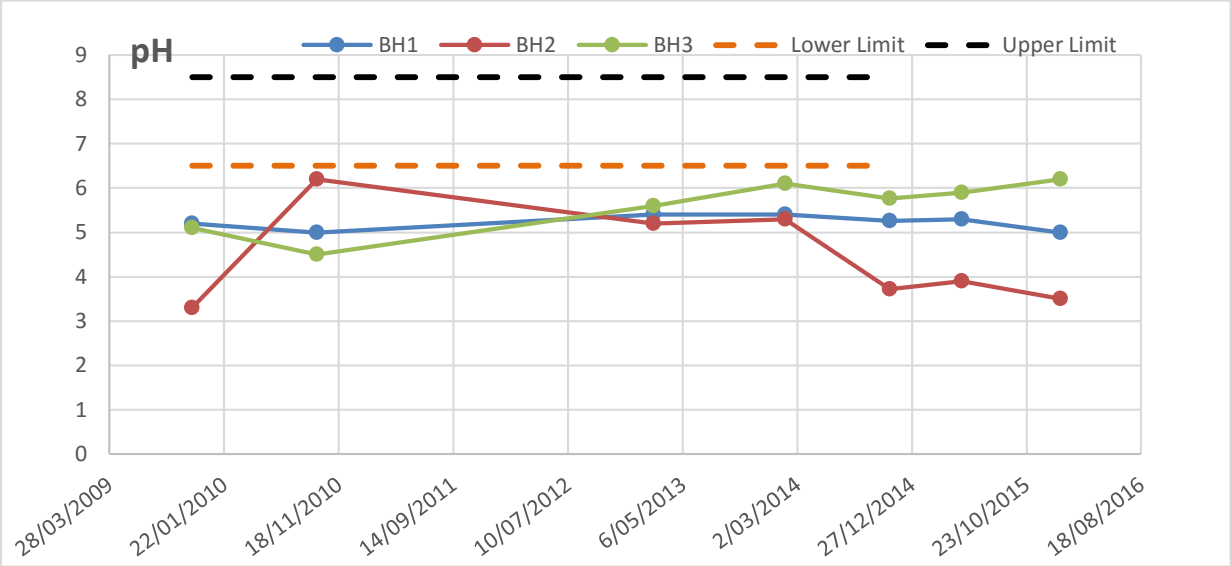

Zinc (mg/L)
BH1
BH2
BH3
Upper Limit
1.4
1.2
1
0.8
0.6
0.4
0.2
0
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016


Chromium (mg/L)
BH1
BH2
BH3
Upper Limit
0.1
0.08
0.06
0.04
0.02
0
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016


Lead (mg/L)
BH1
BH2
BH3
Upper Limit
0.04
0.03
0.02
0.01
0
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016

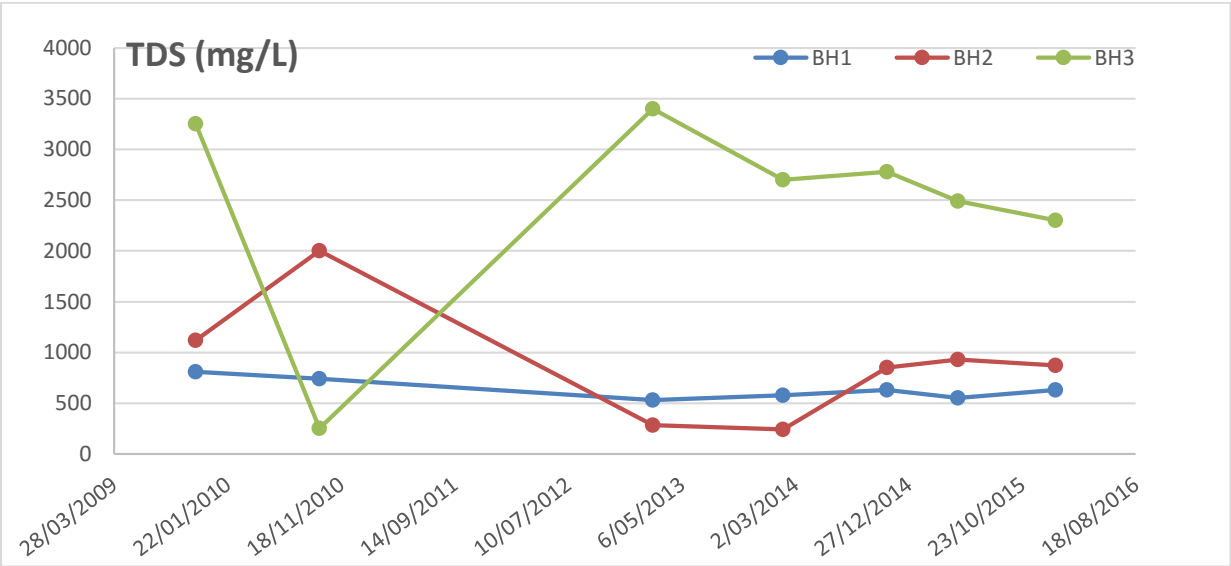
4.6. pH

pH results in bores 1 and 3 have shown consistent and similar trends. Bore 2 results shows the largest variation. All bore results obtained are below and outside of the ADWG pH guidelines of 6.5-8.5.



4.7. Total Dissolved Solids (TDS)

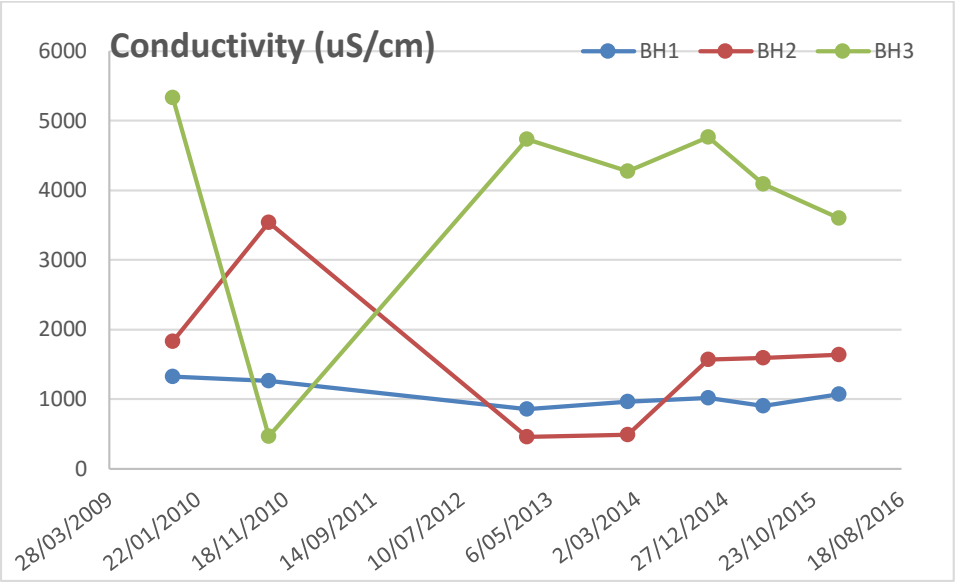
Concentrations of TDS are generally used as an indicator for drinking water quality based on aesthetics and taste value. TDS but can be indicative of unnatural movement of material related to changes in land use. Bore 1 shows very consistent TDS values (between 529 and 807 mg/L) indicating fair to good water quality. Bores 2 (243-2000 mg/L) and 3 (251-3401 mg/L) show greater variation with the majority of results for bore 3 being >1200 mg/L indicating unacceptable drinking water quality.

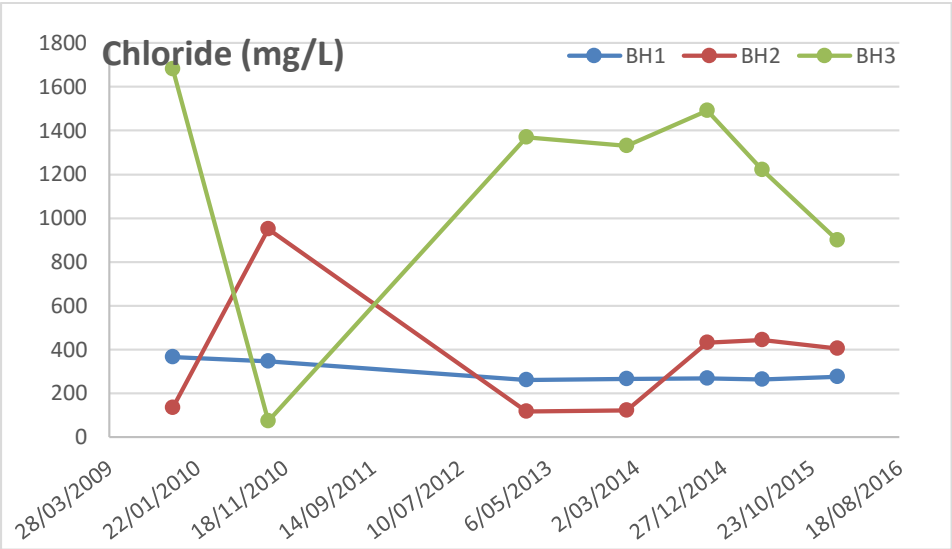


4.8. Conductivity and Chloride

Conductivity in water is affected by the presence of inorganic dissolved solids (i.e chloride, nitrate, sulfate, and phosphate anions -ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminium cations (ions that carry a positive charge).

Bore 3 has much higher conductivity levels than bores 1 and 2 and the low conductivity result obtained during 2010 sampling is an anomaly to the otherwise high results. Bore 3 has higher concentrations of chloride, sodium and magnesium than bores 1 and 2 thereby resulting in the higher levels of conductivity. Conductivity is also impacted by temperature and geology. The relationship between conductivity and chloride is shown below with the similar graph trends.



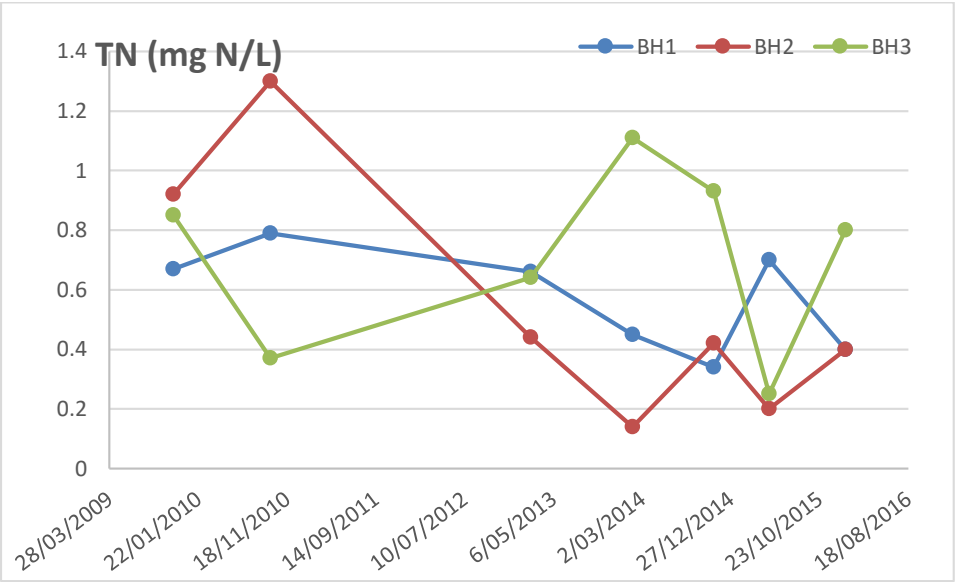


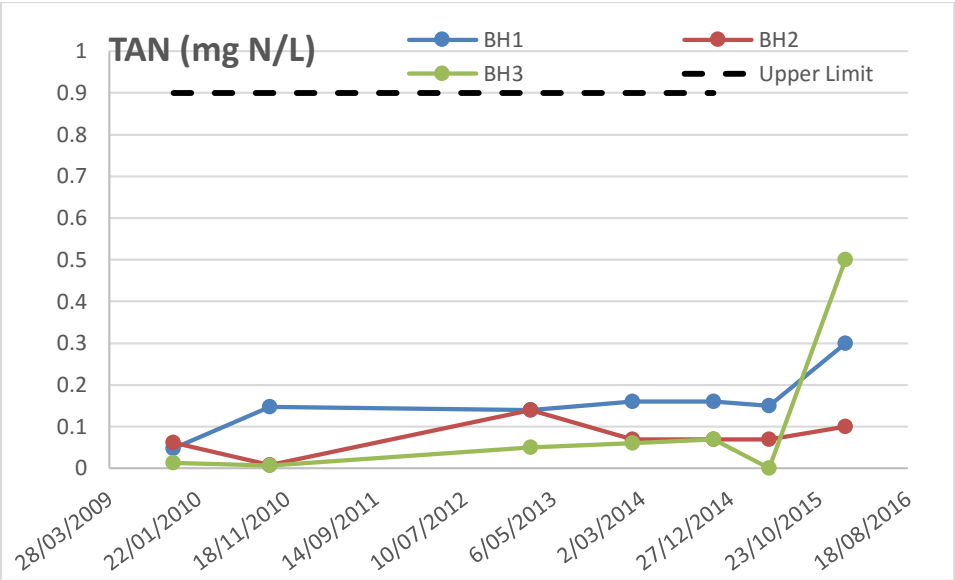
4.9. Total Nitrogen, Ammonia, Nitrate and Nitrite

Total nitrogen is the sum of organic and inorganic nitrogen sources with ammonia nitrogen, nitrate and nitrite playing the main roles in biochemical processes. Total nitrogen levels varied between bores and between sampling events with no apparent correlations of increasing or decreasing tends.

All bores and all monitoring events obtained ammonia nitrogen concentrations below the ANZECC and NEPM guideline value of 0.9mgN/L. All boreshow increasing trends between 2014 and 2016. The concentrations in bore 3 being the highest and he rate on increase in bore 1 should be closely monitored to ensure that any potential impact can be addressed prior to values exceed guidelines.

Concentrations of nitrite and nitrate in all bores have not exceeded the ANZECC or ADWG guideline limits.



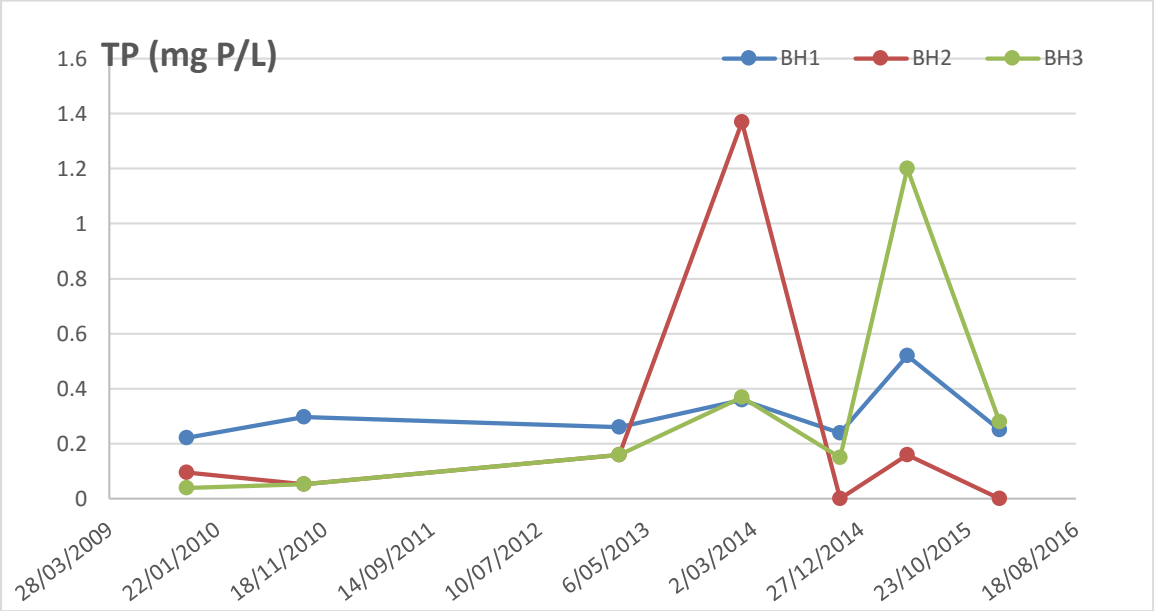


4.10. Phosphorus (Total and Soluble Reactive)

Total phosphorus is the sum of three forms of phosphorus- soluble reactive phosphorus (SRP), soluble unreactive phosphorus (SUP) and particulate phosphorus (PP). As a non toxic nutrient the impact phosphourous can have regard altering the natural growing balance of biota.

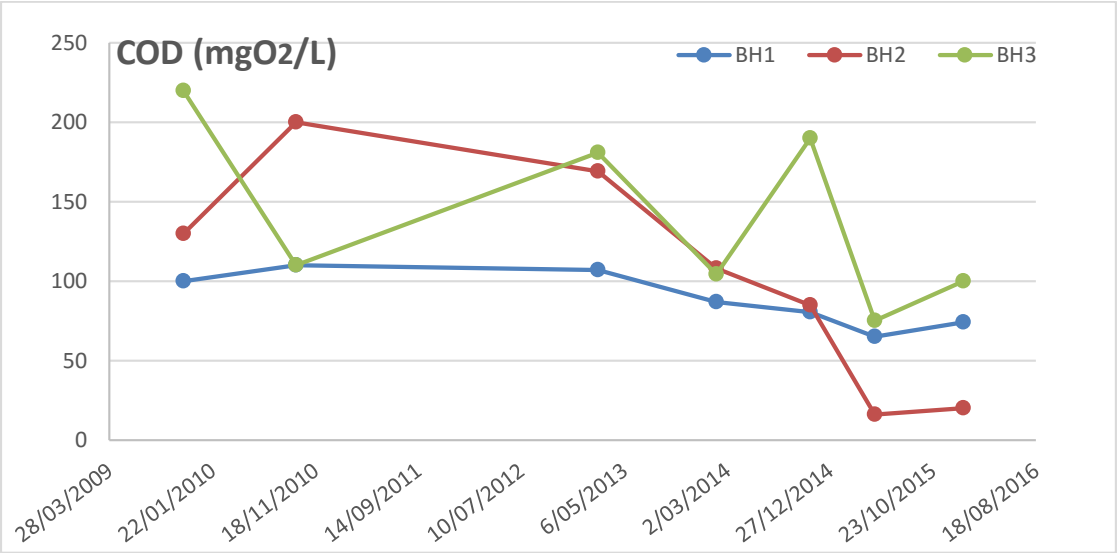
The forms of phosphorous were not individually recorded in 2015 and 2016. Results from 2009-2014 indicated that in Bore 1, the major phosphorus component is SRP whilst Bores 2 and 3 the major components were therefore SUP and/or PP.

The phosphorus form is determined by multiple factors including geology, suspended sediments, particulates and plant matter. The TP result of 1.37mgP/L in bore 2 and 1.2mgP/L in bore 3 is high and may be an indicator of land use impact. The ANZECC trigger values fro short term (up to 20 years) values is 0.8-12 and all recordings are within that range. The visible spikes in the graph could be related to an incident /spill and in a site investigation this should be looked at.



4.11. Chemical Oxygen Demand (COD)

The concentration of COD in the background Bore 1 is high. However, results for Bore 1 are consistent. Concentrations of COD in Bore 2 and Bore 3 are sporadic with no apparent trends. It is likely high spikes are the result of impacts from the disposal site.


COD (mgO2/L)
BH1
BH2
BH3
250
200
150
100
50
0
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016

5. SURFACEWATER RESULTS

The surface water monitoring point were observed dry in 2015 and 2016. The site is dry and has no apparent location where surface water could be tested. A review of the monitoring point should look into viable surface water with close proximity.

6. RECOMMENDATIONS

Based upon the available date are the following recommendations:

- Review the ANZECC acceptable values and lower the limit of LOR to match these in for example:
    - Organochloride Pesticides
    - Metals
- As per Flinders Council EPN Permit conditions continue to analyse total metals, rather than dissolved.
- Further analyse the high chromium and Hexavalent results in bore 2.
- Closely monitor levels of chromium, copper and zinc for increasing concentrations in all bores.
- Conduct a site investigation looking for potential spills or sources of contamination with regards to
    - Total Petroleum Hydrocarbons (TPH)
    - Metals, especially chromium
    - TN and TAN
- Conduct an assessment to identify viable surface water monitoring points
- Revaluate bore 1 as a control bore.

APPENDIX 1 - GROUNDWATER BORE 1

BH1		[Aesthetic trigger values in brackets]			Results are dissolved not total						
		Guidelines are dissolved			Samples collected by SEAM		Samples collected by Just Waste				
		ANZECC	NEPM GILs	ADWG							
	unit		Fresh water		30/10/2009	22/09/2010	19/02/2013	29/01/2014	30/10/2014	6/05/2015	19/01/2016
pH				6.5-8.5	5.2	5	5.4	5.4	5.26	5.3	5
Conductivity	uS/cm				1320	1260	859	960	1020	900	1070
TDS	mg/L				807	742	529	581	629	550	630
TN	mg N/L				0.67	0.79	0.66	0.45	0.34	0.7	0.4
TP	mg P/L				0.222	0.298	0.26	0.36	0.24	0.52	0.25
TAN	mg N/L	0.9	0.9		0.048	0.148	0.14	0.16	0.16	0.15	0.3
NO2	mg N/L			3	<0.002	<0.002	0.008	<0.005	<0.005	0.01	<0.1
NO3	mg N/L	0.7		50	<0.002	<0.002	<0.005	<0.005	<0.005	<0.0.1	<0.1
SRP	mg P/L				0.004	0.035	0.16	0.16	0.12		
Total As	mg/L	0.024		[0.01]		<0.01	<0.025	<0.025	<0.03	<0.0.1	
Total Ca	mg/L				7.27	5.38	3.88	4.56	4.47	5.3	5.6
Total Cd	mg/L	0.0002	0.0002	0.002	<0.001	<0.001	<0.010	<0.010	<0.010	<0.001	<0.001
Total Cr	mg/L	0.001		0.05	0.003	0.002	<0.005	<0.005	<0.005	<0.005	<0.01
Total Cu	mg/L	0.0014	0.0014	2	<0.001	0.003	<0.015	<0.015	<0.015	<0.005	<0.01
Total Fe	mg/L			[0.3]	13.5	11.4	6.53	8.7	9.28	6.6	15
Sol Fe	mg/L				11.5	2.69	3.92	7.48			
Total K	mg/L				7.81	6.78	8.35	8.66	7.75	7.2	7.8
Total Mg	mg/L				23	21.4	15	15.4	16	20	20
Total Mn	mg/L	1.9	1.9	0.5	0.52	0.216	0.139	0.165	0.184	0.19	0.22
Total Na	mg/L				190	169	126	147	141	170	180
Total Ni	mg/L	0.011	0.011	0.02	<0.01	<0.01	<0.005	<0.005	<0.005	0.005	<0.01
Total Pb	mg/L	0.0034	0.0034	0.01	<0.007	<0.007	<0.020	<0.020	<0.020	<0.005	<0.01
Total Se	mg/L	0.011	0.005			<0.015	<0.030	<0.030	<0.030	<0.01	
Total Zn	mg/L	0.008	0.008		0.017	0.11	<0.030	0.051	<0.03	0.015	0.14
COD	mg O2/L				100	110	107	87	80.6	65	74
Oxidation reduction Pote	Eh mV				404	433	549		585		
chloride	mg/L				367	347	262	267	268	265	275
sulphate	mg/L			500	40.8	44.4	32.3	35.3	36.7	43	39
total cyanide	ug/L	7	7	80	<5	<5	<5	16	<5	<0.01	<5
NPOC dissolved	mg/L							29	23		
DOC	mg/L				26	17	28			28	27
Total mercury	ug/L	0.6	0.06	1		<0.05	<0.05	<0.05	<0.05	<0.0001	
PCB	ug/L					<0.1	<0.1	<0.1	<0.1	<0.1	
Benzene	ug/L	0.95	0.95	1		<1	<1	<1	<1	<1	
Ethyl benzene	ug/L			300		<1	<1	<1	<1	<1	
o,m,p & Xylene	ug/L	350 (o- xy) 200 (p-xy)	350 (o- xy) 200 (p-xy)	600		<2	<2	<2	<2	<2	
Toluene	ug/L			800		<1	<1	<1	<1	<1	
Total BTEX	ug/L					<5	<5	<5	<5	<5	
TPH	ug/L					<40	<40	40	<40	110	
TPH C6-C9	ug/L					<10	<10	<10	<10	<10	
TPH C10-C14	ug/L					<10	<10	<10	<10	<10	
TPH C15-C28	ug/L					<10	<10	<10	<10	110	
TPH C29-C36	ug/L					<10	<10	40	<10	<10	
Acenaph-thylene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Acenaphthene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Anthracene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Benzo[a]anthracene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Benzo[a]pyrene	ug/L			0.01		<0.5	<0.5	<0.5	<0.5	<0.5	
Benzo[b&k]fluoranthene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Benzo[ghi]perylene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Chrysene	ug/L					<0.5	<0.8	<0.8	<0.8	<0.8	
Dibenzo[a,h]anthracene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Fluoranthrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Fluorene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Indeno[1,2,3-cd]pyrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Napthalene	ug/L	16	16			<0.5	<0.5	<0.5	<0.5	<0.5	
Phenanthrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Pyrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
a-BHC	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Aldrin	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
b-BHC	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Chlordane	ug/L	0.08		2		<0.50	<0.50	<0.50	<0.50	<0.5	
Chlorpyrifos	ug/L	0.01				<0.10	<0.10	<0.10	<0.10	<0.1	
d-BHC	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Diazinon	ug/L	0.01		4		<0.10	<0.10	<0.10	<0.10	<0.1	
Dieldrin	ug/L			4		<0.20	<0.20	<0.20	<0.20	<0.2	
Dimethoate	ug/L	0.15	0.15	7		<0.10	<0.10	<0.10	<0.10	<0.1	
Disulfoton	ug/L			4		<0.20	<0.20	<0.20	<0.20	<0.2	
Endosulfan I	ug/L	0.2	0.03	20		<0.10	<0.10	<0.10	<0.10	<0.1	
Endosulfan II	ug/L					<0.40	<0.40	<0.40	<0.40	<0.4	
Endosulfan sulphate	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Endrin	ug/L	0.02	0.01			<0.10	<0.10	<0.10	<0.10	<0.1	
Endrin aldehyde	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Ethyl parathion	ug/L					<0.1	<0.30	<0.30	<0.30	<0.3	
Famphur	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
g-BHC	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachlor	ug/L	0.09	0.01			<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachlor epoxide	ug/L			0.3		<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachloro benzene	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Malathion	ug/L	0.05	0.05	70		<0.20	<0.20	<0.20	<0.20	<0.20	
Methyl parathion	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
p,p"-DDD	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
p,p"-DDE	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	
p,p"-DDT	ug/L	0.01				<0.10	<0.10	<0.10	<0.10	<0.10	
Phorate	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	
Sulfotep	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
Thionazin	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	

APPENDIX 2 - GROUNDWATER BORE 2

BH2	Notes:	Aesthetic trigger values in brackets			Results are dissolved not total						
		Guidelines are dissolved			Samples collected by SEAM		Samples collected by Just Waste				
		ANZECC	NEPM GILs	ADWG							
	unit		Fresh water		30/10/2009	22/09/2010	19/02/2013	29/01/2014	30/10/2014	6/05/2015	19/01/2016
pH				6.5-8.5	3.3	6.2	5.2	5.3	3.72	3.9	3.5
Conductivity	uS/cm			TDS	1830	3540	460	485	1568	1590	1640
TDS	mg/L				1120	2000	286	243	854	930	870
TN	mg N/L				0.92	1.3	0.44	0.14	0.42	0.2	0.4
TP	mg P/L				0.095	0.053	0.16	1.37	<0.05	0.16	<0.1
TAN	mg N/L	0.9	0.9		0.062	0.008	0.14	0.07	0.07	0.07	0.1
NO2	mg N/L			3	0.002	0.004	0.057	<0.005	<0.005	0.01	<0.1
NO3	mg N/L	0.7		50	0.002	0.319	<0.005	0.067	0.127	<0.01	<0.1
SRP	mg P/L				<0.002	0.009	0.09	<0.05	<0.05		
Total As	mg/L	0.024		[0.01]		<0.01	**0.105**	**0.045**	<0.03	<0.01	
Total Ca	mg/L				15.2	4.4	2.39	1.65	2.35	**10**	2.8
Total Cd	mg/L	0.0002	0.0002	0.002	<0.001	<0.001	<0.010	<0.010	<0.010	>0.001	<0.001
Total Cr	mg/L	0.001		0.05	**0.009**	**0.002**	**0.079**	**0.035**	**0.012**	<0.005	<0.01
Total Cu	mg/L	0.0014	0.0014	2	**0.002**	**0.004**	**0.028**	<0.015	<0.015	<0.005	<0.01
Total Fe	mg/L			[0.3]	67.4	0.413	26.4	15.6	8.41	6.6	9
Sol Fe	mg/L				89.5	1.62	0.043	0.059			
Total K	mg/L				7.19	11.4	7.74	8.41	5.89	**7.2**	4.5
Total Mg	mg/L				73.2	67.5	15.6	13.8	43.3	20	49
Total Mn	mg/L	1.9	1.9	0.5	**0.572**	0.016	0.249	0.165	0.121	0.19	0.09
Total Na	mg/L				133	565	70.6	76.2	250	255	210
Total Ni	mg/L	0.011	0.011	0.02	**0.09**	<0.01	**0.016**	<0.005	**0.013**	0.03	<0.01
Total Pb	mg/L	0.0034	0.0034	0.01	<0.007	<0.007	**0.033**	**0.022**	<0.020	<0.005	<0.01
Total Se	mg/L	0.011	0.005			<0.015	<0.030	<0.030	<0.03	<0.01	
Total Zn	mg/L	0.008	0.008		**1.17**	**0.086**	**0.334**	**0.092**	**0.226**	**0.015**	**0.32**
COD	mg O2/L				130	200	169	108	84.8	16	20
Oxidation reduction Pote	Eh mV				672	427	621		666		
chloride	mg/L				134	951	119	123	432	445	405
sulphate	mg/L			500	765	228	55.3	31.5	80.6	160	115
total cyanide	ug/L	7	7	80	<5	<5	<5	<5	<5	<0.01	<5
NPOC dissolved	mg/L							3.9	4.7		
DOC	mg/L				18	41	2.9			6	6
Total mercury	ug/L	0.6	0.06	1		<0.05	<0.05	<0.05	<0.05	<0.0001	
PCB	ug/L					<0.1	<0.1	<0.2	<0.1	<0.1	
Benzene	ug/L	0.95	0.95	1		<1	<1	<1	<1	<1	
Ethyl benzene	ug/L			300		<1	<1	<1	<1	<1	
o,m,p & Xylene	ug/L	350 (o-xy) 200 (p-xy)	350 (o- xy) 200 (p-xy)	600		<2	<2	<2	<2	<2	
Toluene	ug/L			800		<1	<1	<1	<1	<1	
Total BTEX	ug/L					<5	<5	<5	<5	<5	
TPH	ug/L					<40	1890	<40	<40	69	
TPH C6-C9	ug/L					<10	<10	<10	<10	<10	
TPH C10-C14	ug/L					<10	<10	<10	<10	<10	
TPH C15-C28	ug/L					<10	1100	<10	<10	69	
TPH C29-C36	ug/L					<10	785	<10	<10	<10	
Acenaph-thylene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Acenaphthene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Anthracene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Benzo[a]anthracene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Benzo[a]pyrene	ug/L			0.01		<0.5	<0.5	<0.5	<0.5	<0.5	
Benzo[b&k]fluoranthene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Benzo[ghi]perylene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Chrysene	ug/L					<0.5	<0.8	<0.8	<0.8	<0.8	
Dibenzo[a,h]anthracene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Fluoranthrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Fluorene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Indeno[1,2,3-cd]pyrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Napthalene	ug/L	16	16			<0.5	<0.5	<0.5	<0.5	<0.5	
Phenanthrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Pyrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
a-BHC	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Aldrin	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
b-BHC	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Chlordane	ug/L	0.08		2		<0.50	<0.50	<0.50	<0.50	<0.5	
Chlorpyrifos	ug/L	0.01				<0.10	<0.10	<0.10	<0.10	<0.1	
d-BHC	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Diazinon	ug/L	0.01		4		<0.10	<0.10	<0.10	<0.10	<0.1	
Dieldrin	ug/L			4		<0.20	<0.20	<0.20	<0.20	<0.2	
Dimethoate	ug/L	0.15	0.15	7		<0.10	<0.10	<0.10	<0.10	<0.1	
Disulfoton	ug/L			4		<0.20	<0.20	<0.20	<0.20	<0.2	
Endosulfan I	ug/L	0.2	0.03	20		<0.10	<0.10	<0.10	<0.10	<0.1	
Endosulfan II	ug/L					<0.40	<0.40	<0.40	<0.40	<0.4	
Endosulfan sulphate	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Endrin	ug/L	0.02	0.01			<0.10	<0.10	<0.10	<0.10	<0.1	
Endrin aldehyde	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Ethyl parathion	ug/L					<0.1	<0.30	<0.30	<0.30	<0.3	
Famphur	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
g-BHC	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachlor	ug/L	0.09	0.01			<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachlor epoxide	ug/L			0.3		<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachloro benzene	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Malathion	ug/L	0.05	0.05	70		<0.20	<0.20	<0.20	<0.20	<0.20	
Methyl parathion	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
p,p"-DDD	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
p,p"-DDE	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	
p,p"-DDT	ug/L	0.01				<0.10	<0.10	<0.10	<0.10	<0.10	
Phorate	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	
Sulfotep	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
Thionazin	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	

APPENDIX 3 - GROUNDWATER BORE 3

BH3	Notes:	Aesthetic trigger values in brackets			Results are dissolved not total						
		Guidelines are dissolved			Samples collected by SEAM		Samples collected by Just Waste				
		ANZECC	NEPM GILs	ADWG							
	unit		Fresh water		30/10/2009	22/09/2010	19/02/2013	29/01/2014	30/10/2014	6/05/2015	19/01/2016
pH				6.5-8.5	**5.1**	**4.5**	**5.6**	**6.1**	**5.77**	**5.9**	**6.2**
Conductivity	uS/cm				5330	468	4730	4270	4760	4090	3600
TDS	mg/L				3250	251	3401	2702	2780	2490	2300
TN	mg N/L				0.85	0.37	0.64	1.11	0.93	0.25	0.8
TP	mg P/L				0.039	0.053	0.16	0.37	0.15	1.2	0.28
TAN	mg N/L	0.9	0.9		0.013	0.007	0.05	0.06	0.07	<0.01	0.5
NO2	mg N/L			3	0.002	<0.002	0.006	<0.005	<0.005	<0.01	<0.1
NO3	mg N/L	0.7		50	0.352	0.098	<0.005	0.072	0.023	<.001	<0.1
SRP	mg P/L				<0.002	<0.002	<0.05	<0.05	<0.05		
Total As	mg/L	0.024		[0.01]		<0.01	<0.025	<0.025	<0.03	<0.01	
Total Ca	mg/L				6.26	2.89	8.28	8.77	8.55	19	12
Total Cd	mg/L	0.0002	0.0002	0.002	<0.001	<0.001	<0.010	<0.010	<0.010	<0.001	<0.001
Total Cr	mg/L	0.001		0.05	**0.004**	**0.002**	**0.007**	<0.005	**0.013**	<0.005	<0.001
Total Cu	mg/L	0.0014	0.0014	2	0.001	**0.006**	<0.015	<0.015	<0.015	<0.005	<0.001
Total Fe	mg/L			[0.3]	8.39	0.085	6.35	3.94	14.7	3.5	5.7
Sol Fe	mg/L				1.01	0.085	0.97	0.271			
Total K	mg/L				15.7	2.25	24.3	24.7	24.8	8.1	21
Total Mg	mg/L				127	11.9	97.4	92.7	88.7	74	73
Total Mn	mg/L	1.9	1.9	0.5	0.059	0.084		0.132	0.376	0.4	0.14
Total Na	mg/L				944	51.8	1003	831	949	840	600
Total Ni	mg/L	0.011	0.011	0.02	<0.01	<0.01		<0.005	0.007	0.015	<0.01
Total Pb	mg/L	0.0034	0.0034	0.01	<0.007	<0.007	<0.020	<0.020	**0.037**	<0.005	<0.01
Total Se	mg/L	0.011	0.005			<0.015	<0.030	<0.030	<0.03	<0.01	
Total Zn	mg/L	0.008	0.008		**0.031**	**0.671**	**0.052**	**0.039**	**0.08**	**0.06**	**0.06**
COD	mg O2/L				220	110	181	104.4	190	75	100
Oxidation reduction Potential	Eh mV				584	407	579		439		
chloride	mg/L				1680	74.5	1370	1330	1490	1220	900
sulphate	mg/L			500	345	89.2	241	254	256	220	170
total cyanide	ug/L	7	7	80	<5	<5	<5	9	<5	<0.01	<5
NPOC dissolved	mg/L							30	21		
DOC	mg/L				40	2.3	22			25	40
Total mercury	ug/L	0.6	0.06	1		<0.05	<0.05	<0.05	<0.05	<0.0001	
PCB	ug/L					<0.1	<0.1	<0.1	<0.1	<0.1	
Benzene	ug/L	0.95	0.95	1		<1	<1	<1	<1	<1	
Ethyl benzene	ug/L			300		<1	<1	<1	<1	<1	
o,m,p & Xylene	ug/L	350 (o-xy) 200 (p-xy)	350 (o- xy) 200 (p-xy)	600		<2	<2	<2	<2	<2	
Toluene	ug/L			800		<1	<1	<1	<1	<1	
Total BTEX	ug/L					<5	<5	<5	<5	<5	
TPH	ug/L					321	<40	<40	<40	100	
TPH C6-C9	ug/L					46	<10	<10	<10	<10	
TPH C10-C14	ug/L					151	<10	<10	<10	<10	
TPH C15-C28	ug/L					104	<10	<10	<10	100	
TPH C29-C36	ug/L					20	<10	<10	<10	<10	
Acenaph-thylene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Acenaphthene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Anthracene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Benzo[a]anthracene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Benzo[a]pyrene	ug/L			0.01		<0.5	<0.5	<0.5	<0.5	<0.5	
Benzo[b&k]fluoranthene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Benzo[ghi]perylene	ug/L					<0.5	<0.6	<0.6	<0.6	<0.6	
Chrysene	ug/L					<0.5	<0.8	<0.8	<0.8	<0.8	
Dibenzo[a,h]anthracene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Fluoranthrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Fluorene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Indeno[1,2,3-cd]pyrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Napthalene	ug/L	16	16			<0.5	<0.5	<0.5	<0.5	<0.5	
Phenanthrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
Pyrene	ug/L					<0.5	<0.5	<0.5	<0.5	<0.5	
a-BHC	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Aldrin	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
b-BHC	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Chlordane	ug/L	0.08		2		<0.50	<0.50	<0.50	<0.50	<0.5	
Chlorpyrifos	ug/L	0.01				<0.10	<0.10	<0.10	<0.10	<0.1	
d-BHC	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Diazinon	ug/L	0.01		4		<0.10	<0.10	<0.10	<0.10	<0.1	
Dieldrin	ug/L			4		<0.20	<0.20	<0.20	<0.20	<0.2	
Dimethoate	ug/L	0.15	0.15	7		<0.10	<0.10	<0.10	<0.10	<0.1	
Disulfoton	ug/L			4		<0.20	<0.20	<0.20	<0.20	<0.2	
Endosulfan I	ug/L	0.2	0.03	20		<0.10	<0.10	<0.10	<0.10	<0.1	
Endosulfan II	ug/L					<0.40	<0.40	<0.40	<0.40	<0.4	
Endosulfan sulphate	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Endrin	ug/L	0.02	0.01			<0.10	<0.10	<0.10	<0.10	<0.1	
Endrin aldehyde	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Ethyl parathion	ug/L					<0.1	<0.30	<0.30	<0.30	<0.3	
Famphur	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
g-BHC	ug/L					<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachlor	ug/L	0.09	0.01			<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachlor epoxide	ug/L			0.3		<0.10	<0.10	<0.10	<0.10	<0.1	
Heptachloro benzene	ug/L					<0.20	<0.20	<0.20	<0.20	<0.2	
Malathion	ug/L	0.05	0.05	70		<0.20	<0.20	<0.20	<0.20	<0.20	
Methyl parathion	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
p,p"-DDD	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
p,p"-DDE	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	
p,p"-DDT	ug/L	0.01				<0.10	<0.10	<0.10	<0.10	<0.10	
Phorate	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	
Sulfotep	ug/L					<0.10	<0.10	<0.10	<0.10	<0.10	
Thionazin	ug/L					<0.20	<0.20	<0.20	<0.20	<0.20	

Flinders Council

Inspection of Unused Refuse Cell

March 29, 2016

Report Prepared by:

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1. Introduction

Background

Flinders Council operates a tip site at Memana Road. At the site is an unused refuse cell constructed during 2008/09. Refer to Figure 1.

The volume of the cell is approximately 2100 cubic meters, has three sides and is lined with a geo-synthetic clay liner (GCL); ELCOSEAL X1000. There is an engineered fall from the southern to northern end of the cell. The cell is open at the northern end and water run-off is directed onto a natural land depression. There is no leachate containment infrastructure constructed at the site.

Figure 1: Subject Site

-Source LIST Map DPIPWE

In February 2016, Council requested that an inspection of the cell be undertaken to determine its serviceability status. The scope of this report is limited to the existing cell in its current state.

An inspection was conducted on 7th March 2016 s and GCL samples were taken from the cell for hydraulic conductivity testing. The liner was also visually inspected at various points and reported to council.

2. Cell Inspection

Dimension

The unused cell has an approximate fill volume of 2100 m^3. The cell is lined with ELCOSEAL X1000 Geo-synthetic clay liner (bentonite clay) supplied to council by GeoTas and was installed in 2008/09. The total existing area covered by the GCL is approximately 1200 m^2 comprising:

- Cell Floor ~ 680m^2
- Western Batter ~200m^2
- Eastern Batter ~260m^2
- Southern Batter ~50m^2.

Cell Floor

The cell floor has been covered with a native soil and various grass and shrub growth is evident.

Excavation of the cover soil at selected sampling sites has revealed that plant and grass roots have not penetrated the GCL. Immediate tree removal and herbicide treatment is recommended.

Cover depth varies over the length of the cell from 100mm at the southern end to 50mm at the northern end of the cell. At the most northern end of the cell floor, approximately 3m^2 of GCL is uncovered and fully exposed to the elements. The average cover over the cell floor is approximately 80mm.

GCL samples taken from the cell floor for hydraulic conductivity testing meet the permeability requirements of the Tasmanian Landfill Sustainability Guide 2004. Refer to Section 3 of this report. The liner is in good visual condition and does not need to be replaced.

The existing cover depth is not sufficient to cater for the strains imposed by machinery (front end loader) that council may operate in the cell and for refuse placed and compacted within the cell.

It is recommended that Council increase the cell floor cover depth to 300mm (compacted clay depth of 300mm) prior to the onset of late autumn and winter rain.

Cell Batters

Large areas of GCL have been exposed to the elements for a number of years and substantial decay has occurred and requires replacement. The exposed liner is UV degraded, frayed and torn in places. Small trees and various grasses are growing through the liner.

Only the lower 30 to 50% of the liner has been covered in native soil. Immediately at the base of the batter, cover depth is 200mm.

A GCL sample taken from the western batter (exposed and weathered GCL) for hydraulic conductivity testing did not meet the permeability requirements of the Tasmanian Landfill Sustainability Guide 2004. Refer to Section 3 of this report.

Figure 2: View towards southern end of cell

Figure 3: View towards northern end of cell

The gradient of each batter is approximately 1V (Vertical) to 1.5H (Horizontal). ELCOSEAL X1000 GCL is not suited for use with this gradient and is designed to be laid on a maximum gradient of 1V:3H that allows the GCL internal shear strength under load to be greater than the interface strength, preventing failure of the liner. Available options are:

Batter Remediation - Option 1 (Recommended)

To re-grade the cell batters to a gradient of 1V:3H, line with ELCOSEAL X1000 GCL and cap with 300mm of compacted clay cover.

The estimated GCL required (accounting for material anchoring and overlapping on batter joints and the existing cell floor GCL) is 1380 m^2. Refer to Table 1 for estimate calculation.

Table 1: GCL Area Estimate for 1V:3H batter gradient.

Estimate	Eastern Batter	Western Batter	Southern Batter
Lateral overlap with cell floor GCL (m)	1	1	1
Batter Lateral Length (m)	10	6.25	5
Top of Batter lateral Keying Length (m)	1.5	1.5	1.5
A: Overlay Length (m)	**12.5**	**8.75**	**7.5**
B: Longitudinal Length (m)	56	56	18
C: GCL Roll Width overlap factor	1.04	1.04	1.04
Total GCL Area (m^2) (A*B*C)	**728**	**510**	**140**
		Total Area (m^2)	**1378**

Estimated minimum costs associated with this option are:

- Material Cost ~ $18,000 (freight cost not included)
- Machinery ~ $3,600 (3 days for excavator and roller at $1200/day)
- Labour ~ $2,400 (3days at $800/day – two operators).
- TOTAL ESTIMATE (excluding freight cost) = $24,000.

X1000 GCL stored in the tip shed may be used. Assuming 10 rolls at 4.7m in width and 30m in length, total available inventory is 1410m^2. Council will need to validate actual inventory quantity and purchase any additional liner as required.

Batter Remediation – Option 2

Maintain the existing cell batters at gradient of 1V:1.5H, line with ELCOSEAL X2000 GCL and cap with 300mm of compacted clay cover. Council does not have an inventory of X2000 material.

The estimated GCL required (accounting for material overlapping on batter joints and the existing cell floor GCL) is 820 $m^{2.}$ Estimated minimum costs associated with this option are:

- Material Cost ~ $14,000 (freight cost not included)
- Machinery ~ $2,400 (2 days for excavator at $1200/day)
- Labour ~ $1,600 (2days at $800/day – two operators).
- TOTAL ESTIMATE (excluding freight cost) = $18,000.

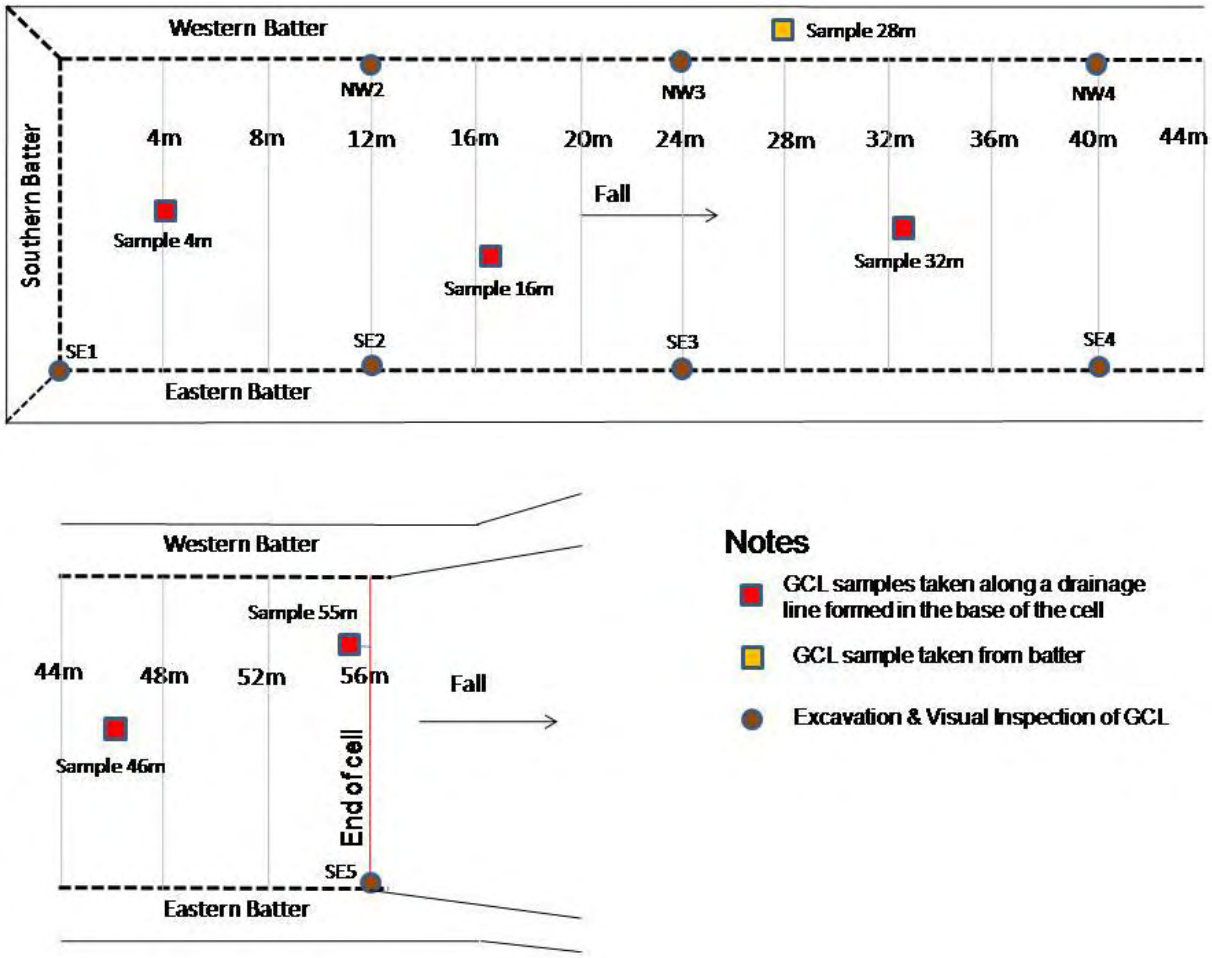
Table 2: GCL Area Estimate for replacing GCL on existing batter gradient.

Estimate	Eastern Batter	Western Batter	Southern Batter
Lateral overlap with cell floor GCL (m)	1	1	1
Batter Lateral Length (m)	3.6	2.5	1.8
Top of Batter lateral Keying Length (m)	1.5	1.5	1.5
A: Overlay Length (m)	**6.1**	**5.0**	**4.3**
B: Cell Length (m)	56	56	18
C: GCL Roll Width overlap factor	1.04	1.04	1.04
Total GCL Area (m^2) (A*B*C)	**355**	**292**	**81**
		Total Area (m^2)	**728**

3. GCL Inspection & Permeability

The cell liner was inspected at 14 points as shown in Figure 4.

Figure 4: Sampling and inspection locations



Six 30*30cm liner samples were carefully hand excavated, cut and removed from the cell. On removal samples were immediately photographed and sealed in plastic wrapping to prevent drying and air freighted to TRI Australasia Pty Ltd to determine hydraulic conductivity against test method ASTM D5887. Measured hydraulic conductivity is tabled in Table 3. Refer to full laboratory report in Attachment 7.

The liner was also visually inspected at five points in the anchor trench located at the base of the eastern batter and at 3 points at the base of the western batter. The purpose was to i) determine

liner depth and ii) to check for root ingress into the upper geotextile layer of the liner and visual deterioration of the liner. Inspections are tabled in Table 4 and Table 5.

Table3: Hydraulic Conductivity Test Results

GCL Sample	Cover (mm)	Sampling Point Observations	Measured Hydraulic Conductivity ASTM D 5887	Landfill sustainability Guide 2004 In-situ Permeability Coefficient requirement
Sample 4m (Cell Floor)	100	• GCL in good visual condition • No root penetration • Refer: Attachment 1	$3.5x10^{-11}$ m/s	Meets < $1x10^{-9}$ m/s requirement
Sample 16m (Cell Floor)	100	• GCL in good visual condition • Minor degree of plant root attachment to the underside of the lower geotextile layer. • No root penetration into GCL. • Refer: Attachment 2	$7.5x10^{-11}$ m/s	Meets < $1x10^{-9}$ m/s requirement
Sample 28m (Western Batter)	0	• GCL in poor visual condition • Plant root penetration into GCL from underside of liner. • Refer: Attachment 3	$1.0x10^{-7}$ m/s	Fails < $1x10^{-9}$ m/s requirement
Sample 32m (Cell Floor)	80	• GCL in good visual condition • Minor degree of plant root attachment to underside of the lower geotextile layer. • No root penetration into GCL. • Refer: Attachment 4	$7.0x10^{-11}$ m/s	Meets < $1x10^{-9}$ m/s requirement
Sample 46m (Cell Floor)	60	• GCL in good visual condition • Minor degree of plant root attachment to underside of the lower geotextile layer. • No root penetration into GCL. • Refer: Attachment 5	$3.9x10^{-11}$ m/s	Meets < $1x10^{-9}$ m/s requirement
Sample 55m (Cell Floor)	0	• Minor lichen growth on top side of liner. • No presence of roots. • Refer: Attachment 6	$6.0x10^{-11}$ m/s	Meets < $1x10^{-9}$ m/s requirement

Table 4: GCL Visual Inspection –Base of Eastern Batter

ID	GCL Cover Depth (mm)	General GCL Condition	Photograph
SE1	120	• Good visual condition • No physical damage evident • Roots observed at liner depth but no obvious penetration of liner	
SE2	200	• Good visual condition • No physical damage evident • No roots observed at liner depth	
SE3	200	• Good visual condition • No physical damage evident • No roots observed at liner depth	
SE4	220	• Good visual condition • No physical damage evident • No roots observed at liner depth	
SE5	240	• Good visual condition • No roots observed at liner depth	

Table 5: GCL Visual Inspection –Base of Western Batter

ID	GCL Cover Depth (mm)	General GCL Condition	Photograph
NW2	200	• Good visual condition • No roots observed at liner depth	
NW3	230	• Good visual condition • No roots observed at liner depth	
NW4	170	• Good visual condition • No roots observed at liner depth	

4. Conclusions & Recommendations

4.1 The ELCOSEAL X1000 GCL on in the cell floor is in visually good condition and sampled material validates that the liner hydraulic conductivity meets the requirements of the Tasmanian Landfill Sustainability Guideline, 2004.

It is recommended that Council take the following actions:

- Control vegetation growing on the cell floor using approved herbicides
- Increase the compacted cover depth over the cell floor to 300mm using available clay resource at the tip site to cater for the strains imposed by machinery (front end loader) that council may operate in the cell and for refuse placed and compacted within the cell.

4.2 The ELCOSEAL X1000 GCL on in the cell batters is in poor condition and requires replacement.

It is recommended that Council re-grade the cell batters to a gradient of 1V:3H, line with ELCOSEAL X1000 GCL and cap with 300mm of compacted clay cover. The estimated cost is $24,000 that includes using local labour and machinery. Unused X1000 liner in on-site storage may be used.

Council may also give consideration to maintaining the existing batter gradient and purchasing mechanically stronger ELCOSEAL X2000 or ELCOSEAL X3000 GCL to line the cell batters.

5. References

- Tasmanian Landfill Sustainability Guide 2004
- Test Method ASTM D 5887 – Hydraulic Conductivity
- ELCOSEAL X1000, X2000 & X3000 technical specifications

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