WHYTES GULLY LANDFILL: SOIL, WATER & LEACHATE MANAGEMENT PLAN 2021

WOLLONGONG CITY COUNCIL Waste Services

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1 Introduction

1.1 Background

Wollongong City Council was granted project approval from the Department of Planning on 3rd April 2013 (Application Number 11-0094) for Stage 1 Landfill Cell at Whytes Gully. Construction approval was subsequently provided by the EPA on the 23rd August 2013 under the existing EPL 5682.

A modification of this Approval was obtained to replace the 'Eastern Gully Landfill Waste Cutback' with an approved alternative stormwater drainage design 'Eastern Gully Stormwater Diversion on the 11th April 2018'. This approved stormwater drainage design greatly reduces the excavation of landfill waste; and was a significant improvement to the original cutback drainage design.

Condition 5(d) of MP 11_0094 MOD2 instrument requires that this soil, water and leachate management plan is updated to incorporate the final detailed design specifications for stormwater management and collection at the site, including the stormwater upgrade drainage works. Also, within Schedule 3 of the Planning Approval, Council is required to prepare and implement a Soil, Water and Leachate Management Plan.

This plan must include:

- a Site Water Balance
- an Erosion and Sediment Control Plan
- a Leachate Management Plan
- a Stormwater Management Plan
- an Ongoing Monitoring Program

The Whytes Gully Landfill Surface Water and Leachate Management Plan (Rienco Consulting 2008) was submitted within the original approved Landfill Environmental Management Plan (LEMP) in September 2014 and included a site water balance and management plan documentation that reflected the site hydrological conditions at the time. This Report follows on from this document (Appendix One) to address the Independent Environmental Audit (IEA 2020) requirement of providing an updated Soil, Water and Leachate Management Plan.

The prolonged drought conditions followed by extraordinary rainfall events over a short period has meant that updates to this Plan are required to be included in the LEMP in accordance with Schedule 5 (Environmental Management, Reporting and Auditing). This document provides additional information outlining current management methods reviewed after storm events in the first quarter of 2020. The table below addresses the s75W Instrument of Modification Conditions (MOD2). This is in accordance with Condition 3 in Schedule 5.

Requirement	Condition Actions	Relevant Section
Site Water Balance	Identifies the source of water collected or stored on site, including rainfall, stormwater and groundwater. Includes details of all water use on site and any discharges. Describes the measures that will be implemented to minimize water use on site.	Whytes Gully Landfill Site Water Balance (GHD 2021). (Appendix Two)

Erosion and Sediment Control Plan	Is consistent with the requirements in the latest version of the Blue Book. Identifies the activities on site that could cause soil erosion and generate sediment. Describes the measures that will be implemented to minimise soil erosion and transport of sediment and stockpiles are managed.	Stockpile Management Plan (August 2021) (Appendix Three)
Leachate Management Plan	Includes final details of leachate management and collection on site. Includes a remedial action plan.	Whytes Gully Landfill - Leachate Management Systems Update (JPG Engineering 2021) (Appendix Four)
Stormwater Management Plan	Is consistent with the Wollongong DCP. Includes detailed design for the stormwater management and collection system. Demonstrates how the requirements of Condition 15 of the schedule has been addressed. Is updated to the satisfaction of the Secretary prior to the construction of works.	Whytes Gully: Preliminary Stormwater Assessment (2021) (Appendix Five)
An Ongoing Monitoring Program	Includes baseline data. A combined surface and groundwater monitoring program. Includes surface and groundwater impact assessment criteria.	Whytes Gully: Preliminary Stormwater Assessment (2021) (Appendix Five)

2 Site Water Balance

The purpose of this water balance analysis and supporting report is to assess and analyse the leachate and stormwater runoff generation for the existing and future leachate, groundwater and stormwater systems at the site. A model was developed to estimate leachate and stormwater volumes for potential rainfall scenarios and was calibrated against leachate and stormwater pond level data. Groundwater was estimated based on typical values for similar site conditions. The water balance analysis is based on current and future conditions of the site (as of October 2021) and has been prepared in response to the DPIE and EPA compliance requirements.

2.1 Overview

A water balance analysis was developed for the site that considers surface water, baseflow (incl. groundwater), and leachate contributions for both the current and future operation of the site. A summary of the water balance model is described in the following section, including details of the model, inputs, calibration, and outcomes. The full report is provided in Appendix Two.

A water balance model (WBM) was developed using the software, Goldsim. The WBM included quantifying the groundwater, leachate and stormwater generated at the site and allowed for management of waters to be simulated. This included the sites ponds, disposal mechanisms and losses as shown in the Figure 1 and 2 below.

The WBM was developed to allow calibration of model inputs to available data and allowed for simulation of a continuous climatic series from 1900 until 2020 based on historical observations. The WBM reported results daily however also includes sub-daily timesteps as required to allow for travel time and dispersion of rainfall derived infiltration and runoff processes.

Development of the WBM was based on the following parameters:

– Existing stormwater and leachate ponds were estimated using available design information, Geographic Information System (GIS), site aerial imagery and site observations.

– Generation of rainfall derived infiltration and rainfall derived runoff were developed using volumetric runoff coefficients with consideration for advection and dispersion through the system.

– Groundwater was estimated during calibration of the WBM, with consideration to estimates provided in the section above.

– Simulation of leachate and stormwater management was based upon discussions with Council and a review of infrastructure, with consideration for disposal and emergency management procedures.

The incomplete bunding north of the Package 2/3 piggyback area was accounted for in the existing modelling scenario and catchment areas for contribution to the active filling area leachate generation rate. The WBM was developed to allow for simulation of the existing site (including calibration to available data), as well as future stages of the site as it is progressively capped and remediated.

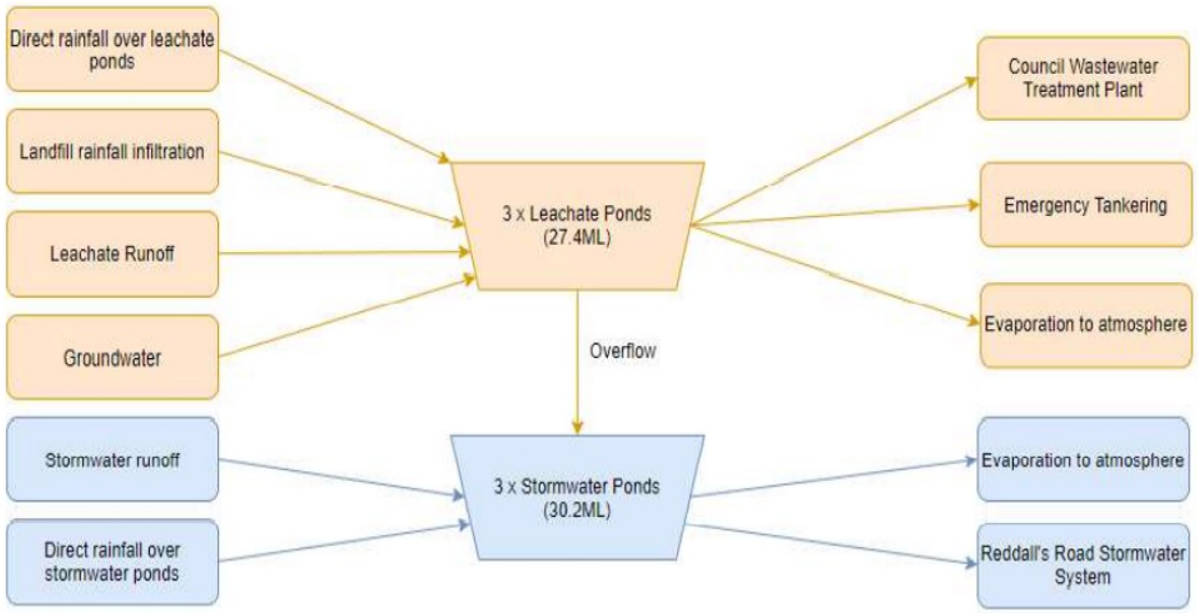


Figure 1 Water Balance Model

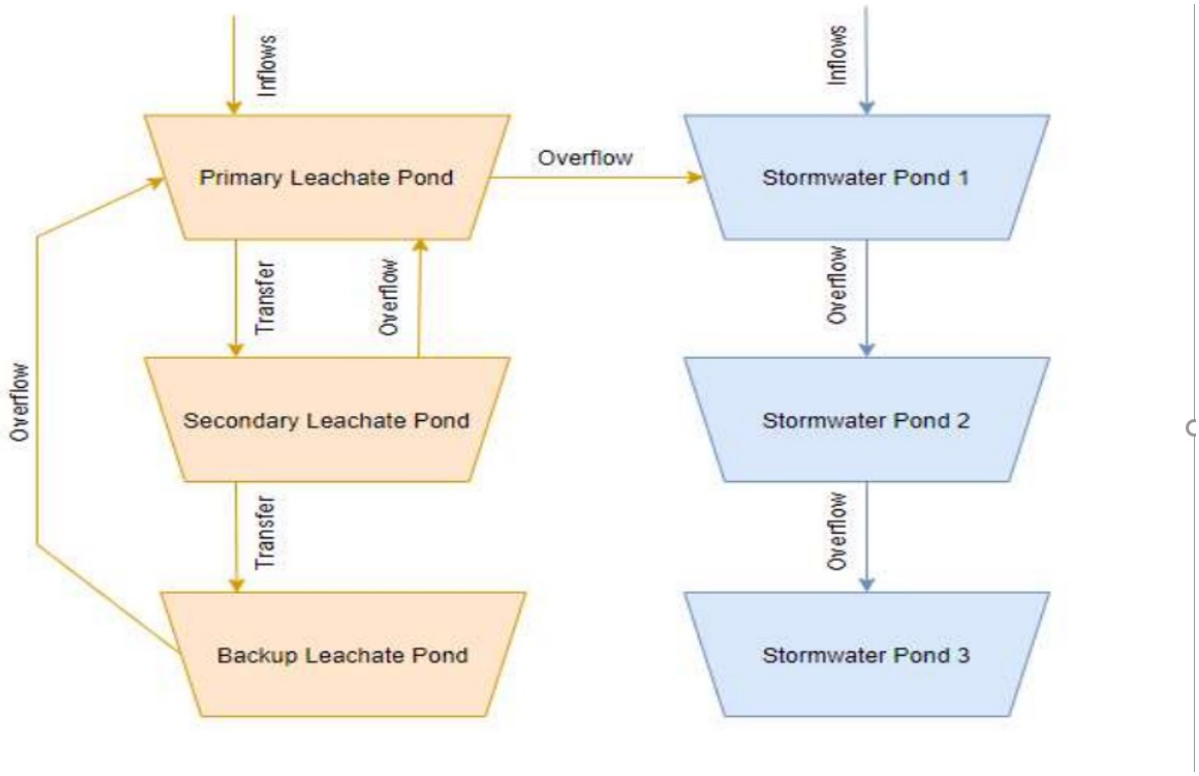


Figure 2 Layout of modelled leachate and stormwater pond systems

2.2 Site Water Balance Outcomes

The key outcomes from the water balance modelling are summarised below:

- Leachate generation is reasonably high, currently estimated to range between 80 to 150 ML/year during dry and wet years, typically approximately 97 ML/yr. Direct rainfall onto the leachate ponds generally ranges from 10 to 30 ML/yr of the 80 to 150 ML/yr and is reasonably steady through future stages.
- Leachate generation is expected to be highest in the current configuration of the site, before decreasing by approximately 20 to 40 ML/yr for Stage 3 and Stage 4, and a further 30 – 80 ML/yr once the final cap is applied.
- Peak daily leachate generation is similar between existing and future stages for more extreme wet periods, suggesting that extreme rainfall onto the ponds is likely to be critical for extreme wet weather management.
- The current configuration of the site is predicted to result in the highest leachate disposal requirement. As the site is progressively capped, the requirement to dispose of leachate decreases over time.
- The requirement to dispose leachate by sewer decreases over time from typically 77.7 ML/yr currently to 15.0 ML/yr once the final cap is applied over the entire landfill area. It is likely that generation would then decrease further.
- Estimation of leachate pond overflow quantities follows the trend of leachate generation, decreasing progressively as the site is capped.
- The leachate storage system appears to readily overflow, however the suitability of the model to predict how leachate is exchanged between the ponds and disposed is difficult to replicate. Despite this, the current disposal rate limit of 250 kL/day (approx. 91 ML/yr) is likely to limit the ability to treat the rates of leachate generated at the site, which typically ranges between 70 and 180 ML/yr. Leachate generation is estimated to exceed the allowable Liquid Trade Waste Agreement disposal rate of 91 ML/year in approximately 61% of years for the modelling period adopting the current configuration.
    - Estimation of leachate overflow quantities indicate that additional leachate treatment/disposal capacity for the existing scenario between 2.4 ML/yr (typical) and 31.4 ML/yr (wet year) is required.

- Large quantities of stormwater are generated at the site based on the current conditions, ranging from 290 ML/yr in drier years to 660 ML/yr in wetter years, with typical values of 430 ML/yr.
- There is limited disposal for stormwater at the site, and it is understood that collected stormwater is not reused from the ponds. Accordingly, disposal by evaporation is the only mechanism – typically around 50 ML/yr, an order of magnitude lower than generation.
- The remainder of stormwater generated at the site that is unable to be disposed, overflows into the receiving environment downstream towards Dapto Creek.
- Stormwater generation and overflow is anticipated to decrease in future stages, as more areas are capped and diverted around the site and into the existing off-site stormwater management systems. – It should be noted that calibration of the stormwater system was not readily available, due to significant, rapid changes in stormwater levels.

Based on the results of the water balance modelling the following recommendations for leachate and stormwater management are provided:

- Final capping and diversion drains should be installed progressively in accordance with the proposed staging plans to:
    - minimise infiltration of rainfall into the capping area; and
    - reduce stormwater contribution to the stormwater ponds through direct discharge of 'clean stormwater' to Dapto Creek.

An application should be made to increase allowable trade waste agreement discharge rates to sewer in the short term to decrease the intensity of predicted leachate overflow events and corresponding increase to leachate treatment plant capacity. Modelling indicates that an additional 2.4 ML/yr (typical) and 31.4 ML/yr (wet year) is required for the existing scenario and an additional 3.9 ML/yr and 10.4 ML/yr for Stage 3 and Stage 4 respectively to address predicted wet year overflows.

3 Erosion and Sediment Control Plan

This Sediment Control Plan is intended to reduce the sediment loading from construction and operational works on the site's stormwater management system. The full report (which includes the new excavation works of the Central Ridge) is provided in Appendix Three. It should be noted that the sediment and erosion control measures provided with this plan are not suitable erosion control to allow direct discharge of surface water off site at this time. For purposes of this management plan and the next stage of construction and operation, the runoff water generated should be considered Dirty Stormwater (per the definitions provided by the Environmental Assessment (EA) (117625003-159-R-Rev0) and Surface Water Assessment (117625003-160-R-Rev0)) and should be routed though the site's stormwater management system. All runoff from the site currently drains to the stormwater ponds as such additional works are not required to facilitate this requirement.

3.1 Legislative Framework and Guidelines

The Whytes Gully Landfill operates under Environmental Protection Licence (EPL) 5862. The EPL includes surface water discharge limits applicable to the site and permits discharge of stormwater from the sites sedimentation ponds provided that the applicable concentration limits are met, and other contaminants are not discharged.

The Whytes Gully New Landfill Cell Project, of which the excavation of the central ridge is a part of, is approved through DPIE Project approval 11_094 (the Project Approval). The Project Approval provides various conditions of consent that should be adhered to including requirements that WCC implement requirements of the following plans and Guidelines:

- Gully New Landfill Cell Construction Environmental Management Plan (ref: 117625003-155-RRev1).
- Whytes Gully New Landfill Cell Landfill Environmental Management Plan (ref: 117625003-061-R-Rev2).
- Landcom (2004) Managing Urban Surface water: Soils and Construction Volume 1 (Blue Book).

- Department of Environment and Climate Change NSW (2008), Managing Urban Surface Water Soils and Construction Volume 2B Waste Landfills.
- Wollongong City Council Development Control Plan (DCP) Chapter E22.

3.2 Key Objectives

The key objectives of this Erosion and Sediment Control Plan include:

- Meeting erosion and sediment control requirements of the Project Approval.
- Reduction of the sediment generation from the works to reduce sediment loading on the Sites Surface Water Ponds.

3.3 Proposed Erosion and Sediment Control Measures

3.3.1 Design Components

The Erosion and Sediment Control Plan includes the following design components:

- Progressive Cover Management (revegetation and/or application of a sprayed polymer erosion cover)
- Check Dams
- Rock Filter Dam
- Sediment Fences

Construction Guidelines (Golder 2019) developed for surface water infrastructure are based on both Landcom (2004), Department of Environment and Climate Change NSW (2008) and Book 5 from Catchment & Creeks and International Erosion Control Association (IECA, 2010). A summary of the erosion and sediment control management measures to be implemented are provided in the table below from Golder (2019). The management measures presented below consists of a treatment train of processes that aims to reduce sediment entrainment and to filter out the entrained sediment before it flows to the onsite ponds. The combination of surface water management techniques in series is consistent with the stated objectives and the recommendations in Landcom (2004) and IECA (2008).

Measure	Control	Application
Progressive cover management	Progressively remove surface cover and vegetation as excavation progresses. Surface cover and vegetation to be removed progressively from upper elevations to lower elevations. Stabilise landform to reduce sediment runoff off site. Establish vegetation cover.	Revegetation by reshaping and revegetating disturbed land into a stable landform and/or application of a sprayed polymer erosion cover. Soils should not be permitted to be exposed for more than 28 days.
Check dams	Control flow velocities and trap small quantities of sediment within catch drains.	Formed using rock at regular intervals along the drainage alignment.
Rock filter dam	Sediment retention trap using settlement and filtration to mitigate sediment pollution flowing downstream	Dam installed within existing drainage alignment.
Sediment fences	Retention trap to mitigate sediment pollution to downslope areas.	Sediment fences installed where required.

The proposed regular check dams and rock filter dams will act as a filter for surface water causing the flows to slow and sediment to settle-out. By utilising these dams in the drainage channels that will capture runoff from the Central Ridge excavation area the majority of entrained sediment will be captured. Excavation and soil cover removal is proposed to progress from upper to lower elevation areas, with the intent of this approach being to utilize the retained vegetation and soil cover below the active excavation area to slow runoff and act as a filter to upper excavation areas. The progressive revegetation of exposed soils will reduce exposed area of soils, limit long term sediment generation and increase the effectiveness of the other erosion control measures and will reduce required de silting of sediment fences, check dams and rock filter dams.

3.3.2 Progressive cover management (revegetation)

The most effective method of erosion control is minimising the exposed soil and by having erosion resistant ground cover. Progressive cover management will be undertaken to rehabilitate disturbed areas as soon as practicable into a stable landform. Land will be reshaped and vegetation in the form of native or a mixture of introduced grasses will be used to stabilise the excavation area and reduce erosion. The soil should be prepared for revegetation with some form of surface roughening to promote vegetation establishment. Alternatively, a sprayed polymer erosion cover or hydromulching can be applied for rapid establishment of vegetative cover and initial soil binding.

3.3.3 Check Dams

The two Existing Drains are to include regularly spaced (vertical distance) Check Dams. Check Dams are a drainage control technique to primarily control flow velocities within unlined drains and additionally offer sediment control through trapping small quantities of sediment. Check Dams are to be constructed from individual sandbags or rock placed along drains at intervals of 0.5m vertical spacing such that level of the base of upgradient check dam matches to the level of crest of the lower check dam.

3.3.4 Rock Filter Dams

Rock filter dams are a sediment control technique primarily used for concentrated surface water flows. Sediment trapping is achieved by both particle settlement within the intermittent shallow settling pond formed by the dam (during high flows) and by filtration of minor flows passing through an aggregate and/or geotextile filter. This Sediment and Erosion Control Plan includes one Rock Filter Dam to be constructed within the existing drainage channel to the south of the central ridge excavation area.

3.3.5 Sediment Fences

Sediment fences are to be placed at the perimeter of disturbed areas and at regular 3.5 m vertically measured spacings across the excavation area. Sediment fences are a form of retention trap used to mitigate sediment movement to downslope lands and waterways. Fences will comprise self-supporting geotextile fabric entrenched 150 mm deep into the ground held up by regularly spaced star-pickets to a height of between 500- 600 mm placed parallel to site contours and perpendicular to flow paths. Sediment fences should be progressively installed as the excavation works commence with the perimeter fences (closest to the Drainage channels) installed prior to excavation commencing. Sediment fences other than the last catch sediment fence closest to the stormwater drainage channels may be omitted where:

- The area upgradient of the proposed sediment fence alignment has been excavated to rock and the exposed rock is not erodible or likely to generate significant sediment; or
- Any areas of exposed up gradient soils (if present) have been effectively revegetated.

3.4 Stockpile Management Plan

It is anticipated that soils materials excavated from the central ridge excavation area will be stockpiled in the current Western Gully Stockpiling area. Where encountered during excavation works, clean topsoil materials should be stockpiled separately for reuse in revegetation activities at the site. Appropriate stockpile tracking should be implemented. A detailed Stockpile Management Plan is provided in Appendix Three.

In summary, erosion control measures to be implemented for stockpiles (as outlined in the Management Plan) include:

- Location of stockpiles more than 30 m from watercourses. Vegetated buffer to be maintained between stockpiles and watercourses.

- Installation of Sediment fences around stockpiles and stockpile areas to manage the migration of fines.
- Maintain vegetated buffer zone of minimum 15 m width between stockpiles and watercourses.
- The surface of stockpiles that are to be in place for more than 28 days should be vegetated as soon as practicable. Soils should not be permitted to be exposed for more than 28 days. Stockpiles of non-erodible materials (i.e. aggregate materials) do not need to be vegetated.
- Dust control measures are to be implemented as required. Measures may potentially include covering of stockpiles and wetting down of stockpiles and application of hydro mulch and or tackifier products to the surface of stockpiles.

3.5 Monitoring and Maintenance Plan

A maintenance plan for erosion and sedimentation control infrastructure is included in the table below from Golder (2019) below. All erosion and sediment control infrastructure outlined in this report should be inspected:

- Immediately after each rainfall event.
- Daily when excavation works are occurring otherwise weekly inspection.

Measure	Trigger Criteria	Maintenance Action
Progressive cover management	Poor regrowth	Water if applicable. Application of a sprayed polymer erosion cover. Consider re-seeding or hydromulch.
Sediment fences	Damaged	Repair/reinstate
	Sediment blocking more than 30% of retention capacity	Remove silt from fence Replace or back-flush any portion
Check dams	Damage to dam structure. Displacement	Reinstate check dam
	Sediment accumulation	Remove any accumulated sediment
	Significant soil scouring around ends of dams	Extend width of dam
	Significant erosion between dams	Install additional intermediate check dams or install channel liner
Rock filter dams	Evidence of erosion damage to filter structure or downstream channel banks	Repair/reinstate
	Accumulated sediment/debris exceeds ~10% of settling pond storage volume	Remove sediment
	Dam drains too rapidly (full dam drains < 8 hours)	Install additional filter aggregate
	Dam drains too slowly	Upstream filter medium to be removed of replaced If geotextile used sediment can be scraped from surface using machinery

4 Leachate Management Plan

4.1 Overview

Leachate collected at the landfill is piped to the first of three leachate treatment ponds where it progressively travels through the system and undergoes biological treatment through natural processes. From there, it is pumped to the onsite leachate treatment plant where it is further treated via a sequencing batch reactor (SBR). The liquid portion of the leachate is then discharged to sewer in accordance with the Trade Waste Agreement and sludge is trucked off-site for safe disposal.

The most practical method of leachate management at Whytes Gully is minimisation. Although historical practices are difficult to rectify, sustainable management and best management practices are implemented in new cell development and constant monitoring and improvement of existing operational infrastructure is undertaken.

At the site, the following integrated methods are used to prevent pollution of water by leachate:

- Leachate Barrier and Collection System
- Surface Water and Sediment controls (see Section 3: Erosion and Sediment Control Plan)
- Leachate Monitoring Program (see Section 5: Stormwater Management Plan)

4.1.1 Leachate Barrier and Collection System

The EPA (2016) Landfill Guidelines require that 'the landfill must have a leachate barrier system to contain leachate and prevent the contamination of surface water and groundwater over the life of the landfill. Pollutants with the potential to degrade the quality of groundwater must not migrate through the strata to any point beyond the boundary of the premises or beyond 150 metres from the landfill footprint, whichever is smaller. If this occurs, additional engineered controls may be required to prevent further pollution migration. It may also be necessary to remediate the existing pollution'.

Reference is also made to schedule 4 condition 17 of the Project Approval and modified schedule 4 condition 18 (MP 11_ 0094 MOD 2) for requirements in relation to leachate management. The primary objective of the leachate barrier system is to provide a physical barrier for stopping leachate migration during the time that it poses significant environmental risk; therefore, neither groundwater nor surface water are affected. Unfortunately, this was not a requirement when the Western Gully Landfill was established in 1984; and subsequently there is no liner system.

4.1.2 Eastern Gully Landfill Leachate Management

The Eastern Gully Landfill was constructed as a lined landfill, with the barrier component of the lining system comprising a high-density polyethylene (HDPE) geomembrane liner (2 mm thickness). This geomembrane liner is underlain by a groundwater drainage layer comprising an approximate 500 mm thick fine gravel layer that is intended to collect any groundwater seepage from the natural materials below the liner. This incorporates a 100 mm diameter collection pipe that drains by gravity to the pond at the toe of the landfill.

The HDPE geomembrane liner in the Eastern Gully is overlain by a blanket leachate drainage layer comprising an approximately 300 mm thick clean sand layer. This layer incorporates two 300 mm diameter leachate collection pipes that drain by gravity to the toe of the landfill - one pipe drains stage 1 and the other pipe drains stage 2. Collected leachate is transferred to the leachate ponds via gravity.

4.1.3 Western Gully Landfill Leachate Management

Collection of leachate was originally through a central 100 mm diameter perforated pipe located at the base of the landfill. This pipe network did not have filter protection and became non-functional early on during the filling process. An alternate leachate collection system was then constructed, and leachate collection horizons were established successively at approximately 5 metre vertical intervals within the landfill mass; comprising a network of finger drains. At the low point on each horizon, flows in the finger drains enter a shallow 300 mm concrete or HDPE pipe; and are conveyed to the base of the landfill batter; a pipe pit was then installed at each horizon. At the toe of the landfill batter, the shallow 300 mm pipe extends through the landfill bund wall to the leachate collection pit near the current landfill access road, where it is transferred to the leachate collection ponds.

Within this Western Gully landfill area, there are two separate collection systems to manage the generation of shallow leachate and a separate one to manage the deeper leachate generation, given that no liner was installed when the landfill was first established.

4.1.4 Western Gully Shallow Leachate Collection System

The shallow leachate drainage system comprises a number of aggregate filled collection trenches each with a perforated collection pipe installed near the trench base. Collected leachate is conveyed under gravity flow through piping installed below the level of Package 2 Landfill Cell to the existing leachate drainage system.

4.1.5 Western Gully Deep Leachate Collection System

The deep leachate collection and drainage system comprises a group of collection wells that form a sump. A HDPE outlet pipe was installed by directional drilling methods through the western gully landfill toe bund to intersect with the base of the collection sump providing drainage under gravity to the site's leachate drainage system.

4.1.6 Leachate Liner

The leachate collection system in all new liner areas comprises a continuous blanket collection layer, comprising either a geo-composite drain or aggregate layer, with a network of leachate collection pipes. The collection pipes are positioned to provide an approximate 50 m (maximium) flow distance from point of entry into the blanket to the nearest pipe and to maintain positive drainage after long term landfill settlement. The system is sized to provide for long term clogging resistance and for pipe clean out access points.

The base of cells 1 to 4 are graded to drain to the south, with a leachate collection sump positioned in the southern corner of each cell. Leachate will drain to the leachate collection sump via gravity. Leachate from the piggyback cells, 2a, 2b and 4a would also drain to one of these four sumps. The sumps are essentially depressions that are filled with drainage aggregate. Each sump drains via gravity to a leachate sump riser outside the perimeter bund. Each leachate sump riser is subsequently drained via gravity through a new leachate drainage pipe to a single external leachate pumping pit for transfer to the leachate ponds and leachate treatment plant.

4.2 Current Leachate Management Practices

JPG Engineering commenced Operation and Maintenance of the Leachate Management Systems at Whytes Gully Landfill in August 2020. Their professional services were engaged to manage and improve leachate management after the stormwater contamination events in the heavy rainfall in February 2020. From the Contract start date to present, numerous upgrades and process modifications have been made or are in the process of being made to the overall system.

These upgrades and process modifications are summarised below with the full list of management activities provided in Appendix Four.

4.2.1 Leachate Collection, Storage and Transfer Systems

- Design, supply and installation of high flow Leachate Transfer Pump Systems between all three Leachate Ponds; Primary (P1), Secondary (S1) and the Backup (B1) has been completed.
- Design, supply and installation of secondary strainer type Pump Suction Pontoon Skids for the Chamber Feed Pumps located in P1 and S1 has been completed. Some benefits of this upgrade include:
- Procurement of spare P1/S1 Chamber Feed Pump has been completed (currently stored in container at Leachate Treatment Plant).
- Installation of electromagnetic flowmeters on both the P1 and S1 Chamber Feed Pump Lines has been completed.
- Hydrostatic Level Probe installation in P1, S1 and B1 Ponds as well as Leachate Chamber 1 and Chamber 2 has been completed.
- Installation of pH and Dissolved Oxygen (DO) measurement systems in the P1 Leachate Dam has been completed.
- Remote automation of the Primary Pond (P1) Surface Aerators has been completed, which allows for the control of P1 Surface Aerators remotely based on pond parameter data.

4.2.2 Leachate Treatment Plant

- The repair of SBR Aspirating Aerator #2 (off-site) has been completed. This aerator was not operational upon Contract handover.
- The Antifoam Pump System was not operational upon Contract handover due to issues with the dosing lines. This has been resolved, however once the system was running it was found that the Anti-Foam product was not effective at controlling the foam during the aeration process. The AntiFoam product has been changed to a silicon based product that has been working effectively.
- Installation of Leachate Feed Pump #1.
- Installation of Effluent Balance Tank. The existing pump was not operational upon Contract handover resulting in sludge build up in the Effluent Balance Tank.
- Design, supply and installation of Effluent Balance Tank discharge strainer to provide pump protection to the Sewer Discharge Pumps has been completed.
- Installation of Sewer Discharge Trade Waste Electromagnetic Flowmeter has been completed. The existing device was not operational upon Contract handover. A downstream isolation valve was also installed on the line to enable isolation of the Sewer Discharge line if any future works are required, avoiding the need to empty the 1.3km Sewer Discharge Rising Main.
- Supply and installation of Dissolved Oxygen (DO) measurement system has been completed. The existing system was not operational upon Contract handover.
- Supply and installation of an electromagnetic flowmeter on the Leachate Blend line has been completed. This will allow control of blend volumes once the Control System Upgrade is complete.
- Analogue (Ultrasonic) level sensors have been installed in the SBR and Effluent Balance Tank.

4.3 Future Directions in Leachate Management

The information collected in the water balance and stormwater management plan will be used to assess the capacity of the current leachate management plant for future expansion works. The Leachate Management Plan Section will be updated on a regular basis now that performance data is available.

5 Stormwater Management Plan

This Management Plan provides an overview of the current stormwater management system, how it is performing and how it can be improved. The Plan also provides a supporting Improvement and Maintenance Program to prioritise Works to ensure compliance and sustainability in stormwater management at Whytes Gully in the future.

5.1 Overview of Stormwater Management at Whytes Gully

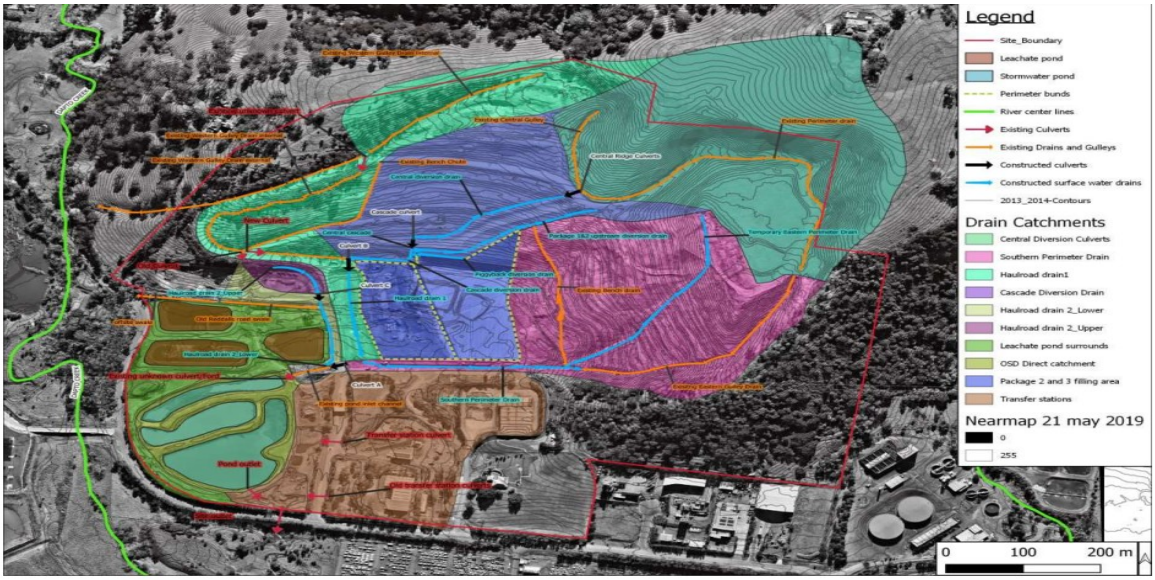
The site surface water management infrastructure encompasses open channel drains, pipes, culverts and various energy dissipation structures. In general, the surface water management encompasses:

- 'Clean' stormwater. Runoff from areas of the site where soil and vegetation have not been disturbed or final capped areas vegetation has been established is considered to be 'Clean'.
- 'Dirty' stormwater. Run off from areas of the site where soils have been disturbed and are likely to generate sediment are considered to be 'Dirty', including areas of immediate cover or final capping that has not fully vegetated.
- 'Leachate': comprises run off from areas of waste or daily cover material as well as leachate generated by the landfill.

Clean surface water is generally diverted around disturbed areas of the site where possible. Dirty surface water is conveyed to the surface water pond system for sediment treatment, storage and eventual discharge. Surface water that comes into contact with waste (leachate) is collected in the leachate collection system.

5.2 Current Stormwater Management System

The current main drainage infrastructure is shown in Figure 1. These are briefly described below and discussed in full in Appendix Five (Site -wide Stormwater Review (Golder 2021).



5.2.1 Existing Western Gully External Drain

This is only one clean stormwater drain that discharges directly into Dapto Creek from the site. All other drains shown in Figure 1 drain dirty stormwater into the pond system.

5.2.2 Central Diversion Drain

The Central Diversion Drain was constructed during the Stage 1 landfill expansion cell works. Reporting catchments include the area north of the Eastern Gully, as well as small northern catchment within the Western Gully. This Drain is connected to the Central Cascade via culverts under a haul road and is designed to convey up to the 1:20 AEP peak flow stormwater event. It was not designed for larger events as it will be removed in the future stages of landfill construction.

5.2.3 Central Cascade

During the development of Stage 1, a gabion cascade structure was constructed at the end of the Central Diversion Drain designed to cope with 1:20 AEP peak flows. This was primarily an energy dissipation structure and was upgraded recently with the further development of Stage 1 and 2A phase plans. Resulting in a 1:100 AEP peak flow capacity.

5.2.4 Cascade Diversion Drain

With the development of Package 2 and 3 phase of the landfill, drainage modifications resulted in the flows from the gabion cascade being directed westward into the Cascade Diversion Drain which confluences with a smaller channel which flows in an eastward direction. This drain is designed to convey the 1:100 peak storm event flows.

5.2.5 Culvert B

Three existing 1.2 metre culverts north of the haul road channel receives flows from the Cascade Diversion Drain as well as existing drains from the west. Flows from both east and west channels were designed to turn 90 degrees for energy dissipation and has been designed for 1:100 AEP peak storm event flows.

5.2.6 Haul Road Drainage Infrastructure

The Haul Road Drains 1 and 2, which rum parallel on the east and west side of the Haul Road respectively, were designed for construction prior to Package 2 and 3 landfill cells to convey peak flows during major storm events. A dissipation basin was designed for Haul Road Drain 1 to reduce flow energy prior to being directed through Culvert A. Culverts A and C have been sized to convey major storm events (1:100 AEP) without overtopping the Haul Road.

5.2.7 Southern Drain

The Southern Drain is a permanent open channel drain on the southern edge of the landfill. It has a gabion mattress lined portion and an inverted box culvert portion. The drain has been sized with capacity for major storm events (1:100 AEP) considering the expanded catchments in future stages.

5.2.8 Surface Water Ponds

All site surface water is currently directed into the Surface Water Pond system located on the south-western portion of the site. The Surface Water Pond system is comprised of three Reed Beds and two Polishing Ponds. The total capacity is approximately 40 000 $m^{3.}$ The polishing ponds discharge through a concrete culvert overflow and then a culvert under Reddalls Road after combining with treated surface water from the transfer stations. The flows then drain through a series of creeks and wetlands before entering Dapto Creek.

5.2.9 Rainsheds

To divert clean runoff away from the landfill cell leachate collection system, a system of channels and pipes (known as the ‘Rainshed’) was designed. The Rainshed consists of an impermeable surface supported by aggregate, creating channels and bunds to divert clean runoff to the temporary eastern drain via outlet pipes. This is a temporary structure in place until the filling of the cell occurs.

5.3 Issues Identified for Improvement in the Existing Stormwater Management System

A site walkover was conducted by Golder and Waste Services staff on the 10th December 2020 to assess the condition and efficiency of stormwater infrastructure at Whytes Gully. The following areas were identified for improvement:

5.3.1 Confluence of Southern Drain and Drain 1

The proposed bund at the southern edge of the basin located at the confluence of the Southern Drain and New Haul Road Drain 1 is not in place. Consideration should be given to bunding as designed.Rip Rap within the confluence of the basin is not visible. Consideration should be given to installing as per design requirements.

5.3.2 Package 1 Filling Plan – Upstream stormwater diversion

Channel erosion and overtopping has recently occurred along the drainage alignment that exists at the north western perimeter of the Package 1 and Package 2 landfill cell, south of the Western Gully Haul Road. These issues are believed to be related to increased catchment draining through this alignment compared to that assumed in the initial design which incorporated the bund mentioned above. This diversion bund should be implemented as per design requirements.

5.3.3 Drainage Channels

Various sections of the drainage channels have sediment accumulation within the interstitial spaces of the aggregate. This sediment has the potential to be eroded and carried during elevated channel flows which can result in elevated sediment load of surface water. There is also vegetation growth in some areas within the drainage channels including grasses, shrubs and trees that may result in reduced channel capacity and increased potential for channel overtopping.

Some areas have evidence of shifting rip rap aggregate and it appears that the Temporary Eastern Drain has collapsed and is in need of repair.

Accumulation of waste materials was noted to occur in the gabion and reno mattress lined portion of the Southern Drain. This area should be cleaned and maintained regularly.

The TRM lined stormwater drainage channels also require regular maintenance. Some areas were noted to not have grass establishment and have signs of erosion. There was some signs of liner damage evident.

5.3.4 Culverts

The main Culverts at Whytes Gully appeared to be functional and free of blockages. Some erosion appears to be occurring at the minor culverts including the accessway to Old Reddalls Road and the western intersection of the Western Gully Haul Road.

5.3.5 Stormwater Ponds

The Ponds are currently being operated via a manual pump out following confirmation of water quality within the pond being compliant with discharge criteria. It is recommended that the operations be reviewed and automated if possible.

Evidence of sedimentation of the ponds and channels was noted and desilting if the system is recommended. A bathymetric survey should be conducted at the same time to accurately measure storage capacity.

5.3.6 Potential Sediment Source Areas

The following areas have the potential to increase sedimentation risk on site:

- Borrow Excavation Areas
- Western Gully Stockpile Area
- Operational Areas
- Landfill Intermediate Cover Batters

5.4 Recommended Preliminary Actions

The following actions are recommended to improve performance of the stormwater management system:

- Development of Sedimentation and Erosion Control Plans for all disturbed and operational areas of the Site.

- Implementation of an inspection and maintenance program for all stormwater drainage infrastructure once upgrade works are undertaken.
- Investigate the suitability of lining at confluence of Southern and Access Road Drain 1 and the need for the proposed bund in the New Haul Road design.
- Implement Diversion Drain as proposed for the Access Ramp Connection design.
- Reconstruction of degraded areas of Rip Rap and TRM lined drains to original design.
- Develop and implement rectification for collapsed section of Temporary Eastern Drain.
- Further review of condition and operation of Stormwater Ponds (e.g. desilting and bathymetric survey).

5.5 Improvement and Maintenance Program

A list of actions to improve performance and reliability of the stormwater management system has been developed based on short, intermediate and long-term strategies. These are discussed below and with appropriate timeframes for completion.

5.5.1 Relocation of Stormwater Monitoring Point 1

Stormwater Monitoring Point 1 was located opposite side of the stormwater discharge outlet on Reddalls Road, Kembla Grange. This point was considered representative of Whytes Gully stormwater discharge quality when the EPL was first issued due to the rural land use surrounding the site. In recent years, there have been significant changes to the catchment, including. an increase in light industrial development. An application to amend the EPL to include this alternate sampling location was submitted and accepted in February 2021 as part of this preliminary assessment.

5.5.2 Desilting of Stormwater Ponds

The ponds currently contain silt, resulting in less than optimum storage and settling volume. It is planned to stage desilting of the three stormwater ponds progressively over the rest of this year. All ponds will have excess sediment removed and stockpiled for reuse on the site. Where possible, the re-established wetland system will be kept to maintain water quality treatment. Siltation control measures will be put in place and all works will be monitored to ensure no water leaves the site during work. The contracting company has been engaged and the first pond works are underway (this will include a bathymetric survey component). Unfortunately, COVID 19 restrictions have impacted project delivery timeframes and as a result desilting and survey works are approximately three months behind schedule.

5.5.3 Stabilisation of Pond Water Quality

The unusually heavy rainfall event of February 2020 (156.5 mm recorded) resulted in leachate migrating into the stormwater management system and impacting water quality. This resulted in a number of treatment methods being put in place based on stormwater analysis results and specialist advice. The methods used were based on a multifaceted approach using a combination of:

• Aeration

• Addition of microorganisms

• Flocking (calcium chloride)

This treatment methodology will continue to be used to maintain and stabilise water quality after rainfall events.

5.6 Water Balance Model for Whytes Gully Waste Facility

The full Site Water Balance is provided in Appendix Two.

5.7 Stormwater Harvesting and Reuse

As part of Wollongong City Council's commitment to sustainable site management, a number of water reuse strategies are being implemented. This will result in reducing pressure on the stormwater management system, reducing operational costs and assist in improving site safety.

Council is currently establishing a rapid fill water tank station on site, which will utilise treated stormwater for dust suppression, emergency management (e.g. firefighting), road cleaning and other site maintenance requirements. The specifications for the project are provided in Appendix Six.

5.8 Automation of Stormwater Management System

Currently, stormwater is discharged via gravity flow or manual pumping. It is also recirculated via manual placing of hoses and pumps as required. This practice is inefficient and requires at least 3 staff to move the heavy equipment, potentially posing an environmental and safety risk. It is planned to automate this system in the near future to allow for flexibility and improved management.

Water quality monitoring was previously conducted through physical sample collection and field analysis as required.

At the beginning of 2021, an insitu monitoring system was installed to automatically collect environmental data including standard water quality parameters and weather data. This has allowed Council to monitor pond quality in real time and improve timely water quality management.

5.9 Drainage Correction and Maintenance based on results of site review of stormwater system.

The site wide stormwater review identified several areas that would improve management on site and alleviate some of the pressure on the pond system. These are detailed in the previous sections and will be prioritised as part of the operations works plan to ensure that best practice design is followed, and optimal drainage performance is maintained.

5.10 Off-site swale Investigation and Rectification

The Golder Sitewide Stormwater Review identified an off-site swale that directed 'dirty' stormwater to an off-site drain. After detailed review of the report; and a ground truthing exercise by Council staff, the swale was confirmed to be located on the northwester portion of the site (Stage 4a). See Figure 3 in the attached Golder Site-wide Stormwater Review (12 August 2021).

The swale directs water to Haulroad Drain 2 (Lower), however it had been temporarily impaired by a bank of soil disturbed on site during some contractor works in the past. There was existing silt fencing and hay bales downstream of the bank that ensured 'dirty' stormwater did not leave the site. This was immediately rectified to ensure stormwater drains into the Haulroad Drain 2(Lower) catchment.

Further erosion/sedimentation controls were placed around the perimeter of the area as recommended in the review.

5.11 Improvement and Maintenance Plan

Strategy	Actions	Timeframe
Relocation of Stormwater Monitoring Point 1	Move sampling point onto the site	Complete
Desilting of Ponds	Scoping Works Bathymetric Survey Silt removal Reed Bed Establishment	Underway December 2021 January 2022 January 2022
Development of a water balance model	Model the stormwater/leachate/ hydrological system at Whytes Gully	Complete
Stormwater Harvesting and Reuse	Rapid Fill Tank Water Station	Underway (See Appendix Seven)

	Hardstand preparation Installation of 2 Tanks Installation of pipe, pump infrastructure	Underway February 2022
Automation of Stormwater Management System	Water Quality Monitoring Network Development of Council real time database Installation of automated pumping/recirculation/discharge system	Complete Complete April 2022
Drainage Correction and Maintenance	Desilting/Clean up of site drains Repair of Damaged Infrastructure (Business Case Development based on site review findings) Litter Removal Maintenance of drainage infrastructure	Underway Underway Weekly & Ongoing Quarterly & Ongoing
Off- site Swale Investigation	Undertake Drainage Assessment Redirect water into Haul Road 2 Drain (Lower) Establish Silt and Sediment Control Measures	Underway Complete Complete

6 Monitoring Plan

Surface and groundwater monitoring is undertaken in accordance with Approval No.11_ 0094 Schedule 4 (conditions pertaining to 'Soil and Water') and is based on the framework outlined in EPL 5862 (Appendix Six).

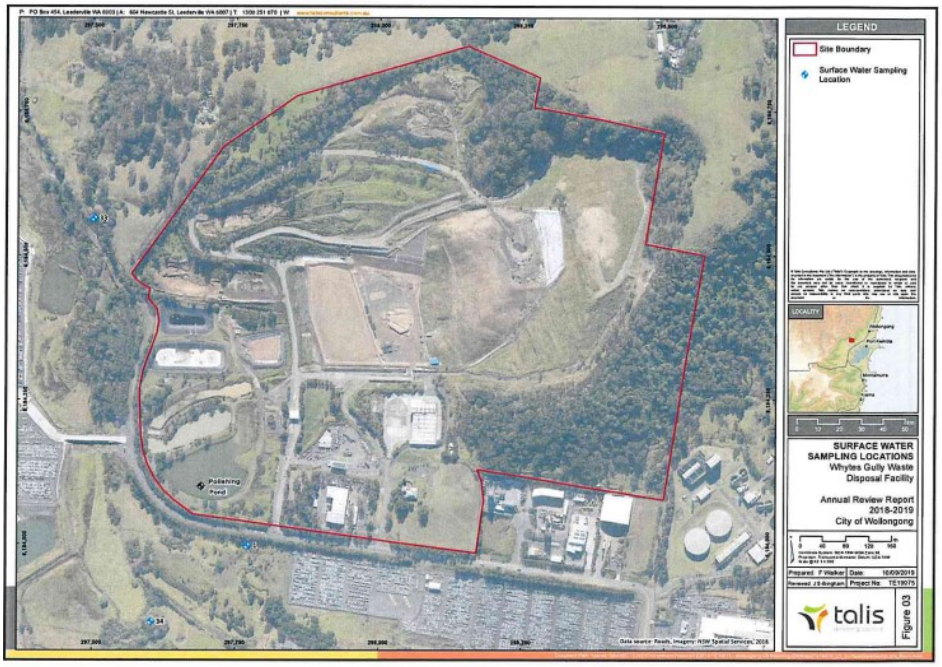
The monitoring plan for Whytes Gully Landfill relating to soil, water and leachate management is outlined in the tables and site plans below.

Table 1 : Surface Water Monitoring

Activity	Description
Purpose	Detect excess sediment loads in stormwater leaving the site and/or potential cross contamination of stormwater with landfill leachate.
Frequency	**Surface Water Monitoring Points**: Following an overflow event, water sampling is undertaken every 24 hours in accordance with EPL 5862; and **Polishing Pond**: During controlled release. Sampled Anually
Location	Sampling locations are those listed in EPL 5862, and included the following: • Monitoring Point 1 – outlet at Reddalls Road • Monitoring Point 33 – Upstream monitoring point; and • Monitoring Point 34 – Downstream Monitoring point In addition, the 'Polishing Pond' is monitored by Council during any controlled release event or overflow.
Methodology	Samples are collected using a 'scoop'; and Field parameters were recorded using a calibrated water quality meter.

	Surface Water Quality Parameters (Point 1, 33 and 34)		
	Annually		
Analytes/Field Parameters	Alkalinity	Calcium	Conductivity (EC)
	Filterable Iron	Magnesium	pH
	Sodium	Temperature	Total phenolics
	Ammonia	Chloride	Dissolved Oxygen
	Fluoride	Nitrate	Potassium
	Sulfate	Total Organic Carbon	Total Suspended Solids
	In addition, the 'Polishing Pond' was subject to analysis for pH and turbidity to ensure the water is suitable for release.		

Figure 3 Surface Water Sampling Locations



The performance criteria for surface water monitoring is detailed in the table below:

Table 2 Surface Water Performance Criteria

Description	Performance Criteria	Reference Document
Stormwater Discharge	No discharge of contaminated stormwater to water under dry weather conditions (*less than 10 mm of rainfall within a 24 hour period).*	EPL 5862
	No discharge of contaminated stormwater to water during a storm event of less than 1:10 year, 24 hour recurrence interval *(less than 297.4 mm of rain within 24 hours*).	
	pH: 6.5 – 8.5	

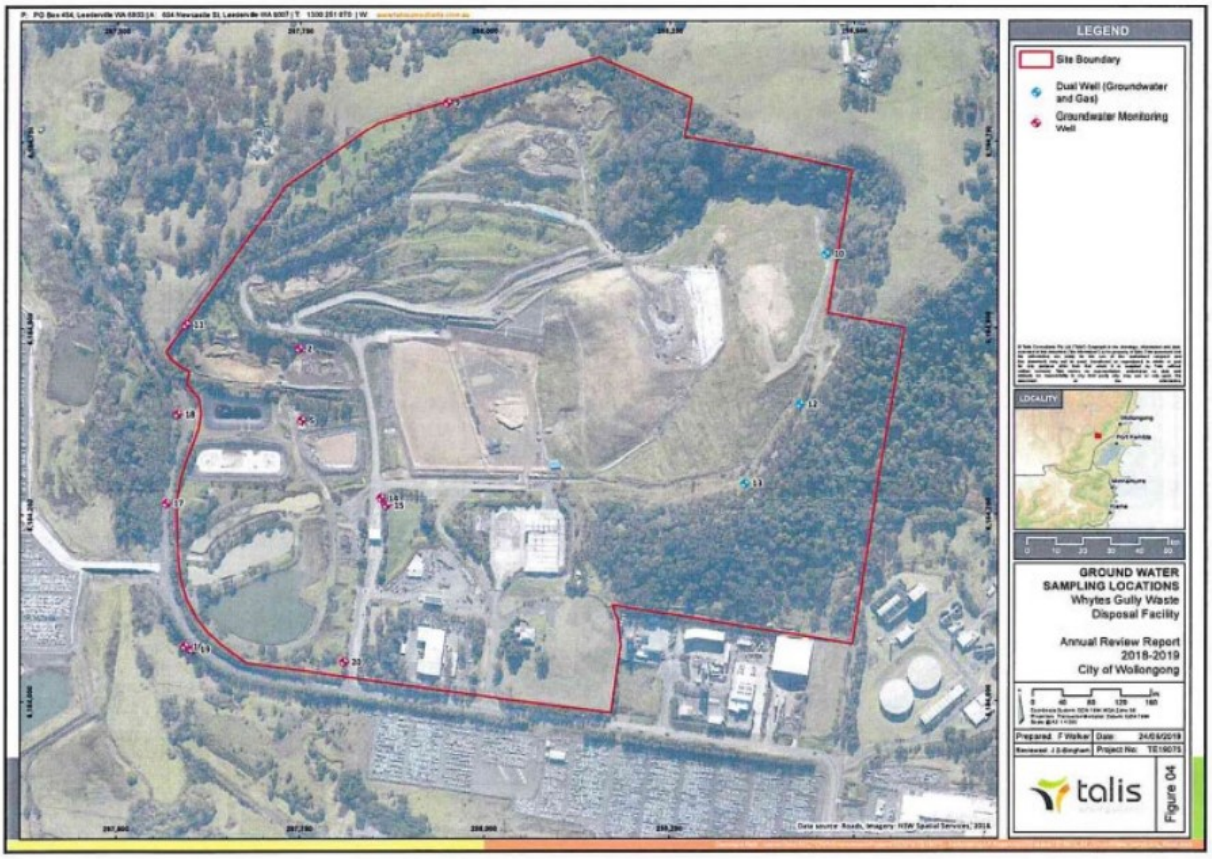
	Turbidity: 40 NTU	
Monitoring Point 1	pH: 6.5 to 8.5 TSS: 50 mg/L	Section 3 (I2) of EPL 5862

In addition to the above, Section 7.4 of the Draft LEMP (Golder 2020) states that all surface water results are to be assessed against the Australian and New Zealand and Australian State and Territory Governments (ANZAST) *Guidelines for Fresh & Marine Water Quality, 2018 (ANZAST 2018).*

Table 3: Groundwater Monitoring

Activity	Description	
Purpose	Detect if groundwater is impacted by leachate.	
Frequency	Quarterly in accordance with EPL 5862.	
Locations	Sampling locations are in accordance with EPL 5862, and included the following monitoring points: 5,9,10,11,12,13,14,15,16,17,18,19 and 20.	
Methodology	Prior to sampling, the sampling the standing water levels (SWLs) are measured using a water level meter; Groundwater samples were collected using a bailer; Field parameters were recorded using a calibrated water quality meter prior to sampling.	
Analytes/Field Parameters	The analysis schedule in accordance with M2.3 of EPL 5862 and included: **Groundwater Parameters**	
	Annually	Quarterly
	Metals: aluminium, arsenic, barium, cadmium, chromium (hexavalent and total), cobalt, copper, lead, manganese, mercury, zinc	Alkalinity
	Benzene, toluene, ethylbenzene, xylene (BTEX)	Major anions and cations: Calcium, magnesium, potassium, sodium, chloride, sulfate
	Fluoride	pH and EC
	Nitrate and nitrite	SWLs
	Organochlorine and organophosphate (OC and OP pesticides)	Total dissolved solids (TDS)
	Polycyclic aromatic hydrocarbons (PAH)	TOC
	Total Petroleum Hydrocarbons (TRH)	Nitrogen – (ammonia)
	Total phenolics	

Figure 4 Groundwater Sampling Locations



7 Conclusion

This Soil, Water and Leachate Management Plan updates previous documents and details current site management practices that were put in place to minimise future contamination and overflow events. This report will be updated yearly in accordance with compliance and reporting requirements as part of the Landfill Environmental Management Plan.