APPENDIX L
Stormwater Management Plan
LANDFILL OPS

STORMWATER MANAGEMENT PLAN FOR MELBOURNE REGIONAL LANDFILL EXTENSION, RAVENHALL VIC

Submitted to:
Landfill Operations Pty Ltd,
C/- Norton Rose Fulbright

Report Number. 1528407-019-R-Rev0
Distribution:
Electronic Copy - Landfill Operations Pty Ltd
Electronic Copy - Golder Associates Pty Ltd
# Table of Contents

1.0 INTRODUCTION .......................................................................................................................... 1

1.1 Approach .................................................................................................................................. 1

2.0 GENERAL SITE DESCRIPTION ................................................................................................. 2

2.1 Buffer Zones and Easements ...................................................................................................... 2

2.2 Topography ................................................................................................................................. 2

2.3 Climate ...................................................................................................................................... 3

2.4 Groundwater ............................................................................................................................... 3

3.0 REVIEW OF REGULATORY REQUIREMENTS .......................................................................... 4

3.1 EPA Publication 1307.10 - Works Approval Application ......................................................... 4

3.2 EPA Publication 788.3 - Landfill BPEM ..................................................................................... 4

3.3 General ..................................................................................................................................... 4

4.0 REVIEW OF CAP DESIGN CONTOURS .................................................................................. 5

5.0 CLASSIFICATION OF STORMWATER ...................................................................................... 5

6.0 WATER USE ON SITE ............................................................................................................... 6

7.0 EXTERNAL CATCHMENT STORMWATER DIVERSION .......................................................... 7

8.0 METHODOLOGY FOR STORMWATER MANAGEMENT ............................................................ 8

8.1 Delineation of Catchments ......................................................................................................... 8

8.2 Drainage Channels ...................................................................................................................... 8

8.3 Stormwater Ponds ...................................................................................................................... 9

8.3.1 Discharge Pond Sizing – Method 1 .......................................................................................... 9

8.3.2 Storage Pond Sizing – Method 2 .......................................................................................... 11

8.4 Discharge Points ......................................................................................................................... 11

9.0 SIZING THE STORMWATER NETWORK ................................................................................... 13

9.1 Cap Swales ............................................................................................................................... 13

9.1.1 Cap Swale Results ................................................................................................................. 13

9.2 Diversion Channels .................................................................................................................... 13

9.3 Stormwater Ponds ..................................................................................................................... 14

9.3.1 Discharge Ponds ................................................................................................................... 14

9.3.1.1 Discharge Pond Results .................................................................................................. 15

9.3.2 Storage Ponds ...................................................................................................................... 15

9.3.2.1 Estimation of Evaporation Rates .................................................................................... 15
9.3.2.2 Estimation of Storage Pond Volume ............................................................... - 17 -
9.3.2.3 Geometry of Stormwater Storage Ponds .................................................. - 21 -
9.4 Quarry floor area to be managed by Landfill Ops ........................................... - 21 -

10.0 CONNECTIONS TO EXISTING SERVICES ....................................................... - 22 -
10.1 Connections to Road Drainage Network ......................................................... - 22 -

11.0 REFERENCES ..................................................................................................... - 22 -

12.0 IMPORTANT INFORMATION RELATING TO THIS REPORT ............................... - 22 -

13.0 CLOSURE .......................................................................................................... - 23 -

TABLES
Table 1: Estimated Extension Annual Water Usage ...................................................... - 7 -
Table 2: Preliminary Swale Sizing Schedule ............................................................... - 13 -
Table 3: Stormwater Pond Types for Proposed Extension Site ................................. - 14 -
Table 4: Discharge Pond Water Hydraulic Results .................................................... - 15 -
Table 5: Storage Ponds ............................................................................................ - 16 -
Table 6: Stormwater Storage Pond Dimensions ....................................................... - 21 -

PLATES
Plate 1: Monthly climate data for Laverton RAAF (BOM Station 087031) .................. - 3 -
Plate 2: Conceptual Cross Section of Discharge Pond .............................................. - 10 -
Plate 3: Cumulative Modelled Inflow and Outflow for Pond 2 for a 1 in 20 Year 24 hour Duration Rain Event ....................... - 17 -
Plate 4: Pond No. 2 Mean Storage Volume ............................................................. - 18 -
Plate 5: Pond No. 3 Mean Storage Volume ............................................................. - 18 -
Plate 6: Pond No. 4 Mean Storage Volume ............................................................. - 19 -
Plate 7: Pond No. 6 Mean Storage Volume ............................................................. - 19 -
Plate 8: Pond No. 9 Mean Storage Volume ............................................................. - 20 -
Plate 9: Pond No. 20 Mean Storage Volume ........................................................... - 20 -
Plate 10: Pond 9 Overflow Plot for a 1 in 20 year 24 hour Storm Event ..................... - 21 -

APPENDICES
APPENDIX A
Figures

APPENDIX B
IFD Data

APPENDIX C
Coefficient of Discharge
APPENDIX D
Important Information Relating to this Report
1.0 INTRODUCTION

Landfill Operations Pty Ltd (Landfill Ops) commissioned Golder Associates Pty Ltd (Golder) to prepare a Stormwater Management Plan (SMP) for the proposed Extension of the Melbourne Regional Landfill (MRL), Ravenhall (the Extension); located as shown on Figure 1 (APPENDIX A). This SMP describes the proposed stormwater management plan to cater for rainfall runoff from the proposed landfill cap and will form an appendix document to the Works Approval Application (WAA) for submission to EPA, Victoria.

The purpose of the SMP is to identify stormwater management measures, which facilitate draining of the landfill caps and address environmental objectives, primarily to:

- Minimise water ingress and limit saturation of waste by managing the collection and discharge of stormwater from the landfill cap and divert stormwater from external catchments.
- Minimise the potential for the discharge of sediment laden water offsite.
- Identify locations within the drainage system that may be prone to localised instability due to stormwater erosion and recommend erosion control measures.

Post approval, it is recommended Landfill Ops undertake a detailed stormwater design for each of the new cells in order to implement the design measures outlined in this SMP.

1.1 Approach

We propose the following approach for the SMP for the Works Approval Application:

- Identify stormwater management measures that are required to be compliant with Publication 788.3 ‘Best Practice Environmental Management - Siting, Design, Operation and Rehabilitation of Landfills, August 2015 (BPEM), in particular Section 6.5.1 Stormwater Management.
- Review of site layouts, engineering standards and available data relating to the site and identify existing drainage features and water usage at the site.
- Identify outfall locations and methods to discharge landfill cap runoff into the natural environment based on site survey data of existing ground levels, outfall invert levels and information provided by Landfill Ops.
- Review of geometry of the South Portion landfill cap and North Portion landfill cap and delineate catchments and sub-catchments based on capping phases.
- Development of a strategy for stormwater management during staging of rehabilitation works and post rehabilitation works including:
  - classification of runoff as either surface water, leachate or sediment laden water
  - managing discharge of surface water from the active landfill areas off-site
  - develop a conceptual strategy for management of stormwater runoff from active and progressively rehabilitated cap areas.
  - separate runoff from the active landfill areas (leachate) and areas of general runoff (clean runoff).
- Develop a conceptual approach for assessing maintenance requirements for the proposed surface water network when quarry operations cease.
- Preliminary sizing of Storage Pond requirements and drainage network based on the Institution of Engineers Australia, Australian Rainfall and Runoff, A Guide to Flood Estimation (ARR87) guidelines and the Bureau of Meteorology intensity duration frequency (IFD) data.
2.0 GENERAL SITE DESCRIPTION

Landfill Ops, a subsidiary of Cleanaway Waste Management Ltd (Cleanaway), is the landfill operating entity for the site. Boral Resources (Vic) Pty Ltd (Boral) own and operate a basalt quarry at the Ravenhall site. Quarried land is progressively released for landfill operations.

Landfill Ops are currently operating an active landfill at the south east corner of the site. The location of the active landfill area is indicated on Figure 2. Environmental control measures including surface water management are being implemented by Landfill Ops at the existing landfill in accordance with the EPA Licence.

Landfills Ops has prepared a WWA for a proposed landfill for submission to EPA. The proposed landfill extension comprises a ‘North Portion’ located north of Riding Boundary Road and a ‘South Portion’ located south of Riding Boundary Road and to the west of the existing landfill. The site extent is shown on the attached site plan, Figure 5 (APPENDIX A). The SMP considers stormwater management from the South Portion and North Portion of the proposed landfill Extension.

We understand Landfill Ops do not currently have a licenced discharge point from the site. The nearest water body to the site is Skeleton Creek located south of Middle Road, as shown on Figure 4 (APPENDIX A).

2.1 Buffer Zones and Easements

The landfill cell design is restricted by several buffer zones and easements to comply with legislation and planning schemes. The buffer zones and easements are shown on the Sensitive Receptors Plan, copy attached. The following buffer zones apply to the Extension site;

- **Active quarry buffer**: There is a 250 metre buffer zone between landfill working faces and active quarrying. In the event that this buffer zone is entered, landfilling operations will need to evacuate the area temporarily during blasting rock activities and resume works once the area has been cleared.

- **Residential buffer**: A 500 metre buffer distance to sensitive receptors is maintained between landfill cells and residential homes to the south west of the site in accordance with BPEM requirements. This buffer zone is required to be maintained for at least 30 years post closure. A 1 kilometre buffer has been prepared to accommodate future residential zones anticipated to be located to the west of the North Portion of the Extension.

- **Powerline easement buffer**: An approximate 65 metre buffer zone is maintained for powerline easements. A power line is located in the south east of the site (South Portion) and across the north west corner (North Portion).

- **Surface water buffer**: In accordance with BPEM requirements a 100 metre buffer zone is to be maintained from surface waters. Skeleton Creek is located to the south west of the site and designated as Land Subject to Inundation by the Melton Planning Scheme. There is no defined creek bed or bank, and stream flow only occurs after heavy rainfall events. This intermittent flow is referred to as an ephemeral stream, often dry with periods when it is wet during heavy rainfall events.

- **Landscape buffer**: A landscape buffer approximately 100 metres wide surrounds the existing quarry operations along Hopkins Road and the Melton Rail Line along the north boundary shown in Figure 1. The buffer along the Riding Boundary Road, Christies Road and the southern site boundary is approximately 60 metres wide as shown on Figure 4. This includes vegetation and earth bunds to visually screen the site from surrounding roads and provide a wind break. The landscape buffer zone is required to be progressively maintained by the quarry surrounding all extraction areas.

2.2 Topography

In the vicinity of the South Portion landfill area the existing topography is influenced by quarry activity comprising largely disturbed areas at low elevations, typically nominally 10 m deep quarry excavations below
surrounding ground level. The area of the South Portion is approximately 97 hectares. The South Portion is located east of Hopkins Road, north of Middle Road and south of Riding Boundary Road. The current EPA licence boundary is located to the east of the South Portion. Surface water management at this location is currently managed by water draining towards surface water sumps or depressions from where it is pumped and re-used as part of quarry and/or landfilling operations or it evaporates.

At the location of the North Portion landfill area the land is currently an undeveloped undulating paddock without any formal drainage network. The approximate area of the North Portion is 117 hectares. The North Portion is bounded by Hopkins Road to the west, Riding Boundary Road to the south, Clarke Road to the east and the Melton Rail Line to the north.

2.3 Climate

The site is located approximately 12 km north of Laverton, Victoria. A review of the Bureau of Meteorology (BOM) climate data for Laverton RAAF (BOM Station 087031) weather station indicates the mean annual rainfall is around 538 mm and ranges from 295 mm to 810 mm, with September, October and November being on average the wettest months. The average annual evaporation of around 1690 mm is considerably higher than the annual rainfall. The average monthly maximum temperatures range from approximately 25 °C during December and January to approximately 14 °C during the period from June to August.

The long term monthly climate data for the Ravenhall area is presented in Plate 1. Rainfall is presented as monthly average, with monthly maximum and minimum temperature values and evaporation.

![Monthly Climate Data for Laverton RAAF (BOM Station 087031)](image)

Plate 1: Monthly climate data for Laverton RAAF (BOM Station 087031)

2.4 Groundwater

Groundwater assessment does not form part of this Stormwater Management Plan. Further information on groundwater, including the geology and hydrogeology of the site is discussed in the URS Report attached to the Works Approval Application.
3.0 REVIEW OF REGULATORY REQUIREMENTS

The stormwater drainage design involves a hydrological assessment of the peak flow rates from rainfall on the Extension and a hydraulic analysis of the proposed stormwater drainage network to cater for predicted peak flows and volumes of rainfall runoff. This assessment is undertaken in accordance with EPA requirements and published engineering guidelines.

3.1 EPA Publication 1307.10 - Works Approval Application

EPA Publication 1307.10 Works Approval Application (WAA) dated April 2015 provides regulatory requirements for a works approval application and sets out a guideline to prevent surface water contamination.

Section 10.1 EPA Publication 1307.10 states:

“Contaminated stormwater and process wastewater must not be discharge to stormwater drains or surface water. Stormwater run-off from process areas are likely to be contaminated.”

In general terms this requires a landfill operator to ensure that leachate from the landfill does not mix with clean surface water runoff from the site.

3.2 EPA Publication 788.3 - Landfill BPEM

EPA Publication 788.3 Best Practice Environmental Management- Siting, design, operation and rehabilitation of landfills dated August 2015 (BPEM) outlines environment performance objectives for Landfills and sets out design criterion to apply in developing a stormwater management system.

Section 6.5 of the BPEM states:

“Storage ponds and other drainage measures should be designed to contain and control rainfall run-off for a 1-in-20-year storm event for a putrescible landfill or a 1-in-10-year storm event for a solid inert landfill. Storm events up to 1-in-100-year recurrence intervals should also be considered to ensure that they do not result in any catastrophic failures such as flooding of the landfill or failure of dams or leachate storage ponds.”

“All dams should have spillways with erosion-control measures such as rocks and erosion-resistant vegetation.

The discharge of stormwater from the site should only occur from dams, and only after confirmation that the water is not contaminated.”

The above design criteria were referred to in establishing estimated peak flows and storage requirements and creating measures to prevent contamination of stormwater at the Extension.

3.3 General

The Extension is located within the Port Phillip Catchment Management Region and is not a declared water supply catchment area. The nearest water body to the site is Skeleton Creek located south west of the South Portion of the Extension.

In accordance with the Water Act 1989, Guidelines for Quarries and Mines 2004, a channel with a catchment of 60 hectares or more is identified as a ‘waterway’. Thereby, in the context of this application Skeleton Creek is defined as a waterway with a catchment of approximately 65 Ha.

The creek is a minor drainage line within the Werribee catchment. According to the SEPP (Waters of Victoria) the Werribee catchment is included in the Cleared Hills and Coastal Plains segment which has a high level of disturbance, and is extensively cleared with some isolated remnant native forests and substantial urban centres. The Werribee catchment flows into the Port Phillip Bay segment which comprises of marine and estuarine segments subject to Schedule F6 of the SEPP (Waters of Victoria).
Skeleton Creek is designated as Land Subject to Inundation by the Melton Planning Scheme. There is no defined creek bed or bank, and stream flow only occurs after rainfall events. Appropriate buffer distances of 100 m are maintained to this designated area, as discussed in Section 6 of the Works Approval Application.

In addition, it is noted there are two tributaries of Skeleton Creek aligned in a North-South orientation located within the Extension, as shown indicatively on Figure 1 – Site Locality Plan. There is no defined creek bed or bank for these two tributaries and stream flow only occurs after rainfall events. It is noted the majority of these tributaries are to be removed by Boral as part of the quarry activities in accordance with their Work Authority for the quarry. A partial segment of one of the tributaries will remain on the western boundary of the North Portion adjoining Hopkins Road. Rainfall runoff from this tributary will be collected in Stormwater Ponds 20 and 22 as part of the Extension’s Stormwater Management System (refer Figure 18 – Stormwater Management Plan). A buffer distance of greater than 100m will be maintained from this tributary to the North Portion landfill cells.

4.0 REVIEW OF CAP DESIGN CONTOURS

The maximum elevation of the Pre-settlement Top of Cap Contour Plan at the South Portion is RL110 m and North Portion RL140 m relative to Australia Height Datum (AHD). The South Portion and North Portion top of cap encompass a central ridge line that typically grades away and down gradient at slopes ranging between 5% and 20% in accordance with the ‘Suggested Measures’ of the BPEM. The cap contours are designed to direct surface water towards cap swale drains and into stormwater ponds defined in Section 8.0.

The South Portion of the proposed landfill cap ties in with the natural surface profile at the landscape buffer zone adjoining Riding Boundary Road, Middle Road and Hopkins Road and with the quarry floor, as shown on Figure 18 – Stormwater Management Plan, copy attached.

The North Portion of the proposed landfill cap ties in with the natural surface profile at the landscape buffer zone adjoining Riding Boundary Road and with the quarry floor to the North, East and West, as shown on the attached Figures. It is noted that groundwater levels are typically well below the quarry floor. Surface water that accumulates on the quarry floor is directed towards stormwater Storage Ponds.

5.0 CLASSIFICATION OF STORMWATER

Stormwater runoff from the landfill will be classified according to the stage of the landfill rehabilitation. A concept sequence plan1 for waste filling and cap construction has been prepared, which identifies the ‘Activity Based Areas’. The following is a list of the Activity Based Areas and the classification of stormwater runoff for each area:

- **Waste Filling Area**
  Rainfall on waste filling areas is treated as ‘leachate’. This leachate will be kept separate from runoff from other areas of the site and will be collected at the leachate sumps on site where it may either be stored in a leachate evaporation storage pond, re-used on site within the landfill footprint (dust suppression on open landfill) or treated / transferred offsite for treatment.

- **Cell Floor Construction Area**
  Rainfall runoff from exposed areas on the quarry site including cell construction areas is not affected by landfill operations. This runoff is classified as ‘sediment laden runoff’ and will be directed towards sediment management infrastructure before discharging off site.

- **Final Cap Area (Rehabilitated Landform)**
  While sediment loads are unlikely to be high once landscaping is established, for the purposes of best practice site management, rainfall runoff from the final landfill cap is classified as ‘sediment laden’, in

---

1 Refer to Works Approval Application Chapter on Sequence Plans.
particular during the establishment period for the landfill cap vegetation. Rainfall runoff from rehabilitated areas (capped areas) is considered to be ‘clean’ and will be directed to on-site stormwater ponds. The cap profile of the rehabilitated areas has been designed to a preliminary level for the Works Approval Application and will be constructed in accordance with a Type 2 landfill cap, in accordance with the intent of BPEM.

Climate data suggests there is currently a water deficit on site, accordingly the collection of surface water for storage and retention will be maximised. Where storage is not possible, outlet flows from the stormwater ponds may discharge to stormwater infrastructure on Middle Road, Hopkins Road or Riding Boundary Road. It should be noted that new stormwater infrastructure may be needed in these road networks (or upgrades to the existing system) to cater for the runoff from site.

Where the stormwater ponds are located on the quarry floor (nominally 10m below ground level) they may also be designed to function as follows:

a) Storage Ponds;

b) water Storage Ponds for use by Boral during quarrying activities;

c) water Storage Ponds for use by Landfill Ops during cell and cap construction and for general dust suppression activities; and

d) to allow infiltration of water into the surrounding soils / rock profile.

Emergency spillways will be incorporated into the stormwater ponds, to reduce the risk of uncontrolled overtopping at the crest of the stormwater ponds.

- Interim Cell Capping Area

The interim cap will be constructed with earthen cover and sediment capture features, such as silt traps, silt fences and temporary vegetation or mulch. Rainfall runoff from the interim cap will be treated as ‘sediment laden runoff’ and will be directed via swale drains towards the stormwater ponds.

- Quarry Floor Area within Landfill Operations Managed Land

Incident rainfall on the quarry floor area within the Landfill Ops managed land will be managed by Landfill Ops. Future quarrying activities will have moved away from the quarry floor area when the stormwater pond is built. This runoff is classified as sediment laden and management options will include sediment control.

As the future quarrying operations adjoining the Works Approval area has not yet been finalised, this SMP will focus on management options for Landfill Ops to consider based on our preliminary design of a stormwater management system.

- External Catchments

Rainfall from external catchments will be diverted around the site using existing stormwater infrastructure. This runoff is classified as clean and will not be treated by Landfill Ops. The extent of the external catchments is shown on Figure 19.

A storage pond (Pond 21) is proposed to collect stormwater outside the Works Approval boundary south of the stormwater diversion bund. The indicative size and location of Pond 21 is shown on Figure 18. The harvested stormwater will be reused for quarrying and landfill operations.

6.0 WATER USE ON SITE

Currently, stormwater is collected in internal catchments that drain into sumps in the landfill and quarry areas and is reused for dust suppression, wheel washing, quarrying activities and earthworks. In addition Landfill Ops extracts groundwater for use in landfiling activities and dust suppression.
The proposed primary uses of water at the Extension are as follows:

- dust suppression along internal haul roads;
- wheel and truck washing;
- onsite firefighting; and
- moisture conditioning of clay used for landfill cell construction and closure.

Estimated annual water used in each of these processes is provided in Table 1.

<table>
<thead>
<tr>
<th>Water Usage</th>
<th>Estimated Volume (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust Suppression¹</td>
<td>21</td>
</tr>
<tr>
<td>Wheel/Truck Washing²</td>
<td>12</td>
</tr>
<tr>
<td>Compacted Clay Liner &amp; Cap Construction³</td>
<td>6</td>
</tr>
<tr>
<td>Onsite firefighting⁴</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Annual Water Use</strong></td>
<td><strong>39 ML per annum</strong></td>
</tr>
</tbody>
</table>

Notes:
1. Allowance for two 10,000 litre trucks running four loads of water per day on each day it does not rain (assumed 265 days)
2. Assuming wheel wash used only on rain days, 0.01ML of water used per operational hour.
3. Based on 210 Ha of 0.5m thick Compacted Clay Base and 0.6m thick Compacted Clay Cap Liner constructed over a 30 year period, assuming 8% water required to achieve Optimum Moisture during construction.
4. Water for firefighting not accounted for as held in stormwater storage for emergency use, not expected to be used.

Landfill Ops are licenced to extract 200 ML of groundwater per annum from their groundwater extraction well. The extracted groundwater is pumped to stormwater ponds for use on site.

**7.0 EXTERNAL CATCHMENT STORMWATER DIVERSION**

Stormwater runoff from the upstream external catchment is expected to flow in three catchment areas, referred to as catchments 1, 2, and 3, located as shown on the attached Figure 19 External Catchment Plan.

Catchment 1 includes existing undeveloped farmland comprising undulating grassed paddocks located west of the site, which includes Skeleton Creek. Rain runoff from this catchment collects in Skeleton Creek and flows in a southern direction to an existing stormwater drain located at the edge of and associated with Hopkins Road. It is understood the general overland flow is southerly.

There is currently a substantial soil bund wall within the subject land’s landscape buffer zone adjoining Hopkins Road at the western perimeter of the South Portion. The existing bundwall appears to be approximately 1.5 m to 2 m high and prevents surface water from entering the existing and future quarry area in and adjoining the South Portion area. Nominal sizing of the stormwater diversion drain indicates a base width of 3 m and depth of 0.8 m is required to cater for a 1 in 20 Year and 1 in 100 Year ARI.

It is noted that a short section of this bundwall is incomplete in the south west corner adjoining Cell 4 that will need to be constructed to separate external runoff from the quarry and landfill area. It is envisaged that the capacity of this bundwall would be confirmed at detailed design stage.

A concrete culvert is to be constructed under Riding Boundary Road to divert stormwater runoff from external catchments along the western boundary of the site. Surface water that flows down Hopkins Road will be directed under Riding Boundary Road and continue south along Hopkins Road.
Catchment 2 includes existing undeveloped farmland comprising undulating grassed paddocks located to the west of the North Portion. Rainfall runoff from this catchment flows in a southerly direction to Skeleton Creek. Nominal sizing of the stormwater diversion drain indicates a base width of 3 m and depth of 1.3 m is required. The eastern edge of Catchment 2 grades to an existing stormwater drain located on the edge of Hopkins Road.

Catchment 3 comprises existing undeveloped farmland including undulating grassed paddocks that grade from north to south towards Riding Boundary Road. The northern part of Catchment 3 is future quarry area and the majority of the catchment comprises the North Portion and immediate surrounds. Rainfall runoff from Catchment 3 is catered for in the site stormwater management system described below in this Stormwater Management Plan.

A scenario was analysed for potential flow rates from external catchments. Runoff coefficients for urban landscapes were assumed for Catchment 1 and Catchment 2. The resulting higher rate of runoff would require a stormwater diversion drain with a base width of 3 m and depth of 0.9 m to accommodate a 1 in 20 year and 1 in 100 year ARI.

8.0 METHODOLOGY FOR STORMWATER MANAGEMENT

The proposed stormwater management system will comprise a series of open channel stormwater swale drains that collect rainfall runoff from the final cap and the interim cap and distribute this rainfall runoff into various stormwater ponds located around the perimeter of the North Portion and South Portion landfill caps. The collected water will be polished by removing sediment from the capping soils and then either discharged to the offsite stormwater network surrounding the site or stored onsite for later use by Landfill Ops and Boral. For the purposes of this SMP, we define the following terms;

- ‘Discharge Pond’ – a short term stormwater pond located at surface level that collects rainfall runoff from the above ground position of the landfill cap. The Discharge Pond collects sediment and discharges clean stormwater offsite at a slow rate, equivalent to the rainfall runoff from a grassed shallow sloping paddock.

- ‘Storage Pond’ – a stormwater pond located on the floor of the quarry (approximately 10 m below surface level) that collects rainfall runoff from the portion of the landfill cap that is below the surrounding surface level. The Storage Pond aims to collect sediment and store clean stormwater onsite for re-use by Landfill Ops for dust suppression and cap and liner construction and by Boral for quarry crushing activities. Water will also evaporate from the Storage Pond due to the net deficit of evaporation being much greater than annual rainfall. Water will be pumped from the Storage Pond for re-use.

This section describes the methodologies and estimations undertaken to size the drains and ponds.

8.1 Delineation of Catchments

The total catchment areas considered for stormwater drainage are based on the proposed cap contours for the South Portion and North Portion, shown on Figure 16 - Pre-Settlement Top of Cap Contour Plan. The cap catchment areas were sub-divided into boundaries representing the contributing area for a particular outlet control point. The sub-catchments areas are based on the proposed filling plan, cap contours and the stormwater drainage layout, as shown on Figure 17 Internal Catchment Plan and Figure 18 Stormwater Management Plan.

The rainfall runoff behaviour for each sub-catchment was analysed in terms of estimating peak runoff rates, peak discharge rates and storage requirements.

Rainfall runoff from the quarry floor within the area managed by Landfill Ops and diversion of external water around the site is delineated in this SMP.

8.2 Drainage Channels

The proposed cap collection network comprises open channel swale drains located on the landfill cap surface. There will be short sections incorporating stormwater pipes and culverts that connect the
stormwater ponds to the outlet locations. Short sections of water crossings (such as fords or culverts) may also be required depending on the final stormwater network layout and the location of the cap access roads. Drainage channels have been sized for diverting external catchment flow around the site.

Stormwater peak flow rates were estimated in accordance with ARR87, applying the Rational Method. The Rational Method formula is:

$$Q = 2.78 \cdot C \cdot A \cdot I_y \text{ (m}^3\text{/s)}$$

- $Q$ = Peak discharge in m$^3$/sec
- $I_y$ = rainfall intensity for a design duration of ‘t’ hours and an ARI of ‘y’ years (mm/hr)
- $C$ = runoff coefficient
- $A$ = Catchment Area (km$^2$)

The following assumptions were applied in estimating peak discharge rates for the 20 year and 100 year Average Recurrence Interval (ARI) critical storm events:

- Catchment size and elevations were based on Figure 16 – Pre-Settlement Top of Cap Contour Plan.
- The time of concentration for each drain was estimated from overland flow time and channel flow travel time.
- The Bureau of Meteorology of Australia has developed a method to allow assessment of a full set of duration / frequency / intensity (IFD) curves, tabulated data and polynomial coefficients for any location in Australia by supplying its latitude and longitude. It is compatible with the manual procedures provided in Book 2 of Australian Rainfall and Runoff.
- The coefficient of discharge ($C$) applied in the Rational Equation was selected from Concrete Pipe Association of Australasia, Hydraulic Design Manual, Figure 2.9, which presents values of $C$ that are based on rainfall intensity and soil type.

The value of $C$ for the landfill cap area was based on a catchment type of “medium soil – open crop”, which is considered to be the nearest equivalent to the final landfill cap cells.

### 8.3 Stormwater Ponds

It is proposed the stormwater ponds will collect runoff from the final cap surface and the intermediate cap surface. We have proposed the following two methodologies for sizing the stormwater ponds. The first methodology is for the sizing of Discharge Ponds and the second for the sizing of Storage Ponds.

#### 8.3.1 Discharge Pond Sizing – Method 1

The proposed Discharge Ponds need to store sediment and slow the water down to discharge offsite at the equivalent of the paddock runoff i.e. pre-quarry and pre-landfill activity. Hence, the Discharge Pond needs a zone to collect sediment, referred to as the ‘Sediment Storage Zone’, and a zone to temporarily store water and slow down its offsite discharge rate, referred to as the ‘Attenuation Storage Zone’. A typical layout of the Discharge Pond is shown below in Plate 2 and further information is provided below. Each storage zone will have its own outlet arrangement.
The Sediment Storage Zone of the ponds will capture potential sediment laden runoff and allow settlement of sediment prior to the discharge of stormwater offsite. The Sediment Storage Zone volumes were designed in accordance with the International Erosion Control Association (IECA) of Australasia 2008, Best Practice Erosion and Sediment Control, Appendix B - Sediment basin design and operation.

The estimated volume of the Sediment Storage Zone is assessed by following design procedures from IECA. A Type D basin was selected based on the soil characteristics. The volume of the basin for Type D sediment ponds consists of a settling volume and a sediment storage zone volume. The settling zone volume is a function of the pond's surface area and depth to allow for particles to settle and was assessed by the following equation:

\[ V_s = 10.R(Y\%,5\text{-day})C_vA \]

Where:
- \( V_s \) = volume of settling zone (m³)
- \( R(Y\%,5\text{-day}) \) = 1 year, 5 day rainfall intensity default values for the percentile of rainfall depth (Y%) (mm)
- \( C_v \) = volumetric runoff coefficient
- \( A \) = catchment area (ha)

The sediment control ponds are designed to accommodate the 85th percentile, 5 day rainfall depth. The 85th percentile was selected based on the recommended application value from Table B4 of the IECA guideline, Appendix B. The 85th percentile value is recommended in Table B4 for basins discharging to sensitive receiving waters. The adopted rainfall depth was based on the site being in Melbourne and values presented in Tables B4 and B5 of the IECA, Best Practice Erosion and Sediment Control, Book 2, Appendix B.

The sediment zone volume is estimated at 50% of the settling zone volume. A larger settling zone is provided in the ponds by the Attenuation Storage Zone, so no additional settling zone volume is provided in the pond design.

**Attenuation Storage Zone**

The Attenuation Storage Zone volume is based on a water balance of peak inflows and discharge outflow rates for the 100 year ARI storm event. Modelling of the Attenuation Storage Zone and outlet pipes was undertaken using the hydraulic model within XPSWMM. XPSWMM is a software package for dynamic modelling of stormwater networks and river systems. It is used for both link-node (one-dimensional) and...
spatially distributed hydraulic models (two-dimensional). The 1D module was used in assessing attenuation Storage Pond sizing and outlet pipe sizing.

The model included allowance for an inflow of rainfall runoff from the landfill cap at a peak inflow rate up to the 100 year ARI rainfall event using a time series method, the pond stage storage curve and an outlet pipe for each pond. The outlet pipe for each pond was modelled based on the hydraulic head based flow rate for a culvert outlet from the pond. The pond geometric model was refined until the stage storage of the ponds was capable of attenuating the required water volume while restricting peak outflow rates to less than the estimated pre-development greenfield runoff rates.

Flows in excess of this rainfall event will discharge offsite via a spillway.

8.3.2 Storage Pond Sizing – Method 2

Storage Ponds need to manage rainfall runoff from the proposed landfill cap without discharging collected water offsite. These types of ponds are proposed where the collected water drains onto the quarry floor, which will be located approximately 10 m below natural ground level.

The sizing of the Storage Ponds is dictated by the interaction of a number of parameters including catchment hydrology and inflows. Other factors such as soil and groundwater conditions and environmental factors may also influence the effectiveness of the Storage Ponds.

For the purpose of a Works Approval Application, we have estimated the input volume based on the 1 in 20 year Average Recurrence Interval (ARI) for a range of storm durations and compared this to the average yearly evaporation rate. A water balance model was created for each Storage Pond using Goldsim software. Goldsim is a Monte Carlo simulation software package used for dynamically modelling complex systems in engineering. The Goldsim model is based on the following assumptions;

- A simulation period of 20 years was used.
- Probabilistic settings in the model were defined to select 100 realisations when undertaking the simulation.
- A maximum operation water depth in the Storage Pond of 2.7 m with a 0.3 m freeboard below the top of crest level for Storage Ponds located on the quarry floor.
- Initial water storage volume in the ponds was assumed to be zero to represent the post construction conditions.
- Daily rainfall data was obtained from the Bureau of Meteorology Melbourne Airport weather station (station number 086282)
- The model excludes any additional losses due to the seepage of clean water through the base of the pond or extraction of stormwater for operational requirements. This is due to the pond being sized for its peak capacity requirements.

8.4 Discharge Points

At the locations where the Sediment Ponds are discharging offsite, we propose the stormwater ponds will restrict outlet flows to pre-development greenfield runoff rates. We propose to restrict outlet flows by selecting a suitably sized outlet pipe or installing a flow control device on the outlet pipe such as an orifice plate or weir. The location of discharge points will aim to either avoid or minimise contact with areas of cultural heritage significance such as along the South Portion western boundary and along Riding Boundary Road. Control measures will be implemented during construction to protect cultural heritage.

The quality of stormwater discharged from the Extension will be monitored. The aim of the monitoring is to detect contamination from leachate or sediment and ensure that contaminated runoff from the landfill is not discharged from site. Sampling will be undertaken after rain events. The source of contamination will be investigated and appropriate remedial actions and control measures implemented.
At the locations where the proposed stormwater ponds are located within the quarry floor, it is not possible to gravity outlet from the proposed stormwater ponds to the external catchment. Storage Ponds overflow is directed towards the quarry floor for increased evaporation and groundwater recharge.

We understand based on our discussions with Landfill Ops that in the short term, and while Boral are operating a quarry at the site, the capacity of the Storage Ponds located on the quarry floor will be managed by Boral and Landfill Ops pumping collected stormwater. The collected stormwater will then be re-used on site in landfill operations and cap irrigation and/or will evaporate from the Storage Ponds. Post closure, the water collected could be transferred to supply neighbouring land owners.

In the long-term, and when Boral have ceased quarrying operations at the site, the proposed ponds located within the quarry footprint will function as an infiltration pond or Storage Pond. A water balance for each of the ponds located within the quarry floor has been undertaken to estimate the pond capacity and dimensions.
9.0 SIZING THE STORMWATER NETWORK

9.1 Cap Swales

The stormwater swale drains located on the landfill cap will be designed to control sediment loads from the cap, promote drainage to the proposed stormwater ponds and prevent cap runoff from freely discharging off site.

Swales have been designed based on peak flow rates and applying these peak flow rates to a typical swale cross section to estimate a corresponding water depth. The swales were initially sized for the 20 year ARI rainfall event with capacity to also convey the 100 year ARI storm event in accordance with the BPEM for a Type 2 landfill.

The typical swale geometry and peak water depths were estimated by applying Manning’s Equation and assuming steady state, uniform flow conditions with free flowing conditions at the downstream boundary. An ‘n’ value of 0.03 for grass lined open channels was applied in sizing the swale drains. The swale drains will be formed into the top of the cap profile and are assumed to have 4H: 1V side slopes.

Localised check dams are to be constructed within swale drains are proposed to trap sediment and dissipate stormwater flow. This will contribute to reducing the amount of sediment entering discharge and Storage Ponds.

9.1.1 Cap Swale Results

Cap swale drains for the smallest and largest stormwater catchments in both the South Portion and North Portion were estimated to produce an approximate range of cap swale dimensions for the proposed system. The results of swale drain sizing assessments are presented in Table 2. A layout plan for the drainage system is provided on Figure 17 in APPENDIX A, which includes Discharge Ponds and swale drains.

Table 2: Preliminary Swale Sizing Schedule

<table>
<thead>
<tr>
<th>Swale ID</th>
<th>Q100 (m³/s)</th>
<th>Slope, S (1V:_H)</th>
<th>Side Slope (_H:1V)</th>
<th>Design Depth (m)</th>
<th>Freeboard (m)</th>
<th>Swale Base Width (m)</th>
<th>Swale Total Top Width (m)</th>
<th>Velocity (m/s)</th>
<th>Erosion Protection Required (Yes / No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Portion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW1.0</td>
<td>1.61</td>
<td>29</td>
<td>4</td>
<td>0.3</td>
<td>0.10</td>
<td>0.5</td>
<td>3.7</td>
<td>1.9</td>
<td>Yes</td>
</tr>
<tr>
<td>SW2.0</td>
<td>3.28</td>
<td>50</td>
<td>4</td>
<td>0.5</td>
<td>0.16</td>
<td>1.5</td>
<td>5.5</td>
<td>1.8</td>
<td>Yes</td>
</tr>
<tr>
<td>North Portion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW3.0</td>
<td>0.35</td>
<td>26</td>
<td>4</td>
<td>0.4</td>
<td>0.06</td>
<td>0.5</td>
<td>3.7</td>
<td>0.3</td>
<td>No</td>
</tr>
<tr>
<td>SW4.0</td>
<td>2.12</td>
<td>56</td>
<td>4</td>
<td>0.45</td>
<td>0.15</td>
<td>1.0</td>
<td>4.6</td>
<td>2.0</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table notes:
1) Freeboard estimate based on the 1 in 20 year rainfall event flow depth.
2) The 'Swale Total Top Width' dimension is based on the design depth of the swale, which is a minimum depth.

The transition from the existing site drainage to the proposed site drainage will require implementation of some intermediate stormwater management measures. In addition, the proposed drainage plan should be implemented progressively as the landfill cells are rehabilitated.

9.2 Diversion Channels

Diversion channels will direct external overland flow around the proposed landfill. The quarry buffer provides a diversion channel and bundwall along the Hopkins Road boundary. Further, a new stormwater diversion bund is proposed outside the eastern boundary of the North Portion. The indicative location of this bund is shown in the stormwater management plan, Figure 18 in APPENDIX A. The purpose of this new diversion
bund is to channel external rainfall runoff from the Boral Quarry located to the north of the North Portion and runoff from Discharge Ponds 13 to 17 into a proposed new stormwater drain located along Clarke Road that discharges clean water to the external stormwater drain located on Riding Boundary Road, refer to Figure 18.

9.3 Stormwater Ponds

The design for the stormwater ponds at the site depends on the location of the pond whether it’s on the landfill cap, within the buffer zone or on the former quarry floor.

Ponds located on the proposed landfill cap and within the buffer zone are intended to be Discharge Ponds, sized to slow the release of peak flow to pre-quarrying runoff rates. These ponds have a gravity outlet and drain collected stormwater towards the surrounding external road drainage network. These ponds are referred to as Discharge Ponds in this SMP.

Ponds located on the quarry floor are Storage Ponds. Water will be re-used onsite and/or will evaporate. The long-term management of stormwater from these ponds was also assessed in terms of yearly average evaporation. These ponds are referred to as Storage Ponds in this SMP. The distribution of Storage and Discharge Ponds is summarised in Table 3.

Table 3: Stormwater Pond Types for Proposed Extension Site

<table>
<thead>
<tr>
<th>Pond ID</th>
<th>Stormwater Pond Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>2</td>
<td>Storage Pond</td>
</tr>
<tr>
<td>3</td>
<td>Storage Pond</td>
</tr>
<tr>
<td>4</td>
<td>Storage Pond</td>
</tr>
<tr>
<td>5</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>6</td>
<td>Storage Pond</td>
</tr>
<tr>
<td>7</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>8</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>9</td>
<td>Storage Pond</td>
</tr>
<tr>
<td>10</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>11</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>12</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>13</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>14</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>15</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>16</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>17</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>18</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>19</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>20</td>
<td>Storage Pond</td>
</tr>
<tr>
<td>21</td>
<td>Discharge Pond</td>
</tr>
<tr>
<td>22</td>
<td>Discharge Pond</td>
</tr>
</tbody>
</table>

9.3.1 Discharge Ponds

The preliminary sizing of the Discharge Ponds takes account of the short term storage of runoff from the site. The pond sizing was estimated based on attenuating peak runoff for the 100 year ARI critical storm events from the concept Top of Cap Contour Plan, while releasing discharge from the Discharge Ponds, limiting the rates to less than the peak rates estimated for the pre-developed catchment area. Based on the pre-
settlement Top of Cap Contour Plan and the statutory water authority discharge limits, we estimate that fifteen Discharge Ponds are required for the site. The general location and layout of the proposed ponds is presented on Figure 18 (APPENDIX A).

The statutory water authority recommended coefficient of discharge equal to 0.2 was used in estimating the allowable discharge from the Discharge Ponds. The modelled peak discharge rates for the ponds are less than the estimated pre-development greenfield runoff rates.

Surface water drains will direct runoff from the cap into these ponds, before discharge into surrounding stormwater assets. The sediment storage zone is designed to retain potential sediment runoff by capturing the initial runoff from the site and allowing the slow release of entrapped water from the sediment via a gravel seepage collection pad with a perforated small diameter pipe constructed on the base of the ponds, refer to Plate 2.

Inflow in excess of that generated by the sediment zone will be attenuated in the depth of the storage between the sediment zone and the spillway level of the stormwater ponds. Sizing of the Attenuation Storage Zone was based on a water balance between inflows to the stormwater ponds and the maximum allowable outflows. An outlet pipe with its invert located at the base of the attenuation storage zone will connect the stormwater ponds to the Council and statutory water authority assets. The Discharge Ponds will normally be dry during periods of no rainfall and will have constant outflow during periods of rainfall.

### 9.3.1.1 Discharge Pond Results

The modelled inflow and discharge volumes were used to estimate the Discharge Pond sizing as summarised in Table 4.

#### Table 4: Discharge Pond Water Hydraulic Results

<table>
<thead>
<tr>
<th>Pond ID</th>
<th>Depth of Sediment Storage Zone (m)</th>
<th>Depth of Attenuation Storage Zone (m)</th>
<th>Attenuation Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Portion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pond 1</td>
<td>0.5</td>
<td>3.0</td>
<td>7 300</td>
</tr>
<tr>
<td>Pond 5</td>
<td>0.3</td>
<td>1.9</td>
<td>5 100</td>
</tr>
<tr>
<td>Pond 7</td>
<td>0.6</td>
<td>3.2</td>
<td>11 800</td>
</tr>
<tr>
<td>Pond 8</td>
<td>0.3</td>
<td>1.7</td>
<td>2 500</td>
</tr>
<tr>
<td>Pond 10</td>
<td>0.3</td>
<td>1.8</td>
<td>5 000</td>
</tr>
<tr>
<td>Pond 11</td>
<td>0.3</td>
<td>1.8</td>
<td>3 200</td>
</tr>
<tr>
<td>Pond 12</td>
<td>0.3</td>
<td>1.8</td>
<td>3 800</td>
</tr>
<tr>
<td>Pond 13</td>
<td>0.3</td>
<td>1.8</td>
<td>4 100</td>
</tr>
<tr>
<td>Pond 14</td>
<td>0.3</td>
<td>1.8</td>
<td>4 100</td>
</tr>
<tr>
<td>Pond 15</td>
<td>0.3</td>
<td>1.8</td>
<td>1 000</td>
</tr>
<tr>
<td>Pond 16</td>
<td>0.3</td>
<td>1.8</td>
<td>2 900</td>
</tr>
<tr>
<td>Pond 17</td>
<td>0.3</td>
<td>1.8</td>
<td>1 100</td>
</tr>
<tr>
<td>Pond 18</td>
<td>0.3</td>
<td>1.8</td>
<td>8 200</td>
</tr>
<tr>
<td>Pond 19</td>
<td>0.3</td>
<td>1.8</td>
<td>5 900</td>
</tr>
<tr>
<td>Pond 22</td>
<td>0.3</td>
<td>1.7</td>
<td>1 800</td>
</tr>
</tbody>
</table>

### 9.3.2 Storage Ponds

#### 9.3.2.1 Estimation of Evaporation Rates

Evaporation data was sourced from PAN evaporation data obtained from the Silo Data Drill, for location 37° 48'South 144° 42' East. Silo is an enhanced climate database published by the Queensland Government Science Delivery Division of the Department of Science, Information Technology and Innovation (DSITI).
The Storage Ponds have been designed according to BPEM requirements. For this SMP we have assumed the following as part of the Storage Ponds design:

- Ponds are assumed to be rectangular in shape with a length to width ratio of 3:1.
- Side slopes are assumed at 4H:1V.
- An evaporation factor of 0.9 from the surface area of the ponds was included in our estimations.

The surface areas of the ponds at top water level (TWL) were estimated based on our assumed pond geometry. A summary of the estimated yearly evaporation at the Storage Ponds is presented in Table 5.

<table>
<thead>
<tr>
<th>Pond ID</th>
<th>Surface Area (Ha)</th>
<th>Estimated Yearly Evaporation Rate (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Portion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.9</td>
<td>29 900</td>
</tr>
<tr>
<td>3</td>
<td>1.6</td>
<td>25 300</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
<td>7 900</td>
</tr>
<tr>
<td>6</td>
<td>1.4</td>
<td>21 600</td>
</tr>
<tr>
<td>North Portion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2.4</td>
<td>37 500</td>
</tr>
<tr>
<td>20</td>
<td>4.7</td>
<td>63 700</td>
</tr>
</tbody>
</table>

Evaporation from the proposed stormwater pond surface exceeds the storm volumes estimated for the 20 year and 100 year ARI events. This suggests the upstream catchment area and climate conditions for this area are unlikely to sustain Storage Ponds at the top water level. Plate 3 compares the Goldsim modelled pond evaporation with pond inflow and rainfall for Pond 2 in the South Portion.
Goldsim was used to model the variation in Storage Pond volume for each proposed Storage Pond. The ponds were sized to contain a 1 in 20 year 24 hour ARI storm event and a 1 in 100 year 24 hour duration ARI storm event. The modelled change in mean storage volume for a 1 in 20 year 24 hour duration ARI rain event is shown in the following Plates 4 to 9. The ponds were sized for the capacity to contain:

- The 50th and 90th percentile inflow from a 1 in 20 year 24 hour duration ARI rain event; and
- The 50th percentile inflow from a 1 in 100 year 24 duration storm event.
Plate 4: Pond No. 2 Mean Storage Volume

Plate 5: Pond No. 3 Mean Storage Volume
Modelling suggests that Pond 4 may periodically overflow during the peak design storm events. The storage capacity of Pond 2 has been expanded to accommodate Pond 4 overflow. Based on post quarrying contours, overflow from Pond 4 is expected to travel along the quarry floor and be collected and stored in Pond 2. The flow path is shown on Figure 18 (APPENDIX A).
Plate 8: Pond No. 9 Mean Storage Volume

Plate 9: Pond No. 20 Mean Storage Volume

Pond 9 was designed to minimise pond spill due to its location adjoining other infrastructure. Overflow from stormwater ponds located on the quarry floor is contained and can be managed by pumping. Plate 10 indicates the cumulative spill volume for Pond 9 over the simulation period. The total volume of stormwater overflowing from the pond over 20 years is minimal, in the order of less than 500 m$^3$. Modelling suggests the probability of overflow occurring at the points shown in Plate 10 is between 1% and 5%.
9.3.2.3 Geometry of Stormwater Storage Ponds

The Storage Pond embankments are assumed to have a crest width of 3 m. All batters are assumed to be at 4H : 1V for slope stability and to allow for safe construction with the proposed conventional earthworks construction techniques. The footprint of the stormwater Storage Ponds is summarised in Table 5.

<table>
<thead>
<tr>
<th>Pond ID</th>
<th>Top of Crest Dimensions (m)</th>
<th>Overall Footprint Dimensions (m)</th>
<th>Overall Area (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Portion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pond 2</td>
<td>100 x 155</td>
<td>130 x 185</td>
<td>2.4</td>
</tr>
<tr>
<td>Pond 3</td>
<td>65 x 195</td>
<td>95 x 225</td>
<td>2.1</td>
</tr>
<tr>
<td>Pond 4</td>
<td>15 x 340</td>
<td>30 x 370</td>
<td>1.1</td>
</tr>
<tr>
<td>Pond 6</td>
<td>60 x 180</td>
<td>86 x 206</td>
<td>1.8</td>
</tr>
<tr>
<td>North Portion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pond 9</td>
<td>80 x 240</td>
<td>270 x 110</td>
<td>3.0</td>
</tr>
<tr>
<td>Pond 20</td>
<td>120 x 280</td>
<td>310 x 150</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Note 1: The overall footprint dimensions for Pond 4 area are based on Pond 4 being positioned against the quarry wall to accommodate the 100 m buffer distance to the landfill.

9.4 Quarry floor area to be managed by Landfill Ops

Surface water runoff that accumulates on the quarry floor area managed by Landfill Ops will be minimised. This runoff is classified as sediment laden and will be subject to sediment control measures. Ponded water on the quarry floor from rainfall or stormwater Storage Pond overflow will be drained into surface water sumps and pumped into Storage Ponds. Alternatively, surface water may be contained in surface water sumps to evaporate or infiltrate through the quarry floor depending on surface water volumes.
10.0 CONNECTIONS TO EXISTING SERVICES

10.1 Connections to Road Drainage Network

It is proposed the Discharge Ponds will discharge to external stormwater systems on Riding Boundary Road, Middle Road and Hopkins Road. The connection details of the pond discharge pipes to the external road drainage network shall be agreed with Council and the statutory water authority during the detail design phase.

Currently there is road stormwater infrastructure surrounding the site. As a result of this stormwater assessment we consider the existing road drainage network may need to be upgraded to account for the proposed facility. In particular along Riding Boundary Road we consider it likely that a surface drain network will need to be upgraded to transfer stormwater discharge from the North Portion and to manage stormwater runoff from the Boral quarry areas located to the north and east of the North Portion section of the landfill. We consider the existing soil bundwall located to the west of the South Portion within the landscape buffer will need an extra small portion of bundwall to be constructed.

11.0 REFERENCES

The following published engineering guidelines and information was assessed in developing this SMP:

1) EPA Publication 788.3 Best Practice Environment Management - Siting, design, operation and rehabilitation of landfills dated August 2015 (BPEM 2015).

2) Institution of Engineers Australia, Australian Rainfall and Runoff (1987), A guide to flood estimation (ARR87)

3) International Erosion Control Association of Australasia (2008), Best Practice Erosion and Sediment Control (IECA)

4) Concrete Pipe Association of Australasia, Hydraulic Design Manual, Hydraulic of Precast Concrete Conduits

12.0 IMPORTANT INFORMATION RELATING TO THIS REPORT

Your attention is drawn to the document – “Important Information Relating to this Report” (LEG04, RL2), which is attached to this SMP as APPENDIX D. The statements presented in this document are intended to advise you of what your realistic expectations of this Report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.
13.0 CLOSURE

This SMP for the Extension describes proposed measures to cater for rainfall runoff from the proposed landfill cap and will form an appendix document to the Works Approval Application (WAA).

The SMP describes water management methods to control and manage stormwater runoff from the Extension site. A proposed drainage layout plan and approximate sizing of swales and ponds are provided in this SMP.

The purpose of the SMP is to identify stormwater management measures, which facilitate draining of the landfill caps and address environmental objectives, primarily to:

- Minimise water ingress and limit saturation of waste by managing the collection and discharge of stormwater from the landfill cap and divert stormwater from external catchments.
- Minimise the potential for the discharge of sediment laden water offsite.
- Identify locations within the drainage system that may be prone to localised instability due to stormwater erosion and recommend erosion control measures.

Post approval, it is recommended Landfill Ops undertake a detailed stormwater design for each of the new cells in order to implement the design measures outlined in this SMP.

GOLDER ASSOCIATES PTY LTD
APPENDIX A
Figures
1. These notes apply to all project drawings in the set unless noted otherwise and shall be read in conjunction with the specification.
2. All levels are in metres to Australian Height Datum (AHD).
3. All co-ordinates are in metres to Map Grid Australia (MGA94, Zone 55).
4. All dimensions are in millimetres unless noted otherwise.
5. Dimensions and location of existing structures shall be confirmed on site by the contractor prior to commencement of works.
6. Location and depth of all services to be verified by the contractor prior to commencement of works.
7. Dimensions shall not be scaled off drawings.
SOUTH PORTION - INTERNAL CATCHMENT PLAN
SCALE 1:10,000

LEGEND
- QUARRY FLOOR (2001 EXISTING CONTOURS LOWERED 10 m)
  AT 10 m INTERVALS
- PERIMETER OF LANDFILL CELL
- PROPOSED INTERNAL CATCHMENT AREA
- PROPOSED STORMWATER DRAIN
- SURFACE WATER FLOW

REFERENCES:
- BASE MAP TAKEN FROM TRANSPACIFIC DATED 27 FEBRUARY 2015 FROM FILE
  X_SU_AERIAL_20150227_3D.DWG
- TITLE BOUNDARIES SHOWN FROM CHARTER KECK CRAMER FILE J055627 1100-1152
  CHRISTIES ROAD, RAVENHALL RE (REV1).DWG DATED 15 OCTOBER 2015 REV 1

NORTH PORTION - INTERNAL CATCHMENT PLAN
SCALE 1:10,000

LEGEND
- QUARRY FLOOR (2001 EXISTING CONTOURS LOWERED 10 m)
  AT 10 m INTERVALS
- PERIMETER OF LANDFILL CELL
- PROPOSED INTERNAL CATCHMENT AREA
- PROPOSED STORMWATER DRAIN
- SURFACE WATER FLOW

REFERENCES:
- BASE MAP TAKEN FROM TRANSPACIFIC DATED 27 FEBRUARY 2015 FROM FILE
  X_SU_AERIAL_20150227_3D.DWG
- TITLE BOUNDARIES SHOWN FROM CHARTER KECK CRAMER FILE J055627 1100-1152
  CHRISTIES ROAD, RAVENHALL RE (REV1).DWG DATED 15 OCTOBER 2015 REV 1
APPENDIX B

IFD Data
DESIGN RAINFALL INTENSITY CHART
Location: 37.775S 144.725E NEAR Ravenhall
Issued: 27/7/2015

AVERAGE RECURRENCE INTERVAL
- 100 Years (upper curve)
- 50 Years
- 20 Years
- 10 Years
- 5 Years
- 2 Years
- 1 Year (lower curve)

(Raw data: 18.13, 3.45, 0.97, 40.03, 7, 1.92, skew=0.36, F2=4.29, F50=14.92)
© Australian Government, Bureau of Meteorology
### Intensity-Frequency-Duration Table

**Location:** 37.775S  144.725E  NEAR..  Ravenhall  Issued: 27/7/2015

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

<table>
<thead>
<tr>
<th>Duration</th>
<th>1 YEAR</th>
<th>2 YEARS</th>
<th>5 YEARS</th>
<th>10 YEARS</th>
<th>20 YEARS</th>
<th>50 YEARS</th>
<th>100 YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5Mins</td>
<td>45.0</td>
<td>60.6</td>
<td>85.5</td>
<td>103</td>
<td>126</td>
<td>160</td>
<td>189</td>
</tr>
<tr>
<td>6Mins</td>
<td>42.0</td>
<td>56.5</td>
<td>79.6</td>
<td>96.0</td>
<td>117</td>
<td>149</td>
<td>176</td>
</tr>
<tr>
<td>10Mins</td>
<td>34.0</td>
<td>45.8</td>
<td>64.2</td>
<td>77.1</td>
<td>94.2</td>
<td>119</td>
<td>140</td>
</tr>
<tr>
<td>20Mins</td>
<td>24.6</td>
<td>32.9</td>
<td>45.8</td>
<td>54.8</td>
<td>66.8</td>
<td>84.1</td>
<td>98.7</td>
</tr>
<tr>
<td>30Mins</td>
<td>19.8</td>
<td>26.5</td>
<td>36.7</td>
<td>43.8</td>
<td>53.2</td>
<td>66.8</td>
<td>78.3</td>
</tr>
<tr>
<td>1Hr</td>
<td>13.2</td>
<td>17.5</td>
<td>24.1</td>
<td>28.6</td>
<td>34.6</td>
<td>43.3</td>
<td>50.5</td>
</tr>
<tr>
<td>2Hrs</td>
<td>8.45</td>
<td>11.2</td>
<td>15.3</td>
<td>18.0</td>
<td>21.7</td>
<td>27.0</td>
<td>31.4</td>
</tr>
<tr>
<td>3Hrs</td>
<td>6.46</td>
<td>8.56</td>
<td>11.6</td>
<td>13.6</td>
<td>16.3</td>
<td>20.2</td>
<td>23.5</td>
</tr>
<tr>
<td>6Hrs</td>
<td>4.06</td>
<td>5.36</td>
<td>7.16</td>
<td>8.38</td>
<td>10.0</td>
<td>12.3</td>
<td>14.2</td>
</tr>
<tr>
<td>12Hrs</td>
<td>2.56</td>
<td>3.37</td>
<td>4.46</td>
<td>5.19</td>
<td>6.17</td>
<td>7.57</td>
<td>8.71</td>
</tr>
<tr>
<td>24Hrs</td>
<td>1.62</td>
<td>2.12</td>
<td>2.80</td>
<td>3.24</td>
<td>3.84</td>
<td>4.69</td>
<td>5.39</td>
</tr>
<tr>
<td>48Hrs</td>
<td>.993</td>
<td>1.30</td>
<td>1.71</td>
<td>1.98</td>
<td>2.35</td>
<td>2.86</td>
<td>3.28</td>
</tr>
<tr>
<td>72Hrs</td>
<td>.720</td>
<td>.950</td>
<td>1.24</td>
<td>1.44</td>
<td>1.70</td>
<td>2.07</td>
<td>2.37</td>
</tr>
</tbody>
</table>

(Raw data: 18.13, 3.45, 0.97, 40.03, 7, 1.92, skew=0.36, F2=4.29, F50=14.92)  © Australian Government, Bureau of Meteorology
APPENDIX C
Coefficient of Discharge
2.3 PEAK FLOW RATE FORMULA

A common method of estimating a peak flow is the ‘Rational Method’.

\[ Q = 2.78 \times C \times A \times I \]

where \( Q \) = maximum flow rate l/s
\( C \) = coefficient of runoff
\( A \) = catchment area ha
\( I \) = rainfall intensity mm/h for the selected recurrence interval with duration equal to the catchment’s time of concentration, \( t_c \) (Section 2.3.2).

2.3.1 COEFFICIENT OF RUNOFF

The coefficient of runoff is the fraction of rainfall that becomes runoff. Its value depends on the characteristics of the catchment, e.g. paved city areas, forests, etc. Average coefficients for common characteristics and a range of rainfall intensities are shown on Figure 2.9.

During a rainstorm the actual runoff coefficient increases as the soil becomes saturated.

2.3.2 TIME CONCENTRATION

The time of concentration is the maximum time taken by water to travel from within the catchment boundaries to the catchment outlet. When this water reaches the outlet under conditions of uniform rainfall, all the catchment is contributing to the runoff. During a storm of duration shorter than the time of concentration only part of the catchment is contributing to the runoff. It is generally assumed that the maximum flow occurs when the rainfall duration equals the time of concentration, hence the use of intensity for duration equal to time of concentration in the peak flow formula. The time required for water to flow over natural surfaces is a function of the nature and the slope of the surface.

For distances up to 1000 m the time of overland flow can be found with sufficient accuracy from the nomogram Figure 2.10.

For larger systems times of concentration should preferably be estimated on the basis of locally observed data such as the time of occurrence of flood peaks at or near the catchment outlet compared with the time of commencement of associated storms.
APPENDIX D

Important Information Relating to this Report
The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder’s obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder’s Client and persons acting on the Client’s behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder’s Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder’s affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification.
As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth’s development while preserving earth’s integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com