Opal Vale Landfill - Victorian Landfill BPEM Comparison Table

Item	BPEM Requirement	Comment
1.	**Introduction**	
	General information	Nil action required.
2.	**Waste Management Framework**	
	General information	Nil action required.
3.	**Community Engagement**	
	General information	Nil action required.
4.	**Classification of Landfills**	
	General information	Nil action required.
5.	**Best-Practise Siting Considerations**	
	A preliminary investigation of all possible landfill sites should be conducted to identify those sites with the best potential to be developed for landfilling in a manner that poses the minimum risk to the environment. The investigation is conducted by the regional waste management group (RWMG) during development of the Regional Waste Management Plan (RWMP), and results in a ranking of preferred waste disposal sites within and adjacent to the region.	Not relevant as Regional Waste Management Group (RWMG) and Regional Waste Management Plan (RWMP) is applicable to Victoria.
5.1	**Screening of Potential Landfill Sites**	
	Screening of potential landfill sites starts with preparing a list of all possible sites. As a minimum, this should include all extractive industry sites in the region and may include undeveloped sites that might be suitable for trench-and-fill or mound landfills (see section 5.1.2). The hierarchy of aspects to be considered when screening for candidate landfill sites is: • Community needs. • Landfill type. • Groundwater. • Alternative potential uses for the site. • Buffer distances. • Geology. • Flora and fauna. • Infrastructure. • Surface water. • Land ownership. Once a list of candidate landfill sites has been derived from a list of all	Opal Vale has and continues to investigate numerous potential landfill sites surrounding the Perth Metropolitan area. This site has been selected as the preferred landfill development site based on the following parameters: • There is no landfill facility within the Shire of Toodyay. • The site is within a reasonable haulage distance from the Perth Metropolitan area. • There is an existing extractive industries void. • There is an extensive depth of clayey material (schist) below the site. • The site has a natural aquitard, which will significantly reduce the impact of groundwater below the landfill. • The site has significant buffer distances. • The geology on the site is conducive to the development of a landfill. • The area proposed for landfilling has previously been cleared of native vegetation and there will be no additional clearing required.

	possible landfill sites, this list should be ranked to indicate the preferred order of development of potential sites as landfills.	• There are existing vehicle access roads to the landfill site. All other infrastructure and services will be included in the landfill development. • There is minimal upstream surface water, with the vast majority being diverted into an adjacent catchment and only minor quantities being shed around the landfill and into the downstream creek line. • The land is not owned by Opal Vale, however, a lease agreement is in place to allow for the development of the landfill.
5.1.1	**Community Need**	
	The community expects the amenity and safety aspects of a landfill to be addressed during operation and post-closure period. This should be considered at a very early stage, and where necessary, particular care should be used to construct bunds for visual screening, noise barriers and landscaping and to ensure that the landfill is designed and managed taking into account environmental and safety outcomes.	The site is located within a relatively remote rural setting. The nearest neighbouring residence is approximately 1.3 km from the edge of the landfill in a north easterly direction and 1.1 km from the Prescribed boundary. Either of these distances is well beyond the minimum 150 m EPA (*Separation Distances between Industrial and Sensitive Land Uses, No. 3, June 2005*) recommended buffer distance and hence will not be adversely impacted by the proposed development. In addition, tree screens will be developed along a portion of the northern edge of the landfill to provide further screening of the proposed development from the neighbouring properties. The operation and closure of the landfill has been developed to ensure that there is minimal impact on the surrounding environment.
5.1.2	**Landfill Types**	
	The area method and the trench-and-fill method are preferred. Mound landfills are to be avoided as their exposed nature requires significant litter controls and present a significant visual impact on the landscape. Further difficulties attached to these landfills are leachate seeps from the side of the landfill and the stability of the landfill cap. Valley fill landfills are to be avoided as they have inherent environmental problems such as unstable slopes, water infiltration and leachate seepage. Due to the open nature of these landfills and shallow placement of waste, they consume a greater amount of soil for cover and capping than an equivalent volume landfill in a disused quarry.	The proposed landfill is a combination of “area method” and “mound landfill” (all area method landfills need to have some mounding above the natural ground to ensure that there is adequate ability to shed surface water off the landfill capped surface and also accommodate some settlement in the waste mass). The operation and closure of the landfill will ensure that the potential negative impacts of the aboveground activity are minimised, the primary considerations being visual screening, litter generation, seeping of leachate from the side slopes and landfill cap stability.
5.1.3	**Groundwater**	
	Landfills must not be located: • In areas of potable groundwater, groundwater recharge areas or in areas identified by the *Water Act 1989* as a Groundwater Supply Protection Area (Victorian document); or, • Below the regional watertable.	The site is not located within a usable potable groundwater area or groundwater supply protected area, but is in an area of groundwater recharge (any land can be considered as a groundwater recharge area). The landfill is not located below the regional watertable.
	A new landfill below the regional watertable should not be considered as it would place the landfill within the groundwater segment of the environment, which must be protected. The risks of significant impacts on beneficial uses of groundwater in this situation would be substantially greater. Typically,	The landfill is not located below the regional watertable.

	installation of a groundwater extraction system would be required to keep the groundwater level to below the landfill (see section 6.3). Hence, below-groundwater landfills are strongly discouraged due to the continual and additional operational requirements to: • Maintain and operate pumps. • Manage an increased volume of groundwater or leachate. • Intensively monitor both groundwater and leachate quality and levels.	
	New landfills must deposit waste at least two metres above the long-term undisturbed depth to groundwater unless: • Additional design and management practices to protect groundwater quality will be implemented; or • Regional circumstances exist that warrant the development of a landfill in this manner.	The base of the landfill has been designed to be a minimum of 2 m above the highest groundwater table; hence, all waste will be as least 2 m above the long-term undisturbed depth to groundwater.
	If the most appropriate site for a landfill is in an area where regional groundwater is elevated, the base of the landfill should be raised to a level above the watertable using a sub-base material designed to attenuate contaminants.	The base of the landfill will be raised at least 2 m above the regional groundwater level.
	The sub-base material between the base of the liner and the watertable (that is, in the unsaturated zone) should be made of a natural or imported fine-grade soil with a cation exchange capacity of about 10 mEq/100g.	Three samples of typical clay quarry base material were analysed by SGS Laboratory in November 2014. The samples recorded a cation exchange capacity of 3.3; 6.0 and 5.7 mEq/100g. The results are less than the threshold of “about 10 mEq/100”, which is consistent with the natural material being more of a schist type material as opposed to a clay. The cation exchange capacity is a function of the natural occurring soils on site and cannot be influenced by design or engineering solutions. The laboratory analysis results are available if required.
	The most preferred site for a landfill is one that minimises the risk of groundwater pollution by providing a natural, unsaturated attenuation layer beneath the liner for contaminants that may leach through the liner. This means that sites with naturally attenuating soils, such as those in clayey areas, are preferred to those that do not have such soils, such as in sandy areas.	The site has naturally clayey materials.
	Table 5.1 - Minimum separation from watertable: • Municipal waste = 2 m. • Solid inert waste = 2 m. • Fill material and potential waste acid sulphate soil = below watertable.	The landfill liner has been designed at a level to ensure that there is the required 2 m separation distance.
5.1.4	**Alternative Potential Sites**	
	Assess potential alternative uses for the site other than for landfill.	The site is an existing extractive industries void, in a relatively remote rural setting. The post-clay extraction rehabilitation proposed is simply to batter back the slopes to a stable angle and plant grass, with surface water

		collection in the bottom of the void. There is no proposed improved value alternative use for the site.
	The rehabilitation of an extractive industry site by landfill is not in itself sufficient justification for a landfill, however, the benefits that may accrue to the community in rehabilitation should be considered.	The landfill development will fill the existing void and will result in an aboveground mound, which is more representative of the pre-clay extraction land profile.
5.1.5	**Buffer Distances**	
	Table 5.2 summarises the buffer required for siting different types of landfills. Refer to section 8.2 for buffer requirements for closed landfills. Table 5.2 – Siting Buffer Distances Required for Landfill Gas Migration, Safety and Amenity Impact: Type 2 Landfill: • 100 m from surface water. • 500 m from building or structures. • 1,500 m or 3,000 m from an aerodrome depending on aircraft type. Type 3 Landfill: • 100 m from surface water. • 200 m from building or structures. • 1,500 m or 3,000 m from an aerodrome depending on aircraft type.	The WA EPA *Separation Distances between Industrial and Sensitive Land Uses, No. 3, June 2005* states that the recommended buffer distances for a Class II landfill should be "*500 m for sensitive uses (subdivisions), 150 m for single residences & an internal buffer of 35 m from boundary*". This proposal complies with all recommended buffer distances, be they Victorian or WA EPA requirements. Minimum distance from landfill to nearest residential property = 1.3 km. Minimum distance from Prescribed boundary to nearest residential property =1.1 km.
	Subject to an evaluation demonstrating that the environment will be protected and the amenity of the sensitive areas will not be adversely affected, lesser buffer distances may be applied subject to a risk assessment that considers design and operational measures. As part of a risk management approach, additional design or operational measures will be required to ameliorate the risks associated with a reduction of the buffer distances identified in Table 5.2.	There is no requirement for reduced buffer distances.
	Buffer distances are set to reflect the potential impacts from landfilling activities. Generally, the buffers are set to manage: • Odour, which is of most concern during landfill operation; and, • Landfill gas impacts, including the risk of explosion and/or asphyxiation. Landfill gas potential risk remain post closure and for at least 30 years post-closure. While other potential impacts such as fire, litter, noise and safety risks exist, the buffers required for protection from these impacts fall within the buffer required for odour and landfill gas.	The proposed buffer distances are well beyond the minimum requirements as set out in the landfill development guidelines; hence, there is not anticipated to be any negative impact as a result of odour or landfill gas.
	Buffers are measured from the sensitive land use to the edge of the closest cell. All cells, including closed cells, need to be considered in calculating buffers. For sites where there is uncertainty in the location of landfill cells, the boundary of the landfill premises is the point of measurement.	This proposal complies with all recommended buffer distances, be they Victorian or WA EPA requirements.
	Buffer measurement also needs to consider other activities capable of causing a nuisance, such as the leachate ponds, to the nearest sensitive land use.	This proposal complies with all recommended buffer distances, be they Victorian or WA EPA requirements. This also takes into account the location of the evaporation ponds.

	Where this buffer has been or is proposed to be encroached, design and management practices need to be significantly increased to provide the same level of protection to sensitive land uses.	There is no proposed encroachment of the buffer zones.
	Proposed developments and any works within the recommended landfill buffer can pose a safety risk by potentially providing preferential pathways for landfill gas migration, or providing an environment where landfill gases can accumulate to dangerous levels. All buildings and structures should be considered, including: • Buildings and structures used for sensitive or non-sensitive uses; • Change of use; • Infrastructure installation; and • Installation of pipelines.	There is no proposed non-landfill development within the required buffer zones. The primary landfill related development will be the landfill gas management infrastructure, which will only be developed a few years after the initial operation of the landfill (depending on actual landfill gas quantities produced).
	Land within buffer areas may be used for non-sensitive uses provided that the use is not adversely affected by landfilling. Therefore, it is better that this land is owned or at least under the control of the landfill operator, maximising control over the maintenance of an appropriate buffer. Landfill operators should develop contingency plans to show how the landfill could be developed and operated to ensure that the safety and amenity of the affected land would still be preserved, should the buffer be encroached.	The landfill operator (Opal Vale) is not the landowner; however, Opal Vale has a lease over the property and the landowner is aware of the proposed development and the fact that there is a requirement for buffer zones. Being a rural property, it is extremely unlikely that the buffer zones will be encroached by any non-landfill development and that the only likely alternative use of the buffer zones will be grain crops and sheep grazing (as currently occurs).
	For landfills with an anticipated lifespan exceeding 10 years, an analysis should be conducted of the anticipated changes in the zoning or land use of the surrounding area during the life of the facility.	The proposed landfill will have a life expectancy in excess of 10 years. With the site being located in a relatively remote rural setting, it is not anticipated that there will be any changes to the zoning that will negatively impact the proposed landfill operation.
	The buildings and structures buffer distance applies to any building or structure (including subsurface structures such as stormwater drains or service trenches) located near a landfill and is there to provide a protection zone around a landfill for subsurface landfill gas migration.	There will be no non-landfill structures within the required buffer zones. The primary structure will be the landfill gas management infrastructure.
	In the event that a building or structure is located within the recommended buffer, monitoring will be required in accordance with EPA landfill gas risk assessment requirements. An environmental audit is recommended where buildings with enclosed spaces that people will enter are proposed to be constructed within the buffer.	With any structures within the buffer zone being landfill related structures, it is not deemed necessary to undertake monitoring in accordance with the EPA landfill gas risk assessment requirements.
5.1.6	**Geological Setting**	
	As the decomposition and stabilisation of waste may take many decades, landfills should be constructed in areas where the landform is stable, thereby enabling the long-term integrity of the landfill cap and liner system.	Golder Associates has undertaken a stability analysis of the proposed site and landfill design and has confirmed that the proposed facility is long-term stable.
	A reasonable degree of assurance of the long-term protection of the landfill from an earthquake is to avoid sites within 100 metres of a fault line displaced in the Holocene period (the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch — about 10,000 to 12,000 years ago — to the present).	The nearest fault line is 500 m from the proposed landfill site.

	A further part of the assessment of the suitability of a potential site is the geotechnical stability of the ground on which the landfill will be placed. This land should be capable of supporting the landfill, with or without engineering assistance. The assessment should also extend to the site embankments and slopes. In an area that has been subject to subsurface mining, it must be demonstrated that the ground will not collapse.	Golder Associates has undertaken a stability analysis of the proposed site and landfill design and has confirmed that the proposed facility is long-term stable. This includes the site embankments and slopes. The area has not previously been subject to subsurface mining.
	Where a landfill is located within a karst region, characterised by sinkholes, caves and possibly large water springs, special attention must be given to the investigation of the stability of the area and the containment of leachate. In general, karst regions are inappropriate for siting landfills.	The landfill is not located within a karst region that is characterised by sinkholes, caves and possibly large water springs. Hence, these considerations are not required.
	A further factor to consider is the mineralogy of the area in which the landfill is to be built. In particular, the shrink/swell characteristics of the landfill substrate should be assessed to minimise the potential for differential movement of the liner resulting from changes in the moisture content of the substrate.	The landfill is proposed to be developed within an existing clay pit void. Evidence from numerous site visits in that there is no evidence of any localised, significant cracking/desiccation of the naturally occurring schist material as a result of wetting and drying cycles. Consequently, there will be no related differential movement as a result of the soil mineralogy.
5.1.7	**Flora and Fauna Protection**	
	Development of landfills may have an adverse impact on the flora and fauna of the local area. The potential impacts on flora and fauna are: • Clearing of vegetation. • Loss of habitat and displacement of fauna. • Loss of biodiversity by impacts on rare or endangered flora and fauna. • Potential for spreading plant diseases and noxious weeds. • Litter from the landfill detrimentally impacting on flora and fauna. • Creation of new habitats for scavenger and predatory species. • Increased vehicular traffic in the area. • Erosion. • Alteration of water courses.	The development is proposed within an existing cleared area. There will be no additional clearing of native bush required nor any loss of biodiversity, habitat or displacement of fauna. With the site being a Class II landfill, there will be minimal green waste delivered to site. With there being significant existing buffer distances of cleared vegetation between the proposed development and the nearest native bushland and the proposal to maintain an active weed management program, there is adequate control in place to manage any plant diseases or noxious weeds. An active litter management program as well as a vermin management program will be implemented to ensure that there is no detrimental impact on flora and fauna. The facility will use existing road access.
	Some of the areas where landfilling must not occur in relation to flora and fauna are: • Critical habitats of taxa and communities of flora and fauna listed under the *Flora and Fauna Guarantee Act 1988* (Victorian document) • State wildlife reserves listed under the *Wildlife Act 1975* (Victorian document) • Matters of national environmental significance as identified in the *Environment Protection and Biodiversity Conservation Act 1999*. (Victorian document).	This refers to Victorian applications, but the concept of flora and fauna protection remain applicable. The proposed development is within an area of existing cleared land and will not have any detrimental impact on any critical habitats or significant environmental areas, neither of which occur on site.
	A survey of the site and collection of comprehensive baseline environmental data are essential steps in the assessment of potential impacts from proposed landfilling operations. The nature and extent of this data should be site-specific, taking into account the size of the proposed operation and the	With the site being located within an existing agricultural area (cleared land) and there being numerous clay pits within the immediate area, the local environment has previously been significantly disturbed. There will be no

	risks posed to adjacent, sensitive areas. This includes potential impacts from scavenger birds on aircraft safety and water supplies, as well as impacts from predatory animals, such as feral cats, on surrounding native fauna.	anticipated detrimental impact from the proposed development on the immediate environment; hence, no new baseline environmental data relating to flora and fauna has been collected.
	An expert in the field should be consulted for an assessment of potential impacts from scavenger birds or predatory animals.	Due to the existing disturbed environment, it has not been deemed necessary to undertake an assessment of the potential impacts from scavenger birds or predatory animals.
5.1.8	**Infrastructure**	
	Local road infrastructure must be able to sustain the operation of a landfill. The preferred transportation route should minimise the transport of waste through residential and other sensitive areas. This consideration may influence the placement of the entrance to the landfill.	With the landfill being located within a relatively remote rural area and the site being on an existing heavy vehicle transport route, the waste delivery vehicles will not be passing through residential areas or other sensitive areas. A transport study has been undertaken and the local road network is adequate to cater for the proposed development.
	A transportation study may reveal the need for additional road infrastructure, such as freeway interchanges, turning lanes or signals.	The transportation study did identify that the intersection of Toodyay Road and Fernie Road was under-designed for the current traffic volumes and should be upgraded in the near future. Main Roads and the Shire of Toodyay are aware of this situation and have taken this into account in future road infrastructure planning. In addition, Opal Vale has previously paid a significant contribution to the upgrade of Salt Valley Road in order to facilitate the operation of its Class I landfill facility on a nearby property. One of the SAT conditions relating to this proposal requires proponent to contribute towards the reasonable road maintenance cost relating to road damage associated with the movement of waste vehicles.
	The availability of services such as reticulated water, sewerage and power will influence the facilities provided for staff at the landfill and perhaps indicate a need to provide additional services, such as water storage for firefighting purposes.	There are no existing services on site. Opal Vale will install all necessary services during development. There will be adequate water supply provided for firefighting purposes.
5.1.9	**Surface Waters**	
	Since leachate can be toxic to aquatic organisms and cause eutrophication (nutrient enrichment of a water body) in the waterways, it must be managed so that it cannot escape to surface waters. Accordingly, landfilling must not occur: • In high-value wetlands, including wetlands of international significance listed under the convention on wetlands (Ramsar, Iran 1971) and listed in a directory of important wetlands in Australia (Environmental Australia 2001). • In marine and coastal reserves listed in the *National Parks Act 1975.* • In areas identified by the *Water Act 1989* as water supply protection areas. • In water supply catchments proclaimed under the *Catchment and*	The proposed development includes a comprehensive leachate collection and management system. The facility is not located within an area of high-value wetland, marine or coastal reserve, land liable to flooding or within 100 m of surface waters. The site is however located within the Avon Catchment and the Avon River Catchment Area under the *Waterways Conservation Act 1978* and within a proclaimed surface water area under the *Rights in Water and Irrigation Act 1914*. As such the landfill is located within a sensitive surface water catchment area. Consequently, the site has been developed to ensure best practise design, construction, operation and closure. All of these factors provide environmental controls to minimise the possibility of any harm to the environment.

	Land Protection Act 1994. • On land liable to flooding if determined to be so liable by the responsible drainage authority. • Within 100 metres of surface waters (see below).	
	Municipal (putrescible) waste landfills must be located more than 100 metres from surface waters. A solid inert landfill may be located within 100 metres of surface waters if an assessment demonstrates that there is not a risk of contamination to surface water and protective measures are in place.	The proposed landfill is not located with 100 m of surface waters. The nearest permanent surface water is the Jimperding Brook, which is approximately 900 m from the landfill.
	Landfills should not be located in a 1% annual exceedance probability (1% AEP) floodplain. Where landfills are within the 1% AEP floodplain, additional engineering and management controls must be in place to ensure that the facility will be protected from flooding, erosion by floodwaters and infiltration from perched watertable.	The landfill is located at the head of a small catchment area and is not on a floodplain.
5.1.10	**Land Ownership**	
	Land ownership will influence the siting of landfills. Where it is proposed that a site be on Crown land, a landfill may not be established without the written consent of the Minister responsible for the relevant Act under which the land is managed.	The land is privately owned and Opal Vale has a lease agreement with the landowner for the proposed development.
6.	**Best-Practise Design**	
6.1	**Environmental Assessment**	
	This assessment must examine the impact of the landfill on the air, groundwater, surface water and noise environments, and should be based on at least two to three years of data. These data may need to be compiled from recent, targeted data sets and existing, less targeted data.	The proposal supporting documentation covers the necessary aspects of the proposed development. Where available, assessments utilise long-term data sets. Project specific groundwater monitoring on site has been ongoing since July 2011.

	An environmental assessment should contain:
	• Meteorological data, including monthly rainfall, monthly evaporation, seasonal wind strength and direction.
	• Hydrogeological assessment in accordance with Hydrogeological assessments (groundwater quality), EPA publication 668.
	• Water management information, including:
	  • Water balance for the site and estimated volume of leachate to be generated.
	  • Leachate collection, storage facilities, treatment and disposal.
	  • Stormwater diversion banks and/or cut-off drains and storage dams.
	  • Fire-fighting equipment and water supply
	  • Wheel washes.
	• Landfill gas and odour control in accordance with landfill gas management requirements (section 6.7).
		The supporting documentation covers all of the recommended assessment aspects:
		• Stass Environmental has provided a hydrogeological assessment.
		• Water Management: Golder Associates has undertaken a water balance to estimate the volume of leachate to be generated. IW Projects has provided the detail of the proposed leachate management system, stormwater management, fire-fighting and water supply. There is no wheel wash proposed as the landfill is located 3 km from the property entrance onto Salt Valley Road. Between the landfill and the property entrance, there are two active clay extraction operations, which, for many years have successfully operated without a wheel wash and there have been no issue with mud or dust from the clay vehicles. The waste vehicles are also not anticipated to cause any related problems. During landfill operations, it is most unusual for waste delivery vehicles to drive over fresh waste (punctures and getting stuck); hence, it is

	• Noise assessment.	extremely unlikely that any waste will be spread on the internal access road. Notwithstanding this, the access road is 3 km long before the vehicles enter public roads. This provides sufficient distance to determine whether any vehicles are spreading waste and for Opal Vale to clean-up the road and implement the appropriate changes at the active tipping face to prevent vehicles from driving over the fresh waste. • Landfill gas management has been covered within the supporting documentation. • Herring Storrer has undertaken a noise modelling assessment of the proposed facility operation.
6.2	**Site Layout**	
	Best-practice operation is to fill the landfill site as a series of independent tipping areas, each taking less than two years to fill, after which they are immediately rehabilitated. Large area fill landfills will require the establishment of independent cells. In the case of trench-and-fill landfills, each trench should be sized to ensure that it is filled within two years. Larger excavations for trench-and-fill landfills must be filled on a cellular basis.	The landfill has been designed in a series of individual cells with an anticipated lifespan of 1 to 2 years (depending on the annual waste quantity). Once the waste mass has reached its final design profile, it will immediately be capped and rehabilitated.
	Where an area fill or large trench-and-fill excavation is to be filled as a series of cells, prudent location of these cells may help to: • Stabilise a batter or embankment. • Screen the landfill operation from view. • Reduce groundwater flow into the site. • Shed clean stormwater into the stormwater system. • Reduce the need to relocate facilities such as leachate dams. • Minimise the need to constantly construct roads within the site. • Avoid active landfilling near areas being developed for residential purposes.	The landfill cell development has taken into consideration these issues: • Golder Associates has modelled the landfill stability. • Perimeter tree planting has been incorporated along a portion of the northern edge of the landfill to improve screening from the neighbouring properties. • There will be no groundwater flow into the landfill as the base of the proposed landfill is above the highest winter groundwater level. • The facility is located on the crest of a hill, so there is no upstream catchment. So what surface water there is, is diverted away from the active landfill area including the remaining clay void and is shed into the adjacent natural water courses. • The associated landfill infrastructure (leachate ponds, landfill gas flare/generators) is located outside of the proposed landfill footprint; hence, will not require relocation during the life of the landfill. • Access to the site will be gained via the existing road network. The internal landfill roads will be positioned to optimise the usability and longevity of the road to prevent them from having to be continually relocated. • The landfilling location is determined by the physical shape of the clay quarry and not at the discretion of the facility operator. In any event, the nearest neighbouring residence is approximately 1.3 km away from the clay void.
	For a trench-and-fill landfill, the trenches should be:	Not applicable as the proposed development is not a trench-and-fill type

	• Aligned perpendicular to the prevailing wind, to reduce litter. • Use excavated soil to create windbreaks. • Aligned perpendicular to the prevailing wind to reduce litter. • Use excavated soil to create windbreaks.	landfill.
	Where required, a transfer station with recycling and drop-off areas should be provided so that the public has no need to unload their vehicles at the tipping area.	Not applicable. There will be no general public access to the facility.
	Best practice for a landfill is to have a gatehouse at the entrance to the site or at a point that cannot be bypassed when travelling to the landfill. There should be facilities such as a viewing platform, elevated mirrors or video camera which allows the gatehouse attendant to readily scrutinise the incoming waste load.	A weighbridge and gatehouse is proposed and will have an elevated camera to view into the back of the waste delivery vehicles. With the requirement to tarp all open road vehicles, this elevated camera will only have limited usefulness.
	A weighbridge is required at landfill sites in Municipalities listed in Schedule C of the EP Act (Victorian document) to facilitate accurate record keeping for the purposes of invoicing clients, landfill levy documentation and monitoring waste disposal rates.	A weighbridge and gatehouse is proposed, which will be able to document all waste deliveries and recyclable material removals. This information will be used for customer invoicing, company records, DER annual reporting and landfill levy payments.
6.3	**Liner and Leachate Collection System**	
	Table 6.1 shows indicative best-practice landfill liner performance standards, which would generally provide a high level of protection to the environment. Table 6.1 Landfill Liner Performance Standards and Indicative Liner Design • Type 2 Landfill = Seepage rate of < 10L/ha/day; or • Type 3 Landfill = Seepage rate of < 1,000L/ha/day.	The design and modelling of the proposed landfill liner is based on the Victorian Type 2 landfill leakage rate of 10 L/ha/day.
	In designing a landfill liner, the landfill designer must ensure that the liner system is geotechnically stable between components and as a total system.	Golder Associates has undertaken the stability assessment of the landfill lining system and confirmed that it is geotechnically stable.
6.3.1	**Sub-base**	
	The sub-base must be well-consolidated, with minimal settlement, in order to supply a firm platform for the compaction of the clay layer, to protect the geomembrane from excessive strains and to ensure that the drainage system drains effectively throughout the life of the landfill. The sub-base should also offer the capacity to further attenuate contaminants seeping through the liner.	The sub-base for the landfill is a combination of cut or filled areas. The material to be used for fill will be the naturally occurring material from the clay excavation and will be placed, moisture conditioned, compacted, tested and inspected to ensure compliance with the approved earthworks specification. In addition, the material will further attenuate contaminants seeping through the liner.
	Where the sub-base is undisturbed material (rock or soil) at the base of a quarry, it is likely to be well consolidated. Where the sub-base has been installed prior to the liner and leachate collection system, it needs to be installed in such a manner that it is geotechnically stable.	Some areas of the base will be excavated quarry floor, which will be intrinsically stable. The areas of fill will be installed, tested and inspected to confirm stability in accordance with the approved specification.
	All plans for the construction of a sub-base must be verified and approved by a geotechnical engineer. The geotechnical engineer may be an environmental auditor or part of the team providing information to the environmental auditor. To provide assurance of the quality of construction of	The earthworks specification has been approved by Golders Associates and a separate earthworks CQA Plan has been developed to incorporate the approved earthworks specification.

	the sub-base, construction of the sub-base must be included in the construction quality assurance (CQA) plan (see section 6.4), verifying that it is fit for its intended purpose.	
6.3.2	**Clay Liner**	
	To meet the performance standards of the whole liner, the clay component needs to be at least one metre thick, with a hydraulic conductivity of less than 1 x 10^{-9} m/s using both fresh water and 50,000 ppm NaCl solution. Australian Standard AS 1289.6.7.1–2001 gives details on how hydraulic conductivity testing should be performed.	Not applicable as the design does not incorporate a compacted clay liner.
	Some of the properties of the soil measured to determine its suitability as a low-permeability liner are particle size distribution and plasticity (described by the soil plasticity index) and cation exchange capacity. Properties for clays suitable for a low-permeability liner are discussed further in Appendix B, 'Clay properties'.	Not applicable as the design does not incorporate a compacted clay liner.
	A key consideration is the potential for desiccation and subsequent cracking.	Not applicable as the design does not incorporate a compacted clay liner.
	Clay liners are constructed in series of lifts compacted to the specifications detailed in a CQA plan prepared by the landfill designer (see section 6.4). To achieve bonding between each lift, the thickness of each lift must permit the compaction equipment, typically a sheepsfoot roller, to penetrate the top lift and knead the previous lift. To improve bonding, scarification of the previous lift may also be required.	Not applicable as the design does not incorporate a compacted clay liner.
	Construct the liner at least one metre thick, and use a minimum of four to six lifts.	Not applicable as the design does not incorporate a compacted clay liner.
	During the installation of the clay liner, continual testing needs to be conducted to ensure that the hydraulic conductivity of the liner is less than 1 x 10^{-9} m/s. The landfill designer must provide details of how performance requirements of the liner, including the hydraulic conductivity, are to be met in a CQA plan. Section 6.4 gives more detail on the development of CQA plans.	Not applicable as the design does not incorporate a compacted clay liner.
	The final surface of a compacted clay liner should be finished to a smooth surface.	Not applicable as the design does not incorporate a compacted clay liner.
6.3.3	**Geosynthetic Clay Liner**	
	The suitability of GCL lining for bottom, sideslope and capping of landfills requires an assessment of water and gas flow, contaminant transport and stability. This must include considerations of hydraulic conductivity, gas permeability, chemical compatibility, diffusion and shear strength.	GCL is incorporated in the base, side slopes and capping of the landfill. Golder Associates has undertaken the necessary modelling of the GCL to confirm its suitability.
	A construction quality assurance (CQA) plan that includes supervision by an independent third party construction quality assurance consultant is required. The third party construction quality assurance consultant can be part of the geotechnical team for the environmental auditor. However, if this consultant is part of the auditor's team, that consultant can not provide	A separate CQA Plan has been developed to cover the synthetic lining activities. These activities will be inspected by an independent third party quality assurance consultant. This will be a separate activity from the geotechnical inspections as lining is seen as a specialist activity and unlikely that a single individual would be adequately skilled/qualified to undertake

	advice to the owner or the contractor on any construction or design issues. Technical specifications and a CQA plan are required to be submitted for EPA approval prior to the installation of any GCLs.	both activities. A copy of the construction specifications and CQA plan have been included in the application.
	Refer to Appendix E for minimum requirements for GCLs to be used in various landfill applications.	Incorporated into the construction specification.
6.3.4	**Geomembranes**	
	Selection of a geomembrane liner should consider: • The hazard posed by the contained material and leachate • Susceptibility of the liner material to chemical attack or deterioration • Tensile strength and elasticity. • Thermal stability. • Puncture, tear and shear resistance. • Anticipated operational life required for effective containment. • Local environmental conditions, including subsoil stability.	The base and side slope geomembrane is to be 2 mm HDPE and the capping geomembrane 2 mm LLDPE. In accordance with the BPEM guidance, the liners could be as thin as 1.5 mm, but the preference is for 2.0 mm liner as this reduces the chance of welding defects and provides 30% more liner thickness for minimal increase in effort and construction cost. These liners are the industry norm for putrescible landfills and is deemed industry best practise. In addition, liner installation companies are well accustomed to utilising this material; hence, construction quality is improved.
	A key design criterion for use of geomembranes is that they are used only as a barrier and not to serve any load-bearing or structural function. While the elimination of stress on a liner in practical terms is impossible, landfill design should place minimising stress as a key design consideration.	The design incorporates a combination of a double textured geomembrane on the base and cap, and single textured geomembrane liner on the side slopes. The double textured liner maximises the transfer of horizontal forces on the landfill base and cap to hold the liner in place and uniformly distribute any shear loading across the full area; hence reduce excessive localised tensile forces developing in isolated areas of the landfill base liner.
	Geotextiles are employed to protect the integrity of the geomembranes.	The liner design incorporates a geotextile cushion protection layer.
	Installation procedure for membranes must minimise wrinkling, buckling and tensioning.	The liner installation specification deals with the importance of minimising wrinkles and buckling as well as specific mentions to prevent trampolining across concave changes in grade. The liner and cap design incorporates a geomembrane textured underside, which increases the friction between the geomemrane and the substrate. During construction, this minimises the geomembrane movement due to expansion and contraction and hence minimises the development of wrinkles once the liner material has been laid. In addition, the side slopes have been limited to a maximum 1 vertical in 3 horizontal. This enables the liner installation equipment to easily traverse the slopes during liner installation; hence, the operators have the maximum control to ensure that the liner is installed with the minimum wrinkles possible.
	A construction quality assurance (CQA) plan that includes supervision by an independent third party construction quality assurance consultant is required. Technical specifications and a CQA plan are required to be submitted for EPA approval prior to the installation of any geomembranes.	A separate CQA Plan has been developed to cover the synthetic lining activities. These activities will be inspected by an independent third party quality assurance consultant. This will be a separate activity from the geotechnical inspections as lining is seen as a specialist activity and unlikely that a single individual would be adequately skilled/qualified to undertake both activities. On completion of the construction works, the CQA Validation

		Report will be presented to the DER as part of the Compliance Certification. A copy of the construction specifications and the CQA plan have been included in the application.
	Refer to Appendices D and F for minimum requirements for geomembranes and geotextiles to be used in various landfill applications.	The relevant requirement have been included within the construction specification.
	A leak detection survey should be undertaken once the geomembrane is installed and the drainage material (see section 6.3.5) is placed to ensure that the geomembrane has not been damaged during its installation and placement of the drainage material.	The construction specification includes the requirement for a specialist leak detection company to be commissioned to undertake the leak detection of the recently sealed works.
6.3.5	**Leachate Collection System**	
	The leachate collection system is an integral component of the overall landfill liner system. The design objectives of the leachate collection system are to ensure that it is: • Able to drain leachate sufficiently that the leachate head above the liner is minimised. • Appropriately sized to collect the estimated volume of leachate (predicted by water balance models). • Resistant to chemical attack, and physical, chemical and biological clogging. • Able to withstand the weight of waste and the compaction equipment without crushing. • Able to be inspected and cleaned by readily available video inspection and pipe-cleaning equipment.	The leachate collection system has been designed to include all of the required components: • The leachate extraction pumps and pipework are adequately sized to extract leachate at a rate of at least double the predicted rate of generation (as predicted by Golder Associate modelling). • The leachate ponds are adequately sized to be able to cater for the predicted leachate volumes (as predicted by Golder Associate modelling). • The leachate aggregate to be used in the leachate drainage layer is good quality, virgin bluemetal. This provides the ideal material to ensure longevity on the drainage layer and minimising the chance of crushing, breakdown or clogging. • The leachate extraction pipework has been designed with a central core that is 200 mm in diameter, which enable a camera to be inserted down the pipe for inspection purposes and also allows pipe-cleaning equipment to be installed. The access point to the leachate pipe is mounted at the leachate extraction point and hence is always accessible.
	The maximum leachate head on the liner (as measured at the lowest point of the liner surface) for a landfill situated above the watertable is 0.3 metres. The leachate head in the sump may exceed 0.3 metres as the sump is generally recessed below the level of the liner; some liquid is usually necessary to protect the pump in the sump.	The leachate extraction system includes a pump with level controls set to ensure that the pump automatically maintains the leachate level in the sump to be a maximum of 300 mm above the liner. Based on the configuration with a sump of 500 mm deep and an allowance for 300 mm above the sump, the pump float switches will be set to commence pumping at 800 mm above the sump base and switch off at 300 mm above the sump base.
	A leachate collection system typically comprises a high-permeability drainage layer, perforated collection pipes, a sump where collected leachate is extracted from the landfill, and geotextiles to protect any geomembrane and prevent clogging of the drainage layer. The liner is sloped into the leachate collection pipes which in turn are sloped to the leachate collection sump. These slopes should be a minimum three per cent to the pipes and	The landfill liner has a 3% slope on the base leading to the leachate collection valley drains. Leachate collection pipes run diagonally to the 3% slope to maximise collection efficiency; hence, the pipes are at a flatter slope (<3%, typically 2%). The leachate collection valley lines have a slope of 1% leading down to the leachate collection sump.

	one per cent to the sump.	
	The drainage layer is a high-porosity medium providing a preferential flow-path to the leachate collection pipes and/or sump. To avoid clogging and capillary action holding water in the drainage layer, coarse material is used, so that there is space within the drainage layer for leachate to drain freely. Using coarse material also ensures leachate flow in the event of some clogging within the leachate collection pipes. The hydraulic conductivity of the drainage layer must be greater than $1x10^{-3}$ m/s.	The design incorporates 20 mm to 38 mm bluemetal. This material is so coarse and free flowing, that it is not possible to test its permeability. Position confirmed via discussion with WA Bluemetal.
	The drainage layer must be across the entire landfill base and comprise at least 0.3 metres of coarse aggregate or a geosynthetic drainage material with the equivalent performance. This ensures that leachate is contained within the drainage layer, thus minimising the potential for clogging of the drainage layer. Properties of aggregate used in the drainage layer can be found in Appendix B, 'Drainage aggregate properties'.	The drainage layer is a minimum of 300 mm thick and covers the complete base of the landfill. The aggregate properties comply with the requirements set out in Appendix B.
	In designing the leachate collection system pipes, the key factors are the spacing between the pipes and the sizing of the pipes. Placing collection pipes close together minimises the head on the liner. The recommended maximum pipe spacing is 25 metres.	The design incorporates a pipe spacing of maximum 25 m. Due to the shape of the landfill, the majority of the pipes are spaced at < 25 m.
	The sizing of leachate pipes is based on leachate flow rates within the pipe and the diameter required for the passage of remote inspection and cleaning equipment. This equipment typically requires pipe diameters greater than 15 to 20 centimetres.	With the use of high quality and free draining aggregate, there is minimal resistance to leachate flow and hence, a large percentage of the leachate does not enter the leachate drainage pipework, but simply flows through the aggregate layer. The central leachate collection pipes have been sized (200 mm internal diameter) to enable camera inspections and the installation of pipe-cleaning equipment. From a leachate flow point of view, there could be significantly smaller pipes used.
	For landfills located above the watertable, the leachate flow rate is derived from a water balance estimation using a model such as the HELP model. For landfills located below the watertable, inflows of groundwater into the landfill must also be incorporated into the calculations. For landfills below the watertable, groundwater inflows will typically dominate calculations of the volume of leachate generated. For landfills above the watertable, the volume of leachate generated should be based on a 1-in-20 year storm event after one lift of waste has been placed in the landfill. In designing the slope of the leachate collection pipes, a minimum pipe slope of one per cent should be used, though greater slopes will minimise the sedimentation in the pipe.	Golder Associates has undertaken the modelling of predicted leachate volumes. They have used the *GoldSim* model in conjunction with the *Visual HELP* model to assess the leachate generation within the landfill.
	The installation of the leachate collection system must be included in the CQA plan (see section 6.4).	This construction activity has been included in the liner installation CQA Plan and will be included in the CQA Validation Report submitted to the DER on completion of construction.
	A geotextile filter must be placed over the drainage layer to protect it from clogging as a result of solids transport, chemical precipitation and growth of biofilm.	A geotextile filter layer has been incorporated into the design.

	Non-woven geotextile filters provide a greater level of protection of the leachate drainage layer than woven geotextiles.	This filter geotextile is a non-woven fabric.
	Leachate collection pipes must not be wrapped in a filter geotextile, as this has been demonstrated to clog rapidly, rendering the collection pipes ineffective.	There is no wrapping of the leachate pipework.
6.4	**Construction Quality Assurance**	
	The CQA plan must be able to verify that: • Materials used comply with specification. • Method of construction/installation is appropriate and, as a result, design requirements have been met.	The CQA Plan covers the requirement to confirm the suitability of the materials and the appropriateness of the installation in comparison to the design requirements.
	The CQA plan must contain the material/construction specifications, testing methods, testing frequency, corrective action and provide for appropriate documentation procedures.	The CQA Plan includes a copy of the construction specification, which in turn includes the necessary testing requirements, testing frequency, corrective actions and appropriate document procedures.
	CQA documentation will be verified by an environmental auditor and the plan will be used by the environmental auditor as part of auditing cell construction.	The CQA Plan has been developed to cover the requirements set out in the Victorian BPEM and is incorporated in the Works Approval documentation and hence, will be approved by the DER. This approved CQA Plan will guide the liner CQA consultant as what to do during the construction activities and the subsequent CQA Validation Report will be provided to the DER as part of the Compliance Certification at the end of the construction works. There will not be an environmental auditor appointed for the project, as there is no such person in WA.
6.4.1	**Sub-grade and Clay Liners**	
	Because of the importance of the sub-grade and clay liner in the overall liner performance, construction of these components must be accompanied by Level 1 geotechnical testing as set out in Appendix B of AS 3798–2007, *Guidelines on earthworks for commercial and residential developments*. This entails, among other requirements, full-time testing and inspection of all earthworks by the geotechnical testing authority, a geotechnical engineer independent of the liner constructor. The geotechnical testing authority must provide a report of all testing and, prior to the liner being accepted as appropriately constructed, must express the opinion that the works comply with the requirements of the specifications and drawings.	There is no compacted clay lining in this project. All earthworks compaction will be covered within the earthworks CQA Plan and will have Level 1 (full time) inspection by an independent geotechnical engineer, with all testing being carried out by an independent NATA certified geotechnical testing authority. Only once the earthworks CQA consultant has signed off on the suitability of the works, will the completed earthworks be accepted.
	If necessary, this independent testing can be undertaken by the auditor's geotechnical team. However, this team can not provide any advice on construction or design issues.	The geotechnical engineer will not be providing any advice on construction or design issues.
	For any landfill it must be demonstrated that the natural sub-grade and/or a constructed sub-base is able to support the landfill without affecting the integrity of the liner system as a result of differential settlement.	Golder Associates has assessed the settlement potential of the subbase and confirmed that any differential settlement will not adversely affect the landfill lining system.
	In the case of a clay liner, the key parameter that must be met is the	The landfill design does not include compacted clay liners.

	hydraulic conductivity.	
	The CQA plan must specify how the materials used to construct the liner will be tested to ensure that the hydraulic conductivity of the liner meets the specification.	The landfill design does not include compacted clay liners.
	Materials testing is discussed in more detail in Appendix B, 'Installation of clay liners'.	The landfill design does not include compacted clay liners.

	The minimum test frequencies are:
	• Properties of the clay (grain size distribution, plasticity index and moisture content) tested once every 5,000 m^3.
	• Field testing for liner density and moisture content at a frequency the greater of:
	  • One test per 500 m^3 of soil;
	  • One test per 2,500 m^2 area per clay lift; or,
	  • Three tests per site visit.
		The earthworks specification includes the following minimum frequency of field density testing, which includes moisture testing:
		• One test per 500 m^3 distributed evenly throughout full depth and area;
		• One test per layer per material type per 2,500 m^2, distributed evenly over the surface of the layer;
		• One test per layer or per 300 mm thickness per 150 m length constructed horizontal layer;
		• Three tests per visit when material is placed in horizontal layers; or
		• Whichever frequency is greater of the above or alternative frequencies that may be agreed with the Principal.

	Following field compaction work, direct permeability testing in the laboratory and/or in the field should be undertaken on undisturbed clay liner samples.	Permeability testing is only applicable to compacted clay liners. The landfill design does not include compacted clay liners.
	Suitable laboratory permeability testing procedures are described in AS 1289.6.7.1–2001, *Soil strength and consolidation tests — Determination of permeability of a soil — Constant head method for a remoulded specimen*.	Permeability testing is only applicable to compacted clay liners. The landfill design does not include compacted clay liners.
	In addition to this physical testing, visual inspections should check for the presence of oversized clods of clay, poorly compacted or dry areas and the homogeneity of the clay.	The landfill design does not include compacted clay liners; however, the earthworks specification covers unsuitable fill material, of which, large particle size is one consideration.
	The CQA plan may also need to specify the measures to be taken to protect the clay liner from desiccation and erosion.	The landfill design does not include compacted clay liners.
	Further to the testing of the quality of the installed clay, the CQA must also address the quality assurance with respect to the thickness of the constructed liner. In particular, the liner should be surveyed at the completion of construction to confirm that the correct grades have been attained.	The landfill design does not include compacted clay liners.
	The CQA plan for a geomembrane, geosynthetic clay liners and geotextiles must meet the requirements set out in Appendices D, E and F.	The CQA Plan for the installation of the synthetic liner covers the necessary requirements set out in Appendix D, E and F.
	A leak detection test should be carried out to ensure that the geomembrane is not damaged.	The construction specification includes the requirement for a specialist leak detection company to be commissioned to undertake the leak detection of the recently sealed works.
6.4.2	**Leachate Collection System**	
	The CQA plan must be able to demonstrate that the drainage layer materials have been placed in a manner that avoids damage to the low-	The specification covers the technical aspects of the leachate collection

	permeability liner and have the following properties: • Appropriate particle size to provide design hydraulic conductivity. • Placed so that no damage occurs to the landfill liner. • Avoid trafficking with heavy machinery after placement. • Correct grades on all surfaces achieved. • Correct thickness of material. • Pipes placed on an even bed. • Proper joining of pipes.	system installation including material size, hydraulic conductivity (limitation of fines in the drainage aggregate), maximum wheel loading of the vehicle(s) spreading the aggregate, grades, material thickness and pipe installation. The CQA Plan sets out the requirement for the CQA consultant to verify that the specification is complied with.
6.5	**Water Management**	
6.5.1	**Stormwater Management**	
	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.	Due to the extremely small upstream catchment area (facility located at the top of a water catchment), the effective surface water runoff is inconsequential and the adopted standard minimum drain size of 1 m deep is substantially over designed; however, has been adopted as a long-term sustainable solution that will require minimal maintenance. Golder Associates has modelled the landfill leachate generation quantities and subsequent leachate storage capacity based on a 1-in-100 year storm event.
	Stormwater can also contribute sediment to the environment if the catchment area is erodible due to a lack of vegetative cover. By retaining and re-establishing as much vegetative cover in the catchment area as possible, this potential for erosion is minimised.	The facility is located at the crest of a hill; hence, there is no upstream catchment. All surface water runoff that is generated around the landfill will be diverted into storage dams prior to being discharged into the downstream creak lines; hence, enabling the control of sediment from entering the downstream environment. Further information on surface water management and monitoring is provided in the application supporting documentation.
	Sediment control features should be designed to enable both silty sediments (able to settle out under gravity) and clayey sediments (will not settle out without flocculating agents) to be removed from the water. Typical features that may remove silty and clayey sediments include shallow, heavily vegetated stormwater control ponds and swales. The need for sediment control features will depend on: • The topography and how this will influence water velocity. • The nature of the water environment into which the eventual discharge from the site will flow. • The typical intensity of storm events. • The extent of vegetative cover on the catchment area.	All surface water runoff will be diverted into storage dams prior to being discharged into the downstream creak lines; hence, enabling the control of silty sediment from entering the downstream environment. The water stored within the dams will be used of dust suppression, firefighting and stock watering; hence, there will be minimal, if any discharge from these dams.
	Where a water supply dam is constructed to provide water for firefighting, dust suppression or irrigation purposes, water from sediment control features should be channelled into the water supply dam. This places an additional control on the discharge of potentially turbid water, thus ensuring	All surface water runoff from around the landfill, excluding that portion that will be diverted into the catchment to the south west of the site, will be diverted into the main storage dam below the landfill site. This storage dam is primarily use to retain water for dust suppression and firefighting

	that the environment is better protected.	purposes, however, is also used to monitor water quality in the event of discharge into the creek line.
	All dams should have spillways with erosion-control measures such as rocks and erosion-resistant vegetation.	The main storage dam will include a spillway with erosion protection.
	The discharge of stormwater from the site should only occur from dams, and only after confirmation that the water is not contaminated. This confirmation should at least be visual where the only possible contaminant source is sediment, but where other contaminants are possible, the water should be tested prior to discharging. The degree of testing will be determined by the risk of contamination and the sensitivity of the receiving environment. Water is not to be discharged if it is suspected or found to be contaminated. The maximum permissible turbidity for stormwater is contained in Table 6.3.	All surface water will be diverted into storage dams. Only the main storage dam within the creek to the north of the landfill will be monitored for contamination and sediment. The other stock watering dams to the south west are fed by a different catchment; hence, there is no possibility of landfill contamination. Sediment in these stock dams is also not proposed to be monitored as the catchments are minimal and the vast majority, if not all of the surface water will be retained in the dams for stock watering purposes.
	Table 6.3 Stormwater Turbidity Limits: • Dry Weather – Max. 50 NTU, Medium 25 NTU. • Stormwater Flow – Max. 100 NTU, Medium 50 NTU.	These turbidity limits are reflected in the surface water management description in the supporting documentation and will be used as the benchmark for sediment monitoring.
6.5.2	**Leachate Management**	
	Prior to and during treatment, leachate must be stored and managed in a manner such that it will not escape into surface water or groundwater, will not cause offensive odours and will minimise human contact with the leachate.	The leachate management system has been designed based on predicted leachate generation quantities (modelling undertaken by Golder Associates). The landfill liner and surface water management system will ensure that there is maximum control of leachate to prevent escape into surface water and groundwater. There will be no direct human contact with any leachate as the pumping and pipework network ensures a closed system not requiring human contact. The site has extensive buffer zones, well in excess of the minimum requirements; hence, odour is not anticipated to be an issue.
	Water used in vehicle and wheel washing should also be managed as leachate.	A vehicle or wheel wash is not incorporated within the proposal.
	In deciding on leachate management options, a water balance should be modelled over at least two consecutive wet years (90th percentile) to ensure that the proposed system has sufficient capacity to deal with all leachate generated over the operational life of the landfill.	The Golder Associate modelling of the leachate generation has included at least 2 years consecutive wet years (90^{th} percentile).
	Any ponds containing leachate should have a freeboard of at least 0.5m.	All leachate ponds have a minimum of 500 mm freeboard.
	Ponds should be lined to the equivalent performance standard as the landfill (see section 6.3 for performance standards).	All leachate ponds have the equivalent lining system as in the base of the landfill.
	If leachate ponds become anaerobic, or where odour is a particularly critical issue due to surrounding sensitive land uses, leachate odours can become an issue. Where odour is an actual or potential issue, then the leachate pond may need to be covered or mechanically aerated.	The design of the leachate ponds has a maximum average leachate operating depth of 2.5 m. This is deemed sufficiently shallow to ensure that the leachate remains in an aerobic state and hence limits the potential odour emissions from the pond surface. With the adequate buffers provided, odour is not anticipated to be an issue.

	Where leachate is to be evaporated, it should be within a closed system where no leachate is able to escape to the environment. The formula for calculating the pond surface area required to evaporate the required volume of leachate is in Appendix B).	Leachate will be evaporated and the evaporation potential of the site has been calculated on the formula recommended in Appendix B (80% of pan evaporation).
	Spraying or otherwise disposing of leachate over any part of the site that has received waste is only to be considered if it forms part of the essential operation of a bioreactor landfill or dust-suppression operations. Further details on bioreactor landfills are provided in section 6.8.	The landfill is not a bioreactor landfill; however, leachate evaporation from the waste surface will be an important leachate management technique. The leachate will be applied by water cart (for dust suppression), sprinklers and/or surface hoses. Leachate will only be applied to the exposed waste surface or areas of daily or temporary cover that are contoured such that surface water is contained within the landfill footprint and does not exit the landfill footprint. As the waste mass develops, subsurface leachate injection will be used to manage leachate volumes and also increase the moisture content of the dry waste in the landfill.
6.5.3	**Groundwater Management**	
	Sites that extract groundwater (such as sites below the watertable) must manage that water so that it does not cause soil or water pollution.	No groundwater extraction is proposed and the base of the landfill is above the highest groundwater level. If during landfill operations, there is insufficient water in the main water storage dam, Opal Vale may opt to develop a water extraction bore to supplement dust suppression and fire-fighting water supplies. In this event, the necessary groundwater extraction licence will be obtained from the Department of Water.
	Landfills below the watertable should also ensure that groundwater is segregated from leachate and stormwater. This can be achieved by groundwater interception drains surrounding the landfill where groundwater is shallow, or deep bores or sumps for deeper groundwater. Groundwater will need to be pumped from the vicinity of the landfill until the waste has stabilised — this can be assumed to be 30 years from the cessation of waste disposal.	The base of the landfill has been designed to be above the highest groundwater level.
6.5.4	**Water Discharge**	
	If a discharge of groundwater or treated leachate is necessary, the wastewater should be treated to the advanced level expected of treated effluent.	There is no discharge of groundwater or treated leachate.
	In considering a discharge to the environment, the existing environment of the receiving waters, such as flow rates, water chemistry, turbidity and biology, should be determined, with this information being used to design the location, volume and quality of any discharge in order to minimise impacts on water quality and ecology in the receiving waters. It is not best practice to discharge leachate to surface waters; the need to discharge groundwater to surface waters should be avoided.	There is no discharge of groundwater or treated leachate.
6.6	**Groundwater**	

	The design of the landfill must consider the local hydrogeological environment. Issues to be considered include: • Liner uplift. • Groundwater monitoring bores. • Groundwater recovery bores.	The landfill design does consider the groundwater level and local hydrogeological environment. There will be no liner uplift as the base of the liner is well above the highest groundwater level. There are nine new groundwater monitoring bores installed externally around the perimeter of the landfill. There are no groundwater recovery bores.
6.6.1	**Liner Uplift**	
	The key to managing this risk is to reduce the level of groundwater beneath the landfill by extracting groundwater. Two of the strategies that will enable this reduction are groundwater underdrains beneath the liner and groundwater extraction bores surrounding the landfill.	The base of the landfill will a minimum of 2 m above the highest recorded groundwater level; hence, there will be no liner uplift.
6.6.2	**Groundwater Monitoring**	
	The bore(s) to establish the background groundwater quality are placed up-gradient of the landfill.	Up-gradient background monitoring bores have been installed (5 off, SE 2; SE 3; SE 4, SE 5 & SE 7).
	Monitoring should occur in all aquifers that may be affected by the landfill. The number of monitoring bores should be commensurate with the size of the facility, the risk of contamination and the nature of the groundwater environment.	In total nine new groundwater monitoring bores have been installed around the proposed landfill perimeter. The location, number and depth was agreed at SAT as being appropriate for the size of the facility and the risk of contamination.
	The bores established in close proximity to the landfill are screened so as to intercept any leachate- contaminated groundwater. For a landfill located above the watertable, the top three to five metres of the watertable aquifer would normally be sampled. Multiple bores screened at various depths in the aquifer may be used to establish the water quality profile.	With there being an aquitard below the site, the groundwater monitoring bores are screened at the level of initial interception of the groundwater and not near the static level of the groundwater level.
	Permission must be obtained from the appropriate regional water authority to install a groundwater bore, and all groundwater monitoring results should be forwarded to the State Groundwater Database.	There is no groundwater extraction bore proposed. However, if in future the need arises, the appropriate application and licence will be obtained from the Department of Water.
6.7	**Air Quality**	
6.7.1	**Landfill Gas**	
	There are a variety of models that can be used to estimate landfill methane generation and emissions (such as the Commonwealth of Australia's Department of Climate Change NGER Solid Waste Calculator 1.3.2 model, USEPA's LandGem and Environment Agency (England & Wales) GasSim).	The landfill gas quantities have been estimated using the Intergovernmental Panel on Climate Change (IPCC) model – 2006 IPCC Guideline for National Greenhouse Gas Inventories.
	Due to its potentially hazardous nature, landfill gas must be appropriately monitored and managed at landfill sites.	Landfill gas is a specialist activity and will be contracted out to a landfill gas management company (as occurs at most Australian landfill sites). This specialist landfill gas management company will undertake the necessary monitoring of landfill gas emissions.
	Potential impacts from landfill gas and possible migration pathways must be identified, monitored and managed to ensure there are no detrimental effects. This will require the collection and treatment of landfill gas using	Landfill gas will be collected and treated by the landfill gas management contractor. The quality of the landfill liner and capping system will minimise the fugitive escape of landfill gas from the landfill, as well as the fact that the

	appropriate methods.	surrounding soil has low permeability and that there are no non-landfill structures within 400 m of the landfill site, results in there being no potential detrimental impact from landfill gas emissions.
	Due to the variable nature of landfill sites, the most appropriate way to evaluate the level of risk posed by landfill gas from an individual site is to conduct a site-specific landfill gas risk assessment (LGRA). Appropriate measures for monitoring and managing landfill gas can subsequently be determined based on the findings of the LGRA. Guidance on how to complete a LGRA is provided in the *Landfill Licensing Guidelines* (EPA publication 1323). LGRA is an ongoing process that must be reviewed and updated on a regular basis taking into account new information (for example, gas monitoring data or new receptors).	A site specific landfill gas risk assessment has been undertaken and is included in the application supporting documentation.
	Landfill gas monitoring is an integral component in landfill gas management and should be developed and implemented based on the findings of a site-specific LGRA.	Landfill gas monitoring will concentrate around the monitoring of the quality and quantity of landfill gas being collected from the landfill and the fugitive emissions through the cap. There will be no monitoring of landfill gas beyond the landfill perimeter as there are no receptors (non-landfill structures) within 400 m of the landfill perimeter (the BPEM sets 250 m as being the maximum distance from the landfill that landfill gas monitoring is required). In addition, the quality of the landfill lining and capping system and the relative impermeability of the natural soils on site make it extremely unlikely that there would be any negative impact from fugitive landfill gas emissions.
	The location and number of landfill gas monitoring locations is site-specific and should be based, as a minimum, on the following key factors: • Type of waste deposited at the site. • Generation rate and composition of the landfill gas. • Possible pathways for landfill gas (LFG) migration. • Nature and location of potential receptors for LFG emissions. • Possible impacts on receptors. • Travel time for gas migration from source to potential receptors. The LFG monitoring should include, as a minimum, the following locations: • The landfill's surface. • Subsurface geology. • Subsurface services on and adjacent to the site. • Buildings/structures on and adjacent to the site. • Landfill gas treatment/management equipment (such as flares and engines). In some cases, it may be appropriate to also monitor landfill gas present in groundwater and leachate. Further guidance on the typical spacing and design of landfill gas monitoring bores is contained in Appendix B.	No landfill gas monitoring is proposed beyond the landfill footprint. As mentioned above, monitoring will occur on the landfill footprint.
	The action levels for landfill gas at different monitoring locations are set out in Table 6.4. When these action levels are exceeded, the landfill operator	Landfill gas emissions will be monitored on the landfill cap. Should the detected levels exceed the reporting thresholds, the DER will be advised

	must notify EPA within 24 hours. The notification is also to advise what action will be taken to address the matter, what further testing will be done to demonstrate effectiveness of the works, anticipated time frame for the works, or when a detailed landfill gas remediation action plan (LFGRAP) would be prepared and forwarded to EPA.	within 24 hours. The information provided to the DER will contain the necessary information on the remedial actions and subsequent monitoring to be undertake.
	Table changed to comply with 8 October 2014 Vic EPA Changes Table 6.4 Landfill Gas Action Levels; • Landfill surface final cap = Methane 100 ppm. • Within 50 mm of penetrations through the final cap = Methane 100 ppm. • Landfill surface intermediate cover areas (no waste within next three months) = Methane 200 ppm. • Within 50 mm of penetrations through the intermediate cover = Methane 1,000 ppm. • Biofilters = Methane flux = 1.0 g/m^2/hr. • Subsurface geology at the landfill boundary = Methane and carbon dioxide concentrations at 1% v/v methane or 1.5% v/v carbon dioxide above background. • Subsurface services on and adjacent to the landfill site = Methane concentration = 10,000 ppm. • Buildings/structures on and adjacent to the landfill site = Methane concentration in air = 5,000 ppm. • Landfill gas flares = Methane and volatile organic compounds = 98% destruction efficiency.	The stated threshold gas action levels will be adopted when monitoring of landfill gas to determine when the DER needs to be advised of any excessive fugitive emissions.
	The landfill gas management system should be designed prior to establishing the landfill and should be progressively installed during the operational period of the landfill. Landfill gas management systems must incorporate any operational modifications required to optimise the quality and volume of gas generated.	Traditionally, in Western Australia landfill gas management is carried out by specialist contractor. The contractor is normally engaged on site once there is sufficient landfill gas available to justify the installation of a gas extraction system. Each landfill gas company has its own specific design and methodology for the management of landfill gas; hence, it is not practical to provide comprehensive gas extraction system design at this stage of the project; however, the supporting documentation does provide detail on the conceptual requirements and design of the likely landfill gas extraction system.
	There are two kinds of extraction wells; vertical and horizontal. A site's landfill gas management system should include one or both of these types of wells as required.	Both horizontal and vertical gas extraction well will be utilised.
	Vertical wells should extend to within 3 to 5 metres of the base of the waste mass.	This requirement is included in the landfill gas management system.
	The design and location of the gas management infrastructure should minimise damage by settlement, vandals, animals, natural processes or operational machinery.	Typical spacing of landfill gas wells is approximately 40 m to 50 m apart. This provides sufficient access between wells for operational equipment; however ensures adequate gas extraction efficiency. The gas wells will be

		installed to accommodate some settlement in the waste mass and if wells are damaged as a result of settlement, where possible, the wells will be replaced (cannot be done once the final cap has been installed). Damage from vandals and animals is not seen as a significant potential problem.
	Landfill gas extraction wells should be monitored and maintained or replaced as required.	The landfill gas contractor will typically monitor the gas wells on a monthly basis, with any defective of damaged wells being redrilled and replaced (where possible). Replacement will only occur for vertical wells in uncapped areas of the landfill. Horizontal wells will be permanently lost if damaged or defective as there is no mechanism to "re-drill" these wells.
6.7.2	**Air Toxics**	
	Assessment of air toxics should be undertaken as part of the landfill gas risk assessment (LFGRA).	It is generally accepted that air toxins are present in landfill gas emitted from most putrescible landfills. The type and quantity of toxins is a function of the landfill construction (base lining system and capping system), the type of waste disposed of within the landfill, the quantity of waste and the efficiency of landfill gas extraction and destruction. The consequence of the emitted toxins is a function of the quantity of toxins emitted and the proximity of a receptor to the source of emission. With the landfill being fully lined, having an active landfill gas extraction system, receiving only Class II waste and at relatively low annual tonnages as well as the fact that the nearest neighbouring residential property is in excess of 8 times the EPA required buffer distance from the edge of the landfill perimeter (1.3 km vs 150 m), air toxins are not deemed to be a health concern.
	Consistent with world best-practice and to ensure protection of public health, a monitoring plan should be developed and implemented for air toxics, where required. Advice should be sought from an environmental auditor during the development or review of the LFGRA.	Due to the low-hazard type of waste being landfilled on site and the distance to the nearest neighbouring human receptor (1.3 km), the likelihood of excessive toxins being emitted from the waste and causing environmental harm is extremely unlikely. Consequently, there is no monitoring of toxins proposed.
	The monitoring should include the bores and ambient air at the boundary of the site. The air sample should be analysed for the indicators specified in the SEPP (AQM) that are relevant for landfill gases or those contained in international guidance on monitoring of air toxics from landfills.	There is no monitoring of toxins proposed.
6.7.3	**Odour**	
	The provision of buffers in accordance with requirements outlined in section 5.1.5 will minimise impacts of odour on surrounding areas. The key means of managing landfill gas odour is to manage the landfill gas in general by oxidising it through some of the measures discussed in section 6.7.1.	The buffer distances available on site are well in excess of the recommended buffers (150 m vs 1.3 km) and operational practises including active landfill gas extraction will ensure that there is minimal (if any) likelihood of odour impact on neighbouring properties.
6.7.4	**Dust Emissions**	
	Reactive management strategies should put in place including real-time monitoring of PM_{10}. The monitoring may be required at the boundary of the premises both upwind and downwind of the active landfill area to assess	Dust management has been covered in the supporting documentation. A reactive strategy will be adopted, with numerous mechanisms available to

	any impact and guide mitigation actions. An hourly trigger level of 80 µg/m^3 should be used to assess the real-time data. If exceeded additional dust management practices, such as increased water sprays and dust suppressants should be applied.	the site operator to comprehensively manage dust emissions.
	Where leachate is to be used for dust suppression it may only be applied to areas that are within the active landfill cell to ensure the leachate does not contaminate stormwater run-off.	Leachate will be used within the landfill footprint to manage dust emissions.
6.8	**Bioreactor Landfills**	
	Generally, waste degradation in a conventional 'dry tomb' landfill is inhibited by the lack of moisture within the waste which impedes the rate of waste decomposition. The addition of moisture in a bioreactor landfill by way of leachate recirculation or fresh water infiltration adds moisture to the waste and promotes the conditions necessary for micro- organisms to achieve rapid rates of waste decomposition.	Most landfills incorporate some degree of leachate recirculation; however, are not classified as bioreactor landfills and hence are also not "dry tomb" landfills. Leachate recirculation is widely used in WA to manage leachate volumes and wet the dry waste to increase the rate of waste decomposition and landfill stabilisation. There will be a degree of leachate recirculation within the waste mass (primarily for leachate management purposes), but not to the extent that the landfill will be classified as a bioreactor landfill.
	The environmental performance and required outcomes for a bioreactor landfill are the same as for a conventional landfill (refer to 'Required outcomes' in Section 8.1).	The landfill will not be a bioreactor landfill.
6.9	**Noise**	
	The BPEM refers to Victorian noise control guidelines.	The WA equivalent is the *Environmental Protection (Noise) Regulations 1997*. Site noise levels are to comply with *the Environmental Protection (Noise) Regulations 1997* and any relevant Local Government noise management requirements. A site specific noise assessment has been undertaken by Herring Storer and has not identified any noise related issues of concern. The site will be operated within the guidelines set out in the Noise Regulations.
6.10	**Traffic Considerations**	
	Due to safety concerns, noise, road grime and the increased cost of road maintenance, movement of trucks on local roads may be a concern to local residents and councils.	This is a Planning Approval matter and was dealt with at SAT. There is a SAT condition (no. 28) requiring a Road Maintenance Plan to be developed and submitted to the Shire and for the proponent to contribute towards road maintenance costs.
	The accumulation of dirt on sealed external access roads can be avoided by vehicles exiting via a wheel wash or some other equivalent wheel and underbody- cleaning mechanism. The road layout within the landfill should encourage the use of wheel-cleaning devices by truck drivers, and be placed so that the gatehouse attendant can visually check that the vehicle has been cleaned.	Due to there being 3 km of internal gravel roads between the landfill and the site exit onto the public road, there is very little possibility that there will be any mud from the landfill tracked off site. There is not proposal to install a vehicle or wheel wash.
	Where external access roads are sealed, the road from the wheel wash	The external road is sealed up to the site entrance. The sealing work was

	should also be sealed and regularly cleaned to reduce the dirt re-entrained by the vehicle. Internal roads should also be sealed as far as possible into the site to reduce the amount of dirt accumulating on the vehicle and allow more time for dirt already accumulated on the vehicle to fall off before it leaves the site.	paid for by the two clay extraction operations and Opal Vale as part of its inert landfill operation on an adjacent property. The section of the road to the north east is not sealed. Vehicles traveling in a south westerly direction currently track dirt onto the sealed portion of the road. The internal roads are not sealed, they are gravel roads that are maintained in good condition. The internal roads are used and maintained by the two existing clay extraction companies on site and once landfill operations commence, Opal Vale will also assist in the maintenance of the internal roads. To date there have been no complaints associated with mud being tracked onto the public roads. This situation will continue once the landfill operation commences.
6.11	**Site Security and Fencing**	
	Site security and fencing is a public liability issue for the landfill operator to manage.	The site property boundary is fully fences. As part of the landfill development, a stock control fence will be installed around part of the Prescribed boundary (so as not to negatively impact on the adjacent clay extraction or the farming activities), but will control stock access to the landfill) and a 2.4 m fence will be installed around the active landfill area. The fencing configuration will allow the operators to securely lock the landfill when unattended.
	When unattended, the gates should be securely locked. Fencing should be regularly inspected and any damage to the fence that would allow unauthorised access be repaired as quickly as possible. When designing a fence, consider the probability that unauthorised people will want to gain entry to the site.	The landfill will be locked when unattended. Fences will be inspected on a weekly basis and if damage is identified, the fences will be immediately repaired (within 48 hours).
	Any particularly dangerous areas, such as disposal areas for slimes or leachate ponds, should have signs to indicate the danger posed.	The leachate ponds are deemed areas of potential safety risk. The ponds will be fenced, incorporate safety lines and floats as well as danger signs.
	The minimum recommended fencing requirements are summarised in Table 6.6: < 10,000 t/yr = A stock-proof fence constructed around the perimeter of the landfill site, and relocatable litter screens erected near the tipping area. >10,000 t/yr = A wire mesh fence at least two metres high constructed around the landfill site perimeter or A wire mesh fence at least two metres high constructed around the tipping area only, and a stock-proof fence around the perimeter of the site.	A 2.4 m high fence will be installed around the active landfill area and a partial stock fence will be installed around the Prescribed boundary. The stock fence will link into the existing site stock control fencing to ensure that there is no stock access to the landfill area.
	In areas where there may be a higher risk of unauthorised people entering the site, such as where the landfill is next to a recreational area, these minimum fencing requirements may need to be upgraded.	Due to the remote location of the landfill site, there are no additional security fencing requirements.
6.12	**Low-Risk Rural Landfills**	
	Small rural municipal landfills that meet criteria set out below may use Type 3 landfill design criteria for capping and lining systems. This variation to requirement for Type 2 landfill containment systems is made on the basis	Although the landfill is in a rural setting, the anticipated annual tonnes means that the site is not deemed a low-risk rural landfill.

	that small, appropriately located rural landfills pose a lower risk and therefore may meet the relevant environmental protection objectives with Type 3 design.	
	The criteria for a site to be considered a low-risk rural landfill are that: • It meets or exceeds the buffer requirements as set out in Table 5.2; • It receives less than 20,000 tonnes of waste per annum; • Wastes are at least two metres above the long-term undisturbed groundwater level; • It is not located in Segment A groundwater; and, • Financial assurance to the satisfaction of EPA is in place. All the above criteria must be met for a landfill to be considered a low-risk rural landfill.	Not applicable.
7	**Best Practise Operation**	
	The elements of a landfill's operations that need to be considered are: • Environmental management. • Financial assurance. • Waste minimisation. • Waste acceptance. • Waste pretreatment. • Waste placement. • Waste cover. • Litter control. • Dust and air emission control. • Fires. • Contingency planning. • Management of chemicals and fuel. • Disease vector control. • Noxious weed control. • Performance monitoring and reporting.	The supporting documentation covers all of these aspects.
7.1	**Environmental Management**	
	The holder of a licence for a landfill site is required to develop an environment improvement plan (EIP).	With the landfill being a new facility (without a history of operation), there are no aspects of the site operation that require improvement. By complying with the BPEM, the commencement of the facility development is deemed as being best practise. In time, once the facility has been operational for some time, there may be operation aspects that require improvement. At that stage, an EIP will be developed.
7.2	**Financial Assurance**	
	Financial assurance is a requirement of the EP Act and all licensed landfill are required to hold an EPA-approved financial assurance.	WA application – Financial assurances are not usually required, but can be implemented by the DER, following approval by the Minister.

		The SAT determination included a requirement for Opal Vale to lodge a cash bond ($120,000) with the Shire to act as a performance guarantee against the satisfactory completion of the rehabilitation of the site.
7.3	**Waste Minimisation**	
	Material presented at a landfill should be sorted either by the waste generator or at some intermediate facility such as a transfer station to remove and recover recyclable material prior to deposition in the landfill.	There will be no transfer station or recycling facility on site. This is purely a landfill development. However, the vast majority of the waste material being received on site will emanate from the Bayswater Resource Recovery Solutions (RRS) waste recycling facility. RRS is associated with Opal Vale. In addition, the Landfill Levy that is charged on all Metropolitan waste being landfilled is a significant incentive for waste generators and collectors to recycle as much as possible prior to sending waste to landfill.
	Where the landfill takes unsorted waste, infrastructure such as a transfer station or drop-off bins should be provided at the landfill to facilitate the recovery of recyclable material. The site recording system should record the waste diverted from landfill separately from waste landfilled.	There will be no transfer station or drop-off bins. The facility will not be open to the general public, only waste generation companies and waste collection companies.
	In some exceptional cases it may be more efficient to sort the waste on the tipping face rather than at a transfer station. This will typically be the case at sites that only receive waste from commercial operators.	There will only be minimal sorting of waste on the tipping face. This will entail the extraction of larger waste items that are either problematic (wire or mattresses) or recyclable (metal). The degree of extraction will be highly dependent on the type of waste being received.
7.4	**Waste Acceptance**	
	Signs advising which wastes may be deposited at the landfill must be provided. Signs should be provided to show where recyclable materials from waste that has not been through a transfer station or municipal recycling facility may be placed.	Appropriate signage will be included to clearly indicate what waste material is acceptable and unacceptable, as well as providing appropriate direction to customers using the site.
	Landfill staff must be vigilant to ensure that only wastes specified in the EPA licence are accepted and deposited at the premises.	Waste acceptance procedures will be in place at the weighbridge and on the tipping face to ensure that there is adequate control and inspection of incoming waste to ensure compliance with the facility licence requirements. The supporting documentation includes details on waste acceptance.
7.5	**Waste Pre-treatment**	
	The pre-treatment of waste prior to landfilling is intended to reduce the long-term risk posed by the waste and to improve general landfill performance.	There will be no pre-treatment of waste on site.
	Approaches to pretreatment include: • Recovering fractions that have high calorific value, are recyclable or are compostable. • Modifying the physical form or mix of wastes going to landfill through shredding, baling or compacting. By removing the waste that has a high calorific value or is compostable, landfills containing the residual waste stream require a shorter aftercare period and have fewer landfill gas emissions to the environment.	There will be no pre-treatment of waste on site.

7.6	**Waste Placement**	
	The thickness of the waste layer should not exceed 0.5 metres and the compactor should make three to five passes over the waste.	The supporting documentation confirms these requirements.
	The tipping face should be kept small, ideally less than 30 metres in length. The total height of the layers combined in the lift should be less than two metres.	The supporting documentation confirms these requirements.
	Wastes, particularly putrescible wastes, must be covered by the end of each day's operation.	The supporting documentation confirms these requirements.
	Gradients steeper than two horizontal to one vertical units should be avoided, unless it can be demonstrated that both the waste and the cover material are mechanically stable.	The supporting documentation confirms these requirements.
7.7	**Waste Cover**	
	Waste must be covered at the end of every day, though landfills that receive significant volumes of waste in a day might need to progressively cover waste during the day.	Daily cover will be applied.
7.8	**Litter Control**	
	As a minimum, a best-practice landfill will use litter screens and train staff in the appropriate placement of the screens to trap as much litter as possible. These litter screens should be portable to be able to follow the tipping area, and should be capable of withstanding wind loads when loaded with litter. Litter screens should be at least four metres high.	4 m high litter screens will be erected at the active tipping face and moved around according to the prevailing winds to optimise litter collection.
7.9	**Fires**	
	Once started, landfill fires are difficult to extinguish, so the primary objective should be to prevent a fire from starting. This is done, as far as is practical, by removing potential ignition sources, such as hot coals, from the tipping area. Other measures include not burning waste and not lighting fires on or near areas where wastes have or are being deposited.	There will be no burning of waste on site. The facility operators will be vigilant when looking out for fires and any fires that do occur will be immediately extinguished.
	Wastes should be covered with non-combustible material.	Waste will be covered with non-combustible daily cover material.
	Equipment to extinguish a fire must be readily available at any time to enable a prompt response to any part of the premises. A water supply, either reticulated water or from dams or tanks, combined with a means of delivery (pump and hoses or a tanker truck) allows the prompt extinguishment of a fire on the site.	There will be a ready water supply available in the main storage dam for fighting fires. The water cart will be the primary fire-fighting equipment and will be fitted with the necessary fittings, pump and hoses to enable the operators to extinguish all but the largest fire. In the event that the site operators are unable to extinguish the fire, the Toodyay fire brigade will be called out to provide assistance,
	Leachate should not be used unless all parties are aware of the possible risks and adequate measures are taken to reduce human exposure.	Leachate will be used to control subterranean fires, where it will be pumped into the void caused by the subterranean fire.
	Where reticulated water is not provided, at least 50,000 litres should be stored onsite for the purpose of combating small fires.	The main storage dam will be used to store firefighting water. In the event that there is insufficient surface water runoff to maintain an adequate supply of firefighting water (minimum 50, 000L), Opal Vale will apply for a licence to

		install a groundwater extraction bore to supplement site supplies. In this event, a minimum 50,000L storage tank will be installed to maintain adequate firefighting water supply on site.
7.10	**Contingency Planning**	
	To ensure that appropriate measures are taken in the event of an incident or anomaly, contingency plans must be developed for implementation to deal with such incident or anomaly.	The supporting documentation deals with contingency planning.
	Contingency planning should form part of the site environment management system. All staff at the landfill must be trained in the implementation of the contingency plan. The contingency plan must consider all impacts discussed in this guideline and, in particular: • The detection of contamination of surface or groundwaters. • Detection of landfill gas. • Blockage of leachate and landfill gas collection pipes. • A landfill fire. • Deposit of unauthorised waste. • Offensive odours or dust beyond the boundary of the premises. • Litter beyond the boundary of the premises. • Equipment breakdown. • Flare or power outage. The contingency plan must be reviewed after the occurrence of any incident covered by the plan to ascertain the effectiveness of the contingency plan and where, if necessary, it could be further improved.	The supporting documentation covers these aspects in contingency planning.
7.11	**Management of Chemicals and Fuels**	
	The storage and handling of flammable and combustible liquids should be in accordance with the provisions of AS 1940–2004 *The storage and handling of flammable and combustible liquids* and *Bunding guidelines* (EPA publication 347).	WA equivalent is *Code of Practise for the Storage and Handling of Dangerous Goods*. All chemicals and fuels will be stored in accordance with the *Code of Practise for the Storage and Handling of Dangerous Goods*.
7.12	**Disease Vector Control**	
	Flies, mosquitoes, rats, cats and birds (typical disease vectors) are attracted by food wastes and still waters at landfills. The main mechanisms for the control of disease vectors are the use of cover material to cover waste daily (see section 7.7) and eliminating any waterbodies that are not required for fire, sediment and leachate control. Other measures, such as scare devices and traps, can also be used to reduce or control infestations. Professional pest exterminators should be employed to reduce problem infestations of vermin.	It is a SAT condition (no. 13) that a Mosquito Management Plan be developed prior to commencement of operations. In addition, the supporting documentation cover vermin management aspects.
7.13	**Noxious Weed Control**	

	Any noxious weeds onsite should be managed by regularly inspecting the site for noxious weeds and eradicating any weeds present through appropriate means.	The supporting documentation cover noxious weed control aspects.
7.14	**Performance Monitoring and Reporting**	
	In order to assess the performance of the measures taken to protect the environment from any potential environmental impacts by the landfill, monitoring, assessment and reporting of the results are required.	Monitoring and reporting are standard licence conditions for landfills. Opal Vale anticipates to have these conditions in the facility operating licence and will comply with these requirements.
8	**Best Practise Rehabilitation and Aftercare**	
8.1	**Rehabilitation**	
8.1.1	**Rehabilitation Plan**	
	Best practice for rehabilitation and aftercare is considered very early in the design and operation phase of the landfill. This section of the Landfill BPEM applies to all existing landfills and closed sites.	As stated, this section is not applicable to new landfill developments. However, rehabilitation and aftercare has been considered in the development proposal. The landfill will be progressively closed and rehabilitated, with all rehabilitated areas monitored and if necessary, rehabilitation practises amended based on lessons learnt.
	A conceptual rehabilitation plan must be developed as part of the initial landfill design. The rehabilitation plan should include: • The potential afteruses of the site, taking into consideration current and likely future land use in the area surrounding the site. • Operational requirements, to ensure that the capping is designed to suit the intended afteruse. • Surface contours before and after settlement. • Specifications and materials to be used in the final cap. • Preservation/installation of environment performance control or monitoring features.	The Works Approval supporting documentation provides a conceptual rehabilitation plan for the proposed development.
8.1.2	**Progressive Rehabilitation**	
	Landfill cell rehabilitation works include: • Capping and revegetation in accordance with regulatory requirements. • Installation and ongoing maintenance and replacement of gas and leachate collection infrastructure. • Decommissioning of infrastructure no longer required.	Covered in the Works Approval supporting documentation.
8.1.3	**Triggers for Rehabilitation**	
	Implementation of the progressive rehabilitation at a landfill should be consistent with the conceptual rehabilitation plan prepared during the initial landfill design.	Covered in the Works Approval supporting documentation.
	A landfill licence-holder should, where operationally practicable, sequence operations to complete the filling of each cell in turn, rather than leaving one	Progress closure and rehabilitation will be carried out.

	or more partly filled cells inactive and not fully rehabilitated.	
	Where cells cannot be fully rehabilitated due to the layout of the site and the sequencing of filling, intermediate (temporary) capping must be installed.	Temporary capping (minimum 300 mm) will be applied to all areas of waste placement that will not receive waste for a period of more than three months.
	In order to take best advantage of its inherent benefits, rehabilitation of a landfill cell should be initiated once: • The landfill cell contents have reached the approved pre-settlement contours, allowing sufficient height to build the landfill capping within the pre-settlement contours. • Further filling of the cell is operationally no longer required or feasible. • There has been a lawful direction to cease filling the cell. • The landfill is to be closed. • Two years have elapsed since commencement of filling.	Progress closure and rehabilitation consistent with these requirements will be carried out.
8.1.4	**Site Afteruse**	
	Proposals for the use of the filled landfill site should be flexible enough to allow for changes in community attitudes or planning requirements in the long period between commencement of landfilling and final rehabilitation.	Due to the rural setting of the landfill, it is most unlikely that there will be any change in community attitudes or planning requirements that would change the ultimate site afteruse.
	Regular reviews of afteruse options are a good way of ensuring that the operation of the landfill does not alienate desired afteruses of the site.	Not deemed necessary due to the rural setting.
8.1.5	**Settlement and Final Surface Profile**	
	The landfill cap design is governed by limiting water infiltration into the landfill and gas migration through the cap; these are a function of the materials used in the cap and its shape. The gradient for a completed cap should be sufficient to prevent water ponding on the cap to minimise infiltration through the cap. Gradients of about five per cent will adequately shed water.	The pre-settlement landfill cap has been designed at a slope of 1 vertical in 5 horizontal (20%), which is seen as the optimum configuration to achieve a reasonable landfill airspace, a long-term stable slope that can easily be rehabilitated and is also able to accommodate waste settlement whilst maintaining the ability to shed excess surface water off the capped surface.
	Where the proposed afteruse of the landfill require a gradient of less than 5% the cap design may need to incorporate additional levels of protection. Cap gradients of less than 1% are likely to have issues with water ponding in areas of differential settlement.	Not applicable.
	Caps should not be steeper than 20%. Caps steeper than this can have erosion problems and are more difficult to maintain than flatter caps. Steep caps will require specific engineering controls to ensure that they are stable.	The cap is not proposed to be steeper than 20%.
	Since compaction of wastes along near-vertical side walls is difficult, the wastes along the walls of the landfill may exhibit the highest initial rate of settlement. The landfill cap needs to make allowance for this by providing sufficient thickness of the cap to ensure that run-off from the cap is not collected in depressions along the perimeter of the landfilled area.	Not applicable as the maximum side slope of the landfill liner is 1 in 3, which allows for a gradual transition of waste settlement.
	The landfill aftercare program must include inspections of the cap, checking for differential settlement and indicators that the integrity of the low-	Covered in the Works Approval supporting documentation.

	permeability cap has been compromised. The frequency of the inspection program will be largely determined from the observed rate of settlement.	
	The use of plants on the landfill caps must consider the particular requirements of the cap design, and vegetation used must be compatible with the cap design. Conventional caps require plant roots not to penetrate the barrier layer underlying the topsoil layer. Phytocaps use different principles than conventional caps and require different vegetation strategies (see section 8.1.7 for further information).	Shallow rooted plant species will be utilised, with localised areas of deeper capping material to accommodate deeper rooted plant species (to achieve a diversity of plant species on the cap).
8.1.6	**Landfill Cap**	
	The design seepage rate of the cap does not exceed 75 per cent of the design seepage rate of the landfill liner.	Golder Associates has undertaken the leakage rate assessment of the landfill lining and capping systems and confirmed the appropriate leakage rates have been achieved.
	Table 8.1 indicates the required performance standards of caps, as well as indicative cap designs.	These performance standards have been used by Golder Associates in the leakage rate assessment.
	Sites without a best-practice basal liner are still required to meet best-practice requirements for capping (in other words, the modelling must assume the basal liner was built in accordance with best-practice requirements).	Not applicable. The proposed basal liner is deemed best-practise.
	Where the proposed afteruse of a landfill will require vegetation of the site, the topmost layer must be able to support vegetation and be of sufficient depth to ensure that roots do not penetrate the cap.	Covered in the Works Approval supporting documentation.
	The surface layer should reflect the type and depth of topsoils normally found in the local area. Where it is not possible to duplicate the local topsoil conditions or the natural soil is too thin to support adequate vegetation for erosion control, an appropriate mix of soils 200 to 300 millimetres thick should be used. Any mulch used in the cap should be pasteurised, to remove weed seeds, plant pathogens and pests.	Covered in the Works Approval supporting documentation.
	Introduced plantings on the landfill should not include any noxious weed variety for that area, nor should the landfill provide a haven for weeds migrating from the surrounding area.	No non-native plants will be utilised for rehabilitation purposes.
	In general, EPA advises that planting be restricted to species indigenous to the area and of local provenance.	This is consistent with the proposed approach.
	To limit seepage, a layer of low-permeability clay and/or a flexible membrane liner may be required in the cap. Selection and installation of geomembranes must comply with the requirements set out in Appendix D.	A composite geosynthetic liner is proposed in the cap.
	A drainage layer is sometimes placed between the soil layer and the low-permeability capping layer. The purpose of the drainage layer is to remove excessive moisture that has permeated through the soil layer and will not be removed by evapotranspiration. Due to problems with desiccation of the surface or low- permeability layer, drainage layers are generally only used in high-rainfall areas or where the cap has a very shallow gradient.	A drainage layer will be utilised.

8.1.7	**Alternative Landfill Cap**	
	Designing of phytocaps requires a detailed understanding of soil properties, including proposed soil source area variability, and acceptance limits for use in the cap where variability exists. This understanding of the soil must also accommodate the range of conditions in which the soil may be placed, including compaction and any conditioning requirements.	Not applicable.
8.1.8	**Low-Risk Rural Landfills – Indicative Phytocap Design**	
	Small, low-risk rural landfills that meet the criteria set out in Section 6.12 of the Landfill BPEM may use Type 3 landfill capping and lining criteria. In recognition of the level of infiltration through a Type 3 cap, as set out in Table 8.1 and Table 6.1, the lysimeter field trial is not required for the development of phytocap designs at these sites. The required phytocap performance on a low-risk rural landfill is the performance requirement outlined in Table 8.1, annualised over a climatic average year. Therefore, the 75 per cent of the seepage rate of 1000 L/ha/day can be interpreted as 274,000 L/ha/year for a Type 3 landfill as the long- term performance requirement for an established phytocap.	Not applicable.
	For these low-risk rural landfills a minimum cap thickness of 1.5 metres is required, regardless of the soil moisture capacity of the proposed soils for the phytocap.	Not applicable.
	Phytocap soils are to be placed to avoid over- compaction of the soils and require a target level of compaction in the range of 75 to 80 per cent standard compaction.	Not applicable.
	A vegetation establishment and maintenance scheme is required and must include the suitability of the soil for propagation of the proposed plants, types of vegetation and a maintenance and reporting program. The annual performance statement to EPA must include a report on the vegetation.	Not applicable.
8.2	**Aftercare Management**	
	Until the waste within the landfill has sufficiently decomposed or stabilised such that it no longer presents a risk to the environment, the landfill must be managed to prevent any environmental impact.	Covered in the Works Approval supporting documentation.

	The following areas must be considered in preparing the aftercare management plan:
	• Maintenance of landfill cap, in particular to:
	  • Prevent/control erosion.
	  • Restore depressions and seal and monitor cracks in the cap caused by settlement.
	  • Restore/maintain vegetation.
	• Maintenance and operation of leachate collection and treatment system.
	• Maintenance and operation of landfill gas- extraction system.
		Covered in the Works Approval supporting documentation.

	• Environmental monitoring of:
	  • Groundwater.
	  • Surfacewater.
	  • Landfill gas.
	  • Leachate.
	  • Settlement.	

	As these activities will continue beyond the income-producing period of the landfill, funds should be allocated during the operational life of the landfill to provide for aftercare management. The typical period of aftercare is about 30 years for a putrescible landfill.	The business financial model will ensure that there are adequate funds allocated to rehabilitation and aftercare activities for a minimum of 30 years.
	The aftercare management plan should address the level of monitoring and frequency of inspection of the landfill and infrastructure.	Covered in the Works Approval supporting documentation.
	During the aftercare period, the frequency of monitoring and inspection may be decreased, frequency being based on the stability of the landfill cap and the consistency of environmental monitoring results.	Covered in the Works Approval supporting documentation.
	The data and observations collected in accordance with the plan should be reviewed by an expert in the field (see section 7.14 for more information on performance monitoring and reporting; the elements discussed in this section apply to monitoring during the operation of the landfill and after its closure).	Covered in the Works Approval supporting documentation.
	The leachate collection and treatment system will need to be inspected and maintained for as long as the landfill is actively generating leachate. This will include inspection and cleaning of leachate collection pipes, maintenance of leachate treatment plants and inspection after periods of heavy rain to ensure that the system is not overloaded. This must continue until an assessment demonstrates the landfill is no longer generating leachate able to detrimentally impact on the environment.	Covered in the Works Approval supporting documentation.
	The landfill gas extraction system needs to be maintained for the life of landfill's gas generation. This includes maintaining the plant, such as generation plant or flares used to combust the gas. This must continue until an assessment demonstrates that it is no longer required or that the system may be downgraded to a less intensive form of management.	Covered in the Works Approval supporting documentation.
	In determining whether maintenance is still required, an environmental audit by an auditor is required. This audit will examine, among other things, the results of monitoring of groundwater, surface water, landfill gas and leachate.	There are no Environmental Auditors in WA. Once the proponent is of the opinion that the landfill has stabilised to such a degree that there is no longer the need to undertake further site maintenance and monitoring, a report prepared by an appropriately experienced consultant will be presented to the DER setting out the justification for the request to cease maintenance and monitoring activities. The DER will then make a determination as to whether the maintenance and monitoring can be ceased.
	If monitoring is conducted regularly, and the trend clearly demonstrates that leachate is clean and minimal landfill gas is being generated, then the	These aspects will be considered by the proponent prior to requesting permission to cease maintenance and monitoring activities.

	auditor can be assured that the site no longer poses a risk to the environment and may recommend reducing maintenance requirements. Where this monitoring is patchy and trends are inconclusive, then this degree of assurance is not provided and EPA will not remove the maintenance requirements.	
	To ensure in the long term that prospective owners of the land are aware that it was once a landfill, measures such as a caveat on the land title or a planning overlay can alert people to the prior use of the site.	In WA there is the Contaminated Sites Legislation which covers this aspect. If regular groundwater monitoring indicates that there is a contaminated groundwater plume below the landfill, the site will be registered as a Contaminated Site.
8.2.1	**Buffers and Measurements**	
	The post-closure buffers are set to manage landfill gas impacts, including the risk of explosion and/or asphyxiation. Landfill gas potential risks remain for at least 30 years post-closure.	The landfill buffers will remain in place until the site is no longer required to undertake any maintenance and monitoring (as determined by the DER).
	Buffers are measured from the sensitive land use to the edge of the closest cell. All cells, including closed cells, need to be considered in calculating buffers. For sites that cannot demonstrate the above, the premises boundary is the point of measurement.	This is consistent with the buffer measurement mechanism.
	Table 8.2 summaries the buffer required for different types of landfill. • Type 2 Landfill = 500 metres from building or structures. • Type 3 Landfill = 200 metres from buildings & structures.	There is a 1.3 km buffer to the nearest neighbouring structure.
8.2.2	**Buffer Distances and Encroachment**	
	Proposed developments and any works within the recommended landfill buffer can pose a safety risk by potentially providing preferential pathways for landfill gas migration, or providing an environment where landfill gases can accumulate to dangerous levels.	Due to the rural setting, it is not anticipate that there will be any buffer encroachment around the landfill.
	Responsible planning authorities need to be provided with sufficient information by the proponent to satisfy them that the proposed new development or rezoning will not be adversely impacted by its proximity to the landfill site.	Due to the rural setting, it is not anticipate that there will be any buffer encroachment around the landfill.
	Building and structure buffer distances apply to closed landfill sites until the site has stabilised to the point where the potential for subsurface gas migration has largely ceased. Typically, this will be a period of about 30 years.	Due to the rural setting, it is not anticipate that there will be any buffer encroachment around the landfill.
9	**References**	
	Nil technical content	