Appendix No 1 - Asbestos Management Plan
OPAL VALE SALT VALLEY ROAD
CLASS II LANDFILL
LOT 11 CHITTY ROAD, TOODYAY
ASBESTOS MANAGEMENT PLAN

Prepared for
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1. Introduction

Opal Vale Pty Ltd (Opal Vale) operates the Salt Valley Road Class II Landfill facility at Lot 11 Chitty Road, Hoddy’s Well, Toodyay. The landfill facility is licensed by the Department of Environment Regulation (DER) to accept asbestos for disposal via burial.

The control and handling of materials containing asbestos products is a critical management aspect on site. Opal Vale takes the responsibility associated with the appropriate control and handling of asbestos products extremely seriously.

2. Purpose

The purpose of this procedure is to:

- Provide guidance to Customers on how asbestos material including asbestos contaminated soil is to be handled and packaged prior to delivery to site.
- Provide guidance to the Facility Operators and Customers on how best to manage asbestos material on site.
- Ensure appropriate procedures are carried out when handling asbestos material.
- Ensure the appropriate burial of asbestos material within the landfill.
- Ensure the appropriate record keeping of information associated with asbestos material that has been disposed of to landfill.

3. Reference

- Salt Valley Road Class II Landfill, Landfill Management Plan Section 11.2.4 - Asbestos Waste.
- Code of Practice for the Management and Control of Asbestos in the Workplace [NOHSC: 2018 (2005)].
4. Distribution

This Plan is distributed to:

- All employees involved in the management and operation of the landfill site.
- Department of Environment Regulation.
- Customers as applicable.
- Any other relevant parties.

5. Definitions

**Asbestos Containing Material (ACM)** - means any material, object, product or debris that contains asbestos, including Asbestos Waste and asbestos contaminated soil.

**Asbestos Incident Report** – the incident report detailing any Substandard ACM identified on site.

**Asbestos Register** – the register in which all disposal of ACM is recorded.

**Asbestos Waste** - means all removed ACM and disposable items used during asbestos work, such as plastic sheeting used to cover surfaces in the asbestos work area, disposable coveralls, disposable respirators, rags used for cleaning.

**Customer** - means an individual or company, responsible for, or delivering ACM to the Facility.

**Dedicated Asbestos Area** – The area within the landfill that is specifically dedicate to the disposal of ACM.

**Disposal** - the appropriate disposal/burial of ACM on site in accordance with the facility operating licence.

**Facility** – The Prescribed Boundary within Lot 11 Chitty Road, Hoddy’s Well, Toodyay – Salt Valley Road Class II Landfill Facility.

**Person in Control** - means a person who has control of the Facility. The person with control is the site supervisor or, when he is not on site, his nominated representative.

**Facility Operator** - means a person undertaking the operational activities of the Facility.

**Personal Protective Equipment (PPE)** - means equipment and clothing that is used or worn by an individual person to protect themselves against, or minimise their exposure to, workplace risks. It includes items such as facemasks and respirators, coveralls, goggles, helmets, gloves and footwear.

**Substandard ACM** – ACM that is either delivered to site or identified on site that has not been wrapped and handled in accordance with this Plan.
6. Responsibility

The Person in Control of the Facility has a duty of care to:

- Implement, maintain and update this Asbestos Management Plan.
- Ensure adequate, appropriate training of Facility Operators.
- Ensure adequate, appropriate information is provided to Customers.
- In conjunction with the Facility Operator, assess the condition of any Substandard ACM that is found on site, the associated asbestos risks and appropriate handling procedures.
- Develop measures to control and dispose of the ACM to minimise the risks and prevent exposure to asbestos.
- Maintain a register of the disposal of ACM.
- Maintain adequate supplies of appropriate PPE on site.

Facility Operator has a duty of care to:

- Inspect incoming waste for the presence of ACM.
- Assess the condition of any ACM delivered to site.
  - Condition of wrapping.
  - Customer’s unloading method.
- In conjunction with the Person in Control, assess the condition of any Substandard ACM that is found and the associated asbestos risks.
- Utilise appropriate PPE.
- Undertake the appropriate control and disposal measures following the delivery or identification of ACM.
- Complete the appropriate Asbestos Incident Report as necessary for Substandard ACM identified.

Customer:

- To be aware of site requirements with regards to the appropriate handling and disposal of ACM.
- Comply with site ACM handling procedures.
7. Awareness Training

Information and training is to be provided to Facility Operators and others who may come into contact with ACM at the Facility, either directly or indirectly.

As a minimum, training is to be provided to all new employees that have the potential to come into contact with ACM and refresher training every two years.

If adequate in-house expertise is not available to undertake the training, suitable external training will be made available.

The asbestos awareness training is to include:

- The purpose of the training.
- The health risks associated with asbestos.
- The types, uses and likely occurrence of ACM in buildings, plant and/or equipment in the workplace.
- The trainees’ roles and responsibilities under the Asbestos Management Plan.
- Facility operating licence conditions surrounding the management of ACM.
- The processes and procedures to be followed following the delivery of ACM to site.
- The timetable for disposal of ACM.
- The processes and procedures to be followed to prevent exposure to ACM.
- The processes and procedures to be followed following the identification of Substandard ACM on site.
- Where the Facility’s Asbestos Register of ACM is located and how Asbestos Incident Report forms can be accessed.
- The processes and procedures to be followed when completing the Asbestos Register and Asbestos Incident Report.

8. ACM Wrapping

ACM is to be wrapped in accordance with the following requirements:

- Utilise the appropriate PPE (Refer Appendix No. 2) while wrapping ACM.
- Separate the ACM from general loads.
- Double wrap and tape ACM in black plastic sheeting (minimum 200 µm thickness) to prevent asbestos fibres entering the atmosphere. In the case of asbestos contaminated soil, the material is to be damp (not saturated) and packaged in suitable sealed containers (bulka bags, sealed bags).
9. ACM Delivery to Site

Prior to the arrival of ACM on site, the Customer is to be aware of the site-specific requirements for the handling and disposal of ACM. Typically this is achieved by the Person in Control providing advanced notice to the Customer of the site-specific requirements. Should ACM be delivered to site that is not appropriately managed, it should be handled in accordance with Substandard ACM procedures.

The Customer is to comply with all applicable ACM requirements on site. Should the Customer not comply with the necessary ACM requirements, the Person in Control will either reject the ACM load and refused the Customer entry to the site or accept the ACM and utilise site staff to appropriately handle the ACM. The Customer will be charged accordingly for the site staff additional effort.

From a health point of view it is preferable that the Substandard ACM not be turned away from site as this will likely result in Substandard ACM (inappropriately wrapped or bagged) being driven along public roads.

10. ACM Accepted on Site

On arrival at the Facility the ACM load is to be inspected by the Facility Operator to ensure that the ACM has been handled in accordance with appropriate site procedures and that the Customer has the ability to unload the material in such a manner as to avoid the generation of dust and the release of asbestos fibres.

Following inspection, the load is to be directed to the Dedicated Asbestos Area for disposal.

Substandard ACM is not to be accepted and buried on site until the Customer or Facility Operators have adequately wrapped the material in accordance with this Plan. Only following this, is the material to be accepted on-site and directed to the Dedicated Asbestos Area for disposal.

Wrapping of Substandard ACM is to be carried out in accordance with the above “ACM Wrapping” procedure. The Person in Control is to ensure that there is an adequate supply of wrapping material available on site.
11. Substandard ACM

On identification of Substandard ACM on site, the following activities are to be undertaken:

- Notification of the Person in Control.
- Assess the type and condition of ACM.
- Utilise the appropriate PPE (Refer Appendix No. 2).
- Separate the ACM from general loads.
- Further inspection to confirm the quantity of ACM.
- Wrap the Substandard ACM in accordance with the above “ACM Wrapping” procedure.
- Load the wrapped or bagged ACM into an empty waste bin, truck or loader bucket:
  - Loading operation to ensure that the plastic sheet wrapping or bag is not ripped.
  - The load is not to be dropped, but placed in the bottom of the bin, truck or loader bucket.
- Immediately remove the ACM to the Dedicated Asbestos Area for burial.
- The Facility Operator is to complete an Asbestos Incident Report (refer Appendix No. 3).
- The Person in Control is to review the incident to assess the appropriateness of the existing Asbestos Management Plan.
- Should any continuous improvement activities be identified, the Person in Control is to carry out the necessary amendment to the Asbestos Management Plan.
- The Person in Control is to enter the Asbestos Incident report into the Asbestos Register.

12. ACM Burial on Site

All ACM buried on site is to be buried in the Dedicated Asbestos Area.

On delivery of the ACM to the Dedicated Asbestos Area, the ACM is to be unloaded from the delivery vehicle in such a manner as to avoid the generation of dust and the release of asbestos fibres. The material is to be unloaded in its final resting position and not pushed around the landfill into place by the landfill equipment.
The asbestos material is to be buried (completely covered with waste or cover material) as soon as possible following its arrival on site, but as a minimum, within four hours.

13. Dedicated Asbestos Area

ACM is only to be buried in the Dedicated Asbestos Area.

At all times on site there is to be a Dedicated Asbestos Area available to accept the delivery of ACM. The Dedicated Asbestos Area is to form a vertical column in the landfill in which all asbestos material is disposed. The plan dimensions of the Dedicated Asbestos Area will be a function of the quantity of ACM being received on-site.

Over the life of the landfill it will be anticipated that there will be a number of Dedicated Asbestos Areas forming numerous vertical columns within the waste mass. The Dedicated Asbestos Area is to be defined by a grid reference on the site plan, which is to form part of the Asbestos Register documentation.

It is essential that at some time in the future all of the Dedicated Asbestos Areas on site can be identified by a survey so that if there is a need to excavate into the waste mass it is possible to identify those locations where ACM has been buried.

14. ACM Record Keeping

The primary method for recording the burial of ACM on site is through the Asbestos Register. The Asbestos Register is to identify all Dedicated Asbestos Areas on site as well as incidents associated with Substandard ACM identified on-site.

The Asbestos Register documentation forms an important record of site activities associated with ACM and will be used in future to identify all areas in which ACM has been buried in case there is a need to excavate into the waste mass.

15. Plan Review

This Plan is to be reviewed by the Person in Control at least every three years or more regularly if circumstances warrant.
Appendices

Appendix No 1 – Examples of Asbestos Containing Materials

(This is not an exhaustive list)

A
Air-conditioning ducts: exterior or interior acoustic and thermal insulation
Arc shields in lift motor rooms or large electrical cabinets
Asbestos-based plastics products - as electrical insulates and acid-resistant compositions or aircraft seat
Asbestos ceiling tiles
Asbestos cement conduit
Asbestos cement electrical fuse boards
Asbestos cement external roofs and walls
Asbestos Cement in the use of form work when pouring concrete
Asbestos cement internal flues and downpipes
Asbestos cement moulded products such as gutters, ridge cappings, gas meter covers, cable troughs and covers
Asbestos cement pieces for packing spaces between floor joists and piers
Asbestos cement (underground) pits, as used for traffic control wiring, telecommunications cabling, etc
Asbestos cement render, plaster, mortar and coursework
Asbestos cement sheet
Asbestos cement sheet behind ceramic tiles
Asbestos cement sheet internal over exhaust canopies such as ovens, fume cupboards, etc.
Asbestos cement sheet internal walls and ceilings
Asbestos cement sheet underlays for vinyl
Asbestos cement storm drain pipes
Asbestos cement water pipes (usually underground)
Asbestos-containing laminates (e.g. formica) used where heat resistance is required, e.g. ships
Asbestos-containing pegboard
Asbestos felts
Asbestos marine board, e.g. marinate
Asbestos mattresses used for covering hot equipment in power stations
Asbestos paper used variously for insulation, filtering and production of fire resistant laminates
Asbestos roof tiles
Asbestos textiles
Asbestos textile gussets in air-conditioning ducting systems
Asbestos yarn
Autoclave / steriliser insulation
B
Bitumen-based water proofing such as malthoid, typically on roofs and floors but also in brickwork
Bituminous adhesives and sealants
Boiler gaskets
Boiler insulation, slabs and wet mix
Brake disc pads
Brake linings

C
Cable penetration insulation bags (typically Telecom)
Calorifier insulation
Car body filters (not common)
Caulking compounds, sealant and adhesives
Cement render
Chrysotile wicks in kerosene heaters
Clutch faces
Compressed asbestos cement panels for flooring, typically verandas, bathrooms and steps for demountable buildings
Compressed asbestos fibres (CAF) used in brakes and gaskets for plant and automobiles

D
Door seals on ovens

E
Electric heat banks - block insulation
Electric hot water services - normally not asbestos but some millboard could be present
Electric light fittings, high wattage, insulation around fitting (and bituminised)
Electrical switchboards – see Pitch-based
Exhausts on vehicles

F
Filler in acetylene gas cylinders
Filters - beverage; wine filtration
Fire blankets
Fire curtains
Fire door insulation
Fire-rated wall rendering containing asbestos with mortar
Fire-resistant plaster board, typically on ships
Fire-retardant material on steel work supporting reactors on columns in refineries in the chemical industry
Flexible hoses
Floor vinyl sheets
Floor vinyl tiles
Fuse blankets and ceramic fuses in switchboards
Galbestos™ roofing materials (decorative coating on metal roof for soundproofing)
Gaskets - chemicals, refineries
Gaskets - general
Gauze mats in laboratories/chemical refineries
Gloves - asbestos

Hairdryers - insulation around heating elements
Header (manifold) insulation

Insulation blocks
Insulation in electric reheat units for air-conditioner systems

Laboratory bench tops
Laboratory fume cupboard panels
Laboratory ovens - wall insulation
Lagged exhaust pipes on emergency power generators
Lagging in penetrations in fireproof walls
Lifts shafts - asbestos cement panels lining the shaft at the opening of each floor, and asbestos packing around penetrations
Limpet asbestos spray insulation
Locomotives - steam; lagging on boilers, steam lines, steam dome and gaskets

Mastics
Millboard between heating unit and wall
Millboard lining of switchboxes
Mortar

Packing materials for gauges, valves, etc., can be square packing, rope or loose fibre
Packing material on window anchorage points in high rise buildings
Paint, typically industrial epoxy paints
Penetrations through concrete slabs in high rise buildings
Pipe insulation including moulded sections, water-mix type, rope braid and sheet
Pitch-based (e.g. zelemite, ausbestos, lebah) electrical switchboard
Plaster and plaster cornice adhesives

Refractory linings
Refractory tiles
Rubber articles - extent of usage unknown
S
Sealant between floor slab and wall, usually in boiler rooms, risers or lift shafts
Sealant or mastik on windows
Sealants and mastics in airconditioning ducting joints
Spackle or plasterboard wall jointing compounds
Sprayed insulation - acoustic wall and ceiling
Sprayed insulation - beams and ceiling slabs
Sprayed insulation - fire retardant sprayed on nut internally, for bolts holding external building wall panels
Stoves - old domestic type; wall insulation

T
Tape and rope - lagging and jointing
Tapered ends of pipe lagging, where lagging is not necessarily asbestos
Tilux sheeting in place of ceramic tiles in bathrooms
Trailing cable under lift cabins
Trains - country - guards vans - millboard between heater and wall
Trains - Harris cars - sprayed asbestos between steel shell and laminex

V
Valve, pump, etc. insulation

W
Welding rods
Woven asbestos cable sheath
Appendix No 2 – Selection and Use of PPE

Personal protective equipment may need to be used, in combination with other effective control measures, when working with asbestos-containing materials. The selection and use of PPE should be based on risk assessments and determined by a competent person.

The ease of decontamination should be one of the factors considered when choosing PPE. Where possible, disposable equipment should be used. All disposable PPE should be disposed of as asbestos waste.

Footwear and gloves

Laced boots should be avoided, as they can be difficult to clean and asbestos dust can gather in the laces and eyelets. Laceless boots, such as gumboots, are preferred where practicable, and boot covers should be worn where necessary.

Safety footwear must be decontaminated before leaving the asbestos work area for any reason, or sealed in double bags for use only on the next asbestos maintenance task. Alternatively, work boots that cannot be effectively decontaminated must be disposed of as asbestos waste at the end of the job.

The use of protective gloves should be determined by a risk assessment. If significant amounts of asbestos fibres may be present, disposable gloves should be worn. Protective gloves can be unsuitable if dexterity is required. Workers must clean their hands and fingernails thoroughly after work, and any gloves used they must be disposed of as asbestos waste.

Respirators

In general, the selection of suitable respiratory protection equipment depends on the nature of the asbestos work, the probable maximum concentrations of asbestos fibres that would be encountered in this work and any personal characteristics of the wearer that may affect the facial fit of the respirator (e.g. facial hair and glasses).

A competent person should determine the most efficient respirator for the task.

Respirators should comply with AS/NZS 1716-2003 Respiratory Protective Devices and be selected, used and maintained in accordance with AS/NZS 1715-1994 Selection, Use and Maintenance of Respiratory Protective Devices. They should always be worn under fitted hoods. Facepieces should be cleaned and disinfected according to the manufacturer’s instructions.

Respiratory protective equipment should be used until all contaminated disposable coveralls and clothing has been vacuum cleaned and/or removed and bagged for disposal, and personal washing has been completed. Respirators should be properly stored when not in use.
### Appendix No 3 – Asbestos Incident Report

<table>
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<tr>
<th>Salt Valley Road Class II Landfill</th>
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<tbody>
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**Class II Landfill Facility**  
Licence Number **XXX**  
Asbestos Incident Report No. ..........

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</tr>
<tr>
<td>Piping</td>
<td>□</td>
</tr>
<tr>
<td>Dust</td>
<td>□</td>
</tr>
<tr>
<td>Other</td>
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<td>Signature:</td>
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<td>Date Report Filed:</td>
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Appendix No 2 - Dust Management Plan
OPAL VALE SALT VALLEY ROAD
CLASS II LANDFILL
LOT 11 CHITTY ROAD, TOODYAY
DUST MANAGEMENT PLAN

Prepared for
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1. Introduction

Opal Vale Pty Ltd (Opal Vale) operates the Salt Valley Road Class II Landfill facility at Lot 11 Chitty Road, Hoddy’s Well, Toodyay.

This Dust Management Plan (DMP) has been developed to manage dust originating from on-site landfill activities as well as considering the adjacent clay extraction operation.

The objective of dust management will be to minimise significant impacts on amenity and environmental impacts as a result of dust emissions, with the primary focus of eliminating dust emissions beyond the Lot 11 property boundary.

Opal Vale takes the responsibility associated with dust management extremely seriously.

In accordance with the *Guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites and remediation and other related activities – Department of Environment and Conservation – March 2011*, the site activities, both landfill construction and operation are classified as Classification 1; hence, the activities are considered as having negligible risk, with no special provisions or contingency arrangements required.

2. Purpose

The purpose of this procedure is to:

- Identified potential dust sources;
- Provide guidance to the Site Operators on how best to manage dust emissions from site; and,
- Ensure appropriate dust management procedures are carried.

3. Reference

- Salt Valley Road Class II Landfill, Landfill Management Plan Section 12.7 – Dust Management.
- Environmental Protection Act 1986.
- A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites and remediation and other related activities – Department of Environment and Conservation – March 2011.
4. Distribution

This Plan is distributed to:

- All employees involved in the management and operation of the landfill site.
- Department of Environment Regulation.
- Customers as applicable.
- Any other relevant parties.

5. Definitions

**Dust** - the generic term used to describe solid airborne particles generated and dispersed into the air by processes such as handling, crushing and grinding of organic or inorganic materials such as rock, ore, metal, coal, wood or grain and stockpiling of materials.

**Nearest Receptor** – the single residential dwelling 1.35 km to the north east of the landfill site.

**Person in Control** - means a person who has control of the site. The person with control is the site supervisor or, when he is not on site, his nominated representative.

**Sensitive Receptor** - Individuals/communities/components of the environment which could be adversely affected by dust emissions, such as dwellings, schools, hospitals, offices, protected wetlands or public recreation areas that exist now and in the future.

**Site** – Lot 11 Chitty Road, Hoddy’s Well, Toodyay – Salt Valley Road Class II Landfill Facility.

**Site Operator** - means a person undertaking the operational activities of the site.

**Trigger Levels** - The “Corrective Action” trigger level is the ambient air dust level/condition which if exceeded will result in corrective action being taken to reduce dust emissions until the dust levels fall below the Corrective Action trigger level.

The Corrective Action trigger level is when dust is seen to be blowing close to a site boundary.

The “Work Stoppage” trigger level is the ambient air dust level/condition, which will result in Work Stoppage until the dust levels fall below the Work Stoppage trigger level.

The Work Stoppage trigger level is when all reasonable dust suppression strategies have been utilized and dust is seen to be blowing across a site boundary (dust suppression activities are no longer effective in controlling dust generated from site activities).

**Vehicle Driver** - means a person driving a vehicle, which either delivers or removes material (waste or recyclable materials) from the site.
6. Chemical Composition of Dust

The chemical composition of dust particles will depend on the nature of the source material. For example, wind-borne dust from cleared areas will reflect the composition of the underlying soil types. In cases where soil has been contaminated, dust may also be associated with inorganic and organic pollutants such as heavy metals and polycyclic aromatic hydrocarbons.

In this particular application the majority of dust being generated is as a result of the physical disturbance of natural soils and road surface material on site as a result of vehicle movements. The chemical composition of this source of dust will typically reflect the underlying soil type on site or road surface material utilised (gravel).

To a lesser extent dust will be generated by the mechanical handling of waste materials delivered to site. The chemical composition of this source of dust will reflect the type of waste and recyclable material being handled. As a Class II landfill site there are strict controls (Landfill Waste Classification and Waste Definitions 1996 - as amended December 2009) on the type of materials received on-site. Typically the dust generating waste materials will consist of minor quantities of sand, building rubble, asphalt and sawdust.

7. Site Background

Lot 11 Chitty Road is within the Shire of Toodyay, approximately 65 km northeast of Perth and 13 km south of the town site of Toodyay. The total property is 619 ha in size, however, the landfill operations occupy approximately 50 ha in the south east corner of the site. A large portion of the site has previously been cleared for grazing, including the immediate surrounds of the landfill operational area.

8. Receptors

The landfill site only occupies a small 50 ha portion of the overall 619 ha lot. Land uses surrounding Lot 11 include:

- Remnant native vegetation to the north and east.
- Remnant native vegetation and a clay pit to the south.
- Remnant native vegetation and partially cleared land for livestock grazing to the west and southwest.
- Nearest Receptor, is a neighbouring residential property approximately 1.35 km to the north east of the proposed landfill site.
- There are no Sensitive Receptors or sensitive environmental areas immediately adjacent to Lot 11.

Environmental regulations require that dust not be emitted beyond the property boundary (Lot 11). Although there is no receptor immediately beyond the site boundaries it is essential that dust emissions be managed to eliminate dust blowing from the site.
9. Site Weather Data

The nearest weather station to the site is the Northam weather station (Station No. 010111), approximately 20 km to the east of the site.

Northam has an average annual rainfall of 426 mm with the vast majority (75%) of the rain falling between May and September each year. The period October to April is the main period when dust management strategies will need to be actively implemented; however, there will still be occasional dust management activities during the winter months, typically during the shoulder periods.

During October to April the typical average monthly wind pattern is for south easterly and easterly winds to blow in the morning and westerly and south westerly winds in the afternoon. The maximum wind speed is in the order of 30 km to 35 km per hour. Mornings tend to have the longer windy periods. Detailed weather data is available on the Bureau of Meteorology website bom.gov.au.

Attachment No.1 – Northam Weather Station Annual Wind Roses provides the annual wind roses from the Northam weather station for 9.00 am and 3.00 pm.

10. Implementation Rationale

The rationale for the implementation of dust suppression strategies is to eliminate visible dust emissions beyond the site boundaries.

The Corrective Action trigger level is when dust is seen to be blowing close to a site boundary.

Following the identification of the Corrective Action trigger level and the subsequent implementation of dust suppression strategies, should these activities not adequately prevent dust emissions beyond site the boundary, further dust suppression strategies should be implemented or existing strategies revised to improve system efficiencies.

Following the implementation of all reasonable dust suppression strategies, should Work Stoppage trigger levels be reached, where there is still visible dust emissions beyond the site boundary, the particular activity causing the excessive dust emissions will be stopped until ambient weather conditions (wind) improve so as to eliminate dust emissions beyond the site boundary.
11. **Sources of Dust Generation**

Potential sources of dust emissions include:

- Construction activities;
- Vehicle movements along access roads;
- Landfill active tipping area activities;
- Loading and unloading of cover material;
- Vehicle wheels spreading dirt around the site; and,
- Adjacent clay extraction operations (existing activity).

All identified sources are deemed relatively minor and easily manageable within the confines of the Prescribed Boundary and the larger Lot 11.

12. **Dust Mitigation Strategies**

There will be a number of dust mitigation strategies that will be employed in order to reduce dust emissions on-site. The mitigation strategy will be a function of the source of dust generation.

12.1. **Construction Activities**

As part of the construction activity, the construction contractor will be required to control dust. During construction, the primary source of dust generation will be vehicle movements along access roads. This dust will be controlled by using a water tanker to wet down the roads.

There will only be minimal dust generated during earthworks as the insitu clayey material will be moist when excavated and moisture conditioned (moisture added) prior to fill compaction. Even the use of stockpiled material will not generate excessive dust, as has been observed during the clay extraction operation, where only access road dust suppression has been required. This will be primarily due to the schistose nature of the clayey material where it is not a true clay material as it lacks the finer clay particles, which are the particles that generate the most dust.

12.2. **Vehicle Movements Along Access Roads**

The type of construction materials used on the road surface will significantly influence the generation of dust. All internal roads (excluding those on the landfill) consist of a gravel surface layer (wearing course). This road construction material will result in some minor dust being generated by vehicle movements along internal access roads; consequently, dust management strategies will be required to be implemented.
Speed is the primary cause of dust generation from vehicles moving along access roads. The reduction of vehicle speed will be the primary method for reducing the generation of dust. A maximum site speed limit of 40 km per hour will be enforced. Appropriate signage will be utilised to indicate the maximum speed limit. Should dust generation continue to be a problem at 40 km per hour, the speed limit will either be reduced or alternative dust control strategies employed to reduce dust emissions.

The primary means of dust suppression along all internal roads will consist of watering via water tanker. The site water tanker will be used on an as needed basis to spread appropriate quantities of water to prevent excessive dust generation as a result of vehicle movements along internal access roads. The "appropriate quantities of water" will be dependent on the ambient weather conditions (heat and wind speed), number of traffic movements and the performance of the road construction material (gravel surface); hence, it will not be appropriate to determine a prescribed application rate. The application rate will be varied dependent on site conditions. The determining factor influencing the water application rate will be the quantity of dust being generated.

Adequate dust suppression will also be achieved by the use of dust suppression agents (Dustex or similar). These dust suppression agents will be spread using the water tanker and in accordance with the manufacturer’s recommendations (application rates). Again dust suppression agents will be used in conjunction with the water tanker to provide additional dust suppression capabilities. Dust suppression agents are ideal for the main internal access roads to reduce water tanker activity and water consumption.

12.3. Landfill Active Tipping Area Activities

The water tanker will be used within the landfill area to suppress dust along the access roads and on the active tipping area. The unloading, placement and compaction of waste material will be unlikely to generate excessive dust (minor dust contributor). If a particular dusty load of waste material were received during periods of adverse weather conditions, the material will be unloaded as close to the landfill tipping face as possible, wet down by the water tanker and left until weather conditions improve. Once weather conditions have improved, only then will the dusty load be pushed and compacted into the landfill.

12.4. Loading and Unloading of Cover Material

Due to the nature of this activity it will be difficult to adequately control dust emissions during adverse weather conditions; however, this activity will not be seen as a potential major contributor towards dust loading on site. The primary method for controlling dust emissions would be, where possible, to delay these activities until weather conditions improve. Where this were not possible, due care would be taken to place the material in vehicles and not drop it from a height. There will be little option for change of methodology with regards to unloading of vehicles during adverse weather conditions. There may; however, be opportunities to load and unload vehicles further away from the site boundary to reduce the risk of dust emissions blowing beyond the boundary.
12.5. Vehicle Wheels Spreading Dirt Around the Site

The site is an active clay pit and landfill facility with non-sealed access roads; consequently, there will be some spreading of dirt in and around active areas on site. The quantity and consequence of the spreading of dirt will be minimal such that it could be managed by the use of a water tanker as part of the usual dust suppression activities on the site assess roads.

12.6. Adjacent Clay Extraction Operation (Existing Activity)

Austral Bricks has been excavating and removing clay material from site for many years without causing dust generation issues. The use of a water tanker to wet down the internal access roads is all that has been necessary to manage dust from this operation. As mentioned above, the schistose nature of the material being excavated results in low dust generation and hence, can be easily managed.

13. Water Source

The primary source of dust suppression water will be from the water storage ponds within the clay void (existing source) and from the new surface water storage dam external to the clay pit. In addition, leachate will be used for dust suppression on the internal access roads within the lined landfill area.

As a fallback position, there will also be water available from the adjacent BGC clay void if required.

14. Emissions Limits

There is a target of no visible dust emissions beyond the Lot 11 property boundary and nil community complaints.

15. Monitoring

Dust emissions will be visually monitored on a continuous basis by site operations staff. The facility will also maintain a comprehensive complaints register, which will be used as a gauge of success with regards to dust emissions management. In the event that there be a dust emissions issue identified, formal dust monitoring will be undertaken by an independent third party to determine the extent of the problem and propose appropriate improved dust management solutions.
16. Dust Management Response Plan

In the event that the regular dust monitoring identifies potential problems with the dust management activities, a response plan will be implemented. This response plan will incorporate the following:

- Assess the location that has been identified as a problem and consider the possible cause(s);
- Consider the impact of the problem(s);
- If possible, rectify the problem (eg. increased use of the water tanker);
- If not possible to rectify the problem (eg. dust from cover material handling), assess the likely impact on neighbouring properties and whether there be any contingency measures that could be implemented to minimise the impact (eg. stop the activity or move further away from the site boundary);
- Consider amending the standard operating procedures if the current procedures are ineffective (eg. increase stockpiled material at the active tipping area during low wind periods to allow for suspension of this activity during high wind periods).

It will not be possible to develop a response plan that covers each likely eventuality and proposed feasible solutions to those possible problems. In the event that a problem be identified, the appropriate specialist will be engaged to develop an incident specific remedial solution. Depending on the degree of the incident, the DER may need to be involved in the process.

17. Responsibility

The Person in Control of the site has a duty of care to:

- Implement, maintain and update this DMP.
- Ensure adequate appropriate training of Site Operators.
- Assess the effectiveness of the various dust suppression strategies implemented on site.
- If necessary, develop measures to improve the dust suppression strategies utilised on site (may include obtaining specialist technical assistance).
- Ensure the appropriate maintenance of dust suppression systems.
- Maintain adequate supplies of appropriate dust suppression system spares on-site.
- Monitor dust emissions beyond the site boundary.
- Ensure that this dust management plan is regularly reviewed.
Site Operator(s) has a duty of care to:

- Be aware of the site dust suppressions strategies.
- Ensure that dust suppression systems are utilised when weather conditions dictate.
- Report faulty or inefficient dust suppression systems to the Person in Control.

Vehicle Driver(s) has the duty of care to:

- Comply with site speed restrictions.
- Obey site-specific instructions directed towards reducing dust emissions.

18. Awareness Training

Information and training is to be provided on an as needed basis to Site Operators, Vehicle Drivers, contractors and others who may be involved in on-site activities that could generate dust emissions.

If adequate in-house expertise is not available to undertake the training, suitable external training will be made available.

The dust management awareness training is to include:

- The purpose of the training.
- The potential sources of dust emissions.
- Available dust suppression methodologies.
- The trainees’ roles and responsibilities under the DMP.
- Site operating licence conditions surrounding the management of dust on site.
- Provision of a copy of the DMP.

19. Plan Review

This Plan is to be reviewed by the Person in Control at least every three years or more regularly if circumstances warrant.
Appendices

Appendix No 1 – Northam Weather Station Annual Wind Roses

Rose of Wind direction versus Wind speed in km/h (01 Jan 1965 to 30 Sep 2010)

Custom times selected, refer to attached note for details

NORTHAM
Site No: 010111 • Opened Jan 1877 • Still Open • Latitude: -31.6508° • Longitude: 116.6586° • Elevation 170m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am
15478 Total Observations

Calm 27%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1965 to 30 Sep 2010)
Custom times selected, refer to attached note for details

NORTHAM
Site No: 010111 • Opened Jan 1877 • 548 Open • Latitude: -31.6508° • Longitude: 116.6586° • Elevation 170m
An asterisk (*) indicates that calm is less than 0.5%,
Other important info about this analysis is available in the accompanying notes.

3 pm
14954 Total Observations

Calm 11%
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1. Introduction

Opal Vale Pty Ltd operates a Salt Valley Road Class II Landfill facility at Lot 11 Chitty Road, Hoddy’s Well, Toodyay. Related activities on site have the potential to result in a fire and hence, fire management is an ever-present concern.

This Fire Management Plan (FMP) has been developed to manage fires originating from on-site activities as well as fires from neighbouring properties.

The objective of this FMP is to increased awareness of the potential dangers of fires as well as minimise the impact of fires.

Opal Vale takes the responsibility associated with fire management extremely seriously.

2. Purpose

The purpose of this Plan is to:

- Identified potential on-site sources of fires.
- Provide guidance to the Site Operators on how best to prevent fires.
- Provide guidance to the Site Operators on how best to manage fires.
- Ensure appropriate fire management procedures are carried out.
- Protect life and property.
- Maintain the rural character of the Shire.

3. Reference

- Shire of Toodyay Firebreak Orders & Fuel Hazard Reduction.
- Bush Fires Act 1954 (as amended).

4. Approval

The development of this FMP is a requirement of the State Administrative Tribunal (SAT) Planning Approval and the Department of Environment Regulation (DER) Works Approval. This Plan has been developed to the satisfaction of the Shire and the DER.
5. Distribution

This Plan is distributed to:

- All employees involved in the management and operation of the landfill site.
- The Shire of Toodyay.
- Department of Environment Regulation.
- Landowner.
- Austral Bricks (adjacent clay extraction operation).
- BGC (adjacent clay extraction operation).
- Any other relevant parties/stakeholders.

6. Definitions

**Customer** - means a person driving a vehicle, which either delivers or removes material (waste or recyclable materials) from the site.

**Minor Fire** - means a fire that originates on-site and is able to be immediately extinguished by Site Operators.

**Person in Control** - means a person who has control of the site. The person with control is the site supervisor or, when he is not on site, his nominated representative.

**Significant Fire** – means a fire that originates on-site and is NOT able to be immediately extinguished by Site Operators. This is a fire that requires off-site assistance in order to bring it under control.

**Site** – The Prescribed Boundary within Lot 11 Chitty Road, Hoddy’s Well, Toodyay – Salt Valley Road Class II Landfill Facility.

**Site Operator** - means a person undertaking the operational activities of the site.

7. Site Background

Lot 11 Chitty Road is within the Shire of Toodyay, approximately 65 km northeast of Perth and 13 km south of the town site of Toodyay. The total property is 619 ha in size, however, the landfill operations occupy approximately 50 ha in the south east corner of the site. A large portion of the site has previously been cleared for grazing, including the immediate surrounds of the landfill operational area.
8. Implementation Rationale

The rationale for the implementation of fire management strategies is to:

- Reduce the risk of fires occurring on site.
- Reduce the damage caused by fires.
- Reduce the risk of fires damaging neighbouring properties.
- Reduce the potential for off-site fires to cross the site boundary.

Should a fire be present on-site or within the immediate area, this FMP will assist in the management of fires as well as the protection of life and property.

9. Fire Mitigation Strategies

There are a number of fire mitigation strategies that will be employed in order to reduce the risk of fires occurring on-site as well as minimise the impact of fires. The mitigation strategy is a function of the type and size of the fire.

9.1. Prevention Strategies

9.1.1. Training

Fire awareness training is an essential activity to reduce the occurrence and improve the management of fires.

All Site Operators are to undergo appropriate fire awareness training. This fire awareness training is to cover all aspects relating to the potential occurrence of fires on site as well as the appropriate management of the various types of fires (ordinary combustibles, electric fires, hydrocarbon fires).

Customers, contractors and visitors are to be provided with sufficient information to enable awareness of potential fire sources as well as appropriate evacuation procedures.

9.1.2. Signage

Appropriate signage is to be installed on site in order to ensure sufficient fire awareness information is available to users of the site. Typical signage would include:

- Evacuation assembly points.
- No smoking signs.
- On-site fires prohibited.
- Fire extinguisher/equipment positions.
- Emergency contact details (during working hours and after hours).
- Additional signs as required.
9.1.3. Site Security

The maintenance of adequate site perimeter fencing to restrict unauthorised site access and potential vandalism.

9.1.4. Fire Breaks

The construction and maintenance of adequate firebreaks is an essential activity as well as a requirement under the *Shire of Toodyay Firebreak Orders & Fuel Hazard Reduction*.

Firebreaks, of a minimum 3 m wide, 3 m vertical clearance and four wheel drive accessible, are to be constructed and maintained along the complete landfill Prescribed Boundary within 10 m of the boundary and within 7 m around any buildings, or fuel storage areas. The firebreaks are to be maintained during the period 1 November through to 30 April of each year.

Should firebreaks not be able to be installed with in 10 m of the Prescribed Boundary, then a Variation to Firebreak is to be applied for to the Shire of Toodyay. This application is required before 1 October each year.

The firebreaks around the site boundary (Lot 11) are the responsibility of the landowner.

Appendix 1 – Firebreak & Assembly Point Site Plan provides details of the firebreaks around the site.

9.1.5. Fire Hazard Reduction

In addition to the construction and maintenance of appropriate firebreaks, it is essential to reduce the potential fire hazard by removing excess dead vegetation matter (fire fuel) from site as well as ensure the appropriate containment (landfilling) of flammable waste materials. This activity is to continue during the period 1 November through to 30 April of each year.

9.1.6. Landfill Operations

A range of landfill operational activities will also improve the fire resistance of the landfilled waste. These include:

- Appropriate waste compaction;
- Application of adequate waste cover;
- Not placing significant quantities of flammable material in a single area within the landfill (piles of tyres); and,
- Not drawing excessive oxygen into the waste mass through the landfill gas extraction system.
9.1.7. Communication

The appropriate communication channels with the Shire, Fire and Emergency Services and local community is essential in the proactive management of fires within the immediate area.

TO REPORT A FIRE DIAL 000

For SMS notifications on Total Fire Bans register at 9395 9500

Shire Office – General Enquiries
9574 2258

Shire Ranger Service – General Enquiries
9574 4555

Toodyay Police Station
9574 9555

Chief Bush Fire Control Officer
0448 284 258

Deputy Chief Bush Fire Control Officers
Mick Rogers – 0428 583 954
Mark Briggs – 0419 048 773
Craig Stewart – 0438 742 037

Community Emergency Services Manager
0458 042 104

Morangup District
Captain Jeff Venn – 0417 714 798
Kim Maddrell – 0477 471 323
Craig Stewart – 0438 742 037
Dieter Bartels – 0428 111 701

Department of Fire and Emergency Services website – www.dfes.wa.gov.au

9.2. On Site Fires

9.2.1. Landfill Fires

There is a risk associated with spontaneous combustion of materials placed within the landfill. Due to the mixed nature of the waste there is potentially material in the waste that if they come into contact, will spontaneously combust, resulting in a landfill fire. These landfill fires are a more common occurrence on the surface of the landfill, but occasionally, occur as subterranean fires.
9.2.2. Equipment Fires
There is a risk associated with fires originating from mobile and static equipment on site. Typically this will result from equipment failure such as electrical systems or hydraulic hoses.

9.2.3. Minor Fires
There is a risk of minor fires occurring on site. These would typically be from the uncontrolled disposal of cigarette butts and other careless activities on-site.

9.3. Off-Site Fires
The Site Operators have little influence over the source of off-site fires; however, they do have an ability to influence the on-site damage caused as a result of this type of fire.

Perimeter firebreaks are the primary mechanism to reduce the potential for off-site fires from entering the site. The effectiveness of firebreaks will be a function of the size of the neighbouring fire and prevailing weather conditions.

Reducing the quantity of combustible material (dead vegetation) on site will significantly reduce the impact of an off-site fire should it breach the perimeter firebreaks.

9.4. Fire Fighting Equipment

9.4.1. Equipment
The availability, maintenance and knowledge of the use of appropriate fire fighting equipment is essential in being able to manage fires on-site.

Due to potential after-hours theft of fire fighting equipment, all portable equipment will be locked up and secured at night. At the commencement of each day’s operations, the Site Operators are to ensure that this mobile fire fighting equipment is readily available to immediately react to an on-site fire.

9.4.2. Water Cart
The water tanker doubles as a dedicated fire-fighting unit and will be the primary fire fighting piece of equipment.

9.4.3. Fire Extinguishers
Portable fire extinguishers are to be readily available to extinguish equipment fires and fuel storage area fires.
10. Fire Identification Procedures

In the event of a fire, the person first identifying the fire is to report the fire to the Person in Control. The Person in Control is to determine whether the fire is deemed a Minor Fire or a Significant Fire.

In the event of a Minor Fire, the site personnel are to fight the fire utilising on-site fire fighting equipment.

In the event of a Significant Fire, the Person in Control is to immediately report the fire to the Shire Ranger and Emergency Services in order to obtain the necessary assistance to manage the fire.

In the event of a significant off-site fire, the Person in Control is to liaise with the Shire Ranger and Emergency Services to determine the extent of the fire and the possible need to evacuate the site.

11. Evacuation Procedure

In the event of a Significant Fire on-site or within the immediate area threatening the site, all non-essential site personnel are to evacuate to the site emergency assembly point and await further instructions from the Person in Control.

Appendix 1 – Firebreak & Assembly Point Site Plan provides the location of the Site Assembly Point.

12. Reporting

As soon as is reasonable following the identification of a Significant Fire, the Person in Control is to report the fire to the appropriate authority. The reporting requirements will depend on the size and location of the fire.

The facility landfill operating licence will determine under which events a fire is required to be reported to the DER. Typically these will relate to fires directly on the landfill.

A Significant Fire is to be immediately reported to the Shire Ranger and Emergency Services.

A Minor Fire is not deemed as being reportable to any authority (unless the facility operating licence requires otherwise).

Any incidences of a fire suspected to have been caused by vandalism are to be reported to the local police.
13. Responsibility

The Person in Control of the site has a duty of care to:

- Implement, maintain and update this FMP;
- Ensure that the fire prevention strategies are appropriately maintained;
- Ensure adequate appropriate training of Site Operators;
- Assess the effectiveness of the various fire management strategies implemented on site;
- If necessary, develop measures to improve the fire management strategies utilised on site (may include obtaining specialist technical assistance);
- Ensure the appropriate maintenance of fire fighting equipment and PPE;
- Maintain adequate supplies of appropriate fire fighting spares on-site;
- Ensure the safety of all visitors to site in the event of a Significant Fire;
- Report fires to the Shire, DER and police as required by this Plan; and,
- Ensure that this FMP is regularly reviewed.

Site Operator(s) has a duty of care to:

- Be aware of the site fire management strategies;
- Ensure that fire management strategies are utilized as appropriate in the event of a fire;
- Report faulty or inefficient fire fighting equipment to the Person in Control;
- Inspect incoming waste for possible ignition sources;
- Notify the Person in Control of any fires that are detected on site or in the immediate area surrounding the site (neighbouring properties);
- In conjunction with the Person in Control, assess the condition of any fires and implement the appropriate fire management procedures;
- Utilise appropriate PPE and fire fighting equipment; and,
- Complete the appropriate Fire Incident Report as necessary and pass on to the Person in Control.

14. Awareness Training

Information and training is to be provided on an as needed basis to Site Operators, Customers, Contractors and others who may be involved in on-site activities that have the potential to cause a fire.

If adequate in-house expertise is not available to undertake the training, suitable external training will be made available.
14.1. Site Operators

The fire management awareness training is to include:

- The purpose of the training;
- The potential fire sources;
- Available fire mitigation strategies;
- Basic fire fighting techniques;
- The trainees’ roles and responsibilities under the FMP;
- Site evacuation procedures;
- Site operating licence conditions surrounding the management and reporting of fires on site;
- Where the facility’s Fire Register is located and how Fire Incident Report forms can be accessed;
- The processes and procedures to be followed when completing the Fire Register and Fire Incident Report; and,
- Provision of a copy of the FMP.

As a minimum, Site Operators are to undergo fire awareness training:

- On commencement of operations on site;
- When a new potential fire hazard has been identified; and,
- Every three years.

14.2. Customers, Contractors and Visitors

The fire management awareness training is to include:

- Appropriate signage in areas of potential fire risk.
- Site evacuation procedures.
- Specific training as deemed appropriate by the Person in Control.

15. Review

This Plan is to be reviewed by the Person in Control at least every three years or more regularly if circumstances warrant.
Appendices

Appendix No 1 – Firebreak and Assembly Point Site Plan
# Appendix No 2 – Fire Incident Report

## Opal Vale Pty Ltd
Lot 11 Chitty Road, Hoddy’s Well, Toodyay

**Salt Valley Road Class II Landfill Facility**  
Licence Number 

**Fire Incident Report No. ……**

### Date & Time Incident Occurred:

<table>
<thead>
<tr>
<th>Date &amp; Time Incident Occurred</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Type of Fire:

- Minor [ ]
- Significant [ ]
- Off-Site [ ]
- Other [ ] Specify _____________________

### Reported to:

- Shire [ ]
- FESA [ ]
- DER [ ]
- Other [ ] Specify _____________________

### Description of Incident:

- ________________________________________________
- ________________________________________________
- ________________________________________________

### Person Responsible for Coordinating Activities

- **Name:** __________________________
- **Designation:** ______________________

### Activities Undertaken:

- ________________________________________________
- ________________________________________________
- ________________________________________________

### Future Preventative Measures Adopted:

- ________________________________________________
- ________________________________________________
- ________________________________________________

### Site Supervisor (Person in Control)

- **Name:** __________________________
- **Signature:** ______________________
- **Date Report Filed:** __________________
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1. Introduction

Opal Vale Pty Ltd (Opal Vale) is committed to the comprehensive closure and rehabilitation of the Salt Valley Road Class II landfill site. This Rehabilitation Management Plan (RMP) sets out the activities to be undertaken as part of the rehabilitation of the site.

The landfill will be progressively closed. As individual landfill cells or portions of the landfill reach the ultimate design profile, these areas will be capped, rehabilitated and closed off.

This RMP provides the framework for the proposed closure and rehabilitation of the landfill site.

2. Future Site Usage

Following the closure and final rehabilitation of the landfill site, the area of past waste placement will be returned back to native vegetation, while the remainder of the area within the Prescribed Boundary will be returned to pasture and/or crops.

An important aspect is to prevent stock from accessing the landfill capped area to enable it to completely rehabilitate over time back to a native bush environment.

3. Site Closure Preparation

At the end of the active landfilling operations, the weighbridge, gatehouse, staff amenities and workshop infrastructure will be removed from site. Internal access roads that are no longer required will be ripped and the area rehabilitated.

The leachate and landfill gas management infrastructure will remain for many years beyond the closure of the landfill operations. These remaining facilities may require additional security measures to be installed to reduce the possibility of vandalism as a result of the site no longer being manned.
4. Landfill Closure

4.1. Environmental Impact

The environmental and social impact of a closed landfill is a function of the type and quantity of waste contained within the landfill, the quality of landfill closure and the distance from the facility to the nearest receptor(s).

The landfill site will be developed and managed to industry best practise and a substantial environmental barrier installed as the landfill cap. Based on these activities, it is not anticipated that there will be any negative environmental impact as a result of the landfill closure. In addition to this, the nearest neighbouring residence is 1.35 km to the north east, which is well beyond the required 150 m buffer zone around the landfill; hence, this receptor will not be impacted by the closure of the facility.

4.2. Closure Capping

The final outcome of the rehabilitated landfill surface is to provide an environment that is long-term sustainable and that will not need ongoing maintenance into the future.

Any significant maintenance work carried out on the landfill cap will result in machinery having to drive over the rehabilitated surface, causing significant damage to the surface and vegetation cover. If this work is done during the wet season when the capped surface is soft, the machinery damage will be significantly greater than if the work were carried out in summer. Consequentially, it is critical that all capping construction and rehabilitation work be carried out to the best possible standard to ensure the least ongoing maintenance requirements.

4.3. Final Landfill Profile

The landfill closure incorporates a final landfill cap with a pre-settlement waste profile at a maximum slope of 1V in 5H (20%). This provides a gradient that achieves a stable, easily manageable slope for capping, rehabilitation and future maintenance.

Appendix No. 1 – Final Pre-settlement Waste Profile Layout Plan provides the design of the final landfill profile.

Over time, the waste mass will settle. This settlement is anticipated to be up to 15% of the waste height. Based on the depth of the waste in the landfill, there could be up to 4 m of settlement at the deepest part of the landfill, tapering gradually down to zero at the landfill perimeter. The impact of this settlement will be to reduce the overall slope on the landfill cap from 1V in 5H, to approximately 1V in 6H. The majority of the settlement will occur uniformly, proportional to the waste depth below the capped surface; however, there will be some localised areas where differential settlement will occur. This differential settlement is not anticipated to be overly dramatic that it will impact on the integrity of the capping system.
4.4. **Progressive Closure**

It is essential that the landfill be progressively closed and capped as the waste reaches the final waste profile and the capping construction not be left to the end of the landfill life. The benefits of continuous closure include:

- Progressively closing off portions of the site;
- Increased ability to shed surface water off the landfill and hence reducing the quantity of leachate being generated;
- Reducing the ongoing closure liability costs for the landfill as these costs are incurred progressively through the life of the landfill;
- Using the capping costs incurred, as a guide to assist in determining the closure reserves that will be required towards the end of the life of the landfill and during the post closure period;
- Reduced litter generation; and,
- Improved aesthetics.

4.5. **Landfill Gas Management**

Active landfill gas extraction will continue for potentially 30 years beyond the operational life of the landfill. Based on forecast landfill gas generation quantities, it is anticipated that the peak gas production will occur approximately two years after the closure of the Stage 1 landfill, and beyond that, start to slowly drop off. Theoretical gas decay curves indicate that landfill gas will continue to be generated within the landfill for up to 70 years beyond the closure of the landfill; however, active extraction is only anticipated to occur for up to 30 years.

Beyond the active extraction phase, when the landfill is only generating small quantities of gas, the soil landfill capping layer has an ability to oxidise some methane as the landfill gas passes through the cap and hence reduce the emissions from the site.

4.6. **Leachate Management**

The active leachate management will typically continue in line with landfill gas production as gas production is an indicator that the landfill waste mass is still biodegrading and hence producing leachate. Consequently, leachate management is likely to continue for potentially 30 years beyond the operational life of the landfill. It is however anticipated that the quantity and contamination level of the leachate will decrease over time (again, in conjunction with the decrease in landfill gas quantity).
4.7. Infrastructure Requirements

There will be a need for perimeter fencing to be installed around the capped surface to control fauna and stock access, to prevent damage to the vegetation and capped surface. Some existing fencing may still be in place as part of the previous landfill operations, but most of this would be removed to facilitate the construction of the capping layer.

After approximately 15 years of landfill closure (half way through the 30 post closure gas and leachate management period), it will likely be necessary to replace the gas flaring system and some, if not all of the leachate pond liners.

4.8. Surface Preparation

Once waste placement has ceased in an area and the final waste profile obtained, the area is to be well compacted (by the waste compactor) to provide a firm waste surface and then covered with temporary cover material (300 mm deep). This surface will then be left for potentially up to 12 months while further areas of the landfill reach final waste profile. During this period, vertical gas wells of up to 20 m deep will be drilled into the waste mass and connected, via a network of distribution pipes to the flare.

4.9. Capping Area

Once there is a reasonable area of completed waste placement a contractor will install the capping works in accordance with the DER Works Approval. Typically there will need to be approximately 2 ha of capping to be undertaken to justify the mobilisation of a contractor and provide sufficient area for up to 10 gas wells. It is also not ideal to have numerous small areas being capped as the capping system then ends up with significantly more construction joins between these small capped areas. Two hectares is seen as an efficient area for a single campaign capping exercise. This would equate to four campaigns for the Stage 1 landfill area (9 ha).

4.10. Capping System

The landfill cap will consist of a geosynthetic lining system overlaid with a 1 m to 2 m layer of clayey material sourced from onsite available materials. This will typically consist of overburdened clay from the existing and future clay excavation.

The capping layer will be a minimum of 1 m thick, and up to a maximum of 2 m. The thicker zones will enable clusters of deeper-rooted species to thrive on the capped surface; hence, providing vegetation diversity.

It is not proposed that a dedicated layer of topsoil be utilised as this is not the naturally occurring situation in the local environment and will primarily promote weed growth. Native vegetation is adequately surviving in the surrounding environment and hence replicating these environmental conditions should be sufficient to sustain native vegetation on the landfill capped areas. By the addition of an organic rich topsoil layer, weed species will thrive to the detriment of the native vegetation.
The capping system is a relatively complex arrangement of geosynthetic and soil layers to achieve the desired maximum allowable leakage rate through the cap. The stability of this capping system is a critical component in the long-term sustainability of the layer works. Prior to any capping works being carried out, the design of the capping system needs to be confirmed by a suitably qualified design engineer in conjunction with the proposed materials to be incorporated into the cap. Prior to construction, the specific geotechnical properties of the particular materials need to be assessed against the theoretical design parameters.

Figure 4.10.1 – Capping System Configuration

4.11. Capping Material

4.11.1. Purpose

The intention of the waste cap is to provide a long-term sustainable barrier between the waste and the environment. The capping system is designed to limit the ingress of moisture to 75% of the leakage rate through the base liner, so as not to accumulate leachate within the landfill.

The intended purpose of the landfill cap includes:

- Provision of a barrier between the waste and the environment;
- Control of moisture ingress;
- Provides a habitat for the establishment of native vegetation;
- Control of erosion of the cap material;
- Prevent vermin access to the decomposing waste;
• Control odour emissions;
• Encourage excess stormwater runoff;
• Ability to accommodate waste settlement;
• Oxidise limited amounts of landfill gas; and,
• Improved aesthetic appeal of the site.

4.11.2. Natural Soil

The natural soil in the immediate area (and the majority of the region) is fine-grained silty soil and hence has a relatively low permeability. This soil is well suited for use as the uncompacted growing medium on top of the geosynthetic liner. This is based on the following:

• The natural soil allows surface water to slowly permeate into the cap and be absorbed and stored in the cap (to sustain the vegetation cover). Excess moisture will either pass through the soil layer into the drainage layer above the geosynthetic liner and be drained out of the cap or be shed off the surface of the landfill;

• Is suitable for vegetation to establish on the surface (moisture retention); and,

• Wind and water erosion can be managed.

There will over time be a large surface area of landfill to cover (9 ha) and a limited amount of overburden soil available within the clay operations. Austral Brick removes between 1 m and 2 m of overburden from the pit prior to excavating of useful clay material. This overburden soil supply needs to be carefully managed during landfill operations to ensure that there is sufficient material available for the capping layer and is not to be used for daily or intermediate cover material. Progressive capping of the completed areas of the landfill will ensure that the overburden soil is apportioned appropriately and not simply consumed as regular cover material.

It is preferable that, if there is to be a shortfall in naturally occurring soils (overburden and other clayey materials not suitable for brick and tile manufacturer), that this soil be utilised as landfill capping material in preference to regular cover material. The native vegetation is thriving in this soil; hence, it is better to use this material in the final cap and imported material as regular cover material (which may be less suitable for sustaining the native vegetation).

4.11.3. Imported Capping Material

If there is insufficient onsite capping material, then there will be a need to import additional material. As mentioned above, it is preferable to use the imported material for regular cover material and the naturally occurring overburden material for final capping material.

If imported material is required, ideally, this material should be sourced from the local environment, as this is the soil that the native vegetation is growing in. If soil is imported from afar, it may be that the native vegetation will not survive in that soil.
type or struggle to survive and hence leave a cap that will always look like a “capped landfill” and not blend into the natural surroundings.

If the imported soil is sourced from different locations, where possible it should be blended to achieve a homogeneous mix. This will provide a more consistent soil type across the landfill and hence there is more likely to be uniform vegetation growth on the capped surface and hence a more natural appearance.

4.12. Growing Medium Thickness

The thickness of the growing medium will primarily be a function of vegetation survival and diversity. If the layer is too thin, the vegetation will only survive for a few years until the plants’ water demand is greater than the moisture retention in the soil. At this time certain species will start to die off and the cap will be left vegetated with one or two species of small shrubs. The cap should ideally be approximately 2 m thick; however, this consumes large quantities of capping material. As a minimum the cap should be at least 1 m thick with substantial areas of up to 2 m.

If a thinner cap (<1.0 m) is utilised it is likely that this depth of cap will be less sustainable, the vegetation will not adequately survive and the capping material will be subjected to progressive erosion (wind and water) and ultimately the landfill cap will need to be reinstated at sometime in the future (at significant additional cost).

4.13. Vegetation

Native vegetation is to be used on the landfill cap. The primary reason is that the native vegetation is currently thriving in the remaining vegetated portions of the site, once established; the capped landfill surface would blend into the natural environment, be long-term sustainable and provide an improved habitat for small native fauna.

The plant species will be selected from a range of shallow rooted plants and shrubs, ideally similar to the surrounding vegetation on site. Prior to the cap construction, a specialist native vegetation horticulturist will be consulted to determine the most appropriate plant species to utilise. The horticulturist will advise and arrange for the collection of native seeds from the larger Lot 11 or further afield. These seeds will be used to rehabilitate the capped surface, as well as spare seeds retained for infill seeding in the event that there are some barren patches on the cap.

Ultimately it is a matter of trial and error to see which plant species survive on the landfill capping surface. Initially a wide range of up to 15 species will be utilised (subject to the advice of the horticulturist) and then over time (a number of years) the stronger species will outperform those that are not suited to the landfill capping environment.

It is preferable to broadcast seeds across the landfill cap as opposed to planting tube stock. The primary advantage is that a significantly larger number of seeds can be applied to the landfill cap for the same effort/cost as would be applicable to a far smaller number of tube stock. Experience on other landfill caps has indicated that within two years it is difficult to identify which plants originated as tube stock or seeds.
4.14. Construction

The design and specification for the capping system construction works will be substantially based on the Works Approval documentation, with site specific amendments to suit the specific area being covered.

Prior to construction, the capping system design needs to be assessed by an appropriately qualified engineer to confirm that the actual materials to be used in construction conform to the stability requirements of the theoretical design.

All capping works are to be carried out in accordance with a valid Works Approval, which, amongst other things, includes the appropriate Construction Quality Assurance and reporting.

When installing the growing medium, care is to be taken not to compact the soil layer other than what is achieved via the placement machinery tracking over the surface during the material placement and spreading operation. From a rehabilitation point of view, greater vegetation survival and growth will be achieved if the soil is only lightly compacted.

The capping soil is simply to be spread out over the surface, to the required thickness. The growing medium is a single uncompacted layer and hence there is no need for placing the material in a number of lifts. It is more efficient to place the full soil layer thickness in a single operation. This also limits the amount of compaction applied to the soil by the construction equipment and hence provides a better growing environment for the vegetation.

4.15. Surface Water Management

The cap profile, thickness and uncompacted nature has been designed to allow surface water infiltration into the growing medium. This is a desirable situation as there is a need for moisture to be retained within the capping material in order to sustain the vegetation planted on top of the landfill cap. In periods of heavy rainfall it is likely that there will be some runoff from the capped areas and also a limited amount of moisture seeping through the soil layer into the drainage layer. Initially, when the plants are relatively small and only require a small amount of moisture, excess moisture will percolate through the soil layer into the drainage layer. However, in time as the plants grow and consume more and more moisture, less water will end up in the drainage layer. The ideal situation is that the vegetation consumes all moisture within the growing medium and no water ends in the drainage layer. This will then be the point of equilibrium where the maximum growth of vegetation has been established on the landfill cap in accordance with available moisture content.

Due to the relatively gentle slopes on the landfill cap (maximum 1V in 5H), it is unlikely that there would be any significant surface water run-off from the capped landfill surface except in heavy rainfall events. In these circumstances, the runoff is to be directed away from the landfill perimeter.
4.16. **Groundwater Management**

The comprehensive landfill capping system will significantly reduce the quantity of rainfall percolating through the waste mass and hence in time decrease the quantity of leachate collecting on the landfill liner and requiring ongoing management. This will have a long-term benefit of reducing the potential for groundwater contamination.

4.17. **Site Monitoring and Maintenance**

Site monitoring and maintenance will be undertaken beyond the closure of portions of the landfill (continuous capping) to ensure that the closure measures adopted as part of the landfill capping plan are providing an ongoing, sustainable environmental solution.

Site monitoring and maintenance tasks include:

- Monitoring and repair of erosion and settlement of the cap;
- Monitoring of vegetation rehabilitation success and infill planting as needed;
- Monitoring of weed infestation and eradication as appropriate;
- Monitoring landfill gas and leachate management systems and effectiveness;
- Monitoring groundwater and if present, surface water quality;
- Minor maintenance of the active landfill gas extraction system;
- In time, installing new landfill gas flaring infrastructure;
- Relining of the leachate ponds.

Some aspects of site monitoring and maintenance will need to occur regularly such as leachate and landfill gas monitoring, while other tasks will only occur six-monthly such as groundwater monitoring (or whatever duration is required by the DER). In time, as the landfill cap and waste mass stabilise, these activities can be carried out less regularly. The actual timing and regularity of the activities will be a function of the way that the landfill is performing and how quickly it stabilises.

With leachate and landfill gas management having been carried out for many years prior to the closure of the landfill, there will be extensive knowledge and experience built up on how these systems operate and how often they require monitoring and maintenance. And then, in time, as the leachate and gas quality and quantity decreases so will the management effort.

Initially, general site monitoring such as the condition of the fencing, capped surface and weed infestation will occur as a minimum every three months, however, more regularly during the winter rainy period. This would last for at least three years and thereafter the monitoring period will be pushed out according to site needs.

Site maintenance will be on an as needs basis in reaction to issues that have been identified during site monitoring.
Groundwater monitoring will occur every six months (or whatever duration is required by the DER) for potentially five years beyond landfill closure and thereafter, in agreement with the DER, be pushed out to annually. It may be that in time (+10 years) the groundwater monitoring period may be pushed out even further.

Should the monitoring identify a deficiency in the proposed closure methodology, then the methodology needs to be modified to suit the on-site conditions and implemented in the next tranche of progressive landfill closure works.

4.18. Post Closure Period

Due to the long period of waste stabilisation and consequential generation of landfill gas and leachate, it will be necessary that there be site monitoring for up to 30 years beyond landfill closure. Towards the end of this period, an assessment of the degree to which the waste mass has stabilised will provide information as to whether it will be necessary to continue monitoring the site beyond the 30-year period and for how long this is likely to continue.

Effectively, the monitoring period will only be completed once it can be conclusively demonstrated that the landfill site has stabilised to a degree that it no longer requires and ongoing monitoring and maintenance.

5. Review

This Plan covers the rehabilitation of the Salt Valley Road Class II Landfill Facility and is based on current best practise. It is envisaged that over time, as the waste management industry and the site’s waste management practices evolve, that this Plan will need to be reviewed and updated.

This RMP should be reviewed and updated in accordance with the following schedule:

- Year 5 (2020) - Review/confirm relevance and update as appropriate; and,
- Year 10 (2025) - Use as a basis for a complete review for the next ten-year period.
Appendices

Appendix No. 1 – Final Pre-Settlement Waste Profile Layout Plan
Appendix No. 28 – IWP Construction Specifications August 2017

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2 SPECIFICATIONS

2.1 DESCRIPTION OF WORKS

The Contract includes all management, operations, labour, plant, materials, supervision, survey and all else required for the construction and completion of the whole of the Works described in these Specifications and shown on the Drawings, and for complying with the Conditions of Contract, together with any additional Works or variations ordered by the Superintendent. The Contract also includes a Defects Liability Period as stated in the Annexure to the General Conditions of Contract.

The scope of Works includes:

1. Survey and setting out.
2. Excavation to suit design layout, including stockpiling of the various excavated materials (topsoil, clay, saline clay) as instructed by the Superintendent.
3. Construction and reshaping of Site access roads and associated stormwater drainage systems.
5. Construction of landfill cell and leachate extraction system, including only the first lift of leachate drainage aggregate.
6. Undertaking leak detection testing of all lined areas that have been covered by leachate drainage aggregate.
7. Construction of a surface water storage dam.
8. Construction of weighbridge, Site office and staff amenities.
9. Ancillary Works including, but not limited to piping, pump, electrics, gates and fencing.
10. Such other Works as shown on the Drawings or as described in these Specifications.
11. Provision of "As Constructed" information.

Activities not include in the scope of Works:

1. Waste placement.
2. Progressive installation of subsequent lifts of leachate drainage aggregate up the side slope above the initial installed lift.
3. Landfill gas management infrastructure.
4. Landfill capping.

2.2 QUALITY ASSURANCE, INSPECTIONS AND REPORTING

The Contractor shall undertake and cover the cost of all Construction Quality Control testing and measurement required in these Specifications to demonstrate that the specified standards of construction have been achieved. The exception being that the Principal shall pay for all Conformance Quality Control testing carried out by the Superintendent as stipulated in these Specifications. Any repeat Conformance Quality Control testing due to material failure (non-conformance) or replacement shall be borne by the Contractor. For the avoidance of doubt, Conformance Quality Control testing refers to the testing of materials, where the Superintendent receives material samples and obtains independent testing thereof to confirm the materials conform to the Specifications.

The Principal shall appoint and pay for the following:

• Superintendent to manage the project on its behalf;
• A Geotechnical Engineer (Earthworks Inspector) to inspect, approve and report on all aspects of the earthworks in accordance with AS 3798-2007, Guidelines of Earthworks for Commercial and Residential Development; and,
• A CQA consultant. The duties of the CQA consultant will include inspections, verifications, audits and evaluation of materials and workmanship, provision of advice on installation, testing, repair and covering of the liner system, and issuing a final CQA report to the Superintendent documenting the quality of the constructed liner Works.

Within these Specifications, the Superintendent is nominated as the responsible party to undertake all Conformance Quality Control testing, inspections, approvals and reporting as the Superintendent has the contractual responsibility for these aspects of the Works; however, the Superintendent will allocate some of these activities to either the Geotechnical Engineer or the CQA consultant, depending on the task to be undertaken.

The Contractor is to provide the necessary assistance to the Geotechnical Engineer and the CQA consultant as if it was dealing with the Superintendent.

If there is any confusion as to which party the Contractor should be dealing with, the Contractor is to always default back to the Superintendent for advice.

The Geotechnical Engineer and the CQA consultant are not entitled to provide the Contractor with any advice of construction or design matters. The Contractor is not to rely on any construction or design advice from either the Geotechnical Engineer or the CQA consultant. Any related queries are to be directed to the Superintendent.

2.3 VEGETATION CLEARING

There is minimal clearing of vegetation associated with the Works.

Clearing shall consist of clearing Works area of trees, standing or fallen, brush, shrubs, grasses and other vegetation, loose rocks and boulders.

The Contractor is to only clear vegetation to the extent shown on the Drawings.

All material and debris resulting from the clearing operation shall be stockpiled within 100 m of the Site at a location approved by the Superintendent. Individual material types will be stockpiled separately. The Contractor shall not be required to pay any charges in connection with the disposal of cleared material and debris. No burning of cleared material shall be allowed on Site.

2.4 MONITORING BORE INFILL

There are five, 10 m deep monitoring bores within the clay void. These bores are to be decommissioned and filled in accordance with the Department of Water - Water Quality Protection Guidelines No. 4 Mining and Mineral Processing - Installation of Mine Site Groundwater Monitoring Bores 2000 Section 4.15. This document refers to “Bores should be decommissioned in accordance with the Agriculture and Resource Management Council of Australia and New Zealand’s Minimum Construction Requirements for Water Bores in Australia”, which requires the following:

Decommissioning by full grouting from top to bottom. The sealing material shall consist of bentonite grout or bentonite pellets/chips.

The process to be followed on site shall be:

• Pump bore dry (if not dry already);
• Remove the existing bore casing;
• Slowly pour bentonite pellets into the bore cavity ensuring that the pellets completely fill the bore from top to bottom;
• Saturate the bentonite pellets by filling the bore with fresh water; and,
• Place a minimum 300 mm earth mound over the bore to cover the void while the bentonite hydrates (prevents ingress of any foreign matter).

During decommissioning of the bores, the following records will be maintained:

• Date/time;
• Bore number;
• Bore depth;
• Bore volume (calculated based on diameter and depth);
• Volume of bentonite pellets poured into the bore void; and,
• Volume of fresh water poured into the bore for it to hydrate the bentonite pellets.

The backfilling of the bores is to be undertaken and recorded a specialist company well experienced in groundwater bore installation and decommissioning.

2.5 EARTHWORKS

2.5.1 INTRODUCTION

The Works covered by this section include, but are not necessarily limited to, the following:

• The setting out of the Works to the lines and levels shown on the Drawings;
• Removal of unsuitable subgrade material and disposal to waste;
• Excavation within the Works area;
• Grading and compaction of cell foundation, including filling in of water storage pond, the leachate extraction sump area and sufficient area beyond the landfill cell to facilitate the tie-in of subsequent cells;
• Excavation and haulage of fill, moisture conditioning, placement and compaction to the required grades and levels; and,
• Control and diversion of surface water and run-off from the site of the Works.

2.5.2 EARTHWORKS INSPECTION

It is a requirement of the environmental approval for the landfill cell construction that all earthworks be accompanied by Level 1 geotechnical testing as set out in Appendix B of AS 3798-2007, Guidelines of Earthworks for Commercial and Residential Development. To achieve this, the Principal will appoint and pay for a full time independent Geotechnical Engineer (Earthworks Inspector) to inspect, approve and report on all aspects of the earthworks. This is to include:

• Approval of the suitability of the fill material used;
• Approval of the suitability of excavations to remove soft and unsuitable material from the landfill base and side slopes;
• Approval of the compaction method used, including the filling in of the water storage pond;
• Inspection of all fill placement and compaction activities;
• Inspection of all third party Construction Quality Control testing and sampling;
• Assessment of the Construction Quality Control testing results and as constructed survey;
• Approval of the earthworks quality and shape;
• Compilation of an earthworks construction completion report for submission to the Environmental Regulator; and,
• Any other activities that are deemed necessary to ensure that appropriate earthworks standard of workmanship and quality of work is achieved.

Where the Specification refers to inspection, approval or other activities relating to the Superintendent, some of these actions may be carried out by the Geotechnical Engineer, on behalf of the Superintendent.

2.5.3 APPLICABLE DOCUMENTS

All Works shall be carried out in accordance with the latest editions of all and any specifications, guidelines and standards referenced with the Contract.
2.5.4 DEFINITIONS
For all purposes of this Section, the words and phrases listed below shall have the meanings herein ascribed to them:

- "Standard Maximum Dry Density" as determined in accordance with AS 1289.5.1.1-2003.

2.5.5 EXCAVATION

2.5.5.1 GENERAL
The Contractor shall carry out all earthworks excavation to the extent shown on the Drawings or directed by the Superintendent. The Contractor is responsible for assessing the soil/rock types on Site and selecting suitable plant and equipment for undertaking excavation Works.

The Contractor is to remove all soft or unsuitable material from the base or side slopes of the existing clay quarry. The Contractor is to be aware that there is likely to be soft or unsuitable material in the bottom and sidewalls of the water storage pond, which has previously been filled with water for an extended period. The Contractor is to remove all soft or unsuitable material to a minimum extent of 500 mm into firm natural ground, as approved by the Superintendent. This applies to both the base and side walls of the water storage pond. The excavation is to form benches of maximum 1 m high, minimum 1 m wide, with the width of the benches determined by the slope of the natural ground. Refer to the Drawings for details of the benching requirements within the water storage pond.

In all other areas of the clay quarry base, the Contractor is to remove all soft or unsuitable material to a minimum extent of 500 mm into firm natural ground, as approved by the Superintendent, prior to any backfill commencing.

All completed earthworks are to be inspected and approved by the Superintendent.

2.5.5.2 EXCAVATED MATERIAL
All suitable excavated material is to be used as fill material.

The Superintendent will determine the suitability of the excavated fill material for use as fill.

All excavated material that is deemed unsuitable to be used as fill, by the Superintendent, will be stockpiled within 100 m of the Works area.

2.5.6 FILL MATERIALS

2.5.6.1 GENERAL
The Contractor shall carry out all earthworks fill to the extent shown on the Drawings or directed by the Superintendent. The Contractor is responsible for assessing the fill requirements and selecting suitable plant and equipment for undertaking required Works.

All material must be approved for use by the Superintendent, who may reject unsuitable material.

2.5.6.2 MATERIAL
Select fill material shall comprise naturally occurring silty/clayey soil sourced on-site from excavation Works within 300 m of the Works area. The material is to be free of debris and with a maximum particle dimension no larger than 40 mm. The suitability of the fill material will be determined by the Superintendent prior to incorporation into the Works.

2.5.6.3 UNSUITABLE MATERIAL
The term "unsuitable material" shall apply to weak deposits and organic material, which, because of its inherent nature, cannot be satisfactorily reconditioned and is not suitable as a foundation, bedding or backfill material. Unsuitable material shall be removed within the limits specified by the Superintendent using whatever equipment is required. All material that is deemed unsuitable by the Superintendent to be used as fill will be stockpiled within 100 m of the Works area.
2.5.7 FOUNDATION PREPARATION

All standing water shall be drained or pumped away before foundation preparation can commence. Precautions shall be taken to prevent further flooding of the Works area by subsequent rain events.

The foundation of the cell shall be graded to maintain a uniform fall to the lowest part of the cell. On the completion of grading, the area shall be thoroughly wetted and rolled with a minimum four passes of a smooth drum vibrating roller.

The completed surface shall be surveyed along the perimeter of the area and on a maximum 20 m grid within the perimeter. The results of the survey shall be provided to the Superintendent prior to inspecting the foundation to confirm the work meets the specified requirements.

No fill shall be placed in any area without the written approval of the Superintendent.

2.5.8 FILL PLACEMENT AND COMPACTION

2.5.8.1 INSPECTION

Before fill is placed in any area, the Superintendent shall be notified in writing 24 hours prior to Works commencing. The Superintendent may inspect the area to confirm the work conforms to the Specifications. Any area of ground that has been disturbed to such a depth that it cannot be compacted to the required standard in conjunction with the first layer of fill, shall be worked and compacted to the required standards before routine fill operations begin.

2.5.8.2 GENERAL PLACEMENT AND COMPACTION STANDARDS

Fill shall be placed, levelled, moisture conditioned to +/- 2 % of optimum, and compacted to not less than 95% of the Standard Maximum Dry Density (SMDD) determined in accordance with AS 1289.5.2.1. As a minimum standard, all areas of fill are to be compacted in layers of no greater than 300 mm or less than 100 mm. Where less than 100 mm is required to be worked, the underlying material shall be scarified to such a depth that the resulting thickness of the layer to the work is greater than 100 mm.

Each layer worked shall be generally parallel to the finished surface and shall, where practicable, extend to the full width of the embankment/fill in that particular level. The Contractor shall at all times prevent ponding of water on the embankment/fill.

The Contractor may propose an alternative fill placement and compaction methodology to the Superintendent for review and acceptance; however, the Contractor is to ensure that any proposed methodology is able to achieve a minimum compaction density of 95% of the Standard Maximum Dry Density (SMDD) determined in accordance with AS 1289.5.2.1.

2.5.8.3 SURFACE PREPARATION

The complete surface of the base, embankments and bunds that are to be covered with environmental barrier liner material (GCL and HDPE) are to be steel drum rolled to provide a smooth surface on which to place the liner material. The surface, prior to rolling is to have been finished to have no irregularities in excess of 40 mm over 3 m. In addition, following rolling, the surface is to have no irregularities in excess of 10 mm deep over a straightedge length of 20 mm (small sharp irregularities).

2.5.8.4 COMPACTION TESTING

The Contractor shall arrange for the testing and sampling of compacted fill. Fill operations shall be interrupted as necessary to allow the recovery of samples or to carry out control tests on the fill.

All materials testing and density testing shall be undertaken by a laboratory that is NATA accredited for those tests being undertaken. Testing will be used to confirm specified moisture conditions and standards of compaction are achieved. All testing shall be undertaken in accordance with the appropriate sections of AS1289 – Methods for Testing Soils for Engineering Purposes.

Testing and sampling will be undertaken at regular intervals by the Contractor or its nominated representatives. The construction programming and Contract price shall include allowances for taking and testing samples and time delays while samples are being collected and tested.

No additional payment will be made for any completed Works requiring removal and/ or repair as a result of any tests organised by the Superintendent.
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Inspection and testing shall be carried out in accordance with the requirements of this Specification.

The frequency of field density testing during these Works shall not be less than the following:

- One test per 500 m³ distributed evenly throughout the full depth and area;
- One test per layer per material type per 2,500 m², 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 Superintendent.

Field density tests shall be determined from either:

- Sand Replacement Density Testing (AS1289.5.3.1) in conjunction with the Hilf Method (AS1289.5.7.1); and/or
- Nuclear Densometer methods (AS1289.5.8.1) in association with standard compaction (AS1289.5.1.1).

Where sand replacement density testing is carried out, a Hilf compaction test shall be carried out for each sand replacement test.

Where nuclear densometer methods are used, compaction shall be carried out in accordance with the Assigned Values Method, as defined by AS1289.5.4.2.

If any areas of the work are found to be non-compliant with the compaction requirements of this Specification, they shall be re-compacted and re-tested for compliance.

2.5.8.5 DIMENSIONS AND TOLERANCES

The finished levels of fill shall be within -25 mm and +25 mm of the design levels. In the case of the landfill base, the finished levels are still required to attain the minimum gradients stated in the Drawings. The fill surface shall be inspected to ensure accuracy and any irregularities in excess of 40 mm when tested with a 3 m long straight edge shall be corrected prior to the surface treatment being applied.

2.5.8.6 CONTROL OF WATER

During excavation and construction, all areas of earthworks shall be kept free of water by temporary drains or other means. Surface water shall be prevented from flowing onto the excavations or fill areas by the construction of diversion drains before any other excavation commences. Excavation and fill areas shall always be graded to facilitate surface drainage and any loose material compacted to prevent absorption. Particular care shall be taken to ensure that surface water does not reach embankments or fill material that has yet to be compacted.

2.5.8.7 CLEAN-UP

On completion of the Works the Site shall be cleared of all materials and debris. Any damage shall be made good and the sites restored to a neat and tidy condition. All work areas shall be smoothed and graded conforming to the natural appearance of the landscape. Where destruction, scarring, damage or defacing has occurred as a result of the operations, repairing, replanting, reseeding, or other correction measures shall be undertaken to the satisfaction of the Superintendent. All fencing shall be reinstated to its original condition.
2.6 LEAK DETECTION TESTING

The Contractor is to carry out a leak detection test of all lined areas that have been covered by leachate drainage aggregate. The testing is to undertaken by a suitably qualified sub-contractor (it could be the main Contractor) that has been approved by the Superintendent.

The leak detection survey is to be undertaken once the geomembrane has been installed and the drainage material has been placed, but before the separation layer has been installed, to ensure that the geomembrane has not been damaged during its installation and placement of the drainage material.

The Contractor is to provide adequate notification (minimum 24 hours) to the Superintendent of when any installation of testing equipment or any testing is being carried.

The results of the leak detection testing are to be provided to the Superintendent for review prior to any repairs being undertaken.

The Contractor is to repair and test all identified leaks in the lining system.

If the Superintendent deems that the area of aggregate removal and replacement is substantial and there is the likelihood that the liner could have been further damaged by the repair activity, the Superintendent may instruct that the area be retested for any further leaks. As an indication, if there is a need to use mechanical equipment to remove and replace the aggregate, the repair is likely to be considered as substantial.

The separation geotextile is only to be installed once the Superintendent has approved the completion of leak detection testing and that all repairs have been carried out, including any retesting if necessary.

2.7 SUPPLY AND INSTALLATION OF GEOSYNTHETIC CLAY LINER

2.7.1 GENERAL

2.7.1.1 GCL SUB-CONTRACTOR

The Contractor shall only engage the specialist liner sub-contractor, which may also be the main Contractor to install the GCL that was accepted by the Principal at the time of Tendering. Any change to the approved liner sub-contractor must be approved in writing by the Superintendent prior to any lining Works being undertaken on Site.

The GCL shall be installed in all locations as indicated in the Drawings. It is noted that there is also a double layer of GCL in the landfill leachate sump and leachate pond sumps (as indicated in the Drawings).

The primary function of the lining system is to prevent leachate from leaking from the impoundment and subsequently entering and polluting the groundwater in the local area. Stringent quality assurance standards shall be maintained throughout the Contract to ensure the integrity of the system.

The Contractor shall provide all materials, supervision, labour and equipment for the installation of the GCL in accordance with the Specifications and Drawings.

Prior to installation, all GCL to be incorporated in the Works shall be approved in writing by the Superintendent.

2.7.1.2 SUBMITTALS

Submittal Documentation

The Contractor is to submit the following to the Superintendent for review and approval, within a reasonable time to expedite shipment or installation of the GCL. This is not an all inclusive list, it is the Contractor’s responsibility to ensure that it has been through these Specifications in sufficient detail to identify all submittal requirements:

- Documentation of manufacturer's qualifications;
- Manufacturer's Quality Control (MQC) program manual or descriptive documentation;
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• A material properties sheet, including as a minimum all properties, including test methods used;
• Minimum 1 m² sample of the material delivered to Site to be used by the Superintendent for Conformance Quality Control testing;
• If any proposed change in liner sub-contractor from what was approved at Tender, documentation of the liner sub-contractor and installer's qualifications:
  o Submit proposed sub-contractor relevant company experience; and,
  o Submit resumes or qualifications of the proposed Field Installation Supervisor, Master Installer and Installer to be assigned to this project; and,
• Liner installation Quality Control Program.

Shop Drawings
Submit copies of shop drawings for the Superintendent's approval within a reasonable time so as not to delay the start of GCL installation. Shop drawings shall show the proposed panel layout. Panels should generally follow the direction of the slope. Where possible, roll-end joins shall not occur on the side slope. Where this is unavoidable, the join is to include an anchor trench as indicated in the Drawings. The joins between GCL on the side slope and the base shall be located in the base at a distance of at least 1.5 m from the slope toe.

Placement of GCL will not be allowed to proceed until the Superintendent has received and approved the shop drawings.

Additional Submittals (In-Progress and at Completion):
This is not an all-inclusive list; it is the Contractor’s responsibility to ensure that it has been through these Specifications in sufficient detail to identify all submittal requirements:

• Daily written acceptance of subgrade surface.
• Daily field installation reports.
• Installation record drawing.

2.7.1.3 QUALITY CONTROL
Installer's Qualifications
Installation and joining of the GCL must be undertaken by GCL installers with extensive experience in installing and joining the same type of GCL being installed and using the same joining procedure to be used on Site.

Installation shall be performed under the direction of a Field Installation Supervisor who shall be responsible throughout the GCL installation, for GCL panel layout, joining, patching, repairs and all other activities of the liner sub-contractor. The Field Installation Supervisor shall have installed or supervised the installation and joining of a minimum of 10 projects involving a total of 500,000 m² of GCL of the type specified or similar project.

Joining shall be performed under the direction of a Master Installer (who may also be the Field Installation Supervisor) who has joined a minimum of 300,000 m² of GCL of the type specified or similar product, using the same type of joining to be used in the current project. The Field Installation Supervisor and/or Master Installer shall be present whenever installation and joining is performed.

Installation and joining shall be performed by an Installer who has installed and joined a minimum of 100,000 m² of GCL of the type specified or similar product, using the same type of joining to be used in the current project.

All joining, patching, other operations shall be performed by qualified installers employed by the GCL sub-contractor.

Third-Party CQA Consultant
The Principal will appoint an independent third-party CQA consultant with experience with GCL and knowledgeable of GCL and joining performance characteristics to verify that the Works have been carried out in accordance with the Specifications.
The duties of the third-party CQA consultant include inspections, verifications, audits and evaluation of materials and workmanship, provision of advice on installation, repair, and covering of the GCL lining system and issuing a final CQA Report to the Principal documenting the quality of the constructed facility.

The cost associated with the appointment of the third-party CQA consultant will be covered by the Principal.

The Contractor is to provide the necessary assistance, advanced notification of lining activities and access to all Works area to the third-party CQA consultant to enable the full inspection of the Works.

2.7.4 DELIVERY, STORAGE AND HANDLING

Each roll of GCL delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the following:

- Manufacturer’s name;
- Product identification (material type);
- Date of manufacture, batch number;
- Roll number;
- Roll length;
- Roll weight;
- Roll width; and,
- Label with handling guidelines.

The geotextile rolls shall be delivered to the Site, handled and stored in such manner that no damage occurs to the GCL or its protective wrapping. The GCL rolls shall be wrapped with heavy duty weatherproof wrapping to protect material from moisture uptake.

Rolls with damaged wrapping shall be pointed out to the Superintendent who will inspect to assess the extent of hydration of the liner. GCL rolls or portions of rolls with moisture content equal or above 40% by weight (ASTM D5993) may be rejected, as instructed by the Superintendent. GCL rolls with damaged wrapping and moisture content lower than 40% shall be re-wrapped and sealed.

A dedicated area shall be used for the storage of all GCL material delivered to Site. The material shall be stored as follows:

- In its original, unopened packaging or resealed following the removal of samples from the roll;
- Away from high traffic areas, but sufficiently close to the active work area to minimise handling;
- On level, dry, well-drained and stable area;
- Not more than three (3) rolls high;
- Protected from precipitation, chemicals, excessive heat, ultraviolet (UV) radiation, standing water, vandalism and animals;
- Blocks provided to prevent sliding or rolling of stacks;
- All roll labeling shall be clearly visible;
- Handling of GCL rolls is to via the use of a spreader stinger bar (a bar protruding from the front end of a forklift or other equipment). The bar must be capable of supporting the full weight of the GCL roll without significant bending; and,
- Under no circumstances may the geotextile rolls be dragged, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle.

Any damaged material shall be assessed by the Superintendent and if deemed necessary, rejected and the Contractor advised to immediately remove the material from Site.
2.7.1.5 PROJECT CONDITIONS

GCL shall not be installed in the presence of standing water, while precipitation is occurring or during excessive winds.

2.7.1.6 GCL PRE-CONSTRUCTION MEETING

A GCL Pre-Construction Meeting (and simultaneously the Geomembrane Per-Construction Meeting) shall be held at the Site prior to installation of the GCL. As a minimum, the meeting shall be attended by the GCL Field Installation Supervisor, the Superintendent, the CQA consultant and the Contractor.

Topics for this meeting shall include:

- Responsibilities of each party;
- Lines of authority and communication;
- Resolution of any project document ambiguity;
- Project QA/QC plan;
- Methods for documenting, reporting and distributing documents and reports;
- Procedures for packaging and storing archive samples;
- Review of time schedule for all installation and inspection;
- Weather limitations;
- Defining acceptable subgrade, GCL, or ambient moisture and temperature conditions for working during liner installation;
- Subgrade conditions, dewatering responsibilities and subgrade maintenance plan;
- Deployment techniques including allowable subgrade for the liner installation;
- Covering of the GCL – normal practice and in the event of rain;
- Measurement and payment schedules; and
- Health and safety.

The Superintendent will take minutes of the meeting and the minutes shall be transmitted to all parties.

2.7.2 PRODUCTS

2.7.2.1 MANUFACTURING QUALITY CONTROL

The test methods and frequencies used by the manufacturer for quality control/quality assurance of the GCL prior to delivery shall be in accordance with section 2.5.5 - Table 1.

The manufacturer's GCL quality control certifications, including results of quality control testing of the products, must be supplied to the Superintendent to verify that the materials supplied for the project are in compliance with all product and/or project Specifications. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

2.7.2.2 MINIMUM REQUIREMENTS FOR GCL

The GCL shall be a reinforced, multi-layered system comprising two layers of geotextiles encapsulating a layer of dry bentonite.

As a minimum, the bentonite shall meet the Specifications indicated below:

- Montmorillonite content > 70 wt%;
- Carbonate content*, 1-2 wt%;
- Bentonite form – Natural Na-bentonite or >80 wt% Sodium as activated bentonite;
- Particle size - Powdered (e.g. 80% passing 75 micron sieve) or Granulated (e.g. < 1% passing 75 micron);
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- Cation exchange capacity ≥ 70 meq/100 g (or cmol/kg); and,
- Free swell index ≥ 24 cm³/2g.

* Carbonate here implies calcite, calcium carbonate or other soluble or partially soluble carbonate minerals.

The GCL will meet the property requirements as shown in section 2.5.5 - Table 1.

Material Conformance Quality Control testing by the Superintendent will be conducted in accordance with the project Specifications and CQA Plan.

2.7.2.3 MQC DOCUMENTATION

MQC documentation from the manufacturer of the GCL supplied must be submitted for approval by Superintendent. Submissions shall include:

- Date of manufacture;
- Lot number, roll number, length and width;
- Bentonite manufacturer quality documentation for the particular lot of clay used in the production of the rolls delivered;
- Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered;
- Cross-referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered;
- QC program laboratory certified reports; and,
- The manufacturer’s approved QA stamp and the technician’s signature.

2.7.2.4 ACCEPTANCE BY SUPERINTENDENT

No materials will be accepted for delivery to Site or for progress payment unless all necessary manufacturer's quality assurance/quality control certification, including results of quality control testing has been provided to the Superintendent. All such data shall be supplied in sufficient time such that no delay shall be caused to the project program. Failure to provide the required certifications and test data and any resultant delay will not be grounds for an extension of time or removal of any commercial penalties that accompany the Contract.

2.7.3 INSTALLATION

2.7.3.1 SURFACE PREPARATION

The surface to be lined shall be uniform and free of all sharp or angular objects that may damage the GCL prior to installation of the liner.

The Contractor, liner sub-contractor and Superintendent shall inspect the surface to be covered with the GCL on each day's operations prior to placement of GCL to verify suitability.

The liner sub-contractor shall provide daily written acceptance for the surface to be covered by the GCL installation, to ensure surface suitability.

All subgrade surface damage caused by construction equipment and deemed unsuitable for GCL deployment shall be repaired by the Contractor prior to placement of the GCL. All repairs require the approval of the Superintendent and the liner sub-contractor.

2.7.3.2 GCL PLACEMENT

No GCL shall be deployed until the applicable certifications and quality control certificates are submitted to and approved by the Superintendent. Should GCL material be deployed prior to approval by the Superintendent it will be at the sole risk of the Contractor. If the material does not meet project Specifications it shall be removed from the Works area at no cost to the Principal.

The GCL shall be installed such that the panels are anchored at the crest of the slope and are continuous down side walls/slopes. The panels should also be continuous across the base. The arrangement of the GCL panels should be according to a predetermined layout plan to minimise the amount of end overlaps.
The GCL shall be installed to the limits shown on the project Drawings and essentially as shown on approved panel layout drawings.

The GCL shall only be placed on adequately prepared surfaces that have been approved by the Superintendent.

Appropriate lifting equipment is to be used to ensure safe and efficient material placement and any damage to the subbase by lifting equipment shall be repaired prior to the laying of any GCL.

Installation of the GCL shall not result in scratching, scoring, tearing or otherwise damaging of the material.

The GCL sub-contractor and Superintendent shall inspect the surface of each roll of material as it is being deployed or after deployment, to verify that the material is free from visual defects such as tears, punctures, abrasions, thin spots or other faults in the material. If damages are identified, they are to be repaired or replaced according to these Specifications or as directed by the Superintendent.

Roll-end joints on the side slopes are to be anchored as indicated in the Drawings.

No longitudinal panel joins are to be within 2 m of the leachate drain invert.

Ideally no vehicular traffic shall travel on the liner material; however, this is not always practical. If vehicle access is required over the placed liner material, it is to be kept to an absolute minimum, vehicles are to travel in straight lines and not turn on the liner material, be approved by the Superintendent and no rough treated tyres are to be used, only “turf tyres” (low tread tyres) with low ground contact pressure to protect the underlying subbase.

GCL placement shall not be carried out during rainfall events, on wet subbase, if moisture prevents proper surface preparation, panel placement or panel joining. Moisture limitations shall be defined in the pre-construction meeting.

Damaged panels or portions of the damaged panels, which have been rejected, shall be marked and removal from the Works area recorded.

The GCL shall not be allowed to “bridge over” voids or low areas in the subgrade. In these areas, the GCL shall be placed to allow the GCL to rest in intimate contact with the subbase. Special attention to this aspect is to be paid when laying material in the central leachate collection valley.

Wrinkles caused by panel placement should be minimised. In the event that wrinkles occur in the GCL or where wrinkles extend to the edge of the roll due to manufacturing tolerances, they will need to be removed prior to installation of any material cover.

Considerations on Site Geometry: In general, joints shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of joints shall be minimised. Joints shall not be located at low points in the subgrade unless geometry requires joins at such locations and if approved by the Superintendent.

Overlap joints between panels shall be formed by overlapping the panels and sealed by bentonite paste or powder/granules. The overlap zone shall be kept clean and shall not be contaminated with loose soil or other debris. There shall be no folds or wrinkles in the overlap zone and no traffic or walking shall occur on the completed overlap. The minimum longitudinal overlap shall be 300 mm and the minimum roll-end overlap shall be 500 mm on the base and 1.5 m on the slope (in conjunction with an anchor trench). A 1.5 m overlay is also to be used for GCL installed on the landfill cap (slope ≤ 1 V in 5 H).

Bentonite used for overlapping shall comply with the same specifications as the bentonite used in the GCL delivered to the Site (same rule applies for sealing penetrations and repairs).

Particular care shall be taken to avoid contaminating the upper surface of the GCL with bentonite powder. The presence of loose bentonite may affect welding of overlying geomembranes and may also influence interface friction.

GCL installed on slopes is to be fixed in anchor trenches. This is to secure the geosynthetic clay liner and prevent it from sloughing or slipping down the side slopes during construction. The front edge of the trench is to be rounded to prevent the development of stress concentrations on the GCL or any other geosynthetics. The GCL shall be laid on the inside wall and base of the trench only and the trench shall be cleared of any debris, gravel or loose material before the GCL is installed. The trench shall be backfilled and compacted with low hydraulic conductivity soils.

GCL shall be covered by the geomembrane liner as soon as practical to prevent water damage.
In the event of any water damage, the Superintendent will inspect the material to assess the extent of hydration of the liner. Areas of GCL with moisture content equal or above 40% by weight (ASTM D5993) may be rejected, as instructed by the Superintendent.

2.7.3.3 JOINING PROCEDURES

Jointing procedures are to be as per the material Manufacture’s installation instructions, with the following minimum overlaps:

- Longitudinal joins – 300 mm
- Roll-end joins:
  - On landfill base – 500 mm;
  - On landfill side slope – 1.5 m (with anchor trench); and,
  - On landfill cap – 1.5 m (without anchor trench).

2.7.3.4 PROTRUSION PROCEDURES

Any protrusions through the GCL liner are to be sealed in accordance with detail contained within the Drawings and where appropriate, the manufacturer’s installation recommendations or as agreed with the Superintendent.

Protrusions through the GCL are only applicable to the landfill cap installation.

2.7.3.5 FIELD QUALITY CONTROL

Daily Field Installation Reports

At the beginning of each day’s Works, the liner sub-contractor shall provide the Superintendent with daily reports for all Works accomplished on the previous Works day. Reports shall include the following:

- Total amount and location of GCL placed; and,
- Drawings of the previous day’s installed GCL showing panel numbers.

2.7.3.6 DAMAGE AND DEFECTS

The Superintendent shall inspect the GCL as it is rolled out on the surface to be lined. The Superintendent shall be responsible for the acceptance or rejection of GCL being incorporated into the Works, and shall make a determination of whether identified damage is a function of manufacture or installation of the GCL.

Manufacturing defects are areas where the geotextile is missing or not continuous and/or areas where the bentonite in the GCL is missing. If a roll is suspected to be of inferior quality the Superintendent shall take samples to assess its conformance with the Specification. All testing is to be carried out in accordance with the appropriate standards and by an NATA certified laboratory. Conformance Quality Control testing results will determine the adequacy of the GCL.

2.7.3.7 REPAIR

If the GCL has been damaged during installation, it can be repaired by patching a new piece of GCL of the same material type and thickness extending a minimum of 500 mm on the base and 1.5 m on the side slope beyond the damaged area in each direction. The patched area must be augmented with bentonite powder or granules/paste as per normal jointing requirements.

2.7.3.8 LINER ACCEPTANCE

GCL liner will be accepted by the Superintendent when:

- The entire installation is finished or an agreed-upon subsection of the installation is finished; and,
- All liner sub-contractor’s QC documentation is completed, submitted to and approved by the Superintendent.
2.7.3.9 DISPOSAL OF SCRAP MATERIALS
On completion of installation, the liner sub-contractor shall dispose of all waste and scrap material in a location approved by the Superintendent, remove equipment used in connection with the Works herein, and shall leave the Site in a neat acceptable manner. No scrap material shall be allowed to remain on the GCL surface.

2.7.4 MATERIALS PROPERTIES AND TESTING SCOPE

2.7.4.1 GENERAL
These Specifications sets forth a set of minimum physical, mechanical and chemical properties that must be met, or exceeded by the GCL being manufactured. In a few cases a range is specified.

In the context of quality systems and management, these Specifications represents manufacturing quality control (MQC).

Note: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this Specification.

2.7.4.2 DEFINITIONS

Manufacturing Quality Control (MQC) - a planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and Contract Specifications.

Manufacturing Quality Assurance (MQA) - a planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and Contract Specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organisation to determine if the manufacturer is in compliance with the product certification and Contract Specifications for this project.

2.7.4.3 MANUFACTURING SPECIFICATIONS AND QUALITY CONTROL

The quality of the GCL shall be in accordance with the requirements of the Geosynthetic Research Institute (GRI) — GCL3. The minimum specifications for quality GCL products are contained in GRI Test Method GCL3 Standard Specification for “Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCL’s)". The GRI specifications set forth a set of minimum physical and mechanical properties that must be met, or exceeded by the GCL being manufactured.

In addition to the above, the following bentonite Specifications shall be verified every 50 tonnes of the product:

- Montmorillonite content > 70 wt%;
- Carbonate content*, 1-2 wt%;
- Bentonite form – Natural Na-bentonite or >80 wt% Sodium as activated bentonite;
- Particle size - Powdered (e.g. 80% passing 75 micron sieve) or Granulated (e.g. < 1% passing 75 micron);
- Cation exchange capacity ≥ 70 meq/100 g (or cmol/kg); and,
- Free swell index ≥ 24 cm³/2g.

* Carbonate here implies calcite, calcium carbonate or other soluble or partially soluble carbonate minerals.

A statement on the origin of the bentonite must be included, as well as certified copies of the quality control certificates issued by the bentonite supplier and reports on the tests conducted by the manufacturer to verify the quality of the bentonite used to manufacture the GCL rolls assigned to the project.

The geotextile components of the GCL must also have been through a QC programme. The manufacturer’s geotextile QC program should be available for auditing.
2.7.4.4 PHYSICAL AND MECHANICAL PROPERTY REQUIREMENTS

The GCL shall conform to the test property requirements prescribed in section 2.5.5 - Table 1.

The properties of the GCL shall be tested at the minimum frequency shown in section 2.5.5 - Table 1. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

2.7.4.5 WORKMANSHIP AND APPEARANCE

The GCL shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the GCL.

General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

2.7.4.6 MQC SAMPLING

Sampling shall be in accordance with the specific test methods listed in section 2.5.5 - Table 1. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

The number of tests shall be in accordance with the appropriate test methods listed in section 2.5.5 - Table 1.

The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables; hence, the values listed are the minimum average values and are designated as "min. ave."

2.7.4.7 MQC RETEST AND REJECTION

If the results of any test do not conform to the requirements of this Specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

2.7.4.8 PACKAGING AND MARKETING

The GCL shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery.

The roll cores shall be sufficiently strong to ensure that they do not deflect by more than half their diameter during transit and handling.

2.7.4.9 CERTIFICATION

A manufacturer's certification that the material was manufactured and tested in accordance with the Specifications, together with a report of the test results shall be furnished at the time of shipment.

2.7.4.10 CONFORMANCE QUALITY CONTROL TESTING

The Contractor shall provide manufacturer's test results for the rolls delivered to Site to demonstrate that the rolls meet the requirements of the Specifications. The test frequency shall be as set out in Section 2.5.5 - Table 1.

The Superintendent will arrange for independent Conformance Quality Control testing of the material. In order to achieve this:

- The Superintendent will determine the location of where the samples are to be received, either at the point of manufacture or on site;
- The timing of when the sampling will occur is to be coordinated by the Superintendent, between all parties, to ensure the most efficient sampling process and handover of the samples. This will either be during or immediately after manufacture or as soon as is reasonable following delivery to site;
- The CQA Consultant will be present at the point of sampling to monitor the sampling procedure and to receive the samples;
- The Contractor is responsible for providing all samples, as required, from the rolls of liner material that will or have been delivered to site and handing the samples to the CQA Consultant; and
- The CQA Consultant will arrange for the delivery and testing of the samples to be carried out at an independent NATA accredited laboratory.

The CQA results from the independent laboratory shall take precedence over the test results provided by the manufacturer of the material. The Conformance Quality Control testing shall be at the Principal’s cost.

Any non-conformance in the materials as identified by the Conformance Quality Control testing shall be addressed by the Contractor and thereafter, if the Superintendent rejects the material, the Contractor shall replace the non-conforming material with conforming material. Again, the delivery of new material will be subject to Conformance Quality Control testing to demonstrate its conformance with the Specifications. Any replacement of non-conforming material and subsequent Conformance Quality Control testing carried out by the Superintendent will be at the Contractor's cost.

The material delivered to Site shall meet the Specifications relative to the independent laboratory test results, for the material to be considered for incorporation into the Works.

Section 2.5.6 - Table 2 sets out the minimum Conformance Quality Control testing that will be carried out by the Superintendent.
2.7.5 **GCL MATERIAL STANDARD**

All GCL material use shall be reinforced and comprised of both woven and non-woven geotextile fully needle punch and heat bonded together to contain the bentonite powder.

The design incorporates GCL material Specifications for the landfill base and cap and a slightly different GCL material for the landfill side slopes.

The GCL shall have the minimum material Specifications as set out in Table 1:

**Table 1: GCL Material Specifications**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Frequency</th>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montmorillonite content</td>
<td>XRD (X-ray diffraction) Quantitative Mineralogy Analysis</td>
<td>50 tonnes</td>
<td>&gt; 70 wt%</td>
<td>&gt; 70 wt%</td>
</tr>
<tr>
<td>Carbonate content (1)</td>
<td></td>
<td>50 tonnes</td>
<td>1-2 wt%</td>
<td>1-2 wt%</td>
</tr>
<tr>
<td>Bentonite form</td>
<td></td>
<td>50 tonnes</td>
<td>Natural Na-bentonite or &gt;80 wt% Sodium as activated bentonite</td>
<td>Natural Na-bentonite or &gt;80 wt% Sodium as activated bentonite</td>
</tr>
<tr>
<td>Particle size</td>
<td>AS 1289-3.6.2</td>
<td>50 tonnes</td>
<td>Powdered (e.g. 80% passing 75 micron sieve) or Granulated (e.g. &lt; 1% passing 75 micron)</td>
<td></td>
</tr>
<tr>
<td>Cation exchange capacity</td>
<td>(Methylene Blue Method)</td>
<td>50 tonnes</td>
<td>≥ 70 meq/100 g (or cmol/kg)</td>
<td>≥ 70 meq/100 g (or cmol/kg)</td>
</tr>
<tr>
<td>Free Swell (bentonite)</td>
<td>ASTM D5890</td>
<td>50 tonnes</td>
<td>≥ 24 mL/2g</td>
<td>≥ 24 mL/2g</td>
</tr>
<tr>
<td>Moisture Content (bentonite) (2)</td>
<td>ASTM D5993</td>
<td>2,500 m²</td>
<td>≤ 25% at Manufacture ≤ 35% Site Samples</td>
<td>≤ 25% at Manufacture ≤ 35% Site Samples</td>
</tr>
<tr>
<td>Fluid Loss (bentonite) (2)</td>
<td>ASTM D5891</td>
<td>50 tonnes</td>
<td>18 ml max.</td>
<td>18 ml max.</td>
</tr>
<tr>
<td>Top Geotextile Mass (3)</td>
<td>ASTM D5261</td>
<td>20,000 m²</td>
<td>≥ 270 g/m²</td>
<td>≥ 290 g/m²</td>
</tr>
<tr>
<td>Mass of GCL (4)</td>
<td>ASTM D5993</td>
<td>2,500 m²</td>
<td>≥ 4,380 g/m²</td>
<td>≥ 4,700 g/m²</td>
</tr>
<tr>
<td>Mass of Bentonite (4)</td>
<td>ASTM D5993</td>
<td>2,500 m²</td>
<td>≥ 4,000 g/m²</td>
<td>≥ 4,000 g/m²</td>
</tr>
<tr>
<td>Bottom Geotextile Mass</td>
<td>ASTM D5261</td>
<td>20,000 m²</td>
<td>≥ 110 g/m²</td>
<td>≥ 410 g/m²</td>
</tr>
<tr>
<td>Composite layer Thickness (Dry)</td>
<td>ASTM D1777</td>
<td>2,500 m²</td>
<td>≥ 6 mm</td>
<td>≥ 6 mm</td>
</tr>
<tr>
<td>Elongation (MD)</td>
<td>ASTM D4632</td>
<td>20,000 m²</td>
<td>≥ 10%</td>
<td>≥ 10%</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D6768</td>
<td>20,000 m²</td>
<td>≥ 8 kN/m</td>
<td>≥ 12 kN/m</td>
</tr>
<tr>
<td>Peel Strength</td>
<td>ASTM D6496</td>
<td>2,500 m²</td>
<td>360 N/m</td>
<td>360 N/m</td>
</tr>
<tr>
<td>Permeability (2)</td>
<td>ASTM D5887</td>
<td>25,000 m²</td>
<td>≤ 5 x 10⁻¹¹ m/s</td>
<td>≤ 5 x 10⁻¹¹ m/s</td>
</tr>
</tbody>
</table>

(1) Carbonate here implies calcite, calcium carbonate or other soluble or partially soluble carbonate minerals.

(2) These values are maximum (all others are minimum).
(3) For both cap and carrier fabrics for non-woven reinforced GCL's; one, or the other, must contain a scrim component of mass ≥ 100 g/m² for dimensional stability. This only applies to GM/GCL composites, which are exposed to the atmosphere for several months or longer so as to mitigate panel separation.

(4) Mass of the GCL and bentonite is measured after oven drying per the stated test method.

The GCL rolls shall include edge treatment of the GCL with 250 dry grams added bentonite per metre length of overlap included in the outer 300 mm strip of the roll. The rolls shall also include edge markings to indicate a minimum 300 mm overlap for panels.
2.7.6 CQA TESTING

The GCL shall undergo the minimum CQA testing as set out in Table 2:

Table 2 – GCL CQA Testing

<table>
<thead>
<tr>
<th>Item</th>
<th>Property</th>
<th>Standard</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformance Quality Control testing (at point of manufacture, supply or upon shipment of GCL to the Site)</td>
<td>Thickness (dry)</td>
<td>ASTM D1777</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Mass per unit area of bentonite component of GCL</td>
<td>ASTM D5993</td>
<td>1 sample per 2,500 m²</td>
</tr>
<tr>
<td></td>
<td>Mass per unit area of GCL</td>
<td>ASTM D5993</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Montmorillonite content (X-ray diffraction method)</td>
<td>XRD (X-ray diffraction) Quantitative Mineralogy Analysis</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>Cation exchange capacity of bentonite</td>
<td>Methylene blue method</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Mass/unit length of bentonite in overlaps</td>
<td>Visual inspection and weighing</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Moisture content of bentonite</td>
<td>AS 1289.2.1.1</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Swell index/free swell of clay</td>
<td>ASTM D5890</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Water absorption</td>
<td>ASTM D5891</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Peel strength (for needle-punched products only)</td>
<td>ASTM D6496</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Tensile strength</td>
<td>ASTM D4595</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>CBR of geotextile</td>
<td>AS 3706-4</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>Puncture resistance of geotextile</td>
<td>AS 3706-5</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>Index flux</td>
<td>ASTM 5887</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td>Visual inspection of GCL</td>
<td>Colour, thickness, needle punching, presence of needles or broken needles, and sewing density or other faults in the material.</td>
<td>Every roll</td>
<td></td>
</tr>
<tr>
<td>Thickness of GCL (i.e. uniformity of bentonite distribution) and apparent variations in the as placed moisture distribution.</td>
<td>On-site</td>
<td>Each roll during placement. If thickness appears to be variable a check of the variability of the mass per unit area should be conducted</td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. All Conformance Quality Control tests must be reviewed, accepted and reported by the Superintendent before deployment of the GCL.
2. All testing must be performed on samples taken from the GCL delivered to site under the Superintendent’s supervision.
3. All laboratory tests must be performed in a third party independent accredited laboratory.
2.8 SUPPLY AND INSTALLATION OF HDPE AND LLDPE GEOMEMBRANE

2.8.1 GENERAL

2.8.1.1 GEOMEMBRANE SUB-CONTRACTOR

The Contractor shall only engage the specialist liner sub-contractor, which may be the main Contractor to install the geomembrane that was accepted by the Principal at the time of Tendering. Any change to the liner sub-contractor must be approved in writing by the Superintendent prior to any lining Works being undertaken on Site.

Geomembrane shall be installed in all locations as indicated in the Drawings. It is noted that there is a one roll width wearing layer down the embankment batter in the vicinity of the Cell 1 leachate extraction point, below the leachate extraction pipework (as indicated in the Drawings).

The primary function of the lining system is to prevent leachate from leaking from the impoundment and subsequently entering and polluting the groundwater in the local area. Stringent quality assurance standards shall be maintained throughout the Contract to ensure the integrity of the system.

The Contractor shall provide all materials, supervision, labour and equipment for the installation of the geomembrane in accordance with the Specifications and Drawings.

Prior to installation, all geomembrane to be incorporated in the Works shall be approved in writing by the Superintendent.

2.8.1.2 SUBMITTALS

Submittal Documentation

The Contractor is to submit the following to the Superintendent for review and approval, within a reasonable time to expedite shipment or installation of the Geomembrane. This is not an all-inclusive list; it is the Contractor's responsibility to ensure that it has been through these Specifications in sufficient detail to identify all submittal requirements:

- Documentation of manufacturer's qualifications;
- Manufacturer's Quality Control program manual or descriptive documentation;
- A material properties sheet, including at a minimum all properties specified, including test methods used;
- Minimum 1 m² sample of the material delivered to Site to be used by the Superintendent for Conformance Quality Control testing;
- If any proposed change in liner sub-contractor from what was approved at Tender, documentation of the liner sub-contractor and installer's qualifications:
  - Submit proposed sub-contractor relevant company experience; and,
  - Submit resumes or qualifications of the proposed Field Installation Supervisor, Master Installer and Installer to be assigned to this project; and,
- Liner sub-contractor Quality Control Program.
- Resin Supplier's name, resin production plant identification, resin brand name and number, production date of the resin, resin Manufacturer's quality control certificates, and certification that the properties of the resin meet the requirements for the project.

Shop Drawings

Submit copies of shop drawings for the Superintendent's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow the direction of the slope. Butt seams or roll-end seams shall not occur on a slope. The connecting seam between geomembranes on the slope and the base shall be located in the base at a distance of at least 1.5 m from the slope toe and also 1 m from any join in the GCL below.
All primary welds used to connect panel end to sheets shall form T-joins (tees). These T-connections must be a distance of at least 0.5 m apart. The welding seams of the geomembrane cannot cross (no cruciform connections).

Placement of geomembrane will not be allowed to proceed until the Superintendent has received and approved the shop drawings.

Additional Submittals (In-Progress and at Completion):
For convenience, the relevant sections have been highlighted; however, these may not necessarily be the only references to submittal documentation required. This is not an all-inclusive list; it is the Contractor’s responsibility to ensure that it has been through these Specifications in sufficient detail to identify all submittal requirements:

- Manufacturer’s warranty.
- Geomembrane installation warranty.
- Daily written acceptance of substrate surface.
- Prequalification test seam samples.
- Field seam non-destructive test results.
- Field seam destructive test results.
- Daily field installation reports.
- Installation record drawing.

2.8.1.3 QUALITY CONTROL

Manufacturer’s Qualifications
The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 1,000,000 m² of the specified type of geomembrane or similar product during the last five years.

Installer’s Qualifications
Installation and seaming of the geomembrane must be undertaken by geomembrane installers with extensive experience in seaming the same type of geomembrane being installed and using the same seaming procedure to be used on Site.

Installation shall be performed under the direction of a Field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs and all other activities of Geomembrane installation. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 500,000 m² of geomembrane of the type specified or similar project.

Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor) who has seamed a minimum of 300,000 m² of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.

Seaming shall be performed by an Installer who has seamed a minimum of 100,000 m² of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project.

All seaming, patching, other welding operations and testing shall be performed by qualified technicians employed by the Geomembrane liner sub-contractor.

Third-Party CQA Consultant
The Principal will appoint an independent third-party CQA consultant with experience with geomembranes and knowledgeable of geomembrane and seam performance characteristics to verify that the Works have been carried out in accordance with the Specifications.
The duties of the third-party CQA consultant include inspections, verifications, audits and evaluation of materials and workmanship, provision of advice on installation, testing, repair, and covering of the geomembrane lining system and issuing a final CQA Report to the Principal documenting the quality of the constructed facility.

The cost associated with the appointment of the third-party CQA consultant will be covered by the Principal.

The Contractor is to provide the necessary assistance, advanced notification of lining activities and access to all Works area to the third-party CQA consultant to enable the full inspection of the Works.

2.8.1.4 DELIVERY, STORAGE AND HANDLING

Each roll of geomembrane delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the following:

- Manufacturer’s name;
- Product identification (material type);
- Material thickness;
- Roll number;
- Roll length;
- Roll weight;
- Roll width;
- Reference number to raw material batch and laboratory certified reports; and
- Manufacturer’s approved QA stamp and the technician’s signature. The technician’s signature may be omitted from each roll label, but then must be included on each of the manufacturer’s test certificates associated with each roll.

Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

Rolls shall not be stacked more than three (3) high.

2.8.1.5 PROJECT CONDITIONS

Geomembrane shall not be installed in the presence of standing water, while precipitation is occurring, during excessive winds or when material temperatures are outside the limits specified in these Specifications.

2.8.1.6 MATERIAL WARRANTY

As required by these Specifications, the Sample Warranty Document to be completed is included in the section 2.6.8.

2.8.1.7 GEOMEMBRANE INSTALLATION WARRANTY

The Geomembrane liner sub-contractor shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance by the Superintendent.

2.8.1.8 GEOMEMBRANE PRE-CONSTRUCTION MEETING

A Geomembrane Pre-Construction Meeting (and simultaneously the GCL Per-Construction Meeting) shall be held at the Site prior to installation of the geomembrane. As a minimum, the meeting shall be attended by the geomembrane Field Installation Supervisor, the Superintendent, the CQA consultant and the Contractor.

Topics for this meeting shall include:

- Responsibilities of each party;
- Lines of authority and communication;
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- Resolution of any project document ambiguity;
- Project QA/QC plan;
- Methods for documenting, reporting and distributing documents and reports;
- Procedures for packaging and storing archive samples;
- Review of time schedule for all installation and testing;
- Review of panel layout and numbering systems for panels and seams including details for marking on geomembrane;
- Procedures and responsibilities for preparation and submission of as-constructed panel and seam drawings;
- Temperature and weather limitations. Installation procedures for adverse weather conditions and temperature conditions for working during liner installation;
- Defining acceptable GCL moisture content prior to over-laying with HDPE;
- GCL/subgrade conditions, dewatering responsibilities and GCL/subgrade maintenance plan;
- Deployment techniques, especially placement of geomembrane on top of GCL with the geomembrane textured side down;
- Plan for controlling expansion/contraction and wrinkling of the geomembrane;
- Covering of the geomembrane and drainage material placement;
- Measurement and payment schedules; and,
- Health and safety.

The Superintendent will take minutes of the meeting and the minutes shall be transmitted to all parties.

2.8.2 PRODUCTS

2.8.2.1 MANUFACTURING QUALITY CONTROL

The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery shall be in accordance with section 2.6.5 - Table 3.

The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, must be supplied to the Superintendent to verify that the materials supplied for the project are in compliance with all product and/or project Specifications. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project have the same base resin and material properties.

2.8.2.2 GEOMEMBRANE

The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this Works which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE - Density ≥0.94) or Linear Low Density Polyethylene (LLDPE - Density ≥0.915 and ≤ 0.926 g/ml) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. The geomembrane will meet the property requirements as shown in section 2.6.5 - Table 3.

Material Conformance Quality Control testing by the Superintendent will be conducted in accordance with the project Specifications and CQA Plan.

The geomembrane seams shall meet the property requirements as shown in section 2.6.6 - Table 4.
2.8.2.3 ACCEPTANCE BY SUPERINTENDENT

No materials will be accepted for delivery to Site or for progress payment unless all necessary manufacturer's quality assurance/quality control certification, including results of quality control testing, has been provided to the Superintendent. All such data shall be supplied in sufficient time such that no delay shall be caused to the project program. Failure to provide the required certifications and test data and any resultant delay will not be grounds for an extension of time or removal of any commercial penalties that accompany the Contract.

2.8.3 INSTALLATION

2.8.3.1 SURFACE PREPARATION

The surface to be lined shall be uniform and free of all sharp or angular objects that may damage the geomembrane prior to installation of the geomembrane.

The principal Contractor, liner sub-contractor and Superintendent shall inspect the surface to be covered with the geomembrane on each day's operations prior to placement of geomembrane to verify suitability.

The liner sub-contractor shall provide daily written acceptance for the surface to be covered by the geomembrane installation, to ensure surface suitability.

All subgrade and GCL surface damage caused by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired by the Contractor prior to placement of the geomembrane. All repairs require the approval of the Superintendent and the liner sub-contractor.

2.8.3.2 GEOMEMBRANE PLACEMENT

No geomembrane shall be deployed until the applicable certifications and quality control certificates as specified are submitted to and approved by the Superintendent. Should geomembrane material be deployed prior to approval by the Superintendent it will be at the sole risk of the Contractor. If the material does not meet project Specifications it shall be removed from the Works area at no cost to the Principal.

The geomembrane shall be installed to the limits shown on the project Drawings and essentially as shown on approved panel layout drawings.

No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 10°C unless otherwise approved by the Superintendent. The specified minimum temperature for material deployment may be adjusted by the Superintendent based on recommendations by the manufacturer and the Superintendent. Temperature limitations should be defined in the pre-construction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

Installation of the geomembrane shall not result in scratching, scoring or crimping of the material.

The liner sub-contractor and Superintendent shall inspect the surface of each roll of material as it is being deployed or after deployment, but before welding, to verify that the material is free from visual defects such as tears, punctures, abrasions, indentations, cracks, thin spots or other faults in the material. If damages are identified, they are to be repaired or replaced according to these Specifications or as directed by the Superintendent.

Ideally no vehicular traffic shall travel on the liner material; however, this is not always practical. If vehicle access is required over the placed liner material, it is to kept to an absolute minimum, vehicles are to travel in straight lines and not turn on the liner material, be approved by the Superintendent and no rough treated tyres are to be used, only “turf tyres” (low tread tyres) with low ground contact pressure to protect the underlying GCL and subbase.

Sandbags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably expected wind conditions. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geomembrane.

Geomembrane placement shall not be done if moisture prevents proper surface preparation, panel placement or panel seaming. Moisture limitations shall be defined in the pre-construction meeting.

Damaged panels or portions of the damaged panels, which have been rejected, shall be marked and its removal from the Works area recorded.
The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. In these areas, the geomembrane shall be placed to allow the geomembrane to rest in intimate contact with the GCL. **Special attention to this aspect is to be paid when laying material in the central leachate collection valley.**

Wrinkles caused by panel placement or thermal expansion should be minimised in accordance with these Specifications.

Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimised. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations and if approved by the Superintendent.

Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to affect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm.

### 2.8.3.3 SEAMING PROCEDURES

Cold weather installations should follow guidelines as outlined in GRI GM 9.

No geomembrane material shall be seamed when liner temperatures are less than 10°C unless the following conditions are complied with:

- Seaming of the geomembrane at material temperatures below 10°C is allowed if the liner sub-contractor can demonstrate to the Superintendent, using prequalification test seams, that field seams comply with the project Specifications, the safety of the crew is ensured and geomembrane material can be repaired at temperatures less than 10°C.
- The liner sub-contractor shall submit to the Superintendent for approval, detailed procedures for seaming at low temperatures, possibly including the following:
  - Preheating of the geomembrane;
  - The provision of a tent or other device if necessary to prevent heat losses during seaming and rapid heat losses subsequent to seaming; and
  - Number of test welds to determine appropriate seaming parameters.

No geomembrane material shall be seamed when the sheet temperature is above 75°C as measured by an infrared thermometer or surface thermocouple unless otherwise approved by the Superintendent. This approval will be based on recommendations by the manufacturer and on a field demonstration by the liner sub-contractor using prequalification test seams to demonstrate that seams comply with the Specification.

Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at, patches, repairs and short (less than a roll width) runs of seams.

The weld surfaces shall be cleaned prior to welding. The weld area shall be free of moisture, dust, debris, markings and foreign materials. In the case of extrusion welding, oxidation by products shall be removed from the surface to be welded by grinding/buffing. Grind marks shall not be deeper than 10% of the geomembrane thickness. Welding shall be performed shortly after grinding (within 30 minutes) so that surface oxide formation does not reform.

The Contractor shall be responsible for regularly checking, calibrating (as per the manufacturer's recommendation) and recording the following items:

- Preheat air flow and temperature at the extruder nozzle;
- Extrudate flow and temperature at the barrel outlet; and,
- Split copper wedge temperature on both contact points.

If the Contractor's welding equipment does not have its own factory fitted temperature gauges to undertake the above measurements, the Contractor shall have an independently calibrated hand-held temperature measuring device to confirm temperatures of each and every welding machine prior to the commencement of any test or field welds. All information regarding the results gained from the temperature device shall be recorded for each welding machine.
Welding of all main joints between adjacent geomembrane panels (primary welds) shall be conducted using hot-wedge welding, producing two parallel seams with an air channel in between (dualtrack fusion welding). The hot-wedge welding shall be conducted using the split head wedge fusion weld method which will fuse the upper and lower overlapped geomembrane sheets.

The welding equipment shall be a fully automated device comprising of a heated copper wedge, pressure rollers and electronic controls. The copper wedge shall be controlled and constantly monitored by a digital temperature gauge display or programmable controller with an audible off temperature alarm and a variable speed drive unit. The copper wedge shall create two contact fusion areas of a minimum width of 15 mm and a 5 mm minimum wide void between each of the separate parallel weld zones. This void shall be created over the entire seam length to allow for field weld pressure testing.

The extrusion process is used primarily for detailed work and repair work (secondary weld) or where approved in areas that would be inaccessible to the dual track fusion weld (such as around structures, pipes and other penetrations). The extrusion welding shall be conducted using surface extrusion hand welders.

The minimum width of the surface extruded bead shall be 30 mm. The surface extrusion welder shall be semi-automated and equipped with electronic controls, which constantly monitor outputs for both preheat and extradite. The unit shall be capable of pre-heating the sheet just prior to the casting of the extradite over the upper and lower section of the weld zone.

The extruded granulate or rod for surface extrusion welding shall be manufactured from the same resin type used in the manufacture of the geomembrane. All physical properties shall be identical to those possessed by the geomembrane raw material. The manufacturer shall provide certified test data with each batch of welding granulate or rod. All granulate or rod supplied shall be packed to prevent the ingress of moisture and other contaminants. If necessary, the Contractor shall also employ an apparatus specifically built for drying granulate to ensure weld quality.

All geomembrane panels subject to hot wedge welding shall be overlapped by a minimum of 125 mm and a minimum of 75 mm for extrusion welding to allow for proper construction quality assurance testing.

The Contractor shall ensure prior to any primary or secondary welding that weld zones be clean, free from moisture, dust and any other foreign matter. All weld zone surfaces shall be either cleaned or abraded no more than 30 minutes prior to the commencement of welding any seam. In extremely bad conditions it may be necessary for the liner Installer to clean and/or abrade the weld zone areas only minutes prior to the required weld.

Fishmouths or excessive wrinkles at the seam overlaps, shall be minimised and when necessary cut along the ridge of the wrinkles back into the panel to affect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm diameter hole) to minimise crack/tear propagation. The overlay shall subsequently be seamed. The keyhole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm beyond the cut in all directions.

2.8.3.4 PROTRUSION PROCEDURES

Any protrusions through the Geomembrane liner are to be sealed in accordance with the details in the Drawings or as agreed with the Superintendent.

2.8.3.5 FIELD QUALITY CONTROL

The Superintendent shall be notified prior to all prequalification and production welding and testing, or as agreed upon in the preconstruction meeting.

Prequalification Test Seams

Test seams shall be prepared and tested by the liner sub-contractor to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.

Test seams shall be made by each welding technician and tested in accordance with ASTM D 5820 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The test seam shall be approximately 3.5 m long for fusion welding and 1m long for extrusion welding with the seam centered lengthwise. As a minimum, test seams should be made by each technician once every 4-6 hours or if any welding stoppage exceeds one hour; additional tests may be required with changes in environmental conditions.
Two 25mm wide specimens shall be die-cut using calibrated equipment by the liner sub-contractor from each end of the test seam (total of four specimens). These specimens shall be tested by the liner sub-contractor using a calibrated field tensiometer, testing both tracks for peel strength and also for shear strength. Each specimen shall fail in the parent material and not in the weld, “Film Tear Bond” (FTD failure). Seam separation equal to or greater than 10% of the track width shall be considered a failing test.

The minimum acceptable seam strength values to be obtained for all specimens tested are listed in section 2.6.6 - Table 4. All four specimens shall pass for the test seam to be a passing seam.

If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.

A sample from each test seam shall be labelled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Superintendent for archiving.

Field Seam Non-destructive Testing

All field seams shall be non-destructively tested by the liner sub-contractor over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Superintendent.

Section 2.6.7 - Table 5 sets out the minimum non-destructive weld testing that will be carried out by the liner sub-contractor.

Testing should be done as the seaming Works progresses, not at the completion of all field seaming. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.

Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.

Non-destructive testing shall be performed by experienced technicians familiar with the specified test methods. The liner sub-contractor shall demonstrate to the Superintendent all test methods to verify the test procedures are valid.

Extrusion seams shall be vacuum box tested by the liner sub-contractor in accordance with ASTM D 5820 and ASTM D 5641 with the following equipment and procedures:

- Testing is to begin no earlier than one (1) hour after welding.
- Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the base, porthole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide brush or mop; and a soapy solution.
- The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).
- The liner sub-contractor shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m by 1.2m (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The liner sub-contractor shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurised and moved over the next adjoining area with an appropriate overlap and the process repeated.
- All areas where soap bubbles appear shall be marked, repaired and then retested.
- At locations where seams cannot be non-destructively tested alternate non-destructive spark testing or equivalent should be substituted.
- All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.
Double fusion seams with an enclosed channel shall be air pressure tested by the liner sub-contractor in accordance with ASTM D 5820 and the following equipment and procedures:

- Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.
- The testing activities shall be performed by the liner sub-contractor. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld.
- The air pump shall be adjusted to a pressure of 210 kPa, and the valve closed. Allow 2 minutes for the air to come to equilibrium in the channel, and sustain pressure for 5 minutes.
- If pressure loss does not exceed 28 kPa after this 5 minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.
- If loss of pressure exceeds 28 kPa during the testing period or pressure does not stabilise, the faulty area shall be located, repaired and retested by the liner sub-contractor.

Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

In addition to the above tests, the welds are to be visually inspected to assess the quality of the workmanship and the appearance of the welded seam. For wedge welds, there needs to be a consistent 'squeeze out' on the weld edge which is an indicator that the correct temperature and pressure were used during installation. In the case of extrusion fillet welds, the weld appearance should be smooth, uniform and free of streaks and lumps. In addition, there should be no obvious scoring, notches or deep scratches introduced by the surface grinding.

**Destructive Field Seam Testing**

One destructive test sample per 150 linear metre seam length of fusion/wedge weld and 120 linear metre of extrusion weld shall be taken by the liner sub-contractor from a random location specified by the Superintendent. The liner sub-contractor shall not be informed in advance of the sample location.

In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the liner sub-contractor as directed by the Superintendent as seaming progresses.

Section 2.6.7 - Table 5 sets out the minimum destructive weld testing that will be carried out by the liner sub-contractor.

All field samples shall be marked with its sample number and seam number. The sample number, date, time, location and seam number shall be recorded. The liner sub-contractor shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

The destructive sample size shall be 300 mm wide by 1m long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Superintendent as an archive sample; one section given to the Superintendent for laboratory testing as specified below; and one section retained by the liner sub-contractor for field testing as specified below.

For field testing, the liner sub-contractor shall cut, using a calibrated die cutter, 10 identical 25 mm wide replicate specimens from its sample. The liner sub-contractor shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, four of five test specimens must pass and the outlier is at least 80% of the stated criteria in Section 2.6.6 with less than 10% separation. If the field test weld is acceptable, the sample qualifies for testing by the testing laboratory if required. If the field test weld is unacceptable in accordance with the above, then the weld is deemed failed and is to be treated accordingly.

Independent seam testing arranged by the Superintendent it shall be conducted in accordance with ASTM D 6392. Laboratory testing, if carried out, is the ultimate confirmation of the acceptability of the weld quality.
Reports of the results of examinations and testing shall be prepared and submitted to the Superintendent.

For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall then be taken by the liner sub-contractor, typically 3 m on either side of the failed sample and laboratory seam tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams. All seams represented by the destructive test location shall be repaired with a cap-strip, extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap-strip seams exceeding 50 m in length shall be destructively tested. All costs associated with additional sampling and testing, including laboratory testing, shall be at the Contractor's expense.

Identification of Defects

Panels and seams shall be inspected by the liner sub-contractor and Superintendent during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

Evaluation of Defects

Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in section 2.6.3.5. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

If a destructive sample fails the field or laboratory test, the liner sub-contractor shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.

Defective seams, tears or holes shall be repaired by re-seaming or applying an extrusion welded cap-strip.

Re-seaming may consist of either:

- Removing the defective weld area and re-welding the parent material using the original welding equipment; or
- Re-seaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.

Blisters, larger holes and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm beyond all edges of the defects.

All repairs shall be measured, located and recorded.

Verification of Repairs on Seams

Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be re-seamed and re-tested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

Daily Field Installation Reports

At the beginning of each day's Works, the liner sub-contractor shall provide the Superintendent with daily reports for all Works accomplished on the previous Works day. Reports shall include the following:

- Total amount and location of geomembrane placed;
- Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
- Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
- Results of prequalification test seams;
- Results of non-destructive testing; and
- Results of vacuum testing of repairs.
Destructive test results shall be reported prior to covering of liner or within 48 hours whichever is the soonest.

2.8.3.6 LINER ACCEPTANCE
Geomembrane liner will be accepted by the Superintendent when:

- The entire installation is finished or an agreed-upon subsection of the installation is finished;
- All liner sub-contractor's QC documentation is completed, submitted and approved by the Superintendent; and
- Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

2.8.3.7 DISPOSAL OF SCRAP MATERIALS
On completion of installation, the liner sub-contractor shall dispose of all waste and scrap material in a location approved by the Superintendent, remove equipment used in connection with the Works herein, and shall leave the Site in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

2.8.4 MATERIALS PROPERTIES AND TESTING SCOPE

2.8.4.1 GENERAL
These Specifications set forth a set of minimum physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

In the context of quality systems and management, these Specifications represents manufacturing quality control (MQC).

Note: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in these Specifications.

These Specifications also presents a recommended warranty, which is focused on the geomembrane material itself.

2.8.4.2 DEFINITIONS
Manufacturing Quality Control (MQC) - a planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and Contract Specifications.

Manufacturing Quality Assurance (MQA) - a planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and Contract Specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organisation to determine if the manufacturer is in compliance with the product certification and Contract Specifications for this project.

2.8.4.3 MANUFACTURING SPECIFICATIONS AND QUALITY CONTROL

HDPE
The quality of the geomembranes shall be in accordance with the requirements of the Geosynthetic Research Institute (GRI) – GM13. The minimum specification for a quality HDPE geomembrane product is contained in GRI Test Method GM-13 Standard Specification for “Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes".
LLDPE
The quality of the geomembranes shall be in accordance with the requirements of the Geosynthetic Research Institute (GRI) – GM17. The minimum specification for a quality LLDPE geomembrane product is contained in GRI Test Method GM-17 Standard Specification “Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes”.

In addition to the above, the Contractor is to provide a statement on the origin of the resin, its identification (type and lot number), its production date and the maximum amount of recycled polymer material added to the raw resin must be included as well as certified copies of the quality control certificates issued by the resin supplier and reports on the tests conducted by the manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to this project.

2.8.4.4 MATERIAL CLASSIFICATION AND FORMULATION
These Specifications cover both high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.94 g/ml and higher and linear low density polyethylene (LLDP) with a formulated sheet density of ≤ 0.939 g/ml as measured in accordance with ASTM D 1505 and D 792.

The base resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher for HDPE and ≥0.915 and ≤ 0.926 g/ml for LLDPE, and have a melt flow index value per ASTM D 1238 of less than 1.0 g/10 min. Base resin density is measured without carbon black and additives added.

Resin for the geomembrane should be virgin, first quality HDPE or LLDPE resin and should not be intermixed with other resin types. Furthermore, it should not contain more than two per cent clean recycled polymer by weight of the resin and with no more than 10% rework. If rework is used, it must be a similar HDPE or LLDPE as the parent material.

No post consumer resin (PCR) of any type shall be added to the formulation.

2.8.4.5 PHYSICAL, MECHANICAL AND CHEMICAL PROPERTY REQUIREMENTS
The geomembrane shall conform to the test property requirements prescribed in section 2.6.5 - Table 3.

The properties of the geomembrane shall be tested at the minimum frequency shown in section 2.6.5 - Table 3. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

2.8.4.6 WORKMANSHIP AND APPEARANCE
The Geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

2.8.4.7 MQC SAMPLING
Sampling shall be in accordance with the specific test methods listed in section 2.6.5 - Table 3. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

The number of tests shall be in accordance with the appropriate test methods listed in section 2.6.5 - Table 3.

The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

2.8.4.8 MQC RETEST AND REJECTION
If the results of any test do not conform to the requirements of these Specifications, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.
2.8.4.9 PACKAGING AND MARKETING
The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery.

2.8.4.10 CERTIFICATION
A manufacturer's certification that the material was manufactured and tested in accordance with the Specifications, together with a report of the test results shall be furnished at the time of shipment.

2.8.4.11 WARRANTY
A Manufacturer's Warranty of the Quality of the material shall be furnished to the Superintendent before any liner material is laid in the Works. The Manufacturer's Warranty shall accord with the Sample Warranty Document included in the section 2.6.8.

2.8.4.12 CONFORMANCE QUALITY CONTROL TESTING
The Contractor shall provide manufacturer's test results for the rolls delivered to Site to demonstrate that the rolls meet the requirements of the Specifications. The test frequency shall be as set out in Section 2.6.5 -Table 3.

The Superintendent will arrange for independent Conformance Quality Control testing of the material. In order to achieve this:

- The Superintendent will determine the location of where the samples are to be received, either at the point of manufacture or on site;
- The timing of when the sampling will occur is to be coordinated by the Superintendent, between all parties, to ensure the most efficient sampling process and handover of the samples. This will either be during or immediately after manufacture or as soon as is reasonable following delivery to site;
- The CQA Consultant will be present at the point of sampling to monitor the sampling procedure and to receive the samples;
- The Contractor is responsible for providing all samples, as required, from the rolls of liner material that will or have been delivered to site and handing the samples to the CQA Consultant; and
- The CQA Consultant will arrange for the delivery and testing of the samples to be carried out at an independent NATA accredited laboratory.

The CQA results from the independent laboratory shall take precedence over the test results provided by the manufacturer of the material. The Conformance Quality Control testing shall be at the Principal's cost.

Any non-conformance in the materials as identified by the Conformance Quality Control testing shall be addressed by the Contractor and thereafter, if the Superintendent rejects the material, the Contractor shall replace the non-conforming material with conforming material. Again, the delivery of new material will be subject to Conformance Quality Control testing to demonstrate its conformance with the Specifications. Any replacement of non-conforming material and subsequent Conformance Quality Control testing carried out by the Superintendent will be at the Contractor's cost.

The material delivered to Site shall meet the Specifications relative to the independent laboratory test results, for the material to be considered for incorporation into the Works.

Section 2.6.7 - Table 5 sets out the minimum Conformance Quality Control testing that will be carried out by the Superintendent.

2.8.5 HDPE AND LLDPE GEOMEMBRANE MATERIAL SPECIFICATIONS
The HDPE and LLDPE geomembrane shall have the minimum material Specifications as set out in Table 3:
### Table 3: HDPE and LLDPE Geomembrane Material Specifications

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>HDPE Test Value – 2.00mm Textured</th>
<th>LLDPE Test Value – 2.00mm Textured</th>
<th>Testing Frequency (minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness (min. ave.)</td>
<td>D 5994</td>
<td>nom. (-5%) 0.40 mm texturized</td>
<td>nom. (-5%) 0.25 mm texturized</td>
<td>Per roll</td>
</tr>
<tr>
<td>• Lowest individual for 8 out of 10 values</td>
<td></td>
<td>-10% texturized</td>
<td>-15% texturized</td>
<td></td>
</tr>
<tr>
<td>• Lowest individual for any of the 10 values</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asperity Height (min. ave.) (1)</td>
<td>D 7466</td>
<td>0.40 mm texturized</td>
<td>0.25 mm texturized</td>
<td>Every 2nd roll (2)</td>
</tr>
<tr>
<td>Density HDPE (min. ave.); LLDPE (max.)</td>
<td>D 1505/D 792</td>
<td>0.940 g/cc</td>
<td>0.939 g/cc</td>
<td>90,000 kg</td>
</tr>
<tr>
<td>Tensile Properties (min. ave.) (3)</td>
<td>D 6693</td>
<td>29 kN/m Type IV</td>
<td>29 kN/m Type IV</td>
<td>9,000 kg</td>
</tr>
<tr>
<td>• yield strength (HDPE only)</td>
<td></td>
<td>21 kN/m</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>• break strength</td>
<td></td>
<td></td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>• yield elongation (HDPE only)</td>
<td></td>
<td>12%</td>
<td>250%</td>
<td></td>
</tr>
<tr>
<td>• break elongation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2% Modulus (max) (LLDPE only)</td>
<td>D 5323</td>
<td>840 kN/m</td>
<td>840 kN/m</td>
<td>Per formulation</td>
</tr>
<tr>
<td>Tear Resistance (min. ave.)</td>
<td>D 1004</td>
<td>249 N</td>
<td>200 N</td>
<td>20,000 kg</td>
</tr>
<tr>
<td>Puncture Resistance (min. ave.)</td>
<td>D 4833</td>
<td>534 N</td>
<td>400 N</td>
<td>20,000 kg</td>
</tr>
<tr>
<td>Axi-Symmetric Break Resistance Strain (min.) (LLDPE only)</td>
<td>D5617</td>
<td>30%</td>
<td>30%</td>
<td>Per formulation</td>
</tr>
<tr>
<td>Carbon Black Content - Particle size ~20 nm (range)</td>
<td>D 4218 (5)</td>
<td>2.0-3.0%</td>
<td>2.0-3.0%</td>
<td>HDPE 9,000 kg LLDPE 20,000 kg</td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>D 5596</td>
<td>note (6)</td>
<td>note (6)</td>
<td>20,000 kg</td>
</tr>
<tr>
<td>Stress Crack Resistance (4)</td>
<td>D 5397 (App.)</td>
<td>500 hr.</td>
<td>500 hr.</td>
<td>Per GRI GM10</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT) (min. ave.)</td>
<td>D 3895</td>
<td>100 min.</td>
<td>100 min.</td>
<td>90,000 kg</td>
</tr>
<tr>
<td>(a) Standard OIT, and</td>
<td>D 5885</td>
<td>400 min.</td>
<td>400 min.</td>
<td></td>
</tr>
<tr>
<td>(b) High Pressure OIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oven Aging at 85°C (7)</td>
<td>D 5721</td>
<td>55%</td>
<td>35%</td>
<td>Per each formulation</td>
</tr>
<tr>
<td>(a) Standard OIT (min. ave.) - % retained after 90 days, and</td>
<td>D 3895</td>
<td>80%</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>(b) High Pressure OIT (min. ave.) - % retained after 90 days</td>
<td>D 5885</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UV Resistance (8)</td>
<td>D 7238</td>
<td>N.R. (10)</td>
<td>N.R. (9)</td>
<td>Per each formulation</td>
</tr>
<tr>
<td>(a) Standard OIT (min. ave.) or</td>
<td>D 3895</td>
<td>50%</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>(b) High Pressure OIT (min. ave.) - % retained after 1,600 hrs (10)</td>
<td>D 5885</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(1) Of 10 readings, 8 out of 10 must be \( \geq 0.35 \) mm, and lowest individual reading must be \( \geq 0.30 \) mm; also see Note 6.

(2) Alternate the measurement side for double sided texture sheet.

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

Yield elongate is calculated using a gauge length of 33 mm.

Break elongation is calculated using a gauge length of 50 mm.

(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be constructed on smooth edges of textured rolls or on smooth sheets made from the same formulation is being used for the textured sheet materials.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer’s mean value via MQC testing.

(5) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percentage retained value regardless of the original HP-OIT value.


The Regulatory Authority landfill design guidelines require that the manufacturer carry out both the standard AND high pressure tests for the Oxidative Induction Time and the Oven Aging properties of the geomembrane, as opposed to the GRI GM13 giving the manufacturer the option to choose which of the two tests to perform.

### 2.8.6 HDPE AND LLDPE GEOMEMBRANE WELD PROPERTIES

The Geomembrane shall have the minimum average weld properties as set out in Table 4, which are applicable to 25 mm wide sample of 2.0 mm thick material:

#### Table 4: Minimum Average Weld Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Unit Strength (kN/m)</th>
<th>Sample Strength (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel strength (fusion &amp; ext.)</td>
<td>ASTM D 6392</td>
<td>18.0</td>
<td>690</td>
</tr>
<tr>
<td>Shear strength (fusion &amp; ext.)</td>
<td>ASTM D 6392</td>
<td>27.6</td>
<td>450</td>
</tr>
</tbody>
</table>
### 2.8.7 HDPE AND LLDPE CQA TESTING

The Geomembrane shall undergo the minimum CQA testing as set out in Table 5:

**Table 5 – Geomembrane CQA Testing**

<table>
<thead>
<tr>
<th>Item</th>
<th>Property</th>
<th>Standard</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conformance Quality Control testing (upon shipment of Geomembrane to the Site)</strong></td>
<td>Thickness</td>
<td>ASTM D5994</td>
<td>Each roll</td>
</tr>
<tr>
<td></td>
<td>Density</td>
<td>ASTM D1505, ASTM D792</td>
<td>One sample per 5,000 m², or every five rolls delivered to Site whichever is the greatest number of tests</td>
</tr>
<tr>
<td></td>
<td>Tensile properties (yield and break stress, yield and break elongation)</td>
<td>ASTM D6693 type IV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Puncture resistance</td>
<td>ASTM D4833</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tear resistance</td>
<td>ASTM D1004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon black content</td>
<td>ASTM D1603</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon black dispersion</td>
<td>ASTM D5596</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Axi-Symmetric Break Resistance Strain (min.) (LLDPE only)</td>
<td>ASTM D5617</td>
<td>Per formulation</td>
</tr>
<tr>
<td></td>
<td>Stress crack resistance (HDPE only)</td>
<td>ASTM D5397</td>
<td>One sample every 10,000 m², or resin type or manufacturing run</td>
</tr>
<tr>
<td></td>
<td>Oxidative induction time</td>
<td>ASTM D3895, ASTM D5885</td>
<td></td>
</tr>
<tr>
<td><strong>Start-up test weld</strong></td>
<td>Welding equipment</td>
<td></td>
<td>Checked daily at start of Works, and whenever the welding equipment is shut-off for more than one hour. Also after significant changes in weather conditions</td>
</tr>
<tr>
<td></td>
<td>Weld conditions</td>
<td></td>
<td>Test weld strips will be required whenever personnel or equipment are changed and/or wide temperature fluctuations are experienced. Minimum 1.5 m continuous seam</td>
</tr>
<tr>
<td><strong>Destructive weld testing</strong></td>
<td>On-site, hand tensiometer in peel and shear</td>
<td>ASTM D6392</td>
<td>Every 150 m (if fusion weld) Every 120 m (if extrusion weld)</td>
</tr>
<tr>
<td></td>
<td>Off-site — weld seam strength in peel and shear</td>
<td>ASTM D6392</td>
<td>Every 150 m (if fusion weld), every 120 m (if extrusion weld) for HDPE Every 300 m (if fusion weld), every 150 m (if extrusion weld) for LLDPE</td>
</tr>
</tbody>
</table>
### Opalvale Class II Landfill - Specification

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Methodology</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-destructive weld testing</td>
<td>Air pressure test, ASTM D5820 Vacuum box test,</td>
<td>All seams over full length</td>
</tr>
<tr>
<td></td>
<td>ASTM D5641</td>
<td></td>
</tr>
<tr>
<td>Visual inspection of geomembrane</td>
<td>Tears, punctures, abrasions, cracks, indentations, thin spots, or other faults in the material.</td>
<td>Every roll</td>
</tr>
<tr>
<td>Thickness of geomembrane</td>
<td>On-site</td>
<td>Five per 100 m, 20 m apart, taken at the edge of the sheet</td>
</tr>
</tbody>
</table>

**Note:**

All conformance tests must be reviewed, accepted and reported by the Superintendent before deployment of the geomembrane.

All testing must be performed on samples taken from the geomembrane delivered to Site under the Superintendent supervision.

All laboratory tests must be performed in a third-party independent accredited geosynthetics laboratory.

The required testing frequencies may be revised by the Superintendent to conform with improvements in testing methods and/or in the state of the art practice and/or to account for the criticality of the application (i.e. to account for the importance of the geomembrane for the safety of Works). Revisions must be approved by the relevant authorities before application.
2.8.8 HDPE AND LLDPE GEOMEMBRANE – SAMPLE WARRANTY DOCUMENT

ABC GEOMEMBRANE COMPANY

LIMITED WARRANTY

Warranty No.
Project No.
Effective Date
Purchaser Name
Project Name
Address/Location
City, State, Post Code, Country
Geomembrane Type/Description

ABC Geomembrane Company warrants each ABC geomembrane to be free from manufacturing defects (as defined by the contract's material specifications) and to be able to withstand normal weathering for a period of 5 years from the above effective date for normal use in approved applications.

This Limited Warranty does not include damages or defects in the ABC geomembrane resulting from acts of God, casualty or catastrophe including but not limited to: earthquakes, floods, piercing hail, tornadoes or force majeure. The term "normal use" as used herein does not include, among other things, the exposure of ABC geomembranes to harmful chemicals, abuse of ABC geomembranes by machinery, equipment or people; improper Site preparation or covering materials, excessive pressures or stresses from any source or improper application or installation. ABC geomembrane material warranty is intended for commercial use only and is not in effect for the consumer as defined in the Magnuson Moss Warranty or any similar federal, state or local statutes. The parties expressly agree that the sale hereunder is for commercial or industrial use only.

Should defects or premature loss of use within the scope of the above Limited Warranty occur, ABC Geomembrane Company will, at its option, repair or replace the ABC geomembrane on a pro-rata basis at the then current price in such manner as to charge the Purchaser/User only for that portion of the warranted life which has elapsed since purchase of the material. ABC Geomembrane Company will have the right to inspect and determine the cause of any alleged defect in the ABC geomembrane and to take appropriate steps to repair or replace the ABC geomembrane if a defect exists which is covered under this warranty. This Limited Warranty extends only to ABC's geomembrane, and does not extend to the installation service of ABC Geomembrane Company or third parties.

Any claim for any alleged breach of this warranty must be made in writing, by certified mail, to the CEO/President of ABC Geomembrane within ten (10) working days of becoming aware of the alleged defect. Should the required notice not be given, the defect and all warranties are waived by the Purchaser, and Purchaser shall not have any rights under this warranty. ABC Geomembrane Company shall not be obligated to perform repairs or replacements under this warranty unless and until the area to be repaired or replaced is clean, dry and unencumbered. This includes, but is not limited to, the area made available for repair and/or replacement of ABC geomembrane to be free from all water, dirt sludge, residuals and liquids of any kind. If after inspection it is determined that there is no claim under this Limited Warranty, Purchaser shall reimburse ABC Geomembrane Company for its costs associated with the Site inspection.

In the event the exclusive remedy provided herein fails in its essential purpose, and in that event only, the Purchaser shall be entitled to a return of the purchase price for so much of the material as ABC Geomembrane Company determines to have violated the warranty provided herein. ABC Geomembrane Company shall not be liable for direct, indirect, special, consequential or incidental damages resulting from a breach of this warranty including, but not limited to, damages for loss of production, loss of profits, personal injury or property damage. ABC Geomembrane Company shall not be obligated to reimburse Purchaser for any repairs, replacement, modifications or alterations made by Purchaser unless ABC Geomembrane Company specifically authorised, in writing, said repairs, replacements, modifications or alteration in advance of them having been made. ABC Geomembrane Company's ability under this warranty shall in no event exceed the replacement cost of the material sold to the Purchaser for the particular installation in which it failed.

ABC Geomembrane Company neither assumes nor authorises any person other than the undersigned of ABC Geomembrane Company to assume for it any other additional liability in connection with the ABC geomembrane made on the basis of the Limited Warranty. The* Limited Warranty on the ABC geomembrane herein is given in lieu of all other possible material warranties, either expressed or implied, "and by accepting delivery of the material, Purchaser waives all other possible warranties except those specifically given.

Limited Warranty is extended to the purchaser/owner and is non-transferable and non-assignable, i.e. there are no third party beneficiaries to this warranty.

Purchaser acknowledges by acceptance that the Limited Warranty given herein is accepted in preference to any and other possible materials warranties.

ABC GEOMEMBRANE COMPANY MAKES NO WARRANTY OF ANY KIND OTHER THAN THAT GIVEN ABOVE AND HEREBY DISCLAIMS ALL WARRANTIES, BOTH EXPRESSED OR IMPLIED, OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS IS THE ONLY WARRANTY THAT APPLIES TO THE MATERIALS REFERRED TO HEREIN AND ABC DISCLAIMS ANY LIABILITY FOR ANY WARRANTIES GIVEN BY ANY OTHER PERSON OR ENTITY, EITHER WRITTEN OR ORAL.

ABC GEOMEMBRANE COMPANY'S WARRANTY BECOMES AN OBLIGATION OF ABC GEOMEMBRANE COMPANY TO PERFORM UNDER THE WARRANTY ONLY UPON RECEIPT OF FINAL PAYMENT

I hereby stated that I have read the above and foregoing Limited Warranty and agree to such by singing hereunder.

DATE

PURCHASER NAME: ____________________________ ABC GEOMEMBRANE COMPANY

SIGNATURE: ____________________________ (CEO/President of Authorised Representative)

TITLE: ____________________________ SWORN BEFORE ME THIS ______________ DAY OF ______________ 2015

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2.9 SUPPLY AND INSTALLATION OF GEOTEXTILES

2.9.1 SCOPE OF WORKS

The scope of Works incorporates the supply and installation of geotextiles as specified and to the extent shown in the Drawings.

The Contractor shall provide all materials, supervision, labour and equipment for the installation of the geotextiles in accordance with these Specifications and Drawings.

Prior to installation, all geotextiles to be incorporated in the Works shall be approved in writing by the Superintendent.

2.9.2 GEOTEXTILE REQUIREMENTS

The geotextile shall be 100 % polyester or polypropylene (with the exception of inhibitors and/or carbon black added for UV resistance), non-woven needle-punched geotextile. Geotextiles shall not be made from recycled materials.

The geotextile filaments shall be rot proof, chemically stable and shall have low water absorbency. It shall resist de-lamination and maintain its relative position in the geotextile.

Geotextiles shall be free of flaws that may have an adverse effect on the physical and mechanical properties of the geotextiles.

Geotextiles shall be free of any manufacturing broken off needles. Should any needles be found either by visual inspection or the Superintendent using a metal detector, the Contractor is to thereafter undertake continuous inspection of each and every roll of geotextile prior to installation. Inspection is to be via a Superintendent approved method of metal detection. Should more than 1 manufacturing needle or part thereof be detected per 200 m² of liner, the Superintendent may reject the complete roll. Should more that 10 rolls, each with more than 1 needle per 200 m² be detected, the Superintendent may reject that complete batch of geotextile.

Geotextiles shall be stabilised against ultraviolet radiation to the degree that twelve (12) months exposure of the geotextile to sunlight should not reduce its strength to less than 90% of the specified values.

The geotextiles shall have the minimum material Specifications as set out in Table 6:

Table 6: Geotextile Material Specifications

<table>
<thead>
<tr>
<th>Geotextile Application</th>
<th>Parameter</th>
<th>Specifications</th>
<th>Test Method &amp; Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextile Cushion Layer</td>
<td>Wide Strip Tensile Strength (MD/XMD)</td>
<td>≥ 41.4/38.0 kN/m</td>
<td>AS 3706-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Grab Tensile Strength (MD/XMD)</td>
<td>≥ 3,010/2,850 N</td>
<td>AS 3706-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Trapezoidal Tear Strength (MD/XMD)</td>
<td>≥ 1,060/1,010 N</td>
<td>AS 3706-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
<tr>
<td></td>
<td>CBR Burst Strength</td>
<td>≥ 6,850 N</td>
<td>AS 3706-4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
<tr>
<td>Geotextile Separation Layer</td>
<td>Wide Strip Tensile Strength (MD/XMD)</td>
<td>≥ 16.0/14.2 kN/m</td>
<td>AS 3706-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Grab Tensile Strength (MD/XMD)</td>
<td>≥ 1,130/1,060 N</td>
<td>AS 3706-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Trapezoidal Tear Strength (MD/XMD)</td>
<td>≥ 430/400 N</td>
<td>AS 3706-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
<tr>
<td></td>
<td>CBR Burst Strength</td>
<td>≥ 2,700 N</td>
<td>AS 3706-4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 sample/5,000 m²</td>
</tr>
</tbody>
</table>
2.9.3 GEOTEXTILE CQA TESTING

The geotextile shall undergo the minimum CQA testing as set out in Table 7:

Table 7 – Geotextile CQA Testing

<table>
<thead>
<tr>
<th>Item</th>
<th>Property</th>
<th>Standard</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformance Quality Control testing (upon shipment of geotextile to the Site)</td>
<td>Wide Strip Tensile Strength</td>
<td>AS 3706–2</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Grab Tensile Strength</td>
<td>AS 3706–2</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Trapezoidal Tear Strength</td>
<td>AS 3706–3</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td></td>
<td>CBR Burst Strength</td>
<td>AS 3706–4</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td>Destructive tests</td>
<td>Tensile tests for joints.</td>
<td>AS 3706–6</td>
<td>As required.</td>
</tr>
<tr>
<td>Visual inspection of geotextile</td>
<td>Colour, thickness, tears, holes, punctures, needle-punching, presence of needles or broken needles, and other faults in the material.</td>
<td></td>
<td>Each roll during placement.</td>
</tr>
</tbody>
</table>

Note:

All conformance tests must be reviewed, accepted and reported by a Superintendent before deployment of the geotextile cushion material. All testing must be performed on samples taken from the geotextile delivered to Site under the Superintendent’s supervision.

All laboratory tests must be performed in an accredited, independent, third-party laboratory.

The required testing frequencies may be revised by the Superintendent to conform with improvements in testing methods and/or in the state-of-the-art practice and/or to account for the criticality of the application (i.e. to account for the importance of the geotextile for the safety of Works). Revisions must be approved by the relevant authorities before application.

2.9.4 MANUFACTURING SPECIFICATIONS AND QUALITY CONTROL

The quality of the geotextile shall be in accordance with the requirements of the Geosynthetic Research Institute (GRI) — GT12(b). The minimum specifications for quality geotextile products are contained in GRI Test Method GT12(b), the standard specification for "Test methods and properties for nonwoven geotextiles used as protection (or cushioning) materials".

The Contractor is to provide a statement from the manufacturer on the origin of the fibres and polymer, as well as certified copies of the quality control certificates issued by the fibre suppliers and polymer manufacturers, as well as reports on the tests conducted by the manufacturer to verify the quality of the fibres and polymers used to manufacture the geotextile rolls assigned to this project. The geotextile must also have been through a quality control (QC) program including processes put in place to detect and remove broken needles.

The manufacturer’s geotextile QC program shall be available for auditing. The manufacturer shall also provide a written certification that the geotextile conforms to the material requirements for this project.

2.9.5 QUALITY ASSURANCE

Manufacturer quality control (MQC) documentation from the manufacturer of the geotextile supplied must be submitted by the Contractor to the Superintendent for approval. Submissions shall include:

- Date of manufacture;
- Lot number, roll number, length and width;
- Polymer quality documentation used in the production of the rolls delivered;
- Fibre quality documentation used in the production of the rolls delivered;
• Manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered;
• QC program laboratory-certified reports; and,
• The manufacturer’s approved QA stamp and the technician’s signature. The technician’s signature may be omitted from each roll label, but then must be included on each of the manufacturer’s test certificates associated with each roll.

Prior to delivery to Site, the Contractor is to have provided the relevant certification documents to the Superintendent to substantiate that the material conforms to the required Specifications.

2.9.6 CONFORMANCE QUALITY CONTROL TESTING

The Contractor shall provide manufacturer’s test results for the rolls delivered to Site to demonstrate that the rolls meet the requirements of the Specifications. The test frequency shall be as set out in Section 2.7.2 -Table 6.

The Superintendent will arrange for independent Conformance Quality Control testing of the material. In order to achieve this:

• The Superintendent will determine the location of where the samples are to be received, either at the point of manufacture or on site;
• The timing of when the sampling will occur is to be coordinated by the Superintendent, between all parties, to ensure the most efficient sampling process and handover of the samples. This will either be during or immediately after manufacture or as soon as is reasonable following delivery to site;
• The CQA Consultant will be present at the point of sampling to monitor the sampling procedure and to receive the samples;
• The Contractor is responsible for providing all samples, as required, from the rolls of liner material that will or have been delivered to site and handing the samples to the CQA Consultant; and
• The CQA Consultant will arrange for the delivery and testing of the samples to be carried out at an independent NATA accredited laboratory.

The CQA results from the independent laboratory shall take precedence over the test results provided by the manufacturer of the material. The Conformance Quality Control testing shall be at the Principal’s cost.

Any non-conformance in the materials as identified by the Conformance Quality Control testing shall be addressed by the Contractor and thereafter, if the Superintendent rejects the material, the Contractor shall replace the non-conforming material with conforming material. Again, the delivery of new material will be subject to Conformance Quality Control testing to demonstrate its conformance with the Specifications. Any replacement of non-conforming material and subsequent Conformance Quality Control testing carried out by the Superintendent will be at the Contractor's cost.

The material delivered to Site shall meet the Specifications relative to the independent laboratory test results, for the material to be considered for incorporation into the Works.

Section 2.7.3 - Table 7 sets out the minimum Conformance Quality Control testing that will be carried out by the Superintendent.

2.9.7 DELIVERY, STORAGE AND HANDLING

Each roll of geotextile delivered to the Site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the following:

• Manufacturer’s name;
• Product identification (material type);
• Date of manufacture, batch number, polymer type;
• Roll number;
• Roll length;
The geotextile rolls shall be delivered to the Site, handled and stored in such manner that no damage occurs to the geotextile or its protective wrapping. The geotextile rolls shall be wrapped with weatherproof wrapping to protect material from ultraviolet degradation and moisture uptake. In the event that rolls are damaged, the Superintendent shall assess the extent of the damage and consider possible rejection of the damaged rolls. A dedicated area shall be used for the storage of all geotextile material delivered to Site.

The material shall be stored as follows:

- Away from high traffic areas, but sufficiently close to the active work area to minimise handling;
- On level, dry, well-drained and stable area;
- Not more than three (3) rolls high;
- Protected from precipitation, chemicals, excessive heat, ultraviolet (UV) radiation, standing water, vandalism and animals;
- Blocks provided to prevent sliding or rolling of stacks;
- All roll labeling shall be clearly visible;
- Appropriate slings used when lifting to prevent damage to any material; and,
- Under no circumstances may the geotextile rolls be dragged, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle.

Any damaged material shall be assessed by the Superintendent and if deemed necessary, rejected and the Contractor advised to immediately remove the material from Site.

**2.9.8 PLACEMENT**

Geotextile placement shall be as follows:

- The Contractor is to provide a panel layout diagram to the Superintendent for approval a minimum of one (1) week prior to any geotextile installation. Once approved by the Superintendent, the geotextile is to be installed in accordance with the approved panel layout.
- No installation of geotextile is to occur until the Superintendent has approved all manufacturer’s QA/QC documentation and all Conformance Quality Control testing has been concluded and the material approved by the Superintendent;
- Installation shall be performed by an Installer who has installed a minimum of 50,000 m² of geotextile of the type specified or similar product, using the same type of installation apparatus to be used in the current project.
- No placement shall occur during heavy rain events or during excessively windy conditions;
- Appropriate lifting equipment is to be used to ensure safe and efficient material placement;
- The cushion geotextile shall be placed above the finished geomembrane. The Contractor shall ensure that all CQA testing and recording on the geomembrane surface has been fully completed and approved by the Superintendent prior to the installation of the geotextile protection material. The geomembrane surface upon which a geotextile will be deployed shall be free of any sharp objects, stones, debris, standing water, or other potentially damaging objects;
- The geotextile shall not be installed until inspection of the geomembrane has been undertaken and deemed suitable and in accordance with these Specifications by the Superintendent;
- The geotextile shall be installed such that the sheets are anchored at the crest of the slope and are rolled down side walls/slopes, so as to keep the geotextile free of wrinkles and folds. The arrangement of the geotextile sheets should be according to a predetermined layout plan;
- The geotextile shall be deployed by hand or using vehicles on pneumatic “turf” tyres with low ground contact pressure to protect the underlying geomembrane. During placement, care must be taken not to entrap (either within or beneath the geotextile) stones, excessive dust or moisture that could damage the geomembrane or hamper subsequent seaming;

- Jointing between sheets shall be formed by overlapping by a minimum of 150 mm. The areas to be joined shall be clean and free of foreign matters;

- Jointing of the sheets shall be conducted by stitching or by heat bonding using an approved hot-air device. The joints shall be continuous along the full join length. On slopes, they shall be constructed parallel to the slope gradient. Where heat bonding is used, the Contractor shall ensure that the bonding method does not pose any risks of damage to the underlying geomembrane. In case of stitching, the thread type must be polymeric with chemical and UV light resultant properties equal or greater than that of the geotextile itself;

- The geotextile protection material shall not have cross joints on side slopes steeper than 1 V: 5 H;

- The entire surface area of each and every roll shall be inspected by the Superintendent (for example, during unrolling/installation) to ensure that there is no damage or other faults in the material (such as significant and obvious variability in thickness/mass per unit area, tears, holes or presence of broken needles). If damage is identified, it will need to be repaired according to these Specifications or as instructed by the Superintendent;

- Geotextiles installed on slopes must be fixed in anchor trenches as indicated in the Drawings;

- The geotextile should be laid on the inside wall and base of the anchor trench only, the trench should be cleared of any debris, gravel or loose material before the geotextile is installed. The trench should be backfilled and compacted with low hydraulic-conductivity soils;

- Adequate sandbags left in place to prevent material being blown around by wind; and,

- The separation geotextile shall be installed on top of the leachate aggregate layer in a similar matter to the cushion geotextile, the exception being that there is to be no vehicles driven on the separation geotextile under any circumstances.

Installation shall comply with the manufacturer's requirements, details of which shall be provided to the Superintendent prior to installation. Installation shall only occur once the Superintendent has accepted the material as being in accordance with the required Specifications.

If the geotextile has been damaged (by tears, holes or otherwise) during installation, it can be repaired by patching a new piece of geotextile made from the same material. Any soil or other material that may have penetrated the damaged geotextile shall first be removed before any repair could be conducted. On slopes, the patch shall be double-seamed into place with the seams 5 mm to 20 mm apart. Elsewhere a patch shall be spot-seamed in place with a minimum of 300 mm overlap in all directions.
2.10 LEACHATE PIPEWORK

2.10.1 GENERAL

The leachate collection, access and pumping pipes shall be specified and installed as indicated in the Drawings. There are a range of pipe diameters utilised for different applications.

The jointing of pipes shall be by butt welding or electro-fusion welding carried out by an appropriately qualified technician. Evidence of suitable qualification shall be provided to the Superintendent prior to the commencement of any pipe welding.

Bends shall be either pre-manufactured standard pipe fittings or specially manufactured bends.

All cut edges and welded joints shall be neat, clean and smooth.

2.10.2 PIPE DRILLING

Portions of the leachate collection pipework are to be drilled. The extent and method of drilling is as indicated in the Drawings.

Where required, drilling of polyethylene pipe shall not be undertaken on the lined area of the Works.

Drilled pipe shall be cleaned out of all drill cuttings prior to being installed in the Works.

2.10.3 INSTALLATION

Polyethylene pipes shall be stored, handled, transported and installed in accordance with the manufacturer’s requirements.

Polyethylene pipes shall not be subject to rough handling, particularly during loading and unloading operations. Pipes shall be suitably protected from scouring from lifting equipment. Pipes shall be suitably supported during lifting to prevent distortion or buckling.

Polyethylene pipes shall be lifted gently into position so as to avoid damage to the pipe and landfill cell liner materials. The pipes shall not be dragged or dropped. The Contractor shall only carry out this Works in the presence of the Superintendent who shall be given at least 24 hours prior notice in writing. Any damage sustained or suspected shall be thoroughly examined and rectified to the satisfaction of the Superintendent. All costs involved shall be borne by the Contractor.

Each pipe shall be accurately laid and aligned in terms of grade and position. Pipes shall be placed directly on the cell liner material. Pipe side support material (leachate drainage aggregate) shall be carefully placed and compacted to provide haunch support to the pipe without damage to the landfill cell liner materials or displacement of the pipe.

Leachate extraction pipework up the side slope shall be held in position prior to the construction of the Cell 1 concrete leachate access platform. Care is to be taken to prevent the pipework from sliding down the embankment slope and damaging the cell liner and leachate sump.

All foreign material shall be removed from the interior surface of the pipes.
2.11 SUPPLY AND INSTALLATION OF LEACHATE DRAINAGE AGGREGATE

2.11.1 GENERAL

The scope of Works incorporates the supply and placement of leachate drainage aggregate as specified and to the extent shown in the Drawings.

The Contractor shall provide all materials, supervision, labour and equipment for the placement of the leachate drainage aggregate in accordance with these Specifications and Drawings.

Prior to placement, all aggregate to be incorporated in the Works shall be approved in writing by the Superintendent.

2.11.2 INSTALLATION TIMING

The Contractor is to install the leachate aggregate over the cushion geotextile as soon as is reasonably possible during the progression of the work, but definitely within two weeks of the installation of the GCL. Any area of GCL installed in the Works is not to be left for more than two weeks without being surcharged with the leachate drainage aggregate.

The Contractor is to program the Works such that the various liner installation and QA activities occur concurrently such that the aggregate is placed within two weeks of any area of GCL having been installed.

2.11.3 LEACHATE DRAINAGE MATERIAL

2.11.3.1 CHARACTERISTICS

Leachate Drainage Material shall consist of clean, virgin aggregate (blue metal), free of organic matter, lumps of clay or other deleterious material and be free of fine-grained material. The maximum particle size of the cell floor drainage material shall be no greater than 37.5 mm. Crushed limestone is not acceptable due to its susceptibility to degradation by leachate.

The Material shall comply with the grading as set out in Table 8:

<table>
<thead>
<tr>
<th>*Sieve Size</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.5</td>
<td>100</td>
</tr>
<tr>
<td>26.5</td>
<td>70 - 100</td>
</tr>
<tr>
<td>13.75</td>
<td>0 - 5</td>
</tr>
<tr>
<td>4.75</td>
<td>0 - 2</td>
</tr>
<tr>
<td>2.36</td>
<td>0 - 1</td>
</tr>
</tbody>
</table>

* Indicative sieve sizing. Different suppliers may use different sieve sizes.

The Contractor shall provide to the Superintendent a 20 kg sample of the proposed material and copies of test results from a NATA registered laboratory, confirming compliance with the Specifications prior to its use in the Works.

2.11.3.2 PLACEMENT

The Contractor shall only carry out the Works in the presence of the Superintendent who shall be given at least 24 hours prior notice in writing. Any damage sustained or suspected to have occurred to the underlying liner layers and substrate shall be thoroughly examined and rectified to the satisfaction of the Superintendent. All costs involved shall be borne by the Contractor.

The leachate drainage material shall be placed in a layer of 300 mm minimum thickness. It is essential that this placement operation be carried out such that no excessive stress is imparted to the underlying liner or substrate Works so as not to damage any previous Works. In particular, the Contractor shall take into account: temperature effects; loads imposed by haulage vehicles, spreading vehicles, etc; drainage material placement techniques; and geomembrane waves.
The aggregate shall be installed above the cushion geotextile in the landfill cell to the extent shown on the Drawings. The aggregate layer is to be placed up the landfill perimeter side slopes to a maximum vertical height of 4.5 m above the toe of the side slope. The remainder of the leachate drainage aggregate will be progressively installed by others as the waste height increases.

The Contractor shall place the aggregate on the liner and not spill or push the aggregate out onto the liner. Any waves formed in the liner materials as a result of the aggregate being pushed out shall be repaired by the Contractor, at no cost to the Principle.

The drainage material shall be spread with a dozer or similar machine with a maximum ground contact pressure of 50 kPa. The dozer shall operate over at least 300 mm thickness of drainage material at all times. The dozer shall not take large cuts into heaped material. This may result in rear track drift and dig into the material causing potential abrasion or rupture of the liner below. The dozer shall not slew or break suddenly unless over a designated temporary haul road or tipping area where the drainage material is maintained at a minimum thickness of 800 mm as measured from the bottom of the deepest ruts in the aggregate to the surface of the geomembrane. When no longer required, temporary haul roads and tipping areas shall be removed by spreading over adjacent uncovered areas of membrane.

Vehicles spreading aggregate are not to turn on the aggregate on the side slope and are only to travel up and down the slope, not sideways on the slope.

Haulage vehicles shall remain on designated haulage roads and tipping areas at all times. No haulage vehicles are to travel on the side slopes.

2.12 LEACHATE COLLECTION SUMP – CELL 1

2.12.1 GENERAL
The leachate collection sump is to be constructed in accordance with the Specifications and Drawings. The sump is to be double lined with GCL and single lined HDPE lining. The first layer of GCL is to be the additional layer that is only placed in the area of the leachate collection sump, while the second layer is to be the main, continuous layer. There is no requirement to apply any bentonite paste or granules between the two layers of GCL.

2.12.2 INSTALLATION
During the installation of the leachate collections sump, care is to be taken to minimise the number of joins within the sump. This applies to both the double GCL layers and HDPE layer.

2.13 LEACHATE ACCESS CONCRETE PLATFORM
The Works consist of the construction of one leachate access platform. The access platform is to be constructed to the detail and at the location as indicated in the Drawings.

2.14 LEACHATE ACCESS PRESSURE MAIN

Material
The various section of pressure main shall be a combination of Class PN16 PE100 complying with AS 4130 and grade 316 stainless steel complying with AS 5200.000 as indicated in the Drawings.

Flange gaskets shall be 6mm full-face natural or neoprene rubber of durometer hardness 65 to 70. Bolts, nuts and washers shall be mild steel, hot dip galvanised to AS1214 and AS1650 respectively.

All mild steel nuts and bolts shall have a petroleum paste or similar applied in accordance with the manufacturer's recommendations to protect against corrosion.
2.15 SUBMERSIBLE PUMP

2.15.1 GENERAL
The Contractor shall supply, install and test the submersible leachate pump as indicated in the Drawings.

2.15.2 PUMP SPECIFICATIONS
The Specification of the submersible leachate pump is as follows:
- SS60/03 Davey pump or similar approved by the Superintendent.

2.15.3 PUMP INSTALLATION AND CONTROL
The Contractor shall install the pump within the HDPE access pipe as shown on the Drawings.

The Contractor shall provide and fit the HDPE rising main discharge pipe. It is not intended to use the HDPE pipe to support the unit in the operating position or to use it to suspend the pump during installation or removal. The pump will be removed using a stainless steel cable, with the HDPE pipe being loosely collected on the surface.

As the HDPE casing will not be installed vertically there will be a need to ensure that the pump, during normal operation, is actually at the bottom of the casing. The Contractor shall install a depth indicator (permanent mark attached to the pipe) on the HDPE pipe to demonstrate that the pump is positioned at the low point in the casing. The Contractor is to also install a plaque on the concrete platform indicating the length of the leachate extraction pipe as indicated in the Drawings.

The leachate extraction pump shall be operated via an automated system of float switches that are arranged to pump leachate between +800 mm and +300 above the base of the leachate sump. The automated system is to have a timer to allow the pump to be switched off afterhours. There is also to be a manual override via an ON/OFF switch to be able to either stop the pump or start the pump. All pump controls are to be housed within the electrical enclosure as indicated in the Drawings.

2.15.4 INSPECTION, TESTING AND COMMISSIONING
The Contractor shall give the Superintendent ten (10) working days notice in writing to enable all necessary arrangements for inspection and testing can be made.

Following installation, inspection and electrical functional testing, the pumping unit shall be tested on Site in the presence of the Superintendent.

Testing shall consist of checking correct rotation of the pumping unit motor and ensuring that the pump will operate after energising. The pumping unit shall be run no longer than 15 seconds at each test start.

The pump shall be started against a fully open discharge valve. The pressure main shall be full of water prior to commencement of testing.

2.15.5 PACKING
Due to the aggressive operating environment, it is essential to protect all coatings from damage during transit to the Site.

Any coating damage shall be repaired at the Contractor’s expense and shall be to the coating manufacturer's recommendations.

Similarly, any damage to any components, which may become evident from inspection after delivery to Site shall be replaced at the Contractor’s expense.

2.15.6 OPERATING MANUALS
The Contractor shall supply three copies of an approved manual containing all installation, operating and maintenance instructions for the pump and control system.
2.16 LEACHATE PIPELINE TESTING

Leachate pipeline and pipework testing shall comply with the requirements of AS2032-1977.

All leachate delivery pipelines and pipework shall be pressure tested. The required test pressure shall be 50 m head of water. Testing shall be undertaken in the presence of the Superintendent.

The Contractor shall undertake all testing and measurements in accordance with these Specification.

2.17 ROAD WORKS

2.17.1 GENERAL

The access roads shall be constructed to the cross-sections, lines and grades shown on the Drawings.

The Works, where applicable shall be carried out in accordance with Main Roads Specification 501 – Pavements. Any variation from the applicable Main Roads specification needs to be approved by the Superintendent, in writing before the relevant Works commence.

2.17.2 CULVERTS

The culverts shall be constructed to the cross-sections, lines and grades shown on the Drawings.

The Works, where applicable shall be carried out in accordance with Main Roads Specification 404 – Culverts. Any variation from the applicable Main Roads specification needs to be approved by the Superintendent, in writing before the relevant Works commence.

2.18 PERIMETER FENCING

The perimeter fencing is to be installed as indicated in the Drawings and in accordance with the manufactures recommendations.

Fencing shall be 1.8 m high mesh fence with three strands of barbed wire above. All fencing material to be galvanized.

2.19 WATER SUPPLY

Water for the Works will be available within the existing clay pit. The Contractor is to ensure that water is conserved and not wasted when used for construction purposes.

2.20 ELECTRICAL SERVICES

2.20.1 GENERAL

There is no on-Site power supply available. All power will be provided via mobile generator. During construction, the Contractor is to provide its own power for its own needs. On completion of the Works, the Principal will provide sufficient generator power to operate the Site.

2.20.2 STANDARDS

Equipment, documentation and Works carried out shall comply with the requirements of:

- AS1101  Graphical symbols for electro technical documentation
- AS 3000  Wiring Rules
- AS 3017  Electrical Installations – Testing guidelines
- AS 3439  Low Voltage Switchgear and Control Gear Assemblies
- AS 60529  Degrees of Protection Provided by Enclosures

The above list is not exhaustive and any other standards that apply directly or indirectly to supplied equipment and the installation shall also apply.

Where an Australian Standards does not exist relevant International/European Standard shall apply.
2.20.3 REGULATIONS, HEALTH SAFETY AND ENVIRONMENT (HSE)

Equipment, documentation and Works carried out shall comply with the requirements of:

- WA Occupational Safety and Health Act 1984
- WA Occupational Safety and Health Regulations 1996 (the Act, Regulations, Codes of Practice and other safety information can be accessed from the WorkSafe WA website at http://www.safetyline.wa.gov.au
- WA Electrical Requirements

All of the Contractor's electrical representatives attending Site shall wear appropriate PPE for the task undertaken.

The Contractor shall submit an electrical installation specific Safety Management Plan to the Superintendent for approval. All of the Contractor's representatives attending Site shall be aware of and adhere to the Safety Management Plan.

The Contractor shall submit a written work plan and JSA to the Superintendent for approval prior to commencing the Works.

All of the Contractor's electrical representatives attending Site shall hold a white/blue construction awareness card.

The Contractor shall appoint an electrical OSH Site representative.

2.20.4 ELECTRICAL REQUIREMENTS

2.20.4.1 ELECTRICAL ENCLOSURE

The electrical enclosure (from herein referred to as a control panel) shall be a form 2 enclosure B&R Pilbara series, constructed in mild steel with sloped roof and powder coated with an ingress protection rating of IP66.

Front access to the control panel to non-qualified electrical personnel shall be possible by the use of an internal escutcheon populated with pump controls, a magnetic flow meter indicator, logic controller and circuit protection devices. No exposed terminals/connections are to be made on the exterior side of the escutcheon.

An A3 document holder shall be fitted to the internal control panel door.

2.20.4.2 MAJOR COMPONENTS

Incomer Clipsal Surface Mount 4C series

A main three phase circuit breaker (10kA Clipsal 4 series power range) and Clipsal 970 Series Surge Arrester shall be housed in a Clipsal surface mount 4C series switchboard on the escutcheon as depicted in the attached example electrical schematic diagram (drawing S001-1A).

Two engraved labels entitled ‘Q1’ and ‘MAIN CB’ shall be affixed above the MCB.

Distribution Clipsal Surface Mount 4C series

Sub-circuit protection devices shall be housed in a second Clipsal surface mount 4C series switchboard on the escutcheon as depicted in the attached example electrical schematic diagram (drawing S001-1A).

Devices as follows:

- 16A 30mA RCD wired to a 15A Clipsal 56 series switch socket outlet (flat pins) mounted on the exterior of the electrical enclosure. With engraved labels entitled ‘Q2’ and ‘GPO’ above the MCB.
- 10A 30mA RCD – internal control panel light. With engraved labels entitled ‘Q3’ and ‘LIGHT’ above the MCB.
- 3 Pole motor starter circuit breaker (Schneider GV2 series or equivalent) with N/O and N/C auxiliary block fitted. With engraved labels entitled ‘Q4’ and ‘PUMP MOTOR’ above the MCB.
Pump Controls

The following controls shall be fitted to the control panel escutcheon:

- Green start pushbutton. With engraved label entitled ‘START PUMP’ above the pushbutton;
- Red stop pushbutton. With engraved label entitled ‘STOP PUMP’ above the pushbutton;
- Two position selector switch. With engraved label entitled ‘AUTO/MANUAL’ above the switch;
- Blue pushbutton. With engraved label entitled ‘RESET FAULT’ above the pushbutton;
- Black pushbutton. With engraved label entitled ‘RESET HOURS RUN & FLOW TOTAL’ above the pushbutton;
- Red LED (24V dc) with engraved label entitled ‘PUMP FAULT’;
- Green LED (24V dc) with engraved label entitled ‘PUMP RUNNING’; and,
- Three phase change over switch (pump direction). With engraved label entitled ‘PUMP DIRECTION’ above the switch.

A pump three phase 4kW contactor (Sprecher + Schuh CA7 series) and a thermistor relay (Sprecher + Schuh RT7-E1 series) shall be mounted on the control panel mounting pan. With engraved label ‘K1’ and ‘K2’ respectively mounted above each device on the mounting pan.

An Omniflex Powerterm 24V dc battery charger and suitably rated batteries to keep the logic controller powered for a minimum of 24 hours following a power outage shall be fitted to the mounting pan and a 1P MCB fitted to the escutcheon housed in a third Clipsal surface mount 4C series switchboard engraved ‘Q7’ and ‘24V dc’.

As per circuitry depicted in the attached example electrical schematic diagram S07020-024.

Magnetic Flow Meter Indicator

A magnetic flow meter remote display unit (240V ac) shall be fitted to the escutcheon. The magnetic flow meter shall be sourced from one of the following manufacturer’s:

- ABB
- Siemens
- Endress & Hauser
- Bürkert

Logic Control

A Mitsubishi Alpha 2 AL2-14MR-D logic controller with perspex cover shall be fitted to the escutcheon.

The logic controller shall start and stop the pump as per the following:

The pump will stop and not restart if:

- Input 1: Motor health is low
- Input 2: Stop pushbutton / battery charger fault signal is low
- Output 1: Pump Contactor is energised and a regular rising edge of Input 7: Flow pulses is not detected within ‘x’ seconds. This low/no flow alarm is reset by depression of the blue push button.
Input 4: Switch set to MANUAL
The pump is started and stopped by the Green and Red pushbuttons

Input 5: Switch set to AUTO
The pump is started and stopped automatically by a start and stop signal from the float valves and overridden by a preset timeout entered via the logic controller LCD display (The logic controller shall be equipped with a real-time clock with its time and date set correctly).

The logic controller LCD display shall indicate totalised pump run hour and flow volume across the first two lines of the display. These counters maybe reset by the depression of the black pushbutton. The magnitude that the flow totaliser increments by in the logic controller shall be equal to that set in the magnetic flow meter display and shall be determined during commissioning.

In the event of a no/low flow alarm the fault shall be displayed on the 4th line of the logic controller display.

In the event that Input 2 is low for greater than 5 seconds the fault ‘Power Failure’ shall be displayed on the 3rd line of the logic controller display.

Provision (space) on the escutcheon shall be made for a future I/O expansion module and Next G / SMS Modem.

Note: The 24V battery backup is required in order for the logic controller to continue to store the totalised hours run and flow volume

2.20.4.3 BUILD REQUIREMENTS
The build requirements are as follows:

- Wiring to be run in trunking, open slot trunking (Iboco or equivalent);
- Terminations to be made by crimped connectors i.e. bootlace ferrules;
- Fixings to be secured by metric set screw (tapped mounting pan) or nutsert so that equipment maybe removed from the mounting pan from the front. Nuts on the rear of the pan and self tappers are not permitted;
- All wires to be fitted with number ident. Grafoiplast or Legrand CAB3 cable/wire marking system is preferred;
- All components mounted on the pan/escutcheon to be identified by an engraved label screwed to the mounting pan directly above the component. (i.e. not on trunking lid);
- Motor control cabling to be 1.0 mm²;
- Motor power cabling to be 2.5 mm²;
- Lighting circuit power cabling to be 1.5 mm²;
- Single phase outlet power cabling to be 2.5 mm²;
- Internal power distribution to be 4.0 mm²;
- Magnetic flow meter power cabling to be 1.5 mm²; and,
- Logic Controller 24V dc cabling to be 0.5 mm² with segregation as far as practically possible.

The Superintendent shall witness full functional tests of the control panel at the electrical contractor’s premises in Perth, any non-conformance items must be corrected at the electrical contractor’s expense before shipment to Site.
2.20.4.4 INSTALLATION

General

In the case of discrepancies between electrical Drawings and other Drawings the Superintendent is to be notified for discrepancy resolution.

All materials and equipment to be supplied shall be new and shall be installed in accordance with manufacturers’ instructions and recommendations.

Cables and conduits shall be run clear of other services and a Site layout plan of all buried electrical services shall be provided as part of the As-Constructed documentation.

Conduits are to be installed within or under slab blinding, NOT within the concrete slab as future pipe work stands and associated infrastructure may compromise their integrity. To facilitate this Contractor shall pre-lay conduits with vertical sections rising above the finished slab level prior to concrete pour at the pre-prepared slab site.

Cable Identification

All cables shall be fitted with a permanent cable identification number at each end with the identification number included on the electrical schematic drawing and electrical site plan drawing.

Control Panel Installation

The control panel is to be mounted on a suitable stand so the internal operator devices are at a serviceable height. The stand shall be fixed to the concrete slab by a suitable method of fixing. Stainless steel 316 and / or galvanised fixing methods and materials are only to be used, the fixings maybe of expansion anchor or chemical bonding type (chemset) as deemed to be appropriate.

Pump Power Outlet

A Maréchal DS2 20A IP66/67 de-contactor with two auxiliary contacts (for pump thermistor) shall be installed at the position indicated on the attached site plan and cabled to the control panel.

The de-contactor shall be mounted on a suitable post type arrangement fixed to the concrete slab by a suitable method of fixing. Stainless steel 316 and / or galvanised fixing methods are only to be used.

Magnetic Flow Meter

A DN50 magnetic flow meter sensing element with Hastelloy ‘C’ electrodes (paired with the magnetic flow meter remote indicator) shall be installed at the point indicated on the Drawings (pipe-work including mounting flanges will be pre-installed by the mechanical installer).

The flow meter is to be installed in accordance with manufacturer’s recommendations; the following in particular is to be adhered to:

- The flow sensing element is to be installed on a section of straight pipe with the length of which is to be at least five pipe diameters upstream and ten pipe diameters downstream.
- The flow sensing element is to be installed in a section where the pipe-work is always full of liquid - either a vertical upward flow line or in a stepped down and then up horizontal section.
- Grounding rings installed on the upstream and downstream side of the magnetic flow sensing element.
- Vendor cables used to connect to the magnetic flow meter remote indicator.

Earthing

The control panel will be earthed from the running Earth within the supply cable from the distribution pillar, fault loop impedance requirements shall be adhered to.

An additional local earth electrode shall be installed adjacent to the control panel to facilitate equipotential bonding of all pipe-work, structural steel and to assist with protection of the instrumentation equipment. This electrode is to have a protective pit marked ‘Earth Electrode’ with a 35mm² bonding conductor bonded/terminated at the control panel Earth bar and marked ‘EQUIPONTENTIAL BONDING CONDUCTOR’.
Equipotential bond all pipe-work and metallic structures with 35mm$^2$ Earth cable, lugged and heat shrunk.

2.20.5 TESTING & COMMISSIONING

All supplied and installed equipment shall be inspected, tested and where applicable energised, configured and operated. Functional tests shall be witnessed by the Superintendent.

The following completed and signed installation and commissioning test sheets shall be submitted to the Superintendent:

- Cable tests – insulation, fault loop impedance, continuity & RCD;
- Western Power safety certificate;
- Pump start/stop functionality including testing of thermistor and on/low flow interlock and corresponding logic controller display; and
- Magflow setup and calibration in accordance with manufacturers guidelines.

2.20.6 AS-CONSTRUCTED RECORDS AND DOCUMENTATION

The following documentation shall be provided in two A4 “D” ring folders:

- As-Constructed multi-line power and control circuit diagrams (schematics) produced in AutoCAD;
- As Constructed Site layout plan of all buried electrical services produced in AutoCAD;
- Printout of the logic controller configuration;
- Manufacturers operating and maintenance manuals and datasheets;
- Equipment guarantees and warranties;
- Recommended spares list; and,
- Troubleshooting guide.

The above documentation shall be provided on CD in ‘PDF’ format. Schematic and site plan drawings shall also be supplied in AutoCAD format.

A copy of the programming software, configured code shall be provided on CD along with a programming cable.

On completion of commissioning a set of red line mark-ups shall be left in the control panel A3 holder to facilitate fault finding in the event of a breakdown until the above documentation is submitted.

The above documentation shall be submitted within two weeks of completion of commissioning.

2.21 SURFACE WATER STORAGE DAM

The Contractor is to construct the surface water storage dam in the location and to the design as indicated in the Drawings.

2.22 WEIGHBRIDGE, SITE OFFICE AND STAFF AMENITIES

The Contractor is to construct the weighbridge and install the Site office and staff amenities in the location and to the design as indicated in the Drawings.

The weighbridge shall have a deck of 30m long x 3m wide and a maximum load capacity of 100 tonnes.

The Site office and staff amenity prefabricated building shall be a Principal supply item. The Principal shall deliver the building to Site to a location identified by the Contractor. Once delivered, the Contractor shall inspect the building for any damage and thereafter signoff on the condition of the building. Should, during the subsequent construction activities, any damage occur to the building, the Contractor will be liable for the cost of all repairs to the building.
2.23 QUALITY ASSURANCE AND TESTING

2.23.1 GENERAL
The Contractor shall at all times be responsible for achieving the specified standards and demonstrating such achievement through testing and measurement and the provision of documentation which shall cover all Works under the Contract, both on-site and off-site and shall include the activities of all sub-contractors and suppliers.

2.23.2 TRACEABILITY
Traceability is required for all materials as stipulated in these Specifications or if not stipulated, as per the relevant Standard, Code of industry norm. The trace shall start at the specified or nominated source point and finish at the location where the material is incorporated into the Works.

Traceability shall apply to:
- HDPE Pipe and Fittings;
- Leachate Pressure Mains and Fittings;
- Geosynthetic Clay Liner;
- HDPE Liner;
- Geotextiles;
- Pump; and,
- Electrical Cabling.

2.23.3 INSPECTION
The Superintendent or its nominated representative shall at all times be provided access to any facility where Works associated with the Contract is being performed, including the facilities of sub-contractors or suppliers either on-site, and any laboratory used for testing.

2.23.4 TESTING PERSONNEL
All quality control testing unless specified otherwise shall be carried out by a laboratory holding current NATA registration for all test methods referred to or required by these Specifications. NATA registration for all test methods shall be held at the time of tendering and be maintained until completion of the Contract. All test reports shall be NATA endorsed by a current NATA signatory approved for the laboratory conducting the testing.

Surveying processes to verify conformance shall be conducted by personnel with a minimum qualification for acceptance to the Institution of Engineering and Mining Surveyors, Australia or equivalent.

2.23.5 SAMPLING AND TEST FREQUENCY
Sampling methods shall be unbiased and either random or systematic in concept or as specified. The minimum frequency of tests shall be as stipulated in these Specifications or if not stipulated, as per the relevant Standard, Code of industry norm.

2.23.6 TESTING

2.23.6.1 LIMITS OF WORK TO BE TESTED
The minimum frequency of tests shall be as stipulated in these Specifications.

2.23.6.2 TEST METHODS
The tests methods shall be as stipulated in these Specifications.

2.23.7 MEASUREMENT AND TEST EQUIPMENT
Measurement and test equipment shall include all equipment necessary for the proper setting out and for production and Conformance Quality Control testing of the Works. Calibration and certification of test equipment shall comply with NATA stipulations.
2.23.8 RECORDS AND REPORTING

The Contractor shall complete all As-Constructed and quality verification documentation and submit all records, including manufacturer's certificates to the Superintendent at regular intervals during the Contract period as agreed with the Superintendent.

Manufacturers' and suppliers' certificates shall enable a clear trace of items from source to the location within the Works.

2.23.9 PAYMENT FOR QUALITY ASSURANCE AND TESTING

The cost of traceability, testing and measurement to the extent required by these Specifications shall be borne by the Contractor.

The Principal shall pay for all Conformance Quality Control testing as stipulated in these Specifications. Any repeat Conformance Quality Control testing due to material failure (non-conformance) or replacement shall be borne by the Contractor.

2.24 AS-CONSTRUCTED DRAWINGS

The Contractor is to provide a set of As-Constructed drawings in AutoCAD format and A3 size hard copy. The As-Constructed drawings are to show the following minimum detail:

- General Site earthworks layout;
- Road system layout;
- Stormwater layout system;
- Landfill cell layout including:
  - Perimeter bund positions;
  - Anchor trench positions
  - Top of HDPE liner position;
  - Top of leachate drainage aggregate layer;
  - Aggregate layer thickness – red for areas <300 mm, green areas >300 mm;
  - Leachate pipe positions – pipe crown (collection, extraction and delivery lines);
  - Leachate sump position;
  - Leachate extraction point position;
- Leachate pond layout including:
  - Perimeter bund positions;
  - Anchor trench positions;
  - Top of HDPE liner position;
  - Leachate pipe positions (delivery lines and inter-pond connection pipework);
  - Leachate sump positions;
- Details of leachate pump, grades, materials, pressure class and diameters;
- The position of all electrical power supply;
- All new fence lines.
Opalvale Salt Valley Road Class II Landfill
Toodyay

Construction Quality Assurance Plan
August 2017

1. Introduction

The Construction Quality Assurance (CQA) is defined as a planned system of activities that provide assurance that the landfill was constructed as specified in the design and documentation. It is an important factor in ensuring that design and installation of the works is done in accordance with the standards and Specifications agreed with the Department of Water and Environment Regulation (DWER).

For this purpose, an independent third party CQA consultant with experience in landfill construction and more specifically geomembrane and geotextile performance characteristics will be appointed to verify that the works have been carried out to the agreed standards. The duties of the third-party CQA consultant will include:

- Inspections;
- Verification;
- Audits and evaluation of materials and workmanship;
- Provision of advice on installation, testing, repair and covering of the critical aspects of construction; and,
- Issuing a final CQA report documenting the quality of the constructed facility.

The CQA Plan will verify that:
- Materials used comply with Specifications; and,
- Method of construction/installation is appropriate and, as a result the design requirements have been met.

The CQA Plan including reference to the construction Specifications contains the material/construction Specifications, testing methods, testing frequency, corrective action and provides for appropriate documentation procedures.

The final CQA report will be prepared by the CQA consultant in accordance with the requirements of the Victorian EPA Siting, Design, Operation and Rehabilitation of Landfills - August 2016, to demonstrate that all requirements of the project Specifications and CQA Plan have been complied with.

2. Critical Aspects of Construction

The critical aspects of construction relating to this particular project include the following:
- Confirmation of the actual material properties in comparison to the design assumption material properties used during the design stability assessment.
- Infill of monitoring bores.
- Sub-Grade preparation.
- Geosynthetic Clay Layer (GCL)
- Geomembrane installation.
- Geotextile installation.
- Leachate collection system.
- Leak detection.
3. Exclusions

Works not included in this CQA Plan include:

- Groundwater monitoring bores – as there are no additional bores required around the landfill perimeter; and,
- Landfill gas infrastructure – as this will form part of a separate Works Approval application process and consequently covered under a separate CQA Plan.

4. Construction Specification

The construction Specifications forming part of the construction works set out the following requirements:

- Material and construction Specifications;
- Applicable Standards;
- Testing methods and procedures;
- Inspections;
- Testing Frequencies;
- Corrective actions; and,
- Documentation Procedures.

The construction Specifications are to be read in conjunction with this CQA Plan. The CQA consultant is to confirm that the works are carried out in accordance with the construction Specifications. The construction Specifications are not repeated within this CQA Plan.

5. Confirmation of Material Properties

The design stability analysis was carried out by Golder Associates, based on assumptions of theoretical material properties. To confirm the appropriateness of these assumptions, the CQA consultant is to liaise with Golder Associates to determine which materials need to be sourced in order for Golder Associates to undertake the necessary site-specific materials testing to confirm their design assessment assumptions.

The CQA consultant is to:

- Liaise with Golder Associates on the type and quantity of site-specific materials required for testing.
- Source the necessary materials and deliver them to Golder Associates;
- Obtain testing outcome results from Golders Associates;
- If the results are acceptable to Golder Associates, include the results and Golder Associates conclusion in the CQA Report;
- If the results are not acceptable, liaise with Golder Associates, the landfill designer and the Superintendent to identify the preferred way forward.
- Document the ultimate outcome in the CQA Report.

6. Infill of Monitoring bores

The CQA consultant is to confirm that all five of the monitoring bores within the clay pit are appropriately infilled and sealed in accordance with the construction Specifications and that during decommissioning the Contractor records the following data for each bore:

- Date/time;
- Bore number;
- Bore depth;
- Bore volume (calculated based on diameter and depth);
- Volume of bentonite pellets poured into the bore void; and,
- Volume of fresh water poured into the bore for it to hydrate the bentonite pellets.
7. **Sub-Grade Preparation**

Because of the importance of the sub-grade integrity in the overall liner performance, construction of these components must be accompanied by geotechnical testing as set out in the Specifications and AS 1289 Methods of Testing Soil for Engineering Purposes. 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.

The minimum field density test frequencies are to comply with the following:

- One test the \( \frac{500}{2} \) \( m^3 \) distributed evenly throughout full depth and area;
- One test 2,500 \( m^2 \) per layer, distributed evenly over the surface of the layer;
- One test per layer or per 300 mm thickness per 150 m length constructed horizontal layer; or
- Three tests per visit when material is placed in horizontal layers;
- Whichever frequency is agreed with the Superintendent.

For further details refer to the construction Specifications under the Earthworks section – Compaction Testing.

Due to there being no rework and subsequent compaction of the clay sub-grade for the purposes of achieving a particular permeability, there is no need to undertake any permeability testing in the laboratory and/or in the field. All compaction testing is primarily to confirm the appropriate density of the material for stability purposes.

In addition to the physical testing, visual inspections should check for the presence of oversized clods of material, poorly compacted or dry areas and the homogeneity of the sub-base.
8. GCL Installation

Manufacturing Specifications and Quality Control
The manufacturing specifications and quality control is to be in accordance with the requirements of the construction Specifications.

Non-Conformances
If there are any non-conformances identified or any changes to the construction Specifications that have a material effect on the outcome of the works, the CQA consultant is to determine:

- The nature of the non-conformance and its level of effect on the project;
- If the non-conformance is an isolated incident or a recurring problem;
- How amendments to procedures to prevent future occurrences of the non-conformance can be implemented;
- The nature of corrective action(s) to be applied to rectify the specific non-conformance;
- The procedures and persons to be notified of the non-conformance and corrective measures;
- Procedures for reporting to the DWER major exceptions/variations to the approved technical Specifications.

Inspection Activities
The CQA consultant is to confirm that the following information and procedures are available and the relevant activities have been carried out in accordance with the construction Specifications:

1. Definitions to be used throughout the project to avoid confusion on acronyms and wording.
2. Descriptions of responsibilities, qualifications, and obligations for each party involved in the CQA plan.
3. The lines of communication and authority for the project. Identify and define the process for addressing request for information, design modifications or changes in the project specifications.
4. A formal process on handling deficiencies which defines responsibilities and the minimum documentation required to correct deficiencies.
5. A project meeting schedule.
6. The proposed level of supervision and quality control.
7. Verification process and review of the quality control certificates of the manufacturers of the GCL, the bentonite and the geotextile.
8. Verification process and review of the property values certified by the GCL manufacturer.
9. Verification process that the measurements of properties by the manufacturer are properly documented, test methods are acceptable, sampling procedure detailed and verification that the geosynthetic clay liner, the geotextile and the bentonite meet the project specifications.
10. Verification process and review of the quality control certificates of the geosynthetic clay liner rolls assigned to the project (note: this includes a need to agree with manufacturer on the frequency of the tests).
11. Details of the delivery, handling and storage of the geosynthetic clay liner on site prior to installation.
12. Verification process of the geosynthetic clay liner handling equipment and restraining methods used on the site.
13. Rejection criteria of the geosynthetic clay liner rolls.
14. Details of the installation staff’s accreditations and verification of their experience.
15. Details of the conformance tests the CQA consultant will undertake on the geosynthetic clay liner rolls delivered to site. Any laboratory tests must be performed at an accredited, independent third-party laboratory.
16. Details of actions to take if geosynthetic clay liner fails conformance tests.
17. Approval procedure of the subgrade and anchor trench including details of testing.
18. Establishment of a field geosynthetic clay liner panel identification.
19. Details of actions to take to insure that field panels and overlap orientation are as indicated in the layout plan.
20. Measures to take to protect the liner if inclement weather occurs during installation.
23. Details of actions to take in case of defects and or damages to the surface of the laid geosynthetic clay liner are identified and corrective measures.
24. Details of actions to take to minimise geosynthetic clay liner wrinkles and bridging.
25. Verification process of the geosynthetic clay liner installation around areas of protrusions and penetrations is made according to specifications.
26. Details of actions and procedure to take to protect and to confine the geosynthetic clay liners following installation.
27. Procedure for ensuring that the GCL does not exceed the manufactured moisture content.
28. CQA consultant daily recordkeeping. The daily log should contain the following:
   - Weather and site conditions
   - Records of the delivery handling and storage of quality of subgrade
   - Description of any material received at the site, including quality control data provided by suppliers
   - Location of daily construction activities and progress
   - Conformance to panel layout design
   - Recording of installation activities consisting of panel placement, roll numbers, overlap locations, repairs and testing results for all works
   - Records (including photos) of the geosynthetic clay liner at the time that cover soil or geomembrane is placed over the geosynthetic clay liner
   - Photographs of construction works and any items of specific interest. The captions of all photographs should contain the name of the project, the date on which the photograph was taken and the identity of the feature being photographed
   - Type of equipment used in each work task (e.g. handling equipment)
   - Testing conducted and test methods used or remedial action on GCL defects or overlap defects
   - Placement of temporary protection to installed GCL
   - Record of any material or workmanship that does not meet specified designs and corrective actions taken to remediate the problem
   - Details of site visits
   - Summaries of any meetings held and action taken
   - Signature of CQA engineer
29. Periodic acceptance reports summarising daily reports.
30. Confirmation that all areas of GCL installed within the Works is surcharged by the leachate drainage aggregate within two weeks of installation.

The contractor shall provide the CQA authority with the following listed test certificates and records prior to, during and at the completion of the works as each report and record is required:
   - Certification and test results of bentonite used in the production of the rolls from bentonite material supplier
   - Certification and test results of geotextiles, fibres used in the production of the rolls
   - Roll test data reports, for each roll of material
   - Accessory bentonite test reports
   - Completed as-built drawing, including roll numbers, panel layout, overlap locations and repair locations.

Any deviations from the approved CQA Plan must be noted and explained and approved by the DWER.
CQA Testing

Table 1 – GCL CQA Testing provides the test properties and minimum testing frequencies. Higher testing frequencies might be required in certain applications (i.e. need to identify the importance of the GCL for the safety of the works, construction and stability included). The onus is on the engineer of record to establish if higher requirements are more appropriate.

<table>
<thead>
<tr>
<th>Item</th>
<th>Property</th>
<th>Standard</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformance Quality Control testing (at point of manufacture, supply or upon shipment of GCL to the Site)</td>
<td>Thickness (dry)</td>
<td>ASTM D1777</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Mass per unit area of bentonite component of GCL</td>
<td>ASTM D5993</td>
<td>1 sample per 2,500 m²</td>
</tr>
<tr>
<td></td>
<td>Mass per unit area of GCL</td>
<td>ASTM D5993</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Montmorillonite content (X-ray diffraction method)</td>
<td>XRD (X-ray diffraction)</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>Cation exchange capacity of bentonite</td>
<td>Methylene blue method</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Mass/unit length of bentonite in overlaps</td>
<td>Visual inspection and weighing</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Moisture content of bentonite</td>
<td>AS 1289.2.1.1</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Swell index/free swell of clay</td>
<td>ASTM D5890</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Water absorption</td>
<td>ASTM D5891</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Peel strength (for needle-punched products only)</td>
<td>ASTM D6496</td>
<td>1 sample per 500 m²</td>
</tr>
<tr>
<td></td>
<td>Tensile strength</td>
<td>ASTM D4595</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>CBR of geotextile</td>
<td>AS 3706-4</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>Puncture resistance of geotextile</td>
<td>AS 3706-5</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td></td>
<td>Index flux</td>
<td>ASTM 5887</td>
<td>1 sample per 10,000 m²</td>
</tr>
<tr>
<td>Visual inspection of GCL</td>
<td>Colour, thickness, needle punching, presence of needles or broken needles, and sewing density or other faults in the material.</td>
<td></td>
<td>Every roll</td>
</tr>
<tr>
<td>Thickness of GCL (i.e. uniformity of bentonite distribution) and apparent variations in the as placed moisture distribution.</td>
<td>On-site</td>
<td></td>
<td>Each roll during placement. If thickness appears to be variable a check of the variability of the mass per unit area should be conducted</td>
</tr>
</tbody>
</table>
Note:
All conformance tests must be reviewed, accepted and reported by the Superintendent before deployment of the GCL.
All testing must be performed on samples taken from the GCL delivered to site under the Superintendent’s supervision.
All laboratory tests must be performed in a third party independent accredited laboratory.
9. Geomembrane Installation

Manufacturing Specifications and Quality Control
The manufacturing specifications and quality control is to be in accordance with the requirements of the construction Specifications.

Non-Conformances
If there are any non-conformances identified or any changes to the construction Specifications that have a material effect on the outcome of the works, the CQA consultant is to determine:

- The nature of the non-conformance and its level of effect on the project;
- If the non-conformance is an isolated incident or a recurring problem;
- How amendments to procedures to prevent future occurrences of the non-conformance can be implemented;
- The nature of corrective action(s) to be applied to rectify the specific non-conformance;
- The procedures and persons to be notified of the non-conformance and corrective measures;
- Procedures for reporting to the DWER major exceptions/variations to the approved technical Specifications.

Inspection Activities
The CQA consultant is to confirm that the following information and procedures are available and the relevant activities have been carried out in accordance with the construction Specifications:

1. Definitions to be used throughout the project to avoid confusion on acronyms and wording.
2. Descriptions of responsibilities, qualifications, and obligations for each party involved in the CQA Plan.
3. The lines of communication and authority for the project. Identify and define the process for addressing request for information, design modifications or changes in the project Specifications.
4. A formal process on handling deficiencies which defines responsibilities and the minimum documentation required to correct deficiencies.
5. A project meeting schedule.
6. The proposed level of supervision and quality control.
7. Verification process and review of the quality control certificates of the resin and the quality of the resin used to manufacture the geomembrane rolls assigned to the project. Same applies to the extrudate rod.
8. Verification process and review of the property values certified by the manufacturer. Same applies to the extrudate rod.
9. Verification process that the measurements of properties by the manufacturer are properly documented, test methods are acceptable, sampling procedure detailed and verification that the geomembrane meets the project Specifications. Same applies to the extrudate rod.
10. Verification process and review of the quality control certificates of the geomembranes rolls assigned to the project (note: need to agree with manufacturer on the frequency of the tests).
11. Details of the planned geomembrane storage on site prior to installation.
12. Verification process of the geomembrane handling equipment used on the site.
13. Rejection criteria of the geomembrane sheets.
14. Details of the installation staff’s accreditations and verification of their experience.
15. Details of the conformance tests the CQA consultant will undertake on the geomembrane delivered to site. Any laboratory tests must be performed at a third-party independent accredited geosynthetics laboratory.
16. Details of actions to take if geomembrane fails a conformance tests.
17. Approval procedure of the subgrade and anchor trench.
18. Establishment of a field geomembrane panel identification.
19. Details of actions to take to insure that field panels and seam orientation are as indicated in the layout plan.
20. Measures to take to protect the liner if inclement weather occurs during installation.
21. Frequency of trial welds and procedure for sampling and evaluation.
22. Procedures for inspecting seam preparation, trial welds, welds, testing and sampling welds, including the details of the nominated geosynthetic accredited laboratory for offsite testing.
23. Verification process of welding equipment, calibration and welding conditions.
24. Details of actions to take after cutting of each destructive test sample from the production seam.
25. Details of actions to take in the event of a defective weld, including retesting procedures.
26. Rejection criteria of the laid geomembrane if test results indicated failure.
27. Details of actions to take in case of defects and or damages to the surface of the laid geomembrane are identified and corrective measures.
28. Details of actions to take if geomembranes have been damaged due to shifting by wind.
29. Details of actions to take to minimise geomembrane wrinkles and bridging.
30. Verification process of the geomembrane installation around areas of protrusions and penetrations is made according to Specifications.
31. Details of actions to take to protect the geomembrane following installation.
32. CQA consultant daily recordkeeping. The daily log should contain the following:
   - Weather and site conditions
   - Quality of subgrade
   - Description of any material received at the site, including quality control data provided by suppliers
   - Location of daily construction activities and progress
   - Conformance to panel layout design
   - Recording of installation activities consisting of panel placement, roll numbers, seam/weld locations, repairs and testing results for all works
   - Records (including photos) of the wrinkling in the geomembrane at the time that cover soil is placed over the geomembrane
   - Photos of construction works and any items of specific interest. The captions of all photographs should contain the name of the project, the date on which the photograph was taken and the identity of the feature being photographed
   - Type of equipment used in each work task (e.g. handling equipment, welding equipment, on-site testing equipment)
   - Calibrations or recalibration of test equipment and weld equipment
   - Testing conducted and test methods used
   - Record of any material or workmanship that does not meet specified designs and corrective actions taken to remediate the problem
   - Details of site visits
   - Summaries of any meetings held and action taken
   - Signature of CQA consultant.
33. Periodic acceptance reports summarising daily reports.
The contractor shall provide the CQA consultant with the following listed test certificates and records prior, during and at the completion of the works as each report and record is required:

- Certification and test results of raw materials from raw material supplier.
- Certification and test results of raw materials from membrane manufacturer.
- Roll test data reports, for each roll of material.
- HDPE/LLDPE welding granulate test reports.
- Daily installation reports for each welder and technician —
  - Trial test weld record
  - Wedge weld records
  - Surface extrusion weld records
  - Weld peel and tensile test records
  - Wedge air-tunnel pressure test records
  - Vacuum box test records
  - Repair records
- Completed as-built drawing, including roll numbers, panel layout, seam locations and repair locations.

Any deviations from the approved CQA Plan must be noted and explained and approved by the DWER.

CQA Testing

**Table 2 – Geomembrane CQA Testing** provides the test properties and minimum testing frequencies. Higher testing frequencies might be required in certain applications (i.e. need to identify the importance of the geomembrane for the safety of the works, construction and stability included). The onus is on the engineer of record to establish if higher requirements are more appropriate.

<table>
<thead>
<tr>
<th>Item</th>
<th>Property</th>
<th>Standard</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformance testing (upon shipment of Geomembrane to the Site)</td>
<td>Thickness</td>
<td>ASTM D5994</td>
<td>Each roll</td>
</tr>
<tr>
<td></td>
<td>Density</td>
<td>ASTM D1505, ASTM D792</td>
<td>One sample per 5,000 m², or every five rolls delivered to site whichever is the greatest number of tests</td>
</tr>
<tr>
<td></td>
<td>Tensile properties (yield and break stress, yield and break elongation)</td>
<td>ASTM D6693 type IV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Puncture resistance</td>
<td>ASTM D4833</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tear resistance</td>
<td>ASTM D1004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon black content</td>
<td>ASTM D1603</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon black dispersion</td>
<td>ASTM D5596</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Axi-Symmetric Break Resistance Strain (min.) (LLDPE only)</td>
<td>ASTM D5617</td>
<td>Per formulation</td>
</tr>
<tr>
<td></td>
<td>Stress crack resistance (HDPE only)</td>
<td>ASTM D5397</td>
<td>One sample every 10,000 m², or resin type or manufacturing run</td>
</tr>
<tr>
<td></td>
<td>Oxidative induction time</td>
<td>ASTM D3895, ASTM D5885</td>
<td></td>
</tr>
<tr>
<td>Start-up test weld</td>
<td>Welding equipment</td>
<td></td>
<td>Checked daily at start of Works, and whenever the welding equipment is shut-off for more than one hour. Also after significant changes in weather conditions</td>
</tr>
<tr>
<td>Weld conditions</td>
<td>Test weld strips will be required whenever personnel or equipment are changed and/or wide temperature fluctuations are experienced. Minimum 1.5 m continuous seam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Destructive weld testing</td>
<td>On-site, hand tensiometer in peel and shear</td>
<td>ASTM D6392</td>
<td>Every weld</td>
</tr>
<tr>
<td></td>
<td>Off-site — weld seam strength in peel and shear</td>
<td>ASTM D6392</td>
<td>Every 150 m (if fusion weld), every 120 m (if extrusion weld) for HDPE. Every 300 m (if fusion weld), every 150 m (if extrusion weld) for LLDPE</td>
</tr>
<tr>
<td>Non-destructive weld testing</td>
<td>Air pressure test, ASTM D5820 Vacuum box test, ASTM D5641</td>
<td>All seams over full length</td>
<td></td>
</tr>
<tr>
<td>Visual inspection of geomembrane</td>
<td>Tears, punctures, abrasions, cracks, indentations, thin spots, or other faults in the material.</td>
<td>Every roll</td>
<td></td>
</tr>
<tr>
<td>Thickness of geomembrane</td>
<td>On-site</td>
<td>Five per 100 m, 20 m apart, taken at the edge of the sheet</td>
<td></td>
</tr>
</tbody>
</table>

Note:
All conformance tests must be reviewed, accepted and reported by the Superintendent before deployment of the geomembrane.
All testing must be performed on samples taken from the geomembrane delivered to Site under the Superintendent supervision.
All laboratory tests must be performed in a third-party independent accredited geosynthetics laboratory.
The required testing frequencies may be revised by the Superintendent to conform with improvements in testing methods and/or in the state of the art practice and/or to account for the criticality of the application (i.e. to account for the importance of the geomembrane for the safety of Works). Revisions must be approved by the relevant authorities before application.
10. Geofabric Installation

Manufacturing Specifications and Quality Control
The manufacturing specifications and quality control is to be in accordance with the construction Specifications.

Non-Conformances
If there are any non-conformances identified or any changes to the construction Specifications that have a material effect on the outcome of the works, the CQA consultant is to determine:

- The nature of the non-conformance and its level of effect on the project;
- If the non-conformance is an isolated incident or a recurring problem;
- How amendments to procedures to prevent future occurrences of the non-conformance can be implemented;
- The nature of corrective action(s) to be applied to rectify that specific non-conformance;
- The procedures and persons to be notified of the non-conformance and corrective measures;
- Procedures for reporting to the DWER major exceptions/variations to the approved technical Specifications.

Inspection Activities
The CQA consultant is to confirm that the following information and procedures are available and the relevant activities have been carried out in accordance with the construction Specifications:

1. Definitions to be used throughout the project to avoid confusion on acronyms and wording.
2. Descriptions of responsibilities, qualifications and obligations for each party involved in the CQA Plan.
3. The lines of communication and authority for the project. Identify and define the process for addressing request for information, design modifications or changes in the project Specifications.
4. A formal process on handling deficiencies that defines responsibilities and the minimum documentation required to correct deficiencies.
5. A project meeting schedule.
6. The proposed level of supervision and quality control.
7. Verification process and review of the quality control certificates of the geotextile manufacturers, the fibre suppliers and the polymer manufacturers, with a list of characteristics of the material.
8. Verification process and review of the property values certified by the geotextile manufacturer.
9. Verification process that the measurements of properties by the manufacturer are properly documented, test methods are acceptable and sampling procedure detailed, and verification that the polymer, fibres and geotextile meet the project Specifications.
10. Verification process and review of the quality control certificates of the geotextile rolls assigned to the project (note: need to agree with manufacturer on the frequency of the tests).
11. Details of the delivery, handling and storage of the geotextile on site prior to installation.
12. Verification process of the geotextile handling equipment and restraining methods used on the site.
13. Rejection criteria for the geotextile rolls.
14. Details of the installation staff’s accreditations and verification of their experience.
15. Details of the conformance tests the CQA consultant will undertake on the geotextile rolls delivered to site. Any laboratory tests must be performed at an accredited, independent, third-party laboratory.
16. Details of actions to take if geotextile fails conformance tests.
17. Approval procedure of the underlying geomembrane and anchor trench, including details of testing.
18. Establishment of a field geotextile panel identification.
19. Details of installation and jointing techniques.
20. Details of actions to take to ensure that field panels and jointing orientation are as indicated in the layout plan.
21. Procedure for inspecting, testing and sampling joints, if appropriate.
22. Measures to take to protect the geotextile if inclement weather occurs during installation.
23. Procedure for sampling and evaluation.
25. Details of actions to take in case defects and/or damage to the surface of the laid geotextile are identified, and corrective measures.
26. Details of actions to take to minimise geotextile wrinkles and bridging.
27. CQA consultant daily recordkeeping. The daily log should contain the following:
   - Weather and site conditions
   - Records of the delivery, handling and storage quality of underlying geomembrane
   - Description of any material received at the site, including quality control data provided by suppliers
   - Location of daily construction activities and progress
   - Conformance to panel layout design
   - Recording of installation activities, consisting of panel placement, roll numbers, overlap locations, repairs and testing results for all works
   - Records (including photos) of the geotextile at the time that cover soil is placed over the geotextile
   - Photographs of construction works and any items of specific interest. The captions of all photographs should contain the name of the project, the date on which the photograph was taken and the identity of the feature being photographed
   - Type of equipment used in each work task (e.g. handling equipment)
   - Testing conducted and test methods used
   - Remedial action on geotextile defects or jointing defects
   - Placement of temporary protection to installed geotextile
   - Record of any material or workmanship that does not meet specified designs and corrective actions taken to remediate the problem
   - Details of site visits
   - Summaries of any meetings held and action taken
   - Signature of CQA consultant.
28. Periodic acceptance reports summarising daily reports.

The contractor shall provide the CQA authority the following listed test certificates and records prior to, during and at the completion of the works as each report and record is required:
   - Certification and test results of geotextiles, fibres and polymer used in the production of the rolls
   - Roll test data reports, for each roll of material
   - Completed as-built drawing, including roll numbers, panel layout, overlap locations and repair locations.

Any deviations from the approved CQA Plan must be noted and explained, and approved by the DWER.
CQA Testing

Table 3 – Geotextile CQA Testing provides the test properties and minimum testing frequencies. Higher testing frequencies might be required in certain applications (need to identify the importance of the geotextile for the safety of the works, construction and stability included). The onus is on the engineer of record to establish whether higher requirements are more appropriate.

**Table 3 – Geotextile CQA Testing**

<table>
<thead>
<tr>
<th>Item</th>
<th>Property</th>
<th>Standard</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformance testing (upon shipment of geotextile to the Site)</td>
<td>Wide Strip Tensile Strength</td>
<td>AS 3706–2</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Grab Tensile Strength</td>
<td>AS 3706–2</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td></td>
<td>Trapezoidal Tear Strength</td>
<td>AS 3706–3</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td></td>
<td>CBR Burst Strength</td>
<td>AS 3706–4</td>
<td>1 sample per 5,000 m²</td>
</tr>
<tr>
<td>Destructive tests</td>
<td>Tensile tests for joints.</td>
<td>AS 3706–6</td>
<td>As required.</td>
</tr>
<tr>
<td>Visual inspection of geotextile</td>
<td>Colour, thickness, tears, holes, punctures, needle-punching, presence of needles or broken needles, and other faults in the material.</td>
<td></td>
<td>Each roll during placement.</td>
</tr>
</tbody>
</table>

Note:

All conformance tests must be reviewed, accepted and reported by a Superintendent before deployment of the geotextile cushion material. All testing must be performed on samples taken from the geotextile delivered to Site under the Superintendent’s supervision.

All laboratory tests must be performed in an accredited, independent, third-party laboratory.

The required testing frequencies may be revised by the Superintendent to conform with improvements in testing methods and/or in the state-of-the-art practice and/or to account for the criticality of the application (i.e. to account for the importance of the geotextile for the safety of Works). Revisions must be approved by the relevant authorities before application.
11. Leachate Collection System

**Specifications and Quality Control**
The Specifications and quality control is to be in accordance with the construction Specifications.

**Inspection Activities**
The CQA consultant is to confirm that the drainage layer materials have been placed in a manner stated in the Specifications that avoids damage to the low-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
- Placed within two weeks of GCL installation
- 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.

12. Leak Detection

**Specifications and Quality Control**
The Specifications and quality control is to be in accordance with the construction Specifications.

**Inspection Activities**
The CQA consultant is to confirm that the leak detection test has been undertaken and the relevant activities have been carried out in accordance with the construction Specifications:
- The party undertaking the testing is suitably qualified
- That the necessary equipment has been installed in the Works in the appropriate location (some test methods require a wire grid or lines to be installed under the geomembrane)
- That the test is carried out in accordance with the equipment manufacturer's instructions
- All leaks that are detected are recorded appropriately
- During repair, that the leachate drainage aggregate is removed carefully so as not to further damage the liner
- That each leak is investigated and repaired appropriately, including the appropriate weld testing
- That the aggregate later is replaced carefully so as not to further damage the liner
- That if deemed necessary, the area is retested for leaks.

13. CQA Report

On completion of the above CQA activities, a CQA report is to be prepared by the CQA consultant in accordance with the requirements of the *Victorian EPA Siting, Design, Operation and Rehabilitation of Landfills - August 2016*, to demonstrate that all requirements of the project Specifications and CQA Plan have been complied with.

The report is to include any variations from the construction Specifications or the above CQA Plan and contain explanations of why the variations occurred and the potential impact on the construction works.

The CQA Report is to be provided to the DWER as part of the Compliance Certificate at the end of the landfill cell construction works.
Appendix No. 30 – Landowner’s Letter of Exclusion

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10 November 2014

Dear Sir/Madam,

As the landowner of Lot 11 Chitty Road, I consent to the development of a Class II putrescible landfill on the site.

In accordance with this proposed development, I acknowledge the presence of the farmhouse that is approximately 400 m to the south west of the landfill footprint and accept that this dwelling can be ignored as a receptor when considering the environmental impact of the proposed development.

If you have any queries please do not hesitate to contact me.

Yours faithfully,

Mr Simon Farrell
Director
Appendix No. 31 – Herring Storer Environmental Noise Assessment December 2014

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LANDFILL SITE
Lot 11 CHITTY ROAD, TOODYAY

ENVIRONMENTAL NOISE ASSESSMENT

DECEMBER 2014

OUR REF: 18650-3-14269
ENVIRONMENTAL NOISE ASSESSMENT
TOODYAY

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FOR

IW PROJECTS

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APPENDIX

A Locality Plan
1. INTRODUCTION

IW Projects commissioned Herring Storer Acoustics to carry out an acoustical assessment of noise emissions from the proposed Landfill Site to be located at Lot 11 Chitty Road, Toodyay. The objectives of the study were to:

- Determine, by modelling, noise propagation from the Landfill Site, including the clay operations.
- Assess the predicted noise levels received at the closest noise sensitive premises, for compliance with the Environmental Protection (Noise) Regulations 1997.
- If exceedances are predicted, investigate possible noise control options that will reduce noise emissions to achieve compliance with the regulations.

For information, an area plan is attached in Appendix A.

2. SUMMARY

It is understood that it is proposed that the landfill site would only operate during the day period (i.e. between 0700 and 1800 hours Monday to Saturday) excluding public holidays. Therefore, noise received at the neighbouring residence from the landfill site needs to comply with the assigned $LA_{10}$ noise level of 45 dB(A) for the day period. Although we believe that at the calculated noise level, noise received at the neighbouring residence would not be tonal, to be conservative, an allowance for the +5 dB(A) penalty for a tonal component has been included in the assessment.

Noise emissions from the landfill operations have been determined to be 36 dB(A) at the worst case residential location. With the inclusion of the Clay extraction operation within the same pit, noise received at the worst case residential location would be 39 dB(A). At this noise level noise received at the neighbouring would be deemed to comply with the requirements of the Environmental Protection (Noise) Regulations 1997, even with the inclusion of a +5 dB(A) penalty for tonality.

3. CRITERIA

The Environmental Protection (Noise) Regulations 1997 stipulate the allowable noise levels that can be received at a premise from other premises. The allowable noise level when received at a residence is determined by the calculations of an influencing factor, which is then added to base noise levels. In this case the influencing factor for closest noise sensitive premises located around the quarry has been calculated at 0.

The assigned noise levels for the neighbouring noise sensitive premises are listed in Table 3.1.

| TABLE 3.1 - ASSIGNED NOISE LEVEL |
|----------------------------------|-----------------|-----------------|-----------------|
| Premises Receiving Noise         | Time of Day     | Assigned Level (dB) |
|                                  |                 | $LA_{10}$ | $LA_{A1}$ | $L_{A_{max}}$ |
| Noise Sensitive Premises         | 0700 – 1900 hours Monday to Saturday | 45+IF | 55+IF | 65+IF |
| Highly sensitive area            | 0900 - 1900 hours Sunday and Public Holidays | 40+IF | 50+IF | 65+IF |
|                                  | 1900 – 2200 hours all days | 40+IF | 50+IF | 55+IF |
| Noise sensitive premises         | 2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and Public Holidays | 35+IF | 45+IF | 55+IF |
| Any area other than highly sensitive area | All Hours | 60 | 75 | 80 |
Note: The $L_{A10}$ noise level is the noise that is exceeded for 10% of the time. The $L_{A1}$ noise level is the noise that is exceeded for 1% of the time. The $L_{Amax}$ noise level is the maximum noise level recorded.

Under the Regulations, a **highly sensitive area** means that area (if any) of noise sensitive premises comprising –

(a) A building, or part of a building, on the premises that is used for a noise sensitive purpose; and

(b) Any other part of the premises within 15 metres of that building or that part of the building;

It is a requirement that noise received at another premises, be free of annoying characteristics (tonality, modulation and impulsiveness), defined below as per Regulation 9.

- **“impulsiveness”** means a variation in the emission of a noise where the difference between $L_{Apeak}$ and $L_{Amax Slow}$ is more than 15dB when determined for a single representative event;

- **“modulation”** means a variation in the emission of noise that –
  
  (a) is more than 3dB $L_{A Fast}$ or is more than 3dB $L_{A Fast}$ in any one-third octave band;
  
  (b) is present for more at least 10% of the representative assessment period; and
  
  (c) is regular, cyclic and audible;

- **“tonality”** means the presence in the noise emission of tonal characteristics where the difference between –
  
  (a) the A-weighted sound pressure level in any one-third octave band; and
  
  (b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

  is greater than 3dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period $T$ is greater than 10% of the representative assessment period, or greater than 8dB at any time when the sound pressure levels are determined as $L_{A Slow}$ levels.

If the above characteristics exist and cannot be practicably removed, then any measured level is adjusted according to Table 3.2 below.

<table>
<thead>
<tr>
<th>TABLE 3.2 - ADJUSTMENTS TO MEASURED LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where <strong>tonality</strong> is present</td>
</tr>
<tr>
<td>+5 dB(A)</td>
</tr>
</tbody>
</table>

Note: these adjustments are cumulative to a maximum of 15 dB.
4. **OPERATIONS**

We understand that the landfill site will operate between the hours of 0700 and 1800 Monday to Saturday, but excluding public holidays. Therefore, noise received at the neighbouring residence from the activities on site will need to comply with the assigned $L_{A10}$ noise level of 45 dB(A) for the day period.

From information supplies, we understand that the equipment used on site will be a small (D7) dozer and a waste compactor. Additionally, there could be up to 3 trucks on site at any one time.

It is noted that at the northern end of the landfill operations, there is a clay extraction operation. From information provided, we understand that the equipment used with the clay pit is a dozer pushing into the pit from ground level to bottom of pit, with a Front End Loader operating within the pit to load trucks. The number of truck movements is limited and there would only be one truck moving on site at any one time.

The closest neighbouring residences of concern are located approximately 1300 metres away to the east and north east. These residences are indicated on the locality plan attached in Appendix A.

5. **METHODOLOGY / MODELLING**

Noise received at the neighbouring residence was determined using the noise modelling computer program “SoundPlan”. SoundPlan uses the theoretical sound power levels determined from measured sound pressure levels to calculate the noise level received at a specific location.

The calculations used the following input data:

a) Ground contours.

b) Sound power levels used in the model were based on file data of similar operations. The sound power data is summarised in Table 5.2.

Weather conditions for the modelling were as stipulated within the Environmental Protection Authority’s “Draft Guidance for Assessment of Environmental Factors No. 8 - Environmental Noise” for the day period were as listed in Table 5.1.

<table>
<thead>
<tr>
<th>TABLE 5.1 - WEATHER CONDITIONS</th>
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</thead>
<tbody>
<tr>
<td>Condition</td>
</tr>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Relative Humidity</td>
</tr>
<tr>
<td>Pasquill Stability Class</td>
</tr>
<tr>
<td>Wind Speed</td>
</tr>
</tbody>
</table>

*From sources, towards receivers.*

<table>
<thead>
<tr>
<th>TABLE 5.2 - SOUND POWER LEVELS dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>Dozer (D7)</td>
</tr>
<tr>
<td>Waste Compactor</td>
</tr>
<tr>
<td>Waste Truck</td>
</tr>
<tr>
<td>Dozer (D11)</td>
</tr>
<tr>
<td>Clay Truck</td>
</tr>
<tr>
<td>Front End Loader</td>
</tr>
</tbody>
</table>
As in this case the operational relative ground level of the equipment will increase over time, noise modelling was undertaken with the mobile equipment positioned at the final ground level (ie top of the landfill).

Based on the proposed operations, noise modelling was carried out for the following scenarios:

- **Landfill**: Dozer and waste compactor operating on top of landfill, with 3 trucks movements on access road.
- **Clay**: Dozer at ground level, Front end loader in pit, with 1 truck movement on access road.

### 6. RESULTS

Single point calculations were carried out for the residence located around the proposed pits, and the results of the single point calculations for the worst case locations for each scenario are listed in Table 6.1.

The residential locations are shown on the attached locality plan attached in Appendix A.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Receiver/Calculated Noise Level dB(A)</th>
<th>Residence to North East</th>
<th>Residence to East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td></td>
<td>36</td>
<td>32</td>
</tr>
<tr>
<td>Clay</td>
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<td>35</td>
<td>28</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>39</strong></td>
<td><strong>33</strong></td>
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</table>

The residential locations are shown on the attached locality plan attached in Appendix A.

### 7. DISCUSSION

We understand that it is proposed that the proposed landfill site will operate between 0700 and 1800 hours Monday to Saturday (excluding public holidays). As the landfill will only operate during the day period, noise received at the neighbouring residence from the site needs to comply with the assigned $L_{A10}$ noise level of 45 dB(A) for the day period.

Although we believe that at the calculated noise level, noise received at the neighbouring residence would not be tonal, to be conservative, an allowance for the +5 dB(A) penalty for a tonal component has been included in the assessment.

Noise received at the neighbouring residence from the landfill operations and including the clay operations would comply with the requirements of the *Environmental Protection (Noise) Regulations 1997*, even with the addition of a +5 dB(A) penalty for tonality.
APPENDIX A

Locality Plan