

Assets | Engineering | Environment | Noise | Spatial | Waste



Technical Specification

Seven Mile Landfill - Cell Development



Prepared for City of Karratha

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Ronan Cullen	Director and Waste Management Section Leader	TW16001 - Technical Specification.1c

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1 Introduction

The work under this Technical Specification consists of all stages of work associated with the City of Karratha (the Principal) Cell Development at the Seven Mile Landfill (the Site). This document forms part of the Contract Documents with the full list described in **Section 1.5**.

1.1 Site Description

The Site is located approximately 8 km (12 km by road) west - south west of Karratha on Crown Reserve numbers 32987 and 33135 on Lots 85 and 552, Seven Mile Road, Gap Ridge, WA 6714. The Site is licenced to undertake the following waste management activities:

- Category 57 – Used Tyre Storage – up to 174,000 tyres;
- Category 61 – Liquid waste facility – 100 to 116,500 tonnes per year;
- Category 62 – Solid Waste Depot – 500 to 20,000 tonnes per year; and
- Category 64 – Class II or Class III putrescible landfill site – 20,000 to 100,000 tonnes per year.

The existing waste mass at the Site has approximately 2 years of air space remaining capacity. The duration has been calculated using the survey carried on the 02/02/16 with the assumptions that the final waste height is 34.5m and the void space consumption is 100,000 tonnes/annum.

The Department of Water and Environmental Regulation (DWER) has advised that a new cell will need to be constructed and lined in accordance with Best Practice Landfill Guidelines (Victorian, BPEM).

1.2 Location

The Site Boundary, as shown in the Licence (L7021/1997/15) and depicted in the Drawings, bounds an area across four lots. The Site Boundary covers the whole of Lot 552 to the north and the whole of Lot 85 to the south. The Site Boundary then encroaches into two lots to the south-west, Lot 551 on Plan 67856 and Lot 215 on Plan 216769. The bulk of the earthworks will occur on Lot 552, with parts of the works covering the whole Site.

Access to the Site from Dampier Highway is via Exploration Drive, which takes vehicles to the north of the Site.

1.3 Geology

The surface geology of the Site is described as 'Pindan' Sands, which consist of red-brown alluvial sand, silt and clay. The Pindan Sands contain frequent pebbles and gravels throughout with harder lenses of calcrete below the surface. The Pindan Sand is underlain by Archaean bedrock of the northern Pilbara Craton, of the granite-greenstone volcanics sequence.

The groundwater is typically 5-10m below natural ground surface and is typically hyper saline-brackish, with no regional groundwater resource noted by the Department of Water (2013) Hydrogeological Atlas.

1.4 Scope of Works

The works to be carried out under this Specification include, but are not limited, to the following:

- Earthworks to create new cells south of the existing landfill;
- Supply and installation of basal lining system to Cell 1 and/or Cell 2 comprising:

- Compacted sub-base;
- Geosynthetic Clay Liner (GCL);
- 2mm High Density Polyethylene (HDPE) Textured Geomembrane;
- Protection Geotextile;
- Leachate Collection Layer - 300mm highly permeable low calcareous gravel; and
- Separation Geotextile;
- Supply and installation of a leachate management system to Cell comprising:
 - HDPE perforated pipework; and
 - 450mm HDPE side riser pipe.

1.5 Tender Documentation

The following Scope of Works, reports and contracts form the Tender Documentation for this Project:

- This Specification;
- Bill of Quantities;
- Drawings;
- Geotechnical Investigation Report;
- Request for Tender;
- Construction Quality Assurance Plan;
- Designer's Safety Report; and
- Conditions of Contract.

1.6 Drawings

The following Drawings form part of the Tender Documentation.

Table 1-1: List of Drawings

Drawing Number	Drawing Title
TW16001-G-010	Existing Topography and Features
TW16001-G-011	Overview of Works
TW16001-C-001	Development of Cell 1 & 2
TW16001-C-002	Leachate Collection & Management Landfill Cell 1 & 2
TW16001-G-901	Leachate Collection Sump & Details
TW16001-G-902	Bund and Basal Lining Details
TW16001-G-903	Access Ramp & Existing Cell Tie-in Detail
TW16001-P-902	Landfill Leachate Collection Piping Details

1.7 Interpretation

Whether or not the words 'provide,' 'install' and/or 'supply' appear in the Tender Document, all equipment for the complete installation shall be provided and installed by the Contractor. Where equipment is to be provided and installed by others, it will be stated.

Terms in use within this Specification are clarified as follows:

- 'Approved', 'directed', 'required', 'rejected', and similar expressions, shall mean approved, directed, required, rejected, and the like, by the Superintendent;



- 'Provide' shall mean the supply and complete installation of the item to the satisfaction of this Specification;
- 'Supply' shall mean supply and delivery without installation;
- 'Install' shall mean complete installation of the item to the satisfaction of this Specification excluding supply;
- Manufacturer's Specifications – applied as directed by the manufacturer by an experienced person with the nominated product;
- 'Give notice', 'submit', 'furnish', and similar expressions, shall mean given notice, submit, furnish, and the like, to the Superintendent;
- 'The Contractor' shall mean the future company contracted by the Principal to execute the works and complete the project;
- 'The Principal' shall be as defined in the Conditions of Contract and for this Project will be the City of Karratha; and
- 'The Superintendent' shall be as defined in the Conditions of Contract and for this Project will be the City of Karratha.



2 General

2.1 Compliance with the DER Licence and Works Approval

Operations at the Site are governed by Licence L7021/1997/15 under the Environmental Protection Act 1986, Part V. A copy of the Licence may be viewed on the Department of Water and Environmental Regulation (DWER) website (www.der.wa.gov.au).

The Contractor shall comply with the relevant conditions of the Licence and any subsequent conditions issued by the DER during the contract.

The rates submitted by the Contractor should allow for compliance with the conditions of the Licence and Works Approval.

2.2 Quality Management

2.2.1 Quality Plan

For all works the Contractor shall plan, develop, document and implement a Quality System based on the principles and practices specified in the AS/NZS ISO 9000 series.

Details of the Contractor's proposed Quality Assurance Plan shall be submitted to the Superintendent for approval within seven (7) days from the Date of Acceptance of Tender. Any delay by the Contractor in obtaining the approval of the Quality Plan by the Superintendent shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent has taken more than seven (7) days to reply to the Contractor's submission.

Works shall not commence until the Superintendent has approved in writing the Contractor's Quality Plan.

2.2.2 Quality Plan Requirements

The Contractor's Quality Assurance Plan shall incorporate:

- Such measures as are necessary to trace each product or service from receipt through to construction;
- Quality assurance and quality control procedures covering all material supply, manufacture and construction carried out by the Contractor and any of its Sub-Contractors;
- Quality control tests and inspections shall include, but not be limited to, the following:
 - The tests and inspections required in accordance with this Specification. The frequency of such tests and inspections shall not be less than the requirements set out in this Specification; and
 - Such tests as are necessary to demonstrate that materials and equipment comply with the requirements of this Specification.

Whenever practicable, the Contractor shall carry out material testing such that the results are available for review by the Superintendent prior to the materials being incorporated into the works. However, should the Contractor proceed in completing any of the works with materials or services which do not comply with the Quality Plan, then the Contractor shall bear the cost of remediating or replacing any non-compliant work.

The Contractor's traceability procedures shall include, but not be limited to, a means of identifying in the works, and the location of all materials represented by a sample which has undergone a quality test.

2.2.3 Quality Plan Contents

The Quality Plan shall include, but not be limited to the following:

- Inspection and test plans for all materials and construction work;
- Items that require approval of the Superintendent before proceeding;
- Non-conformance identification and action procedures;
- Details of quality personnel and relationship to the company; and
- Safety procedures and checklists.

2.2.4 Construction Quality Assurance (CQA) Plan

The supply, storage and placement of Geotextiles and Geomembranes shall be carried out following the below order of precedence:

- The Manufacturer's Instructions; and
- The Construction Quality Assurance (CQA) Plan as mentioned in Appendix D.

2.3 Programme of Works

The Contractor shall provide a Programme of Works in accordance with the following requirements:

- The Contractor must submit a detailed Construction Programme to the Superintendent for acceptance within seven (7) days of the Date of Acceptance of Tender.
- The Construction Programme must:
 - Be submitted in accordance with (1a-1e) below; and
 - Comply with the Date of Practical Completion set out in Annexure A to the General Conditions of Contract.

If the Superintendent considers that the Construction Programme submitted does not show sufficient details or does not conform to the requirements of the Contract, then they may direct by written notice, the Contractor to amend the programme. Such amendments shall be provided within seven (7) days of issuing the written notice.

The Construction Programme submitted, and any subsequent amendments thereto submitted by the Contractor shall, when accepted by the Superintendent, be termed the Construction Programme.

1. Details to be shown on the Construction Programme shall include, but not be limited to:
 - a. Details of the proposed order of work and the planned dates of completion of the various parts of the works;
 - b. Placing of orders by both the Contractor and Sub-Contractors;
 - c. Hold points at listed in Section 2.6;
 - d. Tests and inspections; and
 - e. Dates of site testing and commissioning.

The Contractor must provide an updated Programme whenever directed by the Superintendent. At intervals determined by the Superintendent, but not exceeding 28 days, the Contractor and the Superintendent together, shall review the actual progress of the works in comparison with the



Construction Programme. If in the opinion of the Superintendent, this review shows that the Contractor will not complete the works by the Date of Practical Completion, the Contractor shall within seven (7) days, amend the Construction Programme so that it complies with the date of Practical Completion stated in Annexure A to General Conditions of Contract and resubmit it to the Superintendent for acceptance.

The Contractor shall not commence works on Site until the Construction Programme has been agreed by the Superintendent. Failure to provide the programme or sufficient detail contained thereon shall not relieve the Contractor of the responsibility for completing the project by the date stated in the Conditions of Contract.

The rates submitted by the Contractor should allow for completing the project in the timeframe set out above.

As much of the work is weather dependent, the Contractor shall make due allowance when resourcing the works to accommodate bad weather by accelerating output if necessary to achieve the deadline.

2.4 Hours of Operation of the Site

The Site is operational by the Principal between the hours of 6.30am and 5.00 pm Sunday to Saturday excluding Christmas Day, New Year's Day and Good Friday when the Site is closed.

The normal working hours for this Contract shall be 6.30 a.m. to 5.00 p.m. Monday to Sunday, unless specified elsewhere in the contract documents. Exceptionally, the Principal's consent for work outside these hours may be given after any necessary application and consultation with the appropriate authorities. Five working days' notice is required from the Contractor when seeking such consent.

Should the Contractor wish to undertake work outside these hours to perform works that are subject to weather conditions e.g. Installation of Basal Liner/tie-in welds, all night work will require portable lighting. All health and safety controls and costs that are incurred by the Contractor, performing work outside of normal hours shall be deemed to be included in tendered rates.

The Contractor shall employ the best practical means to minimise noise produced by his operations including plant maintenance, and shall comply with the recommendations in **AS 2436**.

2.5 Time for Completion

With the Tender, a realistic time for completion shall be submitted, in accordance with the practical completion date documented in Item 7 Annexure Part A of the Conditions of Contract. This time shall include for all annual holidays, public holidays and weather constraints. This realistic time will be presented in the programme of works as described in **Section 2.3**.

2.6 Hold Points

The critical hold points for completed works that require the Superintendent and/or the CQA Auditor to check and sign off before the preceding works commence are listed below in **Table 2-1**.

Table 2-1: Project Hold Points

Hold Point Number	Item	Description
1	Approval of Traffic Management Plan	Section 2.13

2	Approval of Formation Surface	Section 4.6.8
3	Approval of GCL Conformance Testing	Section 7.5.2
4	Approval of GCL Installation	Section 7.5.2
5	Approval of HDPE Conformance Testing	Section 7.5.7
6	Approval of HDPE Non-destructive Testing	Section 7.5.10.1
7	Approval of HDPE Destructive Testing	Section 7.5.10.2
8	Approval of Protection Geotextile Conformance Testing	Section 7.5.12 and Section 7.5.12.1
9	Approval of Protection Geotextile Installation	Section 7.5.12.2
10	Approval of Leachate Drainage & Collection Pipes	Section 6.2.1
11	Leak Detection Survey & Results	Section 8
12	Approval of Separator Geotextile Conformance Testing	Section 7.5.13.1
13	Approval of Separator Geotextile Installation	Section 7.5.13.2
14	Installation and Testing of Leachate Rising Main	Section 6.3

2.7 Site Meetings

The Contractor and any Sub-Contractors that the Contractor deems necessary shall attend a Preliminary Site meeting with the Superintendent and/or the Principal. The meeting will include, but not be limited to, a walk-over of the Site and an opportunity for the meeting attendees to discuss any outstanding issues relating to the works.

The Contractor shall attend Site Meetings when requested by the Superintendent or Client for the proper management and supervision of the contract works. The tendered price shall allow for weekly attendance on site by the Contractor and/or Sub-Contractors (Domestic or Nominated). Regular meetings shall be called to discuss, but not be limited to:

- Information flow;
- Occupational Health & Safety;
- Co-ordination;
- Resources;
- Progress;
- Quality;
- Procurement; and
- Costs.

The Superintendent shall minute the meetings and distribute the minutes within two working days of the meeting ending. The minutes will include all items discussed and in particular actionable items discussed and the person responsible for closing out that item with the due date.

2.8 Safe Work Method Statements

Safe Work Method Statements (SWMS) are required for all major works to include, but not be limited to, the Scope of Works outlined in **Section 1.4**. The Contractor shall submit relevant SWMS to the Superintendent prior to the works commencing that at a minimum shall address the following:

- Describes how the work are carried out;
- Identifies the work activities assessed as having safety or environmental risks;
- States what the safety and environmental risks are;
- Describes the control measures that will be applied to the work activities to minimise risks to the environment and ensure safety of the workers and end users;
- Describes how measures will be implemented to do the work in a safe and environmentally sound manner;
- Outlines the legislation, standards and codes to be complied with; and
- Includes a description of the equipment used in the work, the qualifications of the personnel doing the work and the training required to do the work in a safe and environmentally sound manner.

The cost of providing the method statements is to be included in the rates associated with the aspects of the work the method statement relates. If the Superintendent considers that the SWMS submitted does not show sufficient details, is impracticable or does not conform to the requirements set out above, the Superintendent may direct the Contractor to amend and resubmit the SWMS.

The Superintendent's acceptance or non-acceptance of the submitted SWMS does not remove the liability for the works from the Contractor.

2.9 Use of Subcontractors

Before commencement of the works, the Contractor shall give full particulars of the Sub-Contractors, if any, it proposes to use for items of work under the Contract. Sub-Contractors shall not be used for any portion of the works without the prior written approval of the Superintendent.

Sub-Contractors shall be skilled in their respective trades.

The Sub-Contractors are to provide SWMS for their work a minimum of two weeks prior to commencing on Site as outlined in **Section 2.8**. The main Contractor is to provide a SWMS pertaining to the Contractor's responsibilities for the Sub-Contractor. The Contractor's SWMS shall also highlight where assistance shall be provided to the Sub-Contractor.

2.10 Drawings and Schedules

The Contractor shall be responsible for checking all Drawings prior to the commencement of the works. If the Contractor discovers any discrepancies between the various Contract Documents or if the Contractor considers that additional Drawings or information are required, then in either case the Contractor shall report such inconsistency to the Superintendent for instruction, or apply in writing for such detail drawings or information at least 28 days before the work concerned is to be initiated. This four week time period shall allow the Superintendent to provide any additional information that may be required.

The Contractor shall not be entitled to claim for any additional cost during this four week period as a result of delays or other increased expenditure which it may incur by not advising the Superintendent in a timely fashion of any discrepancy or query in the information provided.

The Contractor shall be responsible for the preparation of manhole, chamber, ducting, pipeline and finishing schedules, from the contract Drawings, as it deems necessary for the satisfactory completion of the works. These may be requested by the Superintendent for approval.

2.10.1 Setting out the Works

The Contractor shall be responsible for setting out the works. The Contractor shall be supplied with electronic information, in the form of digital terrain model (DTM), with which to establish the lines and levels of the works.

The Map Grid of Australia Zone 50, using GDA94 shall be used for the setting out of the works.

The Contractor shall provide all necessary hardware and software on Site, a drawing package compatible with AutoCAD, electronic surveying equipment and suitably qualified staff, which will enable it to determine setting out co-ordinates at locations deemed necessary.

All control points and reference points shall be clearly marked and where appropriate bedded in concrete. They shall be adequately protected during the construction of the works. Where it is necessary to remove a control point, additional reference points shall be provided to the satisfaction of the Superintendent.

Prior to commencing construction, the Contractor shall check all centre lines, prominent footprints and grid lines in sufficient detail to ensure that the work is fully compatible with existing features.

The setting out of the works shall be perfectly co-ordinated with and shall be continuous with that of any adjacent works. The Contractor shall, when instructed by the Superintendent, make any adjustments necessary to satisfy these requirements. Where appropriate, reference points shall be adjusted to take account of the new locations of the master control points.

Subsequently, the Contractor shall be fully responsible for the setting out of the works and the Superintendent accepts no responsibility for replacing any of the master control points or master levels where given. The Superintendent's acceptance or non-acceptance of the setting-out does not remove the liability for the works from the Contractor.

2.10.2 Working and Fabrication drawings

Whenever required by the Superintendent, the Contractor shall supply calculations, test reports, data sheets, etc., in support of its detailed working and fabrication drawings. Such documents shall remain the property of the Superintendent.

The Contractor shall submit three copies of all relevant documents to the Superintendent at least four weeks in advance of the date on which the Contractor proposes to commence such works.

Drawings shall be to an appropriate scale and in sufficient detail to enable the Superintendent to assess the Contractor's proposals.

2.10.3 As-Built Drawings

The Contractor shall supply as-built records, Drawings, details and surveys etc. of all completed work. These records are to be submitted in full to the Superintendent within one month of practical completion of the works in AutoCAD and PDF electronic formats.

Notwithstanding the above timescale, the Contractor shall note that certain as-built drawings are required to accompany the CQA report as specified elsewhere in this document. The Contractor shall note that the main contract works may only be offered for handover to the Principal upon approval of validation report.

The following is a list of minimum criteria to be adhered to when creating the as-built drawings:

- Line types and colours shall be set 'By Layer';
- Layer names should not be abbreviated, and must be self-explanatory;
- All break lines to identify toes and crests of earthwork slopes;
- Units shall be in metres;
- Levels to Australian Height Datum (AHD); and
- Common Site layouts such as surveys, as-built buildings and road layouts shall be externally referenced to all relevant drawings (insert 0, 0, 0 (X, Y, Z) and to Map Grid of Australia Zone 50, using GDA94).

2.11 Surface Water and Groundwater Management

Where not included in the permanent works, the Contractor shall make allowances in his system of working and pricing for dewatering both surface and subsurface water if required and permitted.

The Contractor shall sequence the works to minimise the build-up of surface water within and outside the Site as a result of its actions, and allow for all arrangements for evaporation on Site. Where it is necessary and permitted to discharge water or groundwater, the Contractor shall not cause overtopping and erosion of any part of the downstream surface water network. In any case, measures shall be implemented to prevent silt entering the offsite surface water network.

Where the sequence or method of work is such that there is a build-up of water within or outside the Site Boundary, the Contractor shall be liable for the expense of dewatering, control and, if necessary, remediation to the infrastructure.

Unless permitted, the build-up of any surface water may not be discharged to the groundwater regime.

2.12 Site Boundary

The Site Boundary shall be as identified on the Drawings.

Should other Contractors, Principal Workers, and/or public be operating on-site during this contract, all elements of the works shall be arranged such as to minimise contact. This may require adherence to new haulage routes and variations to the proposed phasing of the works as agreed with the Superintendent.

2.13 Traffic Requirements

2.13.1 General

The Contractor shall submit a Traffic Management Plan (TMP) for the works to the Superintendent for review at least 5 days prior to commencement of works. The Contractor shall implement and maintain the endorsed TMP during the works.

The Contractor shall provide traffic signs and undertake any temporary works to comply with the requirements of the Contract. All signs and method of traffic control shall be generally in accordance with **AS 1742** and to the express approval of The Local Authority Engineer or Main Roads Western Australia (MRWA) as appropriate. A copy of the relevant standard method of signing will need to be obtained by the successful Contractor.

Should circumstances arise which are not adequately covered in this section, the Contractor shall submit alternative proposals to the Superintendent for review and approval prior to works proceeding.

The Contractor shall be liable for any accident, damage or injury to any person and/or any claim or litigation or other matters arising out of the works of this Contract.

2.13.2 Traffic Safety and Management – Internal Road Network

The Contractor shall acknowledge that the Site as a whole is open to the public, third party companies and the Principal's own staff and vehicles. This flow of traffic has priority over usage of the internal road network. In carrying the works, the Contractor shall not adversely impact the smooth traffic flows for other users. Where the Contractor, its Sub-Contractors and/or suppliers causes congestion or blockages, the Superintendent may require immediate removal of the offending vehicles, plant, equipment and/or supplies regardless of the consequences to the Contractor's operations.

The Superintendent will not entertain any claim for financial compensation or extension of time to the Contract as a result of the removal of the congestion or blockages.

Where the Contractor, Sub-Contractors and/or Suppliers has vehicles which crosses from non-metalled surfaces to asphalt roads, the Contractor shall ensure that no detritus, mud, litter or other contamination is transferred to the road network. Where the road network surrounding the Site becomes dirty or contaminated, the Superintendent shall require the Contractor to clean the surfacing.

The Contractor shall include cleaning the road surfacing in its pricing structure.

2.13.3 Traffic Safety and Management – External Road Network

All necessary traffic safety precautions shall be taken by the Contractor to ensure the safety of all traffic and pedestrians using the existing roads adjacent to the Site and connecting minor roads during the execution and completion of the works, and all precautions shall be taken to minimise disruption to the local residents.

The Contractor shall ensure that no item of plant, goods, vehicles and/or equipment (including stores or offices) shall be temporarily placed or parked on the public roadway or its verges in a manner which may result in danger to the personnel on the Site or members of the public, or which may restrict sight distances on all accesses to the Site or on public roads.

The Contractor shall ensure that no plant, equipment, goods and/or vehicles shall be parked overnight on the public roads adjacent to the Site.

2.13.4 Cleaning and Damage to Roadways

All roads, accesses, drains, ditches and grips shall be kept clear of all dirt, mud and material arising from the execution and completion of the works and suitable clearing equipment and labour shall be provided by the Contractor for this purpose. Where this is likely, the Contractor shall install temporary wheelwash facilities and/or provide road cleaning equipment.

Particular attention shall be paid to the loading of trucks carrying bulk materials into the Site and spoil from the Site to ensure that these shall not be overloaded or loaded in such a way that spillage shall be unavoidable. Any dirt or mud adhering to the tyres or chassis of any vehicles shall be thoroughly cleaned off before the vehicle shall be permitted to leave the Site. In the case of delivery to the Site, vehicles shall be thoroughly cleaned before they leave the point of collection. The Contractor shall be equally responsible for the vehicles of their Sub-Contractors and Suppliers and the like.

Despite any measures and actions undertaken by the Contractor, should it not prove successful in clearing the roads in a timely manner, then the Superintendent will arrange for professional street cleaners to undertake the work. The cost of doing this shall be subtracted from the monthly or final valuations.

The Contractor shall take particular care to avoid damage to roads, footpaths, grass margins and other surfaces outside of the authorised Site and shall be liable for the cost of repairing all such damage caused by the Contractor's operations to the satisfaction of the Superintendent and the Principal. The Contractor shall also take precautions to prevent spillage of diesel fuel or solvents. Should a spillage arise from either the Contractor, its Sub-Contractors or Suppliers then it will promptly clear up the spillage and remediate any damage.

The Contractor shall have regard to the maximum legal permissible loads for public roads in WA and where requested by the Superintendent, shall provide evidence of compliance with regard to delivery of material to Site. The Contractor shall also prohibit the use of tracked plant on road surfaces outside of the Site unless suitably approved protective measures are taken to safeguard the integrity of the road surfaces. Pumping of water onto a public road or private property shall not be permitted. Heavy discharges to gullies and storm drains shall have silt traps incorporated in the temporary discharge arrangement. Any damage so caused shall be made good by the Contractor at its own expense.

2.14 Engineering Control

All verbal instructions given by the Superintendent/CQA Consultant shall be accompanied by a Confirmation of Verbal Instruction (CVI) prior to undertaking in writing or by email. Verbal instructions or verbal requests for information alone shall not be considered binding.

Technical Queries (TQs) from the Contractor to the Superintendent/CQA Consultant are to be issued electronically in a format to be agreed with the Superintendent.

2.15 Variations of Work

Where extra works are ordered, they shall be valued in accordance with the Rates in the Bill of Quantities, where they exist or otherwise in accordance with the Conditions of Contract. Where any additional works are not fully covered by the rates in the Bill of Quantities, the Superintendent will request



a separate quotation for the work. Where approved, the Superintendent may commission these works using the Day Rates.

Such works shall not be carried out until a written order has been issued by the Superintendent, and if it is authorised to be carried out on a Time and Materials basis, the Contractor shall submit to the Superintendent weekly time and material sheets for checking and approval. Payment will not be made for work carried out in this manner unless previously authorised by the Superintendent.

The Superintendent reserves the right on the Principal's behalf to omit any part or parts of the Contract and claims for any loss of profit due to any omissions will not be entertained by the Superintendent unless further specified in the Conditions Contract.

2.16 Dayworks

The Contractor shall provide the following:

- 48 hours' notice in writing outlining why the existing rates in the documents are not sufficient to cover the works;
- Contractor to submit maximum working hours in a day;
- Dayworks shall be pre-approved by the Superintendent;
- Dayworks shall be signed off by Superintendent at the end of each day; and
- A list of dayworks rates for all personnel and plant that shall be used during the contract.

Should the personnel or plant change during the Contract, revised rates shall be agreed with the Superintendent before commencement of dayworks.

The Contractor shall give notice to the Superintendent of the commencement and completion of any work for which the Contractor intends to submit daywork records in accordance with the Conditions of Contract. The Contractor shall submit to the Superintendent at the end of each month an application for payment for all dayworks done in the preceding month.

The dayworks records to support applications for payment will include at a minimum the following:

- Description of work done;
- Operative's name and trade;
- Plant type, make and model;
- Rates and hours worked segregated into normal time; and
- Types and quantities of materials used.

2.17 Control of Environmental Issues

The Contractor shall, within 14 days of the Date of Acceptance of Tender, provide the Superintendent with an Environmental Management Plan (EMP), detailing how the Contractor will implement and maintain environmental management measures to comply with all requirements set out in **Sections 2.17.1 to 2.17.8**. This plan shall include the name of the relevant manager/supervisor with the primary responsibility for environmental matters and environment related communications.

The EMP shall adhere to the requirement of the Excavation Works Management Plan (EWMP) included as part of the Contract Documents.

The Contractor shall address the above commitments in the EMP, as well as the requirements set out in **Sections 2.17.1 to 2.17.8** of this Specification.

2.17.1 Noise

The normal working hours within the Site shall be as detailed in Section 2.4 of this Specification. Exceptionally, the Superintendent's consent for work outside these hours may be given after any necessary consultation. Five working days' notice is required from the Contractor when seeking such consent. If complaints are received and justified, during work outside the normal hours the Principal reserves the right to require all construction works to be undertaken during the approved hours as per the Environmental Protection (Noise) Regulations 1997.

The Contractor shall employ the best practical means to minimise noise produced by his operations including plant maintenance, and shall comply with the recommendations in **AS 2436**.

2.17.2 Mud

The Contractor shall prevent any nuisance occurring through the discharge of dirt, water, fumes and the like on to persons or property.

The Contractor shall ensure that waste products of whatever description associated with the execution and completion of the works shall not enter watercourses, whether dry or not, which are adjacent to the Site.

2.17.3 Dust

Fine material encountered on the Site is susceptible to erosion by wind under normal wind conditions when the surface material is dry. The Contractor shall provide, use, maintain and keep available plant and equipment necessary to minimise the formation and accumulation of dust arising from the works, normally in dry weather conditions. The Contractor shall implement all measures necessary to minimise wind erosion and prevent material from the Site being blown over or onto property outside the Site or onto others on the Site. The measures shall include, but not be limited to:

- Frequent watering of areas disturbed by the Contractor;
- Not carrying out operations with dust-creating potential at a time of high winds; and
- Control of dust caused by the works.

The Contractor shall allow for any delay and effect on the Contract Programme caused by diverting manpower and equipment to control dust and windborne material.

The Contractor shall be responsible for the cost of controlling dust and windborne material generated by the immediate activities of plant, equipment and/or personnel.

If, during the actual construction of work, the suggested dust suppression measures are found to be insufficient, the responsibility for carrying out additional measures necessary to achieve the desired level of dust suppression rests totally with the Contractor. If this is not carried out in a timely manner, the Superintendent shall arrange for additional dust suppression, the cost of which shall be taken from the monthly or final account.

2.17.4 Contaminated Water and Sewage

The Contractor must, at its own cost, provide toilet and adequate wash facilities for its personnel and that of its Sub-Contractors. These facilities shall be connected to a storage tank, or other facility approved by the Superintendent, which shall have a minimum of 14 days storage capacity and shall be located in a place approved by the Superintendent.

The Contractor shall arrange for the removal of all sewage from the holding tank to be collected at regular intervals and disposed of at approved and lawful locations outside the work site.

2.17.5 Smoking

Smoking shall only be permitted in authorised areas as agreed with the Superintendent. Smoking is prohibited in Site offices, lunchrooms or enclosed toilet facilities.

2.17.6 Fire Prevention

No fires shall be set alight by the Contractor under any circumstance. The Contractor shall provide and maintain adequate fire-fighting equipment on Site and must comply with the Bush Fires Act 1954.

2.17.7 Refuse Disposal

All Site refuse (including foodstuffs) shall be handled and disposed of in accordance with the requirements of relevant statutes and to the approval of the Superintendent.

Litter and general rubbish generated by the Contractor in executing the works shall be temporarily stored in appropriate receptacles prior to being conveyed to a licensed disposal facility. Prior approval for the disposal of litter and general rubbish at suitable facilities on Site, should they exist, shall be obtained from the Superintendent. All debris, spoil, rubbish or materials shall be suitably contained and covered in vehicles during transportation to or from the Site to prevent spillage or contamination of adjoining and other areas or property.

2.17.8 Vehicles

The Contractor shall maintain vehicles, wheels and tracks in a suitable clean condition to prevent transfer of mud onto adjacent roads or other areas. The location of all servicing/maintenance of plant and equipment on Site shall be agreed with the Superintendent. The Contractor shall identify all the key environmental aspects for the storage, use, and safe disposal of hazardous materials/fluids and mitigation of any fuel/oil/diesel etc. spills during the works.

2.18 Occupational Health and Safety

The Contractor shall comply with the Occupational Safety & Health Act 1984 (the OSH Act) and the Occupational Safety & Health Regulations 1996 (the OSH Regulations) and with any amendments that may be made to the OSH Act and OSH Regulations from time to time.

The Contractor shall comply with all relevant safety and security procedures and rules of the Principal. Where there is conflict between the OSH Acts/Regulations and the Principal's safety and security procedures and rules, the more rigorous requirements shall apply.

2.18.1 Contract Safety Risk Assessment

Within 14 days of the Date of Acceptance of Tender, the Contractor shall carry out a Contract Safety Risk Assessment and shall supply the Superintendent with a copy of the potential hazards identified and the proposed control measures to be implemented for consideration.

Throughout the Contract period, the Contractor shall report to the Superintendent any potential hazards identified or notified.

2.18.2 Safety Management Plan

The Contractor shall, throughout the Contract, implement and maintain a "Safety Management Plan". The Contractor shall prepare the Safety Management Plan in conjunction with a person suitably experienced and qualified in safety matters.

Prior to the commencement of the Contract, the Contractor shall supply to the Superintendent, in writing, its Safety Management Plan.

2.18.3 Induction Training

Employees of the Contractor, its Sub-Contractors and employees of Sub-Contractors shall not commence work on the Site until the Contractor has carried out Site induction training. Prior to this, the Contractor's Representative shall receive the scope of the induction from the Principal in order that it may cascade it to the staff, sub-contractors and suppliers. The Contractor is reminded that the Site induction training is separate to any safety training that it is legally required to impart to its staff. The Contractor's staff, Sub-Contractors and Suppliers will not be allowed to access the Site independently without the Site induction training. To this effect all people engaged in the works will be required to sign an Induction Form confirming that they have received the training.

Upon commencement of work on the Site, the Contractor shall further induct each employee with regard to all significant hazards associated with their particular activity and area of employment on the Site and where relevant, shall include the use of powered plant, tools and equipment. If requested by the Superintendent, the Contractor shall provide appropriate documentation detailing the satisfaction training of its employees on the safe use of all plant, vehicles and equipment to be used on the project. Failure to provide appropriate certification may lead to the relevant employees being removed from the working roster.

2.18.4 Safe Working Procedures

Where legislation or codes of practice identify particularly hazardous activities, including but not limited to, work in confined spaces, asbestos removal, demolition work, excavation work, working near power lines and live conductors and working at heights, the Contractor shall supply to the Superintendent a Safe Work Procedure (SWP) document prior to commencing such activity or type of work on the Site, which complies with the Site Licence.

The Contractor shall induct its employees and its Sub-Contractors with regard to SWP and shall prepare "Training Session Attendance" sheets signed by each attendee verifying that such induction has occurred.

2.18.5 Site and Public Security & Safety

Notwithstanding the Contractor's obligations to the Site and public security as stated elsewhere in this Contract, the Contractor shall monitor and control wherever practical, the access of all persons to the Site.

Where the general safety of the Public is concerned, and time of notification of the Contractor further jeopardises this safety, the Superintendent may order immediate remedial works to be conducted at the Contractor's expense.



2.18.6 Contractor's Safety Agreement

The Contractor shall liaise with the Principal's Occupational Safety & Health (OS&H) Co-ordinator to complete and sign a Contractor's Safety Agreement.

2.18.7 Safety Notifications, Compliance & Standards

The Contractor shall notify the Department of Labour and Industry of all Notifiable Works and make payment of all inspection and other fees in connection with such works.

The Contractor shall conduct the construction of the works in accordance with all current statutory requirements, Local Government By-laws and the provisions of AS 1470, together with any other Code relating specifically to type of machine, process, handling procedures or materials. The Contractor shall provide employees with all necessary equipment and protective clothing to allow the safe construction of the works and shall ensure maintenance to all plant and machinery allows for their safe operation.

2.18.8 Unsafe Machinery or Structures

On notification from the Superintendent, in respect to any operation, machine or structure being, in the opinion of the Superintendent, unsafe, the Contractor shall cease use immediately of such operation, machine or structure and shall conduct remedial work to the satisfaction of the Superintendent before continuing to use the operation, machine or structure in the works. Where no remedial action can ensure continued safe use of an operation, machine or structure, the Contractor shall, in the case of an operation, cease such operation, and, in the case of a machine or structure, shall dismantle and remove such machine or structure from the Site.

2.18.9 Fire Prevention

The Contractor shall provide and maintain adequate, approved fire-fighting equipment on Site. The Contractor shall observe the provisions of the WA Bushfires Act, Local Authority regulations, WA Fire Brigades Board regulations and any other regulation in respect to fire prevention.

BURNING ON SITE IS PROHIBITED.

The Contractor shall ensure that all flammable materials are used and stored in accordance with the Explosives and Dangerous Goods Act and any other statute or regulation governing storage and use of such materials, and shall obtain such permits and licenses and pay all relevant fees and charges.

2.19 Containment of Leachate and/or Surface Water Run-Off

Should the Contractor in the course of the works cause a leachate or surface water break out, the Contractor shall immediately inform the Superintendent and remedy the situation at the Contractor's own expense.

Should the Contractor notice a leachate or surface water breakout, the Contractor shall immediately inform the Superintendent and await instruction as to what course of action is required.



2.20 Disposal Areas for Contractor

The area identified on the contract Drawings is the only area available for the Contractor to dispose of waste arising from excavations. The Contractor is to provide reports to the Superintendent on the same day as the tip area is used, detailing the following:

- Location from where the material was extracted;
- Nature of the fill; and
- Number and type of vehicle used for moving the fill.

No material externally sourced from the Site shall be tipped in the tip area unless it is approved by the Superintendent.

Haulage rates internal to the Site are deemed to be included in the appropriate rates.

2.21 Materials Delivered to Site

The Contractor is to provide 24 hours' notice of deliveries to Site, and provide written documentation on delivery to Site. Materials shall not be accepted on Site without the appropriate documentation, demonstrating compliance with the specifications. Such documentation should indicate the volume/amount of product delivered.

The Contractor is to maintain a diary of material deliveries, which must be accessible by the Superintendent at all times. Should materials be present on Site for more than 24 hours and not have a corresponding entry in the diary, the materials shall require immediate removal from Site.

2.22 Stability of Ground Conditions

The Contractor is to make all personnel aware (particularly those operating heavy plant and those placing earth) of the hazards associated with working on domestic and industrial waste. The Contractor is to demonstrate to the Superintendent that work practices and sequencing of earth movement shall not increase the risks associated with ground subsidence and slope failure.

The Contractor is to immediately inform the Superintendent should the Contractor become aware of signals indicating subsidence and/or slippage.

2.23 Completion of the Work

The Contractor shall leave the whole of the works in a clean and neat state, perfectly free from all rubbish and superfluous material of any kind. The Contractor shall clear up and cart away all surplus materials and rubbish to an approved waste disposal /recycling facility Site and shall remove all temporary markings, coverings and protective wrappings unless otherwise instructed.

Surplus excavation material shall be transported at the Contractor's expense to a location approved by Superintendent.

Where new works tie in to existing works and Site boundaries, the existing works shall be reinstated to a standard similar to that which existed prior to the commencement of the works, or as approved by the Superintendent.

2.23.1 Protection of Works

The Contractor shall take all necessary precautions to safeguard all existing structures or infrastructure from ground movement, settlement, and all other activities associated with the execution of the Contract.

The Contractor shall make all necessary records (photographic or otherwise) of existing structures and other properties that could be affected by execution of the works prior to the commencement of construction.

The Contractor shall carefully case and fix boarding, sheeting or devices, to protect, works and materials from damage by weather or any other external element including other contractors, during the contract period until the works have been handed over.

The Contractor shall provide for protection of the works and property, for the protection and convenience of the public, adjacent owners and occupiers including all necessary watching, lighting, barriers, guard rails, warning notices and for all precautions required by the Superintendent.

The Contractor shall take adequate precautions to prevent trespass on adjoining property by employees, sub-contractors and/or their employees. The Contractor shall restrict its activities and Site usage to the area of the works as indicated on the Drawings as approved by the Superintendent.

Thorough measures shall be taken to prevent damage occurring and hence the necessity to make good damaged work. The Contractor shall be responsible for notifying the Superintendent of any damage to the temporary or permanent works as soon as it arises. The Contractor shall anticipate the possible sources of damage to its works and those of others and take active and positive protection measures to the satisfaction of the Superintendent. The Contractor shall provide protection against damage arising from ground and surface water weather conditions, construction, other contractors, warping, distortion, abrasion, sunlight, humidity or other conditions, which could have an adverse effect on its works and could be reasonably anticipated.

The Contractor must allow for the necessary maintenance, alteration and adaptation of protection during construction to allow for other trades to progress and to allow the possibility of damage to the contract works by others and allow for removal of protection upon completion. It shall be a requirement of this Contract that a statement on the Contractor's proposals for protecting the works before during and upon completion shall be submitted for approval by the Superintendent. The Contractor shall provide all necessary scaffolding, barriers and rails and other protective measures to excavations, floor openings and edges during the period of the contract works.

The Contractor shall protect its work during loading, transportation unloading and storage on Site, prior to incorporation in the works.

Protection used within the context of this document means that the Contractor is required to protect the contract works until completion/handover. The type and extent of protection must be sufficient to protect finished or partly finished work, or any damage, caused by accident or otherwise, likely to occur within the currency of the contract works and with regard to the nature of operations being concurrently executed by others. The Contractor is to allow in its tender for providing such protection as necessary and will be held fully liable for any and all damage resulting from its failure to protect.

2.24 Site Climatic Conditions

The Contractor shall inform itself fully in regard to the climatic conditions likely to be experienced at the Site, and shall make its own assessment of the effect that such conditions may have on the execution of the works and make due allowances for it in the Construction Programme. The rainfall and other weather conditions details can be accessed Bureau of Meteorology website (www.bom.gov.au).

2.25 Control of Quantities on Site

The method adopted to verify volume/mass relationship shall be determined prior to works commencing.

The Contractor is responsible for programming such surveying to limit any delays to the programme and to allow completion of the surveying to the satisfaction of the Superintendent.

The Contractor is required to coordinate with the surveyor to ensure that the surveying is completed in accordance with the Superintendent's requirements without adversely affecting the programme of the works. The independent ground surveyor shall be required at a minimum to survey at the following stages:

- Location of specified Site investigations (trial pits and boreholes) carried out by the Contractor at the direction of the Superintendent;
- The reinstated formation levels at the landfill and all other construction areas;
- The surfaces of the individually completed layers, such as but not limited to, engineered clay, geomembrane, GCL, sub-bases, etc.;
- Topographical survey of completed construction including finished earthworks, drainage, all other aspects of the infrastructure and affected areas of the borrow source should it be relevant; and
- Any requirements as stipulated in the CQA Plan as mentioned in the Appendices of this Specification.

2.26 Temporary Accommodation

The Contractor is to allow for providing, erecting, furnishing, maintaining and removal on completion of all temporary accommodation. The Contractor shall arrange for adequate office, storage, workshop, lock-up, sanitary, washing, drying, and changing/ shelter facilities for use by its staff and visiting personnel to the Site. These facilities shall be provided before construction work commences and be maintained for the duration of the contract. The minimum facilities shall be those as specified by the OSH Act and the OSH Regulations and with any amendments that may be made to the OSH Act and OSH Regulations from time to time. The Contractor will not be permitted to set-up any residential (donga/demountable) accommodation on Site, for Staff or Sub-Contractors when undertaking the contract works.

2.27 Security

The Contractor shall be responsible for establishing and maintaining a secure Site for the duration of the Contract during and outside of normal working hours. All new structures shall be made secure.

The Contractor shall allow in its tender for security and provision of all necessary accommodation and utilities, including lighting, for the carrying out of these duties.



Security fencing shall be erected where required to delineate working areas/compounds and access to any open excavations at the end of the working day should be cordoned off, with restricted access.

The security measures to be employed by the Contractor must be to the satisfaction of the Superintendent.

3 Site Works

3.1 Entry on to the Site

The Contractor shall notify the Superintendent in writing, 14 days in advance, of its intention to start work within each work / borrow area.

The Contractor shall allow the Principal unfettered access to all areas of the Site to inspect works and conduct ALL work as required by the Site Licence.

3.2 Site Fencing

Where the type and location of temporary Site fencing are shown in the Contract, the Contractor shall erect such fencing as soon as it is given possession of the relevant portion of the Site. The Contractor shall regularly inspect and maintain all such fencing with any defects being made good without delay. Temporary fencing shall remain in position until either it is replaced by permanent fencing, or the works are sufficiently completed to enable that portion of the Site to be brought into use.

3.3 Contractor's Site Facilities

The Contractor must supply and maintain all facilities on-site as deemed necessary by the Contractor for Contractor's staff, Sub-Contractors and Superintendent. The facilities shall include all necessary offices, stores, toilets, washing facilities and other facilities as required by industrial agreements for such camps, including the cleaning and maintenance of the camp.

The Contractor must provide facilities satisfactory for the storage of such materials as may be described in the various sections of the Specifications.

Prior to erecting any Site facilities, the Contractor will ensure that the proposed location and positioning of the units have been agreed with the Superintendent.

All buildings and facilities established and used by the Contractor must be removed from the Site at no cost to the Principal on completion of the works and the Site must be left in a clean and tidy condition.

3.4 Office Accommodation for the Superintendent/ CQA Consultant

The Contractor shall provide office accommodation to the Superintendent/CQA Consultant and/or their staff for the duration of the works. The office accommodation shall have sufficient climate control, light and be maintained in a clean and tidy state. Offices and other accommodation shall be erected, furnished and ready for occupation within seven days of the date for commencement of the works and fully equipped and serviced for use within seven days of that date. The compound shall be maintained by the Contractor to the satisfaction of the Superintendent, for the duration of the contract works.

The Contractor shall allow for the re-location of the Superintendent's accommodation as it deems necessary to complete the contract works. Should the Superintendent's accommodation be relocated, the new location shall be approved by the Superintendent.

Where the Contract requires telephone, fax and modem facilities for the Superintendent, such facilities shall have separate connection direct to the public telephone exchange with privacy of conversation for the Superintendent.

3.5 Interference with Land Interests

The Contractor shall confine its constructional operations within the Site, or such other area of land as may be negotiated, and shall instruct its employees not to trespass.

Subject to any unavoidable disturbance which may be necessitated by the execution of the Contract, the Contractor shall not interfere with any sporting, fishing or other rights which may be enjoyed on or near the Site.

3.6 Interference with Existing Access

Before interfering with access to any property, the Contractor shall provide alternative arrangements. The Contractor shall notify the Superintendent and the relevant occupiers, in writing, 14 days in advance of any such interference and shall confirm to the Superintendent that alternative arrangements have been agreed.

3.7 Protection against Damage

The Contractor shall take all necessary precautions to avoid causing any unwarranted damage to roads, lands, properties, trees, monitoring boreholes and other features during the currency of the Contract, and shall deal promptly with any complaints by owners or occupiers.

Where any portion of the works is close to, across or under any existing apparatus of public utilities or other parties, the Contractor shall temporarily support and work around, under or adjacent to all apparatuses in a manner designed to avoid damage, leakage or danger, and to ensure uninterrupted operation.

If any damage occurs, the Contractor shall, at once, notify the Superintendent and the Statutory Authority or owner concerned. Any damaged or affected apparatus shall be repaired or replaced at the expense of the Contractor.

The Contractor shall take all reasonable necessary precautions to avoid damage to its own works, by its own employers, domestic and nominated Sub-Contractors, until such time as the works have been handed over and accepted by the Principal.

Where deemed necessary by the Superintendent, stockpiled materials shall be covered with tarpaulin to avoid contamination of adjacent streams.

3.8 Location of Existing Services

The Contractor shall be responsible for the maintenance and protection of existing services which may be affected by the contract works. It is not warranted that the services shown on the Drawings are in the exact position or are to the full extent shown. Prior to commencing any works, the Contractor should make such investigations with all service authorities and Dial Before You Dig (<http://www.1100.com.au/>) that are necessary to locate all services on Site or within the work areas adjacent to the Site.



If services are located which are not shown on the Drawings, the Contractor shall give at least three (3) working days' notice to the Superintendent prior to commencement of any construction activity that may affect the service.

The Contractor shall make good any damage resulting from its operations and shall indemnify the Principal against any claim for damage to drains, sewers, mains, cables, water pipes, fittings, boxes or other property, caused by its operations. The tendered rates are to include for all identification, protection, repair and/or other necessary work to the presence of the services.

Existing private and public statutory services such as water mains, gas mains, cables, house drains, culverts, etc., shall be located insofar as possible before commencement of the works. The Contractor shall proceed with the works in such a manner that the works shall be constructed without interference.

The Contractor shall make its own arrangements for any diversion or removal of services which it may require for its own convenience or because of its proposed method of work and shall, in all cases, inform the Superintendent in advance of its proposals.

Should any service be found to exist which are not indicated, or not as indicated in the Contract, the Contractor shall, at once, give written notice to the Superintendent.

All located services shall be surveyed for size, position and level, by the Contractor and a record of these services given to the Superintendent.

3.9 Advertising and Project Works Signs

Strictly no advertising will be permitted on the Site other than:

- Project signs approved in writing by the Superintendent;
- Names of manufacturers or names of owner on items of construction plant; and
- Contractor's mail box.

All Project Works signs must be approved by the Superintendent prior to their manufacture.

Project Works signs must be installed by the Contractor no later than one week from the Principal issuing Possession of Site. The Contractor shall be responsible for all costs and charges relating to the manufacture, installation, maintenance and subsequent removal of all Project Works signs from the Site.

The Contractor must remove all project signs from the Site to an authorised disposal site no earlier than 4 weeks and no later than 6 weeks from the date of Practical Completion unless otherwise directed by the Superintendent.

3.10 Fencing, Watching and Lighting

In the case of all excavations to which the public may have access, the Contractor shall include for the temporary fencing off of such excavations and for temporary watching and lighting of the excavations during the hours of darkness. If spoil heaps obtrude on public areas or Contractor's plant is parked on public areas during the hours of darkness, the Contractor shall define the boundary of its operations as part of the approved TMP.



3.11 Tidiness of Site

The Contractor shall be responsible for the proper upkeep and maintenance of the Site and the works and shall remove, from the Site, rubbish and other waste as it accumulates. Materials and equipment shall be positioned, stored and stacked in an orderly manner.

3.12 Works Affecting Watercourses

The Contractor shall be responsible for maintaining watercourses within and adjacent to the Site in effective working condition at all times and shall take all practicable measures, which shall be to the prior approval of the Superintendent, to prevent the deposition of silt or other materials in existing watercourses. Settling ponds shall be installed prior to all water discharges to watercourses. Settling ponds shall have a minimum 5-day retention capacity.

4 Earthworks

All works carried out under this section of the Specification shall comply with the following standards, and those specified therein, which shall be held to be incorporated in the Specification:

- **AS 3798:** Guidelines on earthworks for commercial and residential developments; and
- **AS 1289:** Methods for testing of soils.

4.1 Definitions

The following definitions of earthworks material shall apply to this and other clauses of the Specification in which reference is made to the defined materials.

“Top Soil” shall mean the top layer of soil that can support vegetation.

“Suitable materials” imported or on Site won material complying with the requirements for use in the permanent works.

“Un-suitable material” shall mean material other than suitable material and shall include:

- Peat materials from swamps, marshes or bogs;
- Logs, stumps and perishable material;
- Material susceptible to spontaneous combustion;
- Material in a frozen condition;
- Clay of liquid limit exceeding 80% and/or plasticity index $< 10\%$ or exceeding 55%;
- Material having a moisture content greater than the maximum permitted for such materials in the Contract, unless otherwise permitted by the Superintendent; and/or
- Non-hazardous material other than those permitted in the Contract.

“Unacceptable Hazardous Material” shall be material having hazardous chemical or physical properties requiring special measures for its excavation, handling, storing, transportation, deposition and disposal.

“Rock” shall mean hard rock in mass formation which can only be removed by the use of a rock breaker or explosives. Boulders in excess of 0.25 m³ volume in pipe trenches or in excess of 1.0 m³ in mass excavation shall be deemed to be rock excavation.

“Cohesive Soil” shall include clays and marls with up to 20% of gravel or rock and have a moisture content not less than the value of the plastic limit minus 4.

“Well-graded granular and dry cohesive soils” shall include clays and marls containing more than 20% of gravel or rock and/or having a moisture content less than the value of the plastic limit minus 4 and well-graded sands and gravels with the uniformity coefficient exceeding 10.

“Uniformly-graded material” shall include sands and gravels with uniformity coefficient of 10 or less, and all silts. Any soil containing 80% or more of material in the practical size range 0.06-0.002 m will be regarded as silt for this purpose.

4.2 Site Clearance

The limits of clearing, as shown on the Drawings, shall be pegged on Site for the Superintendent’s inspection prior to the commencement of works.



Clearing operations shall be undertaken to meet the requirements for erosion and sedimentation control as specified in this Specification.

Clearing shall include, but not be limited to;

- The felling, cutting and removal of all trees standing or fallen;
- The removal of all brush, shrubs, grasses and other vegetation;
- The removal of rubbish and debris;
- The removal of surface boulders and boulders dislodged during vegetation removal; and
- The grubbing out of all stumps and roots larger than 80mm diameter or with any dimension greater than 300mm to a depth of 300mm below either the existing surface or the finished subgrade surface, whichever is the lower.

Depressions caused by grubbing out tree roots and stumps, in cleared areas with no topsoil removal, shall be promptly backfilled with clean fill and compacted to the density and surface levels of the surrounding undisturbed ground.

Cleared vegetation shall be temporarily stockpiled on site at a location to be agreed with the Superintendent. Following the completion of the clearing works or when directed by the Superintendent, the Contractor shall be required to transport this material to an approved waste disposal facility.

Burning of cleared vegetative materials shall not be permitted under any circumstances.

4.3 Demolition

This section refers to the demolition, relocation, and/or disposal of all structures and/or infrastructure to be removed as shown on the Drawings and as specified herein.

The Contractor shall be responsible for the protection of facilities adjacent to the areas of demolition and shall maintain continuous operation of existing facilities and minimise operational inconvenience. If the Contractor damages any structures and/or infrastructure not shown on the Drawings or directed by the Superintendent, it should return said structure and/or infrastructure to its original condition at no expense to the Principal.

The limits of demolition, as shown on the Drawings, shall be pegged on Site for the Superintendent's inspection prior to the commencement of works.

4.4 Trial Holes

Before commencing general excavation work, it may be necessary to carry out trial holing to ascertain the exact location of underground services, which may affect the works. Before such trial holing commences, the Contractor shall notify the Dial Before You Dig (<http://www.1100.com.au>) involved so that an inspector may be present if required, while the trial holing proceeds. The cost of any trial holes shall be deemed to be included in the tendered rates.

The Contractor shall note the requirements of Section 3.8 whilst undertaking any trial holes. Any disruption to existing services while carrying out trial holes shall be repaired at the full expense to the Contractor.



4.5 Products and Materials

4.5.1 Use of Materials

The Contractor shall be responsible for any assumptions made by the Contractor in relation to the nature and types of materials encountered in excavations and the bulking and compaction characteristics of materials incorporated in any earthworks. The summary of the estimated quantity for general earthworks provided includes all types of materials that may be encountered in the cuttings.

Where material from excavations is suitable for use in the earthworks, but the Contractor elects to:

- Spoil it; or
- Use it for the Contractor's own purposes; or
- Use it as a source of pavement materials; or
- Construct embankments with dimensions other than those shown on the Drawings, or to dimensions as otherwise authorised by the Superintendent,

and a deficiency of material for earthwork construction is thereby created, the Contractor shall make good that deficiency from sources of suitable material. The making good of such deficiency of material shall be affected at no cost to the Principal.

4.5.2 Unsuitable Material

Some materials are unsuitable for forming structural fill and should be either removed to spoil or used in non-critical areas. In addition to the definition in **Section 4.1**, unsuitable materials, as detailed in **AS 3798** may include:

- Organic soils, such as many topsoils, severely root-affected subsoils and peat;
- Materials contaminated through past Site usage which may contain toxic substances or soluble compounds harmful to water supply or agriculture;
- Materials containing substances that can be dissolved or leached out in the presence of moisture (e.g. gypsum), or which undergo volume change or loss of strength when disturbed and exposed to moisture (e.g. some shales and sandstones), unless these matters are specifically addressed in the design;
- Silts, or materials that have the deleterious engineering properties of silt;
- Other materials with properties that are unsuitable for the forming of structural fill; and
- Fill that contains wood, metal, plastic, boulders or other deleterious material, in sufficient proportions to affect the required performance of the fill.

In some circumstances a design may allow for the use of some of these materials in structural fill. Before allowing for such use, the Contractor must supply specialised advice from a geotechnical professional. The use of any material in structural fill not specified in the Drawings or otherwise must be approved by the Superintendent before using such materials.

4.5.3 Select Fill

Unless otherwise specified or approved by the Superintendent, select fill shall be non-cohesive granular material complying with the particle size distribution in **Table 4-1**.

Table 4-1: Particle Size Distribution for Select Fill

AS Sieve Size (mm)	% Passing by Mass
37.5	100
19	80 - 100
9.5	60 - 100
4.75	45 - 100
2.36	30 - 100
1.18	20 - 100
0.425	5 - 100
0.150	3 - 30
0.075	1 - 10

The linear shrinkage for the portion of the material passing the 0.425mm sieve of the distribution of the select fill shall not exceed 1.0%. The source of the select fill material shall be clean and free from vegetation, contamination and be certified as "Dieback-free". The material shall contain no more than 1% organic matter. The material may contain up to 20% recycled glass cullet as approved by the Superintendent.

4.5.4 Sub-base

The sub-base shall be well consolidated, with minimal settlement as to supply a firm platform for the fore coming layers.

4.5.5 Leachate Collection Layer

The leachate collection layer shall be a nominal 16-32mm sized aggregate with the hydraulic conductivity $> 1 \times 10^{-3}$ m/s with the properties in **Table 4-2**.

Table 4-2: Properties of Leachate Collection Layer (Aggregate)

Property	Requirement
Uniformity Coefficient	> 5
Maximum Particle Size	40mm
Percent Passing 37.5mm sieve	Minimum 95%
Percent fines value	$< 1\%$
Soaked Ten percent fines value	100kN

The leachate collection layer shall be placed in a single layer. Placement of this layer shall be carried out without any deforming of the underlying materials. The final surface shall be smooth and free from surface aberrations.

It is a requirement that the proposed material for the leachate collection layer be approved by the Superintendent prior to its intended placement. The Superintendent reserves the right to reject the use of any material that they deem unsuitable for use in the leachate collection layer, whether or not it conforms to this Specification. All expenses for the transport, testing, placing of material that the Superintendent has not approved will be worn by the Contractor.

4.6 Excavation

4.6.1 Protection of Excavations

The Contractor shall provide all the necessary supports to secure the sides of any excavations whether mass excavation or trench excavation. Except where required by or permitted under the Contract, sides of the excavations shall not be battered. The Contractor shall be responsible for all trench boxes, planking and strutting necessary to ensure the stability of the side slopes of excavation. The Contractor will be responsible for the costs associated with such temporary works. Any battering or collapsed excavations shall be backfilled with material approved by the Superintendent.

All excavations shall have adequate warning lights, handrail and guarding to allow safe work within and on top of the excavations.

4.6.2 Excavated Materials

Excavated material shall be disposed of in accordance with the Contract. No excavated materials, suitable for use in the works shall be removed from the Site except on the direction, or with the permission, of the Superintendent.

4.6.3 Water in Excavations

The Contractor shall not allow water to lie in any part of the works unless required to do so under the Contract. Water arising from or draining into the works shall be drained or pumped to an approved disposal point. Any drainage sumps required shall, where practicable, be sited outside the area excavated for the Permanent Works, and shall be refilled with suitable approved fill material to the level of the underside of the adjacent Permanent Works.

The Contractor shall take all the necessary precautions to prevent any adjacent ground from being adversely affected by loss of fines through any dewatering process. The Contractor shall likewise take all necessary precautions to prevent any ground water from entering mains to be used for the conveyance of potable water. The Contractor shall install efficient settling basins or grit traps through which such water will pass before discharge, to the approval of the Superintendent.

Leachate encountered in excavations shall not be pumped to any watercourse and the location and method of removal shall be agreed with the Superintendent.

4.6.4 Excavation below Formation Level

If the Contractor encounters ground below formation level which is considered unsuitable, or if the formation level is damaged and allowed to deteriorate, the Superintendent shall be promptly informed. Any unauthorised excavation to a depth greater than is necessary for the proper execution of the works shall be filled with suitably approved fill material to bring it to the correct formation level. Any underground services or structures within 500 mm below the formation shall be removed and the excavation backfilled with crushed rock material or equivalent approved.

4.6.5 Hand Excavation

Hand excavation shall be used in confined spaces where the use of excavating machinery is unsuitable and for other operations such as trimming the formation to final level whether in open cut or in trench. Hand excavation shall be used around and adjacent to existing services to expose and locate them.

4.6.6 Topsoil

The existing topsoil shall be stripped from all areas within the earthworks to a minimum depth nominated in the Drawings or Bill of Quantities.

Prior to the commencement of the removal of topsoil from all Designated and Other Areas, the Contractor shall certify to the Superintendent that:

- Topsoil to be stripped and stockpiled or removed to spoil is correctly pegged on Site;
- The location of stockpile sites for topsoil and other materials are correctly pegged on Site, including any alternative locations as nominated by the Contractor;
- Environmental controls are in place in accordance with **Section 2.17** of the Specification.

Topsoil shall be used, where possible, immediately, but if not shall be stockpiled in heights not exceeding 2m. Unless otherwise stated, it shall not be stockpiled for more than 2 years. It shall be deposited and spread on the areas to the layers not exceeding 150mm, unless otherwise stated. Each layer shall be firmed before spreading the next layer. The thickness shall be reduced where necessary to allow for any subsequent turfing.

The Contractor shall ensure that appropriate plant and equipment are utilised by competent operators to ensure that the subsoil and topsoil layers are not mixed and the subgrade integrity is not affected during the stripping and stockpiling process.

The Contractor shall protect and stabilise stockpiles by appropriate measures, to minimise erosion and loss of materials, as approved by the Superintendent.

4.6.7 Excavation to Formation Levels

After removal of topsoil, the Contractor shall cut to the design formation levels shown on the Drawings and transport the material to the areas to be filled, exported off-site to designated locations or disposed of at an appropriately licensed facility. The Contractor shall take precautions that prior to any subsequent works placed on top of the formation the surface shall be protected from trafficking, storage, rainfall and any other climatic condition.

Where necessary, the Contractor shall temporarily stockpile all cut material in areas to be agreed with the Superintendent.

Any areas that are over excavated shall be refilled in accordance with **Section 4.5.3** to the correct design levels and compacted as specified in **Section 4.6.8**.

Indigenous materials to be used as fill shall be assessed in-situ for its suitability for re-use by the Contractor and agreed by the Superintendent. Where appropriate, in-situ or laboratory testing shall be conducted to confirm the material's suitability for use in the permanent works. The material shall be designated as being Unsuitable or Suitable for incorporation into the permanent works.

4.6.8 Proofing and Inspection of Formation Surfaces

Formation surfaces shall be proof rolled with a 10 tonne dead-weight roller to prove the formations structural strength and capacity. Soft spots shall be excavated and disposed of as directed by the Superintendent and filled with crushed rock material or similar approved. The Contractor shall not be entitled to claim for any delays associated with the approval of formations.

To provide protection and to avoid damage to the final excavated surface a minimum of 150mm may be left on the final surface until immediately before being offered for inspection. Seepage and surface water shall be kept off the works as specified.

The formation levels shall not be trafficked upon except for that required for the preparation of the formation.

Any damage to the formation shall be notified to the Superintendent and the Contractor shall be responsible for the costs of their remedial works to the formation. All formations shall be trimmed, levelled, cleared of loose material and compacted in accordance with this Specification. No work shall commence on the final excavated surface until the Superintendent has approved the surface.

A contractor quality sign-off form shall be issued by the Contractor prior to any filling on the formation level to the Superintendent/CQA Consultant 24 hours in advance of intent to fill, for approval. The Superintendent's/CQA Consultant's acceptance or non-acceptance of the formation surface does not remove the liability for the works from the Contractor.

4.7 Filling

4.7.1 General Filling

This Specification defines general fill as material to be used in fill locations upon which embankments and other areas of structural fill are not required. All general fill shall still meet the requirements for suitable materials as per **AS 3798** and be deemed acceptable by the Superintendent.

Filling shall, wherever practicable, be undertaken immediately after the specified operations preceding it have been completed. Filling shall not, however, be commenced until the works to be covered have achieved a strength sufficient to withstand all loading imposed thereon.

Filling around tanks and other structures shall be undertaken in such a manner as to avoid uneven loading.

No filling shall take place in water. All filling with on-site won and imported fill material shall be compacted in accordance with **AS 3798**. Unless specified elsewhere, general fill shall be compacted to 95% of its maximum dry density in layers not exceeding 300mm, unconsolidated thickness and compacted to form stable backfill.

4.7.2 Formation Preparation

Subgrade preparation shall be completed in all areas where a structural fill is to be placed.

The subgrade surface shall be constructed to the shape and levels as shown in the Drawings and to the specified requirements and tolerances of this Clause.

During the whole of the compaction process the moisture content, at any point in the Lot, of the subgrade material shall be within $\pm 2\%$ of the optimum moisture content for that material.

The completed subgrade layer shall be in a homogeneous uniformly bonded condition with no evidence of layering or disintegration.

The completed subgrade surface shall be maintained in its conforming condition until construction commences and shall be watered as necessary to prevent shrinkage cracking, dusting or loosening of its surface.

Where material for a depth of 150mm below the subgrade surface contains more than 20% by mass of material retained on a 37.5mm sieve then that material shall be compacted as detailed in **Section 4.6.8** of this Specification except that the vibratory pad-foot rolling shall be followed by no less than six (6) complete coverage by a fully ballasted 15 tonne rubber tyred roller.

The shape of the subgrade surface shall be deemed to be conforming when the maximum deviation from a 3m straight edge placed in any position on the surface does not exceed 15mm.

4.7.3 Sub-base

The sub-base shall be installed to the grades and levels as shown on the provided Drawings. The surface shall be smooth, free of debris, roots, sticks and sharp rocks.

The sub-base shall be compacted as per the requirements in **Section 4.6.8** of this Specification.

The sub-base should be approved by the Superintendent prior to subsequent layers being placed on the sub-base.

4.7.4 Filling against Structures

Filling shall not be placed against structures until the structure has been inspected and approved for filling. Fill materials shall be placed in horizontal uniform layers not exceeding 150mm thickness and shall be compacted to a minimum dry density ratio of 98% when tested in accordance with **AS1289 E2.1** or **E3.3**. Backfilling over and around structures shall avoid unbalanced loading or create movement.

The Contractor shall be responsible for any damage to existing structures as a result of filling and compacting operations.

4.7.5 Finishing of Batters and Ground Surfaces

Except during the construction of benched or stepped batters, batter slopes shall be smoothly shaped to a uniform plane from top to bottom as shown on the Drawings.

The top and toe of all batters shall be rounded, where practical, to match the shape of the surrounding topography as shown in the Drawings. Typical cross-section for rounding of batter line edges, unless otherwise specified in the Contract.

The surface of all batters and other areas nominated for revegetation and landscaping works shall be excavated and filled, shaped and/or graded as necessary to achieve the finished soil levels and contours nominated in the Drawings, prior to any surface preparation and soil improvements.

The toe of mounds shall be graded evenly to meet adjoining surface levels. The ground surface shall be shaped and/or graded evenly to avoid abrupt changes in levels abutting structures and paved surfaces.

5 Drainage

5.1 Culverts

The works under this Section consists of the supply and installation of reinforced concrete pipes (RCPs), reinforced concrete end treatments for culverts and the supply and installation of RCP stormwater drains.

5.1.1 Products and Materials

5.1.1.1 Reinforced Concrete Pipes

Concrete pipes for culverts shall be pre-cast reinforced concrete pipes (RCPs) to the Classes shown on the Drawings. Concrete pipes shall be manufactured, tested and inspected in accordance with the requirements of **AS/NZS 4058** and **AS/NZS 3725**. Concrete pipe shall be manufactured to suit the in-situ ground conditions as specified for the Site. Joint types shall be as specified in the Drawings.

Rubber ring joints shall be provided for all spigot and socket pipes, unless otherwise shown on the Drawings. Rubber ring gaskets required for jointing spigot and socket concrete pipes shall conform to the requirements of **AS 1646**.

5.1.1.2 Reinforcement & In-situ Concrete

Reinforcing steel shall conform to the requirements of **AS/NZS 4671**.

The supply and placement of all concrete shall conform to the requirements of all current Australian Standards.

5.1.1.3 Cement Stabilised Backfill

Cement stabilised backfill material shall consist of basecourse material, or other suitable material approved by the Superintendent, stabilised in the proportion of 100kg of Type GP Cement to one cubic metre of uncompacted backfill material.

Water for cement stabilisation shall be clean and potable.

5.1.1.4 Select Bedding Material

Select bedding material shall be basecourse material, or other suitable material approved by the Superintendent, containing less than 20% by mass of material retained on the 37.5mm sieve as determined by MRWA Test Method WA 115.2.

5.1.1.5 Joint Sealant

Acceptable joint sealants for masking external joints are Flash Tac Scotch Wrap No.50 and Rock Wrap 3000 or a suitable equivalent approved by the Superintendent.

5.1.2 Installation

The installation of pipes and box culverts shall include all trench excavations, construction and backfill to the details shown on the Drawings and as described in this Specification.

5.1.2.1 Trench Excavation

Trenches shall be excavated to the width shown in the Drawings with vertical sides throughout where the excavation is up to 1.5m deep. Where the excavation is greater than 1.5m deep, the trench shall be excavated in accordance with the requirements of the Drawings. Any loose or disturbed material shall be removed from the walls of the trench. All spoil material from excavations, including excavations for end treatments and rock protection, shall be disposed of as specified in **Section 4.5.2** of this Specification. Excavations shall be kept free from water until work below ground level is sufficiently set or protected. Dewatering operations shall be undertaken in accordance with **Section 4.6.3** of this Specification, and water discharged from trenches shall in no circumstances be disposed of to sanitary sewers. Trench excavations in rock, including excavation for end treatments, shall be carried out in accordance with **Section 4.6.7** of this Specification.

5.1.2.2 Protection of Foundation Surfaces

The exposed surface at the bottom of the excavation shall be adequately protected from disturbance by the Contractors operations or by the action of storm water or ground water. Where required, dewatering shall be undertaken in accordance with the requirements of **Section 4.6.3** of this Specification. Any disturbance shall be reinstated to original conditions by the Contractor at no cost to the Principal.

5.1.2.3 Bedding

Culverts shall be bedded as detailed on the Drawings. Excavation for culverts, bedding and end treatments shall be undertaken to the extent shown on the Drawings. Unless shown otherwise on the Drawings, the culverts and end treatments shall be bedded on the in-situ foundation material that has been compacted to the requirements specified in **Section 4.7** of this Specification. Select bedding material shall be constructed to the dimensions shown in the Drawings. Select bedding material shall be compacted to the Characteristic Dry Density Ratio specified in **Section 4.7.1** of this Specification. Provisions shall be made to accommodate pipe socket/connections to ensure pipes are fully supported along the barrels.

5.1.2.4 Damage

Pre-cast concrete pipes and box culvert units shall be handled and installed in such a manner that no non-conforming cracking or other non-conforming defect occurs that will impair its performance, as determined by the Superintendent. Damaged pipe and box culverts shall be assessed and repaired or replaced to the Superintendent's satisfaction at no cost to the Principal.

5.1.2.5 Backfill and Compaction

Prior to backfilling the Contractor shall certify to the Superintendent that compliance has been achieved with all specified requirements.

The backfill requirements for all culverts shall be as detailed in the Drawings. Unless otherwise shown on the Drawings backfill material, other than cement stabilised backfill shall be embankment material placed and compacted to the requirements specified in **Section 4.6.8** of this Specification. Backfill levels on each side of any conduit shall not differ by more than 150mm. The Contractor shall ensure that the backfill placement does not damage the end treatments.

The dimensional requirements relating to backfill shall be as shown on the Drawings. All sheeting, struts, braces, and similar temporary supports shall be entirely removed from the trench prior to backfilling.

Removal shall be effected in such a way so as not to disturb or displace the culvert. Appropriate precautions, such as the use of holding-down straps, shall be taken to ensure that corrugated metal pipe culvert barrels do not 'float' during the backfilling process, particularly during vibration of the backfill. The Contractor shall ensure that the equipment used during compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with **AS/NZS 3725** for reinforced concrete pipes or **AS 1597** for reinforced box culverts. No backfill shall be placed behind in-situ wingwalls or headwalls within seven days of concrete being placed in the wingwalls or headwalls.

5.1.2.6 Culverts

Batter slopes at culverts shall be evenly transitioned over a length of 10m from the edge of the wingwall to match culvert wingwall slopes. All culverts shall be constructed to the correct alignment and cross-sectional shape and shall conform to dimensions, levels and other details specified or shown in the Drawings. Inlet and outlet invert levels shall be as shown in the Drawings plus or minus 10mm. Inverts shall be smooth and of uniform gradient throughout each culvert length. Any culvert which is not true to line, level or grade, or shows settlement after laying, or which is damaged during backfilling, compaction or subsequent operations, shall be removed by the Contractor and replaced at no cost to the Principal. On completion of installation no diameter measured across the indelible markings on metal culverts shall differ from the supplied preinstalled dimension by more than 5 percent. Testing frequency shall be in accordance with this Specification. Where shown on the Drawings, metal culverts shall be anchored to an in-situ concrete collar. All culverts shall be flushed clean from end to end on completion of the installation and maintained in proper working order for the duration of the Contract. Culverts shall be laid with the connections kept clean and shall be laid with the inverts true to the lines and levels shown on the Drawings and to the following tolerances:

- Horizontal alignment $\pm 25\text{mm}$
- Vertical level $\pm 10\text{mm}$

The Contractor shall seal the ends of the culverts with a temporary plug to exclude water, sand or other deleterious materials caused from work under the Contract unless otherwise approved by the Superintendent.

5.1.2.7 Concrete Pipe Culverts

Pipe laying shall proceed up-grade with the pipe sockets at the higher end of the pipes. Rubber ring joints shall be lubricated in accordance with the manufacturer's recommendations.

Pipe handling shall be carefully controlled to avoid disturbing the rubber ring and to ensure that it is free from dirt and other foreign materials. Any rubber ring so disturbed shall be removed, cleaned and re-lubricated before refitting. Care shall be taken to properly align the pipe before the joint is forced home. During the jointing operation the pipe shall be partially supported in a suitable manner to minimise unequal lateral pressure on the rubber ring and to maintain concentricity until the rubber ring is properly seated.

Flush jointed concrete pipes shall be installed in accordance with the manufacturer's recommendations, with the rubber jointing bands and pipe joints being kept free from dirt and foreign materials. The installation and jointing recommendations provided by the pipe manufacturer shall be followed at all times. Sufficient pressure shall be applied in making the joint to ensure proper seating and sufficient restraint shall be applied to ensure that the line does not creep until backfill material can



be placed and thoroughly compacted around the pipe. At the end of the work day the last pipe shall be blocked in an effective manner to prevent creep.

5.1.2.8 End Treatments

Unless otherwise shown on the Drawings, all culvert end treatments shall be constructed of cast in-situ concrete, or where applicable of mortared rock pitching in accordance with the Drawings. The dimensions of the end treatments shall be within 10mm of those shown on the Drawings when measured in accordance with **AS 3610**. Surface irregularities of the concrete end walls, wing walls, cut-off walls and aprons shall be less than 5mm abrupt and 8mm over a 3m straight edge. Unless otherwise shown on the Drawings, mortar for mortared rock pitching shall comprise a 6 to 1 mix of builder's sand and ordinary Portland cement, with all sand being from the same source.

6 Pipe Laying

6.1 Products and Materials

6.1.1 Select Bedding Material

Select bedding material shall be subbase material meeting the requirements of **Section 4.5.4**, or other suitable material approved by the Superintendent, containing less than 20% by mass of material retained on the 37.5mm sieve as determined by MRWA Test Method **WA 115.2**.

6.1.2 Backfill Material

Backfill material shall consist of subbase material meeting the requirements of **Section 4.5.4**, or other suitable material approved by the Superintendent.

6.1.3 High Density Polyethylene Pipes

High Density Polyethylene (HDPE) pipes shall be supplied in accordance with this Specification and Drawings and shall be installed and tested in accordance with **Section 6.3** of this Specification.

All HDPE pipework shall be to the nominal diameter and standard dimension ratio as shown on the Drawings. All HDPE pipes shall be butt weld jointed by proprietary welding equipment unless specified elsewhere. Welding shall take place in locations which are protected from unfavourable weather conditions. All butt welds shall be reamed internally in order to remove excess beading. Plain pipes shall be tested to 1.5 times the working pressure.

HDPE pipe shall be obtained directly from the supplier and shall be formed from solid pipe. The pipe manufacturer shall submit calculation to confirm the integrity of the pipes as not being compromised by the installation of slots/perforations. Unless agreed otherwise by the Superintendent, slots shall be as indicated on the Drawings, extend for 2/3 of the circumference of the pipe. Double wall construction HDPE pipes of an equivalent proven strength may be used upon approval on the Superintendent.

All leachate collection pipework shall be laid upon 100mm of drainage layer material, shall have twice the pipe diameter of cover. For leachate collection pipes, the Contractor shall submit calculations from the pipework manufacturer using ATV 127 Method (or similar approved) to demonstrate the following requirements:

- Pipe deflection < 6%;
- D85/hole diameter > 1.0 (Circular perforations -5% open area);
- D85/hole diameter > 1.2 (Slot perforations - 5% open area);
- Where D85 refers to the pipe granular surround. The following assumptions can be made:
 - waste Density 1000 kg/m³;
 - maximum waste depth = 20m;
 - soil stiffness of an uncompacted unconfined gravel surround on the base of the landfill (Bank installation under ATV); and
 - pipe is perforated.

6.1.4 Unplasticised Polyvinyl Chloride Pipes

Unplasticised Polyvinyl Chloride (uPVC) pipes shall meet the requirements set forth in **AS 2032**.

uPVC pipes shall be supplied in straight lengths, reasonably smooth and clean both inside and outside and free from clause. Bends and branches, unless otherwise specified, shall be standard uPVC. Other specials shall be of grey or ductile iron complying with the appropriate standards.

6.1.5 Bends and Tees

In general, all specials such as bends and tees shall be of cast iron or ductile iron with suitable ends to join with the parent pipe material. Steel specials shall be used with steel mains. Specials shall be manufactured in accordance with **AS 2129**.

6.1.6 Pipe Joints

In general, buried pipelines shall have flexible mechanical joints to manufacturer's details. Where detachable or bolted type joints are used, all bolts shall be galvanised and the joint shall be wrapped with an approved insulating tape on completion. Steel mains shall be butt-welded in accordance with **AS 4041**.

Joint lubricants for sliding joints shall have no deleterious effects on either the joint rings or pipes, and be unaffected by the liquid to be conveyed. Lubricants to be used for jointing watermains shall not impart to the water taste, colour or any effect known to be injurious to health, and shall be resistant to bacterial growth.

Where flanged joints are specified in the Contract, they shall comply with the provisions of **AS 2129**.

Gaskets for flanged pipe joints shall be of the inside-bolt-circle type. The dimensions of gaskets shall comply with **AS 2129**. Gaskets shall be manufactured from material complying with the provisions of **AS 2129**.

6.1.7 Valves and Fittings

All valves shall be manufactured in accordance with **AS 1271** and shall be clockwise closing. The class of valve shall conform to the required working pressure in the pipeline. The internal surfaces of all valves and fittings shall be lined or coated to give full and permanent protection against the materials being conducted in the parent pipelines to which they are fixed.

6.1.8 Air Valves

Air valves shall be provided as specified in the Drawings and Bill of Quantities.

6.1.8.1 Single Air Valves (SAV)

A single air valve shall be suitable for releasing air in small quantities during the operation of the parent main. The valve shall be mounted on a 75mm flange and shall contain a 98mm rubber covered ball. The valve seating shall be of rubber backed with leather. The valve shall be fitted with an isolating cock so that the valve can be examined without shutting off the main. In certain applications, the single air valve may have a screwed gas thread for screwing on to the main directly.

6.1.8.2 Double Air and Stop Valve (DAV)

A double air valve shall consist of two outlet vents with an isolating screw down valve between them. One side of the valve shall contain a large orifice for venting large volumes of air. The other side shall have a small orifice for venting small amounts of air similar to a single air valve. Valves shall be fixed

to the main by means of a 75mm flanged joint. Short lengths of 75mm flanged cast iron pipework shall be used to bring the valve to an accessible level.

6.1.8.3 Kinetic Type Double Air Valve

A kinetic double air valve is a special type of air valve for use on pumping mains. It is designed specifically to ensure that the large orifice ball does not seat prematurely on the on-rush of air from the main. Where this type of valve is specified in the Contract, it shall be similar in type to Glenfield and Kennedy Type H40 K.

6.1.9 Valve Chambers and Surface Boxes

All gate valves, air valves and hydrants shall be housed in chambers as specified in the Contract and detailed on the Drawings. Valves which are too deep to be accessible by the use of a standard valve key shall be fitted with extended spindles as shown in the Drawings to enable the valve to be operated from the surface.

All box covers shall be heavy duty ductile iron covers and frames and shall include for the provision of lifting keys and indicator plates.

6.1.10 Other Specials

All other specials such as reflux valves, non-return valves, pressure retaining or pressure reducing valves, flow meters and wastewater meters, ball valves, etc. shall be provided as detailed in the Contract.

6.2 Installation

6.2.1 Inspection of Pipe Materials

All materials to be used in the pipe laying operations shall be carefully inspected before use to ensure that damaged material is not used in the works. The interior of pipes, specials and fittings shall be carefully cleaned before being laid in the trench.

Pipe laying shall not commence until the bottom of the trench and the pipe bed has been approved by the Superintendent. Pipes shall be brought to the correct alignment and inclination, concentric with the pipes already laid.

6.2.2 Continuity of Laying

All pipelines shall be laid in a continuous operation. It will not be permissible to leave gaps where fittings, etc., occur and return later to infill the gaps. The Contractor shall ensure that all bends and specials are available for each section of the work before work commences on that particular section. Immediately after laying, the open end of a pipe will have to be sealed with a wooden plug or approved stopper of appropriate size to prevent the entry of material which contaminates the pipeline, damages linings or effects the working of valves etc. Adequate precautions shall be taken to prevent floatation of the pipeline in the event of the trench being flooded.

6.2.3 Tolerances

The tolerances shown in **Table 6-1** shall apply to all installed pipes, unless specified otherwise.

Table 6-1: Tolerances of Pipes and their Components

Component	Alignment	Level
Pipes	±25mm	±5mm
Manholes and drainage structures	±20mm	±10mm

6.2.4 Sub-surface Pipes

6.2.4.1 Trench Excavation

Trenches shall be excavated to the width shown in the Drawings with vertical sides throughout where the excavation is up to 1.5m deep. Where the excavation is greater than 1.5m deep, the trench shall be excavated in accordance with the requirements of the Drawings. Any loose or disturbed material shall be removed from the walls of the trench. All spoil material from excavations, including excavations for end treatments and rock protection, shall be disposed. Excavations shall be kept free from water until work below ground level is sufficiently set or protected. Dewatering operations shall be undertaken in accordance with **Section 4.6.3** of this Specification, and water discharged from trenches shall in no circumstances be disposed of to sanitary sewers.

Trench excavation for pipelines shall conform to the longitudinal sections shown on the Contract Drawings. Sharp changes in gradient shall be avoided. Horizontally, smooth curves may be used to avoid bends provided that the maximum deflection of any pipe joint does not exceed the manufacturer's recommendations.

The length of trench to be opened at any one time shall be at the Superintendent's discretion and cognisance shall be taken of inconvenience to the public and the disruption to traffic.

6.2.4.2 Protection of Foundation Surfaces

The exposed surface at the bottom of the excavation shall be adequately protected from disturbance by the Contractor's operations or by the action of storm water or ground water. Where required, dewatering shall be undertaken in accordance with the requirements of **Section 4.6.3** of this Specification. Any disturbance shall be reinstated to original conditions by the Contractor at no cost to the Principal.

6.2.4.3 Pipe Bedding

Bedding shall be well compacted, provide sound, uniform support, and not be disturbed by groundwater or other similar conditions. Bedding material shall be free from organic matter. Where conditions are dry, the Superintendent may authorise the use of excavated sand as bedding material. In the event of wet conditions, bedding material shall be granular material as approved by the Superintendent.

Pipe bedding material shall be shaped to suit the barrel of the pipe to give full support to the length of the pipe. Bedding shall be tamped into position up the sides of the pipe to give full support to the diameter of the pipe. At collars, the bedding material shall be scooped out to allow jointing to be carried out and the pipe shall not rest on the pipe collars.

6.2.4.4 Pipe Laying

All pipes shall be laid in accordance with the manufacturer's recommendations to uniform gradients and to levels shown. Pipes shall be set in an upstream direction unless otherwise approved by the Superintendent.

PE pipes should be 'snaked' during installation and backfilled immediately as to minimise thermal movements.

The Contractor shall provide all necessary fittings and accessories including junctions, branches, and other fitments.

6.2.4.5 Backfilling

Following satisfactory inspection, testing and recording of as-constructed information, the trench shall be backfilled and compacted by hand with selected materials as shown on the Drawings. Backfill will be carefully placed and compacted under, around and over the pipe taking precautions to ensure the pipe is not disturbed in line or level, or damaged. Backfill levels on each side of any conduit shall not differ by more than 150mm. The Contractor shall ensure that the backfill placement does not damage the end treatments.

The dimensional requirements relating to backfill shall be as shown on the Drawings. All sheeting, struts, braces, and similar temporary supports shall be entirely removed from the trench prior to backfilling. Removal shall be effected in such a way so as not to disturb or displace the conduit.

Backfill will be placed in continuous horizontal layers not exceeding 150mm loose thickness using light compaction equipment above the pipe until a minimum depth of 150mm has been placed and compacted over the pipe.

Once the backfill is over 150mm above the crown of the pipe, backfill shall proceed in 300mm loose layers.

Heavy compaction equipment will not be permitted until 600mm of fill has been properly compacted over the pipe.

6.3 Acceptance

6.3.1 Field Testing of Mains

All solid pipelines and manholes shall be subjected to hydrostatic test before being brought into service. The required field test on pipes shall be 1.5 times the maximum working pressure. The test pressure shall be applied and maintained for at least 24 hours.

If a drop in pressure occurs, the quantity of water to be added in order to re-establish the test pressure shall be measured. The test shall be considered satisfactory when the amount of water added does not exceed 0.1 litres/mm of diameter/km of length/30m of head/24hr (i.e. 1 gallon/inch diameter/mile/100ft head/24hr).

If the pipeline fails to meet the above criteria, the fault shall be found and rectified. To this purpose, it is advisable to leave as many joints exposed as possible during the test by partially backfilling only between joints.

6.3.2 Overall Pressure Test

When all pipelaying has been completed, and all sections of main are interconnected in the system, an overall hydrostatic test shall be applied to the system at 1.5 times the working pressure.



6.3.3 Pneumatic Testing

The Contractor may utilise pneumatic (air) testing on any portion of the pipeline where it sees fit. However, such tests shall only be supplementary to the hydrostatic tests described above and will not be acceptable as an alternative means of testing.

6.3.4 Water for Testing

The Contractor shall make his own arrangements for providing test water on Site. Where a public water supply is not available, the Contractor shall locate suitable sources of water for testing purposes on Site and shall obtain the Superintendent's approval to the use of such sources.

A contractor quality sign-off form shall be issued by the Contractor, for the witnessing of testing of all pipework and manholes, to the Superintendent 24 hours in advance of the test being carried out, for approval.

7 Geosynthetic Liners

7.1 General

This section outlines the supply and installation of all geosynthetic materials necessary for the completion of the project. This section should be read in conjunction with the CQA Plan as described in the **Appendix D** of this Specification.

7.2 Codes & Standards

The works shall comply with all current Australian Standards and Statutory regulations where applicable, unless specified otherwise in this Specification. In particular, the following shall apply:

- ASTM D570 Test Method for Water Adsorption of Plastics;
- ASTM D638 Test Method for Tensile Properties of Plastics;
- ASTM D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics;
- ASTM D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact;
- ASTM D751 Method of Testing Coated Fabrics;
- ASTM D1004 Trapezoidal Tear Strength;
- ASTM D1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastomer;
- ASTM D1505 Test Method for Density of Plastics by the Density-Gradient Technique;
- ASTM D1603 Test Method for Carbon Black in Olefin Plastics;
- ASTM D1822 Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials;
- ASTM D3015 Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds;
- ASTM D3895 Oxidative Induction Time of Polyolefins;
- ASTM D4437 Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Membranes;
- ASTM D4716 Test Method for Constant Head Hydraulic Transmissivity (in – Plane Flow) of Geotextiles and Geotextile Related Products;
- ASTM D5385 Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes;
- ASTM D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test;
- ASTM D5596 Carbon Black Dispersion;
- ASTM D5820 Air Testing of Dual Hot Wedge Seams;
- ASTM D5993 Measuring the Mass Per Unit Area of GCL;
- ASTM D6768 Tensile Strength of Geosynthetic Clay Liners;
- ASTM D6693 Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes;
- ASTM D5721 Air-Oven Aging of Polyolefin Geomembranes;
- AS 3706.1 General Requirements, Sampling, Conditioning, Basic Physical Properties and Statistical Analysis;
- AS 3706.2 Determination of Tensile Properties - Wide Strip Method;
- AS 3706.3 Determination of Tearing Strength - Trapezoidal Method;
- AS 3706.4 Determination of Burst Strength - California Bearing Ratio (CBR) Plunger Method;
- AS 3706.6 Determination of Seam Strength;
- AS 3706.9 Determination of Permittivity;
- FTMS 101B Puncture Resistance;



- ISO 9001 Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing;
- GRI-GM13 Standard Specification for HDPE Geomembranes; and
- GRI-GM19 Seam Strength of Thermally Bonded Geomembranes.

7.3 Environmental Conditions

The Contractor is to take whatever measures are necessary to ensure the timely and effective execution of the works without compromising workmanship, safety or seaming quality. The Contractor shall be responsible for provision of all temporary protection and anchorage for the geosynthetic materials.

7.4 Supply, Handling and Storage

All materials supplied shall be manufactured and provided in accordance with a quality system approved by the Superintendent/CQA Consultant.

The Contractor shall be responsible for all freight, transportation to Site, handling and storage, including security.

Lining materials are generally delivered in rolls weighing up to 1,500kg. For handling and deployment it is considered by the Principal to be necessary to support this weight using an appropriate core pipe which must not deflect more than 50mm as measured from end to midpoint when a full roll is lifted.

Lifting chains or straps rated for at least twice the load of the roll should be used in combination with a spreader bar. The spreader bar must be wide enough to ensure that the lifting chains or straps do not chafe against the ends of the roll, which must be able to rotate freely during installation.

All lining components must be handled with care to avoid damage to the material. Any damaged geosynthetic liner material shall be replaced at the Contractor's expense. Delays in shipping geosynthetic materials shall not qualify for claims for Extension of Time.

Each roll of geosynthetics shall bear a label which identifies the following:

- Manufacturer;
- Product identification;
- Roll number;
- Raw material;
- Batch number;
- Roll width; and
- Roll length.

Lining geosynthetics shall be stacked in accordance with the manufacturer's recommendations. The Superintendent may direct the Contractor to make adjustments to the stored materials if evidence of damage is observed. Any defects or damage detected shall be repaired to acceptable standards or totally replaced. The rolls shall not be stored on ground conditions which are likely to impose damage or affect the integrity of its long term performance.

7.5 Products and Materials

7.5.1 Geosynthetic Clay Liner

The Geosynthetic Clay Liner (GCL) shall be a needle punched multi-layered system comprising two layers of geotextiles encapsulating a layer of dry bentonite.

The bentonite shall be powdered or granulated meeting the requirements in **Table 7-1**.

Table 7-1: Bentonite Minimum Requirements

Property	Range or Value
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 sieve)
Cation Exchange Capacity	≥ 70 meg/100g (or cmol/kg)
Free Swell Index	≥ 24 ml/2g

No additives shall be allowed to the bentonite unless the supplier can demonstrate the nature, suitability and long term durability of the additive. In all cases the final decision regarding acceptability shall be made by the Superintendent.

The GCL shall meet the requirements of **Table 7-2**.

Table 7-2: Geosynthetic Clay Liner Minimum Requirements

Property	Unit	Range or Value
Geotextile Component		
Cover Layer	g/m ²	≥ 220
Carrier Layer	g/m ²	≥ 110
Bentonite Component		
Mass per unit area	g/m ²	≥ 3,600 @ 0% MC
Swell Index	ml/2g	≥ 24
Fluid Loss	ml	≤ 18
Geosynthetic Clay Liner		
Mass per unit area	g/m ²	≥ 4,900
Thickness	mm	≥ 6
Maximum Tensile Strength (Machine Direction)	kN/m	≥ 8
CBR/Puncture Resistance	N	≥ 2,000
Hydraulic Conductivity/Permeability	m/s	≤ 2 x 10 ⁻¹¹

The use of additional reinforcing geotextiles above or below the GCL to provide sufficient angle of internal friction on the side slopes shall be allowed subject to calculations provided and subject to the final decision of the Superintendent.

Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternative material meets all requirements of this Specification, and must obtain prior approval of the alternative GCL by the Superintendent.

7.5.2 GCL Acceptance

GCL conformance testing shall be undertaken by the Contractor. Materials shall not be incorporated into the works until the Superintendent/CQA Consultant has assessed the laboratory results.

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission.

Testing will be undertaken at an accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant.

In addition, the CQA Consultant will undertake onsite visual inspection of the GCL roll delivered to the Site. All Conformance Testing and Visual Inspections are detailed within **Table 7-3**.

Table 7-3: Minimum CQA Testing for GCL

Property	Frequency	Standards
Conformance Testing (in factory sampling)		
Thickness (dry)	1 sample per 10,000 m ²	ASTM D1777
Mass per unit area of bentonite component of GCL	1 sample per 2,500m ²	ASTM D5993
Mass per unit area of GCL	1 sample per 2,500m ²	ASTM D5993
Montmorillonite content (X-ray diffraction method)	1 sample per 10,000m ²	
Cation exchange capacity of bentonite (methylene blue method)	1 sample per 20,000m ²	
Mass/unit length of bentonite in overlaps (visual inspection and weighting)	Daily visual inspections	
Moisture content of bentonite	1 sample per roll or 2,500m ²	AS 1289.2.1.1
Swell index/free swell of clay	1 sample per 5,000m ²	ASTM D5890
Water absorption	1 sample per 5,000m ²	ASTM D5891
Peel strength (for needle-punched products only)	1 sample per 4,000 m ²	ASTM D6496
Permeability	1 sample per 25,000m ²	ASTM D5887
Tensile strength	1 sample per 10,000m ²	ASTM D4595



CBR of geotextile	1 sample per 25,000m ²	AS 3706-4
Puncture resistance of geotextile	1 sample per 25,000m ²	AS 3706-5
Index Flux	1 sample per 25,000 m ²	ASTM D5887
Visual Inspection of GCL (on arrival and during placement at the Site)		
Colour, thickness, needle punching, presence of needles or broken needles, and sewing density or other faults in the material	Every roll	
Thickness of GCL (i.e. uniformity of bentonite distribution) and apparent variations in the as placed moisture distribution		
Thickness of GCL (i.e. uniformity of bentonite distribution) and apparent variations in the as placed moisture distribution	Each roll during placement. If thickness appears to be variable a check of the variability of the mass per unit area should be conducted	

All conformance tests must be supervised, reviewed, accepted and reported by the CQA Consultant before deployment of the geosynthetic clay liner. All sampling taken from the GCL at the manufacturer' premises or Site shall be under the CQA Consultant's supervision.

7.5.3 GCL Installation

The laying and installation of all GCL shall follow the manufacturer's details as well as the requirements as specified.

The method of installation of the GCL shall ensure that the following are complied with:

- On slopes, the GCL shall be securely anchored and the GCL material then deployed down the slope in such a manner as to keep the GCL panel in tension. The dimensions of the anchor trenches are as shown on the Drawings;
- Seams shall be placed perpendicular to the line of slope. Horizontal seams shall only be permitted on the face of the slope where directed by the contract drawings;
- Where slope lengths are longer than manufactured roll lengths, the GCL is to be secured in intermediate anchor trenches. Upslope panels will rainlap (roof-tile) downslope panels with a minimum overlap of 1.0m;
- The Contractor shall take all necessary precautions to prevent damage to the underlying layers during placement of the GCL;
- During placement of the GCL, care shall be taken not to entrap beneath the GCL, any stones, excessive dust or moisture that could damage the GCL;
- After installation, a visual examination of the GCL shall be carried out to ensure that no potentially harmful foreign objects, contaminated soil or damaged areas are present; and
- Excess loss of bentonite on edges during deployment should be minimised.

The seams shall have a minimum overlap of 300mm and shall be joined by the addition of bentonite powder, at a minimum of 0.3kg/m length of seam, unless the GCL has impregnated surfaces along sheet edges and is installed under the manufacturer's guidelines. The CQA Consultant will visually inspect all seams and shall reserve the right to remove samples for weighing.

No more GCL material will be deployed during one working day than can be covered by the end of that day. GCL deployment shall not be undertaken during precipitation. The Contractor shall ensure full protection is afforded to the GCL so that premature hydration does not occur.

7.5.4 GCL Repair Procedures

Any portion of the GCL exhibiting flaws shall be repaired. Prior to the acceptance of the installed GCL, the contractor shall locate and repair all damaged areas of the liner. Defects or damage can be identified by rips, tears, premature hydration of the GCL or delamination of the geotextiles.

Rips or tears in the GCL shall be covered by another piece of material meeting the project specifications. The material shall extend over the entire damaged area with a minimum 300mm overlap in all directions. Addition of bentonite shall be in accordance with manufacturer's recommendations.

Where the GCL has been exposed to moisture and has prematurely hydrated prior to placement of overlying material, the material shall be removed and replaced with material meeting the specification.

7.5.5 GCL Materials Placement

Construction vehicles shall not be allowed to operate directly on top of the GCL and will only be permitted to travel over the geosynthetics on haul roads that are a minimum of 1m in depth constructed out of soils/drainage materials. Spreading of the cover materials will only be allowed with Low Ground Pressure Plant (30kPa), and in a manner that minimise the propagation of wrinkles in the installed geosynthetics. The Contractor is to submit method statements and Plant details for the approval of the Superintendent prior to placement of the cover materials.

It is proposed that the cover materials/soils is spread upslope as per good practice to prevent tension/damage within the lower geosynthetics.

7.5.6 Geomembrane (HDPE)

The raw material used for High Density Polyethylene (HDPE) geomembrane manufacture shall be first quality virgin resin, of the type nominated with no more than 10% factory re-work material and no post-consumer resin. The quality of the HDPE geomembrane shall be in accordance with the requirements of the Geosynthetic Research Institute (GRI) - GM13 as indicated on **Table 7-4** and **Table 7-5**.

The geomembrane liner shall be a new, first-quality product designed specifically for the purpose of hydraulic containment and a thickness of not less than that specified. The membrane shall be uniform and free of pin-holes, blisters, undispersed raw materials and contamination by foreign matter. The membrane liner shall be shop manufactured in rolls to a seamless width of not less than 5 metres, each roll identifiable in thickness, length and manufacturer's roll number.

Any defects such as holes, tears, blisters, 'fish eyes', delamination, undispersed raw materials or visible non-uniformity or contamination by foreign matter which in the opinion of the Superintendent is detrimental to the long service life required of the membrane liner, shall be grounds for rejection of the membrane liner material.

Defects which are considered as minor by the Superintendent shall be repaired in the presence of the Superintendent. Such repair shall be carried out using the extrusion fusion welding technique in



accordance with the Manufacturer's recommendation and tested in a manner agreeable to the Superintendent.

A material warranty of 20 years is required from the geomembrane manufacturer. The Contractor shall provide the warranty in writing prior to the commencement of geomembrane installation.

Table 7-4: Raw Material (Polymer Resin) - Minimum Test Values Required

Property	Test Method	Standard HDPE
Density	ASTM D1505 or D792	0.935g/cm ³
Melt Flow Index (minimum) At 190°C/21.6kg At 190°C/5kg	ASTM D1238	<10g/10min <1g/10min
Oxidative Induction Time Standard OIT	ASTM D3895	100mins

The required minimum test values for geomembrane are set out below:

Table 7-5: High Density Polyethylene (HDPE) Geomembrane – Textured

Properties	Test Method	0.75mm	1.00mm	1.25mm	1.50mm	2.00mm	2.50mm	3.00mm	Testing Frequency (minimum)
Thickness – mills (min.ave.) ● Lowest individual for 8 out of 10 values ● Lowest individual for any of the 10 values	D5199	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	Per roll
Asperity Height mills (min. ave.) (1)	GM 12	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	90,000 kg
Density (min.ave.)	D1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	Every2nd roll (2)
Tensile Properties (min.ave.) (3) Yield strength Break strength Yield elongation Break elongation	D 6693 Type IV	11 kN/m 8 kN/m 12% 100%	15 kN/m 10 kN/m 12% 100%	18 kN/m 13 kN/m 12% 100%	22 kN/m 16 kN/m 12% 100%	29 kN/m 21 kN/m 12% 100%	37kN/m 26 kN/m 12% 100%	44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min.ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min.ave.)	D 4833	200 N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance (4)	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	Per GRI GM 10
Carbon Black Content (range)	D 1603 (3)	2.0 – 3.0%	2.0 – 3.0%	2.0 – 3.0%	2.0 – 3.0%	2.0 – 3.0%	2.0 – 3.0%	2.0 – 3.0%	9,000 kg
Carbon Black Dispersion	D5596	Note (6)	Note (4)	Note (4)	Note (4)	Note (4)	Note (4)	Note (4)	20, 000 kg
Oxidative Induction Time (OIT) (min. ave.) (7) (a) Standard OIT or – (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	90,000 kg
Oven Aging at 85°C (7), (8) (a) Standard OIT (min. ave.) - % retained after 90 days - or – (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55 % 80 %	55 % 80 %	5 % 80 %	55 % 80 %	55 % 80 %	55 % 80 %	55 % 80 %	Per each formulation
UV Resistance (9) (a) Standard OIT (min. ave.) - or – (b) High pressure OIT (min, ave.) - % retained after 1600hrs (11)	D 3895 D 5885	N. R. (10) 50 %	N. R. (8) 50 %	N. R. (8) 50 %	N. R. (8) 50 %	N. R. (8) 50 %	N. R. (8) 50 %	N. R. (8) 50 %	Per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm.

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

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

Yield elongation is calculated using a gage length of 33mm.

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

(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets the same formulation as 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 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) 10 different views:

9 in categories 1 or 2 and 1 in category 3.

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

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

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

(10) 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.

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

7.5.7 Geomembrane Conformance Testing Requirements

As a minimum, the tests outlined in **Table 7-6** should be completed.

Geomembrane conformance testing shall be undertaken by the Contractor. Materials shall not be incorporated into the works until the Superintendent/CQA Consultant has assessed the laboratory results.

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission.

Testing will be undertaken at an accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant.

Table 7-6: Minimum CQA Testing for Geomembranes

Item	Property	Standards	Frequency
Conformance Testing (upon shipment of geomembrane to the Site)	Thickness	ASTM D5994	Each roll
	Density	ASTM D1505, ASTM D792	One sample per 5,000m ² , or every five rolls delivered to Site, whichever is the greatest number of tests
	Tensile properties (yield and break stress, yield and break elongation)	ASTM D6693 type IV	
	Puncture resistance	ASTM D4833	
	Tear resistance	ASTM D1004	
	Carbon black content	ASTM D1603	
	Carbon black dispersion	ASTM D5596	
	Stress crack resistance	ASTM D5397	One sample every 10,000m ² , or resin type or manufacturing run (HDPE only)
	Oxidative induction time	ASTM D3895, ASTM D5885	Per formulation (LLDPE only)
	Axi-Symmetric break resistance strain	ASTM D5617	
	Oxidative induction time	ASTM D3895, ASTM D5885	
	Oven ageing and oxidative induction Time	ASTM D5721, ASTM D3895, ASTM D5885	



Start-up test weld	Welding equipment		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
	Weld conditions		Test weld strips will be required whenever personnel or equipment are changed and/or wide temperature fluctuations are experienced. Minimum 1.5m continuous seam
Destructive weld testing	Onsite, hand tensiometer in peel and shear	ASTM D6392	Every weld
	Offsite - weld seam strength in peel and shear	ASTM D6392	Every 300m (if fusion weld, every 150m (if extrusion weld))
Non - destructive weld testing		Air pressure test, ASTM D5820 Vacuum box test, ASTM D5641	All seams over full length
Visual inspection of geomembrane	Tears, punctures, abrasions, cracks, indentations, thin spots, or other faults in the material		Every roll
Thickness of geomembrane	Onsite		Five per 100m, 20m apart, taken at the edge of the sheet

Note:

- (1) All conformance tests must be reviewed, accepted and reported by a CQA Consultant before deployment of the geomembrane.
- (2) All testing must be performed on samples taken from the geomembrane delivered to Site under the CQA Consultant supervision.
- (3) All laboratory tests must be performed in a third-party independent accredited geosynthetics laboratory.
- (4) The required testing frequencies may be revised by the CQA Consultant to conform to 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.

7.5.8 Subgrade Acceptance

The geomembrane shall, except where stated, be deployed on prepared sub-grade. The sub-grade preparation shall be such that damage will not be caused to the geomembrane either during installation or during operation. The subgrade material shall be placed and compacted such that the geomembrane will be in continuous contact with the layer and the geomembrane shall not be stretched or bridged over any hollows or humps.

The installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable.

After the supporting subgrade has been accepted by the Contractor it will be the Contractor's responsibility to maintain its condition and to indicate to the Superintendent/CQA Consultant any change in the supporting soil condition that may require repair work. The Contractor will ensure that the supporting soil is repaired prior to placement of the relevant panels of geomembrane.

7.5.9 Seaming

All seaming shall conform to the methods detailed in the EPA Technical Guidance Document, "The Fabrication of Polyethylene FML Field Seams" (no. EPA/530/SW-09/069, September 1989).

The Contractor shall submit method statements not less than one week prior to commencing installation, detailing the following as a minimum:

- Proposed seaming technique or techniques and their proposed applications;
- Proposed seaming machinery;
- Overlap widths and overlap preparation prior to seaming;
- Proposed acceptable temperature ranges for extrudate and/or hot wedge; and
- Proposed acceptable maximum seaming speed if automated machinery to be used.

The Contractor should be aware of the possible temperature differential at the Site during the installation works. Typical Bureau of Meteorology weather statistics from Karratha Aerodrome are presented in **Table 7-7**.

Table 7-7: BOM Karratha Monthly Weather Statistics

Karratha Aerodrome (1981-2010)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Maximum Temperature (°C)	36.1	35.4	36.1	34.2	30.2	26.6	26.2	28.1	30.6	33.8	35	35.8
Highest Temperature (°C)	48.2	47.7	45.8	41.3	36.7	32.8	32.7	35.4	40.7	44.7	44.4	46.9
Mean Minimum Temperature (°C)	26.8	26.7	25.8	22.6	18.2	15.0	13.7	14.3	17.0	20.6	23	25.5

To minimise the propagation of wrinkles and tensions during installation due the expansion/contraction of the geomembrane, the Contractor shall be deemed to have allowed for all precautions as deemed necessary by the specialist lining Contractor including welding at night (if required) for all general seaming and tie-in welds.

All night work will require portable lighting. All health and safety controls and costs that are incurred by the Contractor, performing work outside of normal hours shall be deemed to be included in tendered rates.

7.5.9.1 Trial Seams

The Contractor shall perform trial seams with each seaming machine and operator at least at the start of each shift, after every four hours of operation and also following any period of machine shutdown or change of operator.

The trial seams shall be at least 1.5m long in the case of extrusion and fusion seams. On completion of the trial seam, the Contractor shall cut six 25mm wide field tabs normal to the seam spaced along the seam length. The tabs shall be subjected to field qualitative destructive testing using a tensiometer. Four of the six tabs shall be tested in peel mode with the other samples tested in shear mode.

The trial seam will be deemed to have passed qualitative destructive testing if the failure occurs solely in the parent material and does not enter the seam. The seam will be deemed to have failed qualitative destructive testing if any of the failure enters the seam.

If a trial seam fails field destructive testing as specified above then the seaming machine and the operator shall not be allowed to perform field seaming until the deficiencies are corrected and both machine and operator have achieved a passing trial seam. Trial seaming and destructive testing will be observed by the Supervisor.

7.5.9.2 Field Seams

The Contractor shall perform field seams only after satisfying trial seam conditions as specified in **Section 7.5.9.1** of this Specification. The Contractor shall ensure that all pre-treatment measures (e.g. grinding and cleaning), as specified in EPA/530/SW-89/069 are carried out and that extrudate and/or wedge temperatures are maintained within a range approved by the Superintendent.

The Contractor's attention is drawn to the stipulations in EPA/530/SW-89/069 that:

Seaming is not allowed during rain, hail or snow unless proper precautions, are made to allow the seam to be made on dry geomembrane materials:

- Seaming above saturated soil is not acceptable;
- Ponded water on the soil surface beneath the geomembrane is not acceptable;
- Seaming above frozen ground is not acceptable; and
- Ambient temperature for seaming should be above 5°C.

All field seams shall be completed to the back edge of the anchor trench, i.e. the edge furthest away from the slope or toe bund. Any seam defects falling within the anchor trench shall be repaired in accordance with **Section 5.10.4** of this Specification.



During construction the specified overlap shall be clearly marked on the edge of the underlying sheet seam prior to seaming. Failure to maintain the minimum overlap may be cause for rejection of the seam.

Extrusion Welding

The Contractor shall verify that extrusion-seaming apparatuses are equipped with gauges giving the relevant temperatures of the extrudate, nozzle, and preheat. In addition, the Contractor shall certify in writing to the Superintendent that the extrudate is compatible with the specifications.

A log of apparatus temperatures, extrudate temperatures, and ambient temperatures at appropriate intervals will be made by the Contractor, during the installation works. Ambient temperatures will be measured approximately 50mm above the geomembrane surface.

Fusion Welding

The Contractor shall ensure that fusion-seaming apparatus comply with the requirements of the Specification. Temperature and pressure settings shall be verified by the Contractor prior to each seaming period, and will be logged (ambient temperatures, seaming apparatus temperatures, speeds). Ambient temperatures will be measured approximately 50mm above the geomembrane surface.

Prior to seaming the Contractor shall confirm that:

- the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
- if seam overlap grinding is required, the process is completed within one hour of the seaming operation, and in a way that does not damage the geomembrane;
- if seam overlap grinding is required, less than 10% of the nominal thickness shall be removed;
- the grinding does not extend more than 10mm on either side of the extrusion seam; and
- seams are aligned with the fewest possible number of wrinkles and "fishmouths".

7.5.10 Sampling and Testing

7.5.10.1 Non-Destructive Testing

The Contractor shall perform non-destructive testing along the entire lengths of all field seams including patches and repairs. The Contractor shall submit not less than one week prior to commencing installation a method statement detailing the proposed non-destructive test technique or techniques and the proposed applications.

For air pressure testing of fusion seams the test length should be sealed at both ends and an approved pressure feed divide inserted into the air channel. The channel should then be pumped to a pressure of between 25 and 30 psi (~2bar) and allowed to stabilise for 1 minute. The test will have deemed to have failed if the loss of pressure exceeds 10% over a 5 minute period following stabilisation. The test will have deemed to have passed if the loss of pressure is less than 10% over a 5 minute period.

For vacuum box testing each section of the seam should be tested and observed for a period of not less than 10 seconds. Apply a generous amount of a strong soapy solution and water to the area to be tested to help create a vacuum. Turn on the vacuum pump and set it to produce approximately 0.35bar of vacuum. It is important that an overlap of a minimum of 75mm is maintained every time the vacuum box is moved along the seam.

For spark testing, a length of copper wire shall be placed along the edge of the repair or extrusion welded seam prior to welding. Following welding, a high tension electrode is passed over the seam, and any faults in the seam are highlighted by a characteristic increased sparking sound and electrical discharge. Any faults shall then be ground to remove any dirt and a further layer of extrudate applied

to ensure a seal is formed. The defect shall then be tested again to ensure that the area has been remediated to a suitable manner.

In the event of a field seam failing non-destructive testing the Contractor shall identify and repair the failed area in accordance with **Section 7.5.10.4** of this Specification. The Contractor shall then subject the repair to further non-destructive testing until the repair shall pass the test.

The Contractor shall advise the Supervisor when he is ready to commence non-destructive testing and shall not perform non-destructive testing unless the Supervisor is in attendance.

7.5.10.2 Qualitative destructive testing

The Contractor shall cut a 25mm wide field tab from the beginning and end of each completed field seam and shall subject it to qualitative destructive testing in peel mode using a tensiometer.

The seam will be deemed to have passed qualitative destructive testing if the failure occurs solely in the parent material and does not enter the seam. The seam will be deemed to have failed qualitative destructive testing if any of the failure enters the seam.

If a field tab fails qualitative destructive testing, the Contractor shall either:

- reconstruct the seam between two tabs shown to have passed qualitative destructive testing; or
- cut further tabs from 3m to each side of the failed tab and subject these to qualitative destructive testing. If these tabs pass qualitative destructive testing the Contractor shall reconstruct the seam between the passed locations in accordance with **Section 7.5.10.4** of this Specification. If either sample fails, the Contractor shall cut and test further field tabs until an area bounded by two passed locations can be identified. The Contractor shall then reconstruct the failed seam in accordance with **Section 7.5.10.4** of this Specification.

The Supervisor reserves the right to request the cutting and destructive testing of further field tabs at any locations along the length of a seam.

7.5.10.3 Quantitative destructive testing

The Contractor shall cut laboratory samples from the field seams when instructed by the Engineer and in any case at a frequency not exceeding 1 sample per 300m (if fusion weld), 1 sample per 150m (if extrusion weld) or one per day of welding of seam performed by an individual machine whichever is greater.

The Contractor shall divide the sample and release sub-sample A to the Superintendent for archiving.

The Contractor shall without delay dispatch sub-sample B to an approved geosynthetic laboratory for destructive testing in accordance with **Table 7-8**, or testing on site utilising a calibrated tensiometer. The Contractor should note that five tabs should be cut for peel tests and five tabs for shear tests. The laboratory shall report quantitative results and the mode of failure for the tests carried out. The Contractor shall issue copies of the test results certificates to the Supervisor immediately upon receipt, within 48 hours of cutting the sample from the installation.

If the samples are tested on Site the Contractor shall provide the calibration certificate to the Superintendent for the field tensiometer prior to undertaking any testing.

The seam will be deemed to have passed quantitative destructive testing if in four out of five of the tabs:

- The failure occurs solely in the parent material and does not enter the seam;
- The peel strength exceeds that indicated in **Table 7-8**; and
- The shear strength exceeds that indicated in **Table 7-8**.

The seam will be deemed to have failed quantitative destructive testing if in more than one out of the five tabs:

- Any of the failure enters the seam;
- The peel strength is less than that indicated in **Table 7-8**; and
- The shear strength is less than that indicated in **Table 7-8**.

If a seam fails quantitative destructive testing the Contractor shall investigate the seam to each side of the failed sample as specified in **Section 7.5.10.2** of this Specification. The Contractor shall cut further laboratory samples from each side of the failed section and perform laboratory tests upon them at the expense of the Contractor until the failed seam is bounded by two passed locations.

The Contractor shall then reconstruct the failed seam in accordance with **Section 7.5.10.4** of this Specification. The Supervisor may at his discretion observe laboratory destructive testing in which event the Contractor shall arrange permission for access to the approved laboratory.

The Contractor shall furnish the CQA Consultant/ Superintendent with a copy of the formal report from the destructive testing detailing the procedures used for testing and including a summary of all results, prior to covering of the geosynthetics.

Table 7-8: Geomembrane Field Seam Destructive Testing Criteria

Test	Method	2.0 mm HDPE Requirement (minimum)
Fusion Welds		
Fusion Shear	ASTM D4437	28.0 N/mm
Fusion Peel	ASTM D4437	21.2 N/mm
Extrusion Welds		
Extrusion Shear	ASTM D4437	28.0 N/mm
Extrusion Peel	ASTM D4437	18.2 N/mm

Notes:

- (1) Peel Test on double fusion welds to be carried out on both welds.
- (2) Peel Separation <25% of seam width.
- (3) Shear Elongation at failure: Smooth >100% x L, Textured >50% x L.
- (4) Both sides of Fusion weld need to pass strength requirements and Film Tear Bond to constitute a pass.
- (5) Seam strengths are in accordance with GRI GM 19.

7.5.10.4 Repairs, Patches and Cap-Strips

All discontinuities in the geomembrane (whether caused by damage, or failure of geomembrane or seams to conform with Specification, or of sampling or testing or other factors), shall be repaired by the Contractor in the following manner, all holes (including pinholes) in the liner will be patched:

Superficial defects, (dents and creases)

- The area shall be prepared in accordance with EPA/530/SW-89/069 and an extra layer of extrudate applied as approved by the Superintendent.
- Large faults, and any holes in the faulted area shall be cut back to remove all imperfections and shall be overlain with a single piece of compatible geomembrane to give a minimum overlap of 100mm in all directions. The area shall then be prepared in accordance with EPA/530/SW-89/069 and seamed in accordance with **Section 7.5.9** of this Specification.

Seam faults

- Faulted extrusion seams shall be overlain with a single piece of compatible geomembrane with a minimum overlap of 100mm in all directions to form a cap strip. The repair may then be completed as for large faults.
- Faulted fusion seams shall be cut back to remove the upper flap, prepared in accordance with EPA/530/SW-89/069, and extruded in accordance with **Section 7.5.9** of this Specification.

The Contractor shall test all repairs in accordance with **Section 7.5.10.1** of this Specification.

7.5.11 Geomembrane Ballasting

Unless specified otherwise, the Contractor shall design, supply and install the geomembrane ballasting system to ensure that the liner will not be adversely affected by wind and/or thermal movement during installation of the lining system. The ballasting system shall be submitted to the Superintendent/CQA Consultant in writing for approval prior to its use.

7.5.12 Protection Geotextile

The geotextile shall be non-woven needle punched constructed from virgin fibres of polypropylene incorporating a minimum 1% by weight active carbon black, or other approved UV stabiliser.

A general guide to the required material properties, test methods, values and units are presented in **Table 7-9**.

*The Contractor should confirm the grade of geotextile proposed to be of sufficient mass, strength and thickness, to protect the underlying geomembrane from damage from the overlying leachate drainage aggregate, with regards to stresses, strains and indentations. **Maximum allowable global strain of 6% for HDPE geomembrane.***

The Contractor shall provide a sample of the proposed stone source/grading and proposed geotextile to an approved laboratory.

International methods for examining performance of a protection geotextile and geomembrane include:

- LFE 2 – Cylinder Testing Geomembranes and their Protective Materials: A Methodology for testing protective materials: A methodology for testing protector geotextiles for their performance in specific Site conditions (UK Environment Agency, 2014);
 - The sample shall be subjected to a loading of 20m of waste at an assumed density 1.0 tonnes/m³ load plus 1.2m of restoration soils at a density of 2.0 tonnes/m³, the total load being factored accordingly to the test duration and temperature. The specific pass and failure criteria for the test should be agreed with the Supervisor following agreement on the specific test method. As guidance a specific strain value may be used for acceptance, with the allowable local strain criteria $\leq 0.25\%$.

- ASTM D5514 / D5514M-14, Standard Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics (ASTM International, 2014);
- EN 13719:2016 – Geotextiles and Geotextile-Related Products – Determination of The Long Term Protection Efficiency Of Geotextiles In Contact With Geosynthetic Barriers; and
- EN 14574:2015 Geosynthetics – Determination of the pyramid puncture resistance of supported geosynthetics.

The Contractor shall inform the CQA Consultant/Superintendent of the proposed test method, including material parameters/stone gradings/loadings/ methodology etc., for approval prior to undertaking the test. The Contractor shall furnish the CQA Consultant/ Superintendent with a copy of the formal report from the performance testing detailing the procedures used for testing and including a summary of all results, for acceptance prior to incorporation of materials in the works.

Table 7-9: Physical Properties for Protective Geotextile

Properties	Test Method	Requirement
CBR Puncture Resistance	AS 3706.4	12,000N
Strip Tensile md	ASTM D4595	50kN/m
Strength cd	ASTM D4533	50kN/m
Elongation at md	ATSM D4632	80%
Thickness @ 2kPa	ASTM D5199 or D5994	5mm
Mass per unit area	ASTM D5261	TBC g/m ² *

**Dependent on MARV of proposed protection geotextile.*

7.5.12.1 Geotextile Conformance Testing Requirements

Geotextile conformance testing shall be undertaken by the Contractor. Materials shall not be incorporated into the works until the Superintendent has assessed the laboratory results.

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission.

Testing will be undertaken at an accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant for the properties detailed in **Table 7-9**.

Table 7-10: Conformance Testing for Protective Geotextile

Item	Property	Standards	Frequency
Conformance Testing	Thickness	ASTM D5199, AS3706.1	One sample per 2,500m ²
	Mass per unit area	ASTM D5261, AS3706.1	
	Tensile Strength	ASTM D4595, AS3706.2	One sample per 5,000m ²
	Tear Strength	ASTM D4833, AS 3706.3	
	Burst Strength	ASTM D6241, AS3706.4	
	Puncture resistance	ASTM D4833, AS3706.5	

7.5.12.2 Protection Geotextile Installation

The manufacturers recommended installation procedures will be submitted by the Contractor for the sewing/thermally bonding of the geotextiles, including procedures for repair. All seaming shall be performed by trained personnel. The Contractor may also be requested to submit training or experience records of the installers to the Superintendent for approval.

Non-woven needle-punched geotextiles shall be installed to the requirements of the construction specifications. The geotextiles shall extend into the anchor trench, as shown on the construction Drawings.

Geotextiles shall be placed by the lining contractor at the locations shown on the contract Drawings. All geotextile seams placed on slopes shall be overlapped a minimum of 300mm and thermally bonded using a "Leister" gun. Seams on sideslopes will be oriented with the slope. End-of-roll seams will be offset a minimum of 1m between adjacent roll ends. Cross-slope seams shall be avoided. Installed bedding fabric shall be covered with the interfacing material as soon as practical, but in no case longer than 14 calendar days. During periods of high winds, sandbags or other methods approved by the manufacturer shall be used to secure any exposed fabric in place.

Construction vehicles shall not be allowed to operate directly on top of the protection geotextile and will only be permitted to travel over the geosynthetics on haul roads that are a minimum of 1m in depth constructed out of soils/drainage materials. Any geotextile that has granular material placed upon it shall have 300mm (minimum) of the material placed onto the fabric and spread in advance of construction equipment with high floatation/low ground pressure equipment. The material will be spread in the same direction as the fabric is seamed. Extreme care is required by the Contractor so that the equipment operator only pushes the materials ahead without damage to the fabric. At no time will construction equipment be permitted to track directly on the fabric.

Any damage to the fabric or lining system will be repaired by the Contractor (using approved methods) at no expense to the Principal. Completed protection geotextile installation shall be approved by the Superintendent/CQA Consultant, prior to installation of the leachate drainage stone.

7.5.13 Separator Geotextile

The geotextile shall be non-woven needle punched constructed from virgin fibres of polypropylene incorporating a minimum 1% by weight active carbon black, or other approved UV stabiliser.

A general guide to the required material properties, test methods, values and units are presented in **Table 7-11**.

Table 7-11: Physical Properties for Separator Geotextile

Properties	Test Method	Requirement
CBR Puncture Resistance	AS 3706.4	2500N
Strip Tensile md	ASTM D4595	12kN/m
Strength cd	ASTM D4533	12kN/m
Elongation at md	ATSM D4632	80%
Thickness @ 2kPa	ASTM D5199 or D5994	TBC mm *
Mass per unit area	ASTM D5261	TBC g/m ² *

**Dependent on MARV of proposed protection geotextile.*

7.5.13.1 Separator Geotextile Conformance Testing Requirements

Geotextile conformance testing shall be undertaken by the Contractor. Materials shall not be incorporated into the works until the Superintendent has assessed the laboratory results.

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission.

Testing will be undertaken at an accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant, at the frequencies shown in **Table 7-10**.

7.5.13.2 Separator Geotextile Installation

The manufacturers recommended installation procedures will be submitted by the Contractor for the thermally bonding of the geotextiles, including procedures for repair. All seaming shall be performed by trained personnel. The Contractor may also be requested to submit training or experience records of the installers to the Superintendent for approval.

Non-woven needle-punched geotextiles shall be installed to the requirements of the construction specifications. The geotextiles shall extend into the anchor trench, as shown on the construction Drawings.

Geotextiles shall be placed by the lining contractor at the locations shown on the contract Drawings. All geotextile seams shall be overlapped a minimum of 300 mm and thermally bonded using a "Leister" gun. Seams on sideslopes will be oriented with the slope. End-of-roll seams will be offset a minimum of 1 m between adjacent roll ends. Cross-slope seams shall be avoided. During periods of high winds, sandbags or other methods approved by the manufacturer shall be used to secure any exposed fabric in place.

At no time will construction equipment be permitted to track directly on the fabric. The separator geotextile is to be placed directly over the leachate drainage and collection system on the base of the landfill cell.

The separator geotextile will be thermally bonded using a "Leister" gun onto the protection geotextile at the extents of installation on the sideslopes and bunds. The Contractor is to place permanent sandbag surcharge on the separator geotextile at a minimum of 5m spacing along the seams and either side of each primary and secondary leachate collection pipe run. The Contractor is to satisfy himself of surcharging adequacy to prevent uplift and damage of the geotextile.

Any damage to the fabric or lining system will be repaired by the Contractor (using approved methods) at no expense to the Principal. Completed separation geotextile installation and surcharging shall be approved by the Superintendent/CQA Consultant.

7.5.14 Anchor Trenches

Excavation

Anchor trenches for the geosynthetic liner components shall be constructed at the locations shown on the Drawings. The anchor trench shape and dimensions shall be as shown on the Drawings.

Where the Contractor considers that there is insufficient room to handle the geosynthetics alongside the anchor trenches, the Contractor may construct a wider working area than shown in the Drawings. This working area shall be removed prior to Practical Completion. The construction of this working area shall be at the discretion of the Contractor, and its construction, maintenance and removal shall not constitute a variation under the Contract or a cause for Extension of Time.

Backfilling

Generally, the excavated material from the anchor trench will be used as backfill over the geosynthetics in the trench. Where this material is unsuitable, it shall be removed and replaced by clay material or other approved by the Superintendent.

The fill shall be placed and suitably compacted in horizontal layers not exceeding 150mm in thickness to an approved density.

Prior to backfilling, the geosynthetic liners shall be checked to ensure that there are no folds or other irregularities. The geosynthetic liners shall be in a stress free, 'layflat' state over the entire area.

All materials cut from the landfill as part of the excavation for anchor trench works will be levelled and compacted in the vicinity of the anchor trench. As such no movement of waste around the landfill should occur. Any exposed or excavated waste shall be covered as soon as is practicably possible and in any event at the end of each working day.

Marker posts are to be installed once the backfilling has been completed to locate the centreline of the anchor trenches.

7.5.15 Maintenance

The geosynthetic materials shall not be exposed for longer than is specified on the manufacturer's installation guidelines. Each layer of geosynthetic liner shall be kept clean, free from dust, sticks and rocks during its temporary exposure.

The Superintendent will not entertain any claim for financial compensation or extension of time to the Contract as a result of delays in the provision of laboratory or onsite testing of geosynthetic materials.



8 Leak Detection Survey

The Contractor is advised that a geomembrane leak location survey following the installation of the leachate drainage blanket and pipework needs to occur. Information on the technique to be used is available from the CQA Consultant/Superintendent.

The Contractor should ensure a 0.5m (minimum) wide strip of geomembrane/geotextile is to be left exposed around the perimeter of the area to be tested, enabling the geomembrane to be electrically isolated from the surrounding ground (adjacent cells) during testing. The Contractor will be required to place drainage blanket material/reinstate access ramp on the isolation strip upon successful completion of the leak detection test. The Contractor shall also ensure that the drainage blanket is wet enough to conduct electricity.

The Contractor will investigate all anomalies and, where required by the CQA Consultant/Superintendent, repair the underlying geomembrane. The geotextile and drainage layer will then be reinstated in accordance with the Specification. All repair works will be at the cost of the Contractor.

Completed leak detection survey results and reporting shall be submitted to the Superintendent/CQA Consultant for approval.



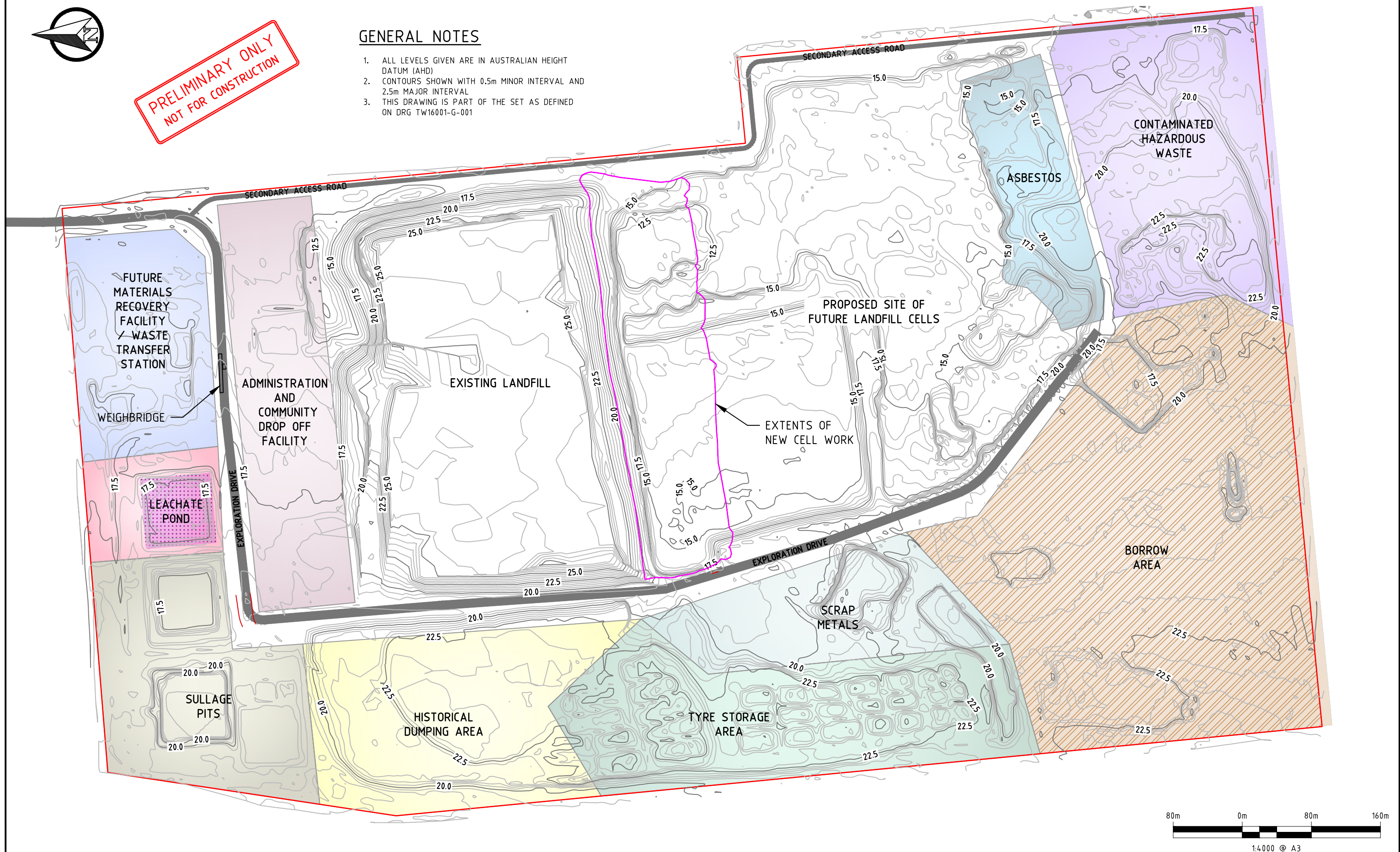
Appendix A : Drawings



PRELIMINARY ONLY
NOT FOR CONSTRUCTION

GENERAL NOTES

1. ALL LEVELS GIVEN ARE IN AUSTRALIAN HEIGHT DATUM (AHD)
2. CONTOURS SHOWN WITH 0.5m MINOR INTERVAL AND 2.5m MAJOR INTERVAL
3. THIS DRAWING IS PART OF THE SET AS DEFINED ON DRG TW16001-G-001



NOTES

1. This drawing is the property of Talis Consultants Pty Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels refer to Australian Height Datum.
3. DO NOT SCALE, use figured dimensions only, if in doubt please contact Talis Consultants.

No.	Date	Drawn CDB	Amendment / Issue	App.
C	14.06.17	CDB	ADDED CELL 2	
B	04.10.16	CDB	RE-ISSUED FOR CLIENT REVIEW	
A	30.06.16	CDB	ISSUED FOR CLIENT REVIEW	

Project:

SEVEN MILE WASTE
FACILITY - KARRATHA

Title:

EXISTING TOPOGRAPHY
AND FEATURES

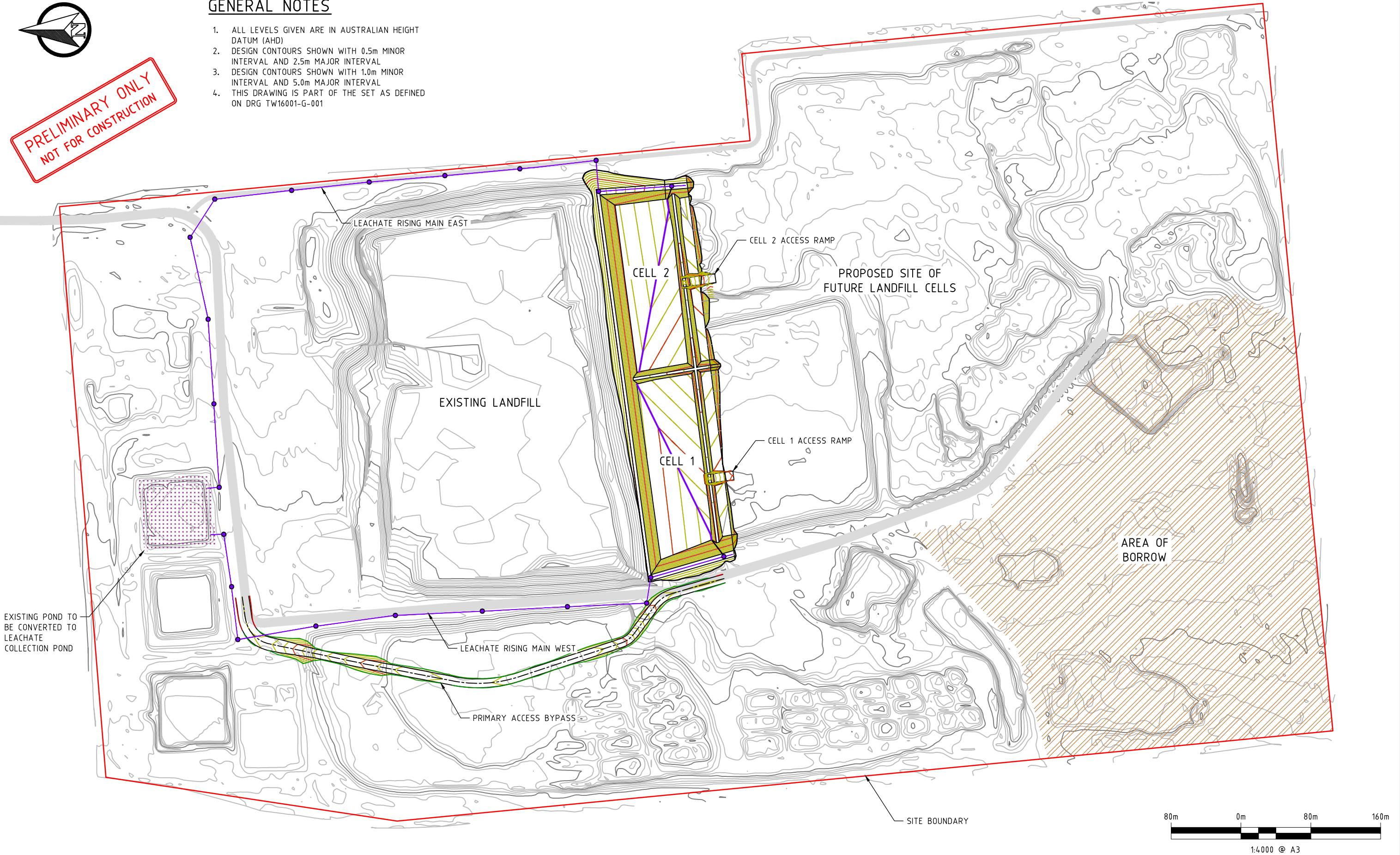
Drawn by:	CDB	Job No:	TW16001
Checked by:	LM	File No:	TW16001-G-010
Approved by:		Drg. No:	G-010
Scale:	1:4000 @ A3	Rev:	C
Date:	14.06.2017		



GENERAL NOTES

- 1. ALL LEVELS GIVEN ARE IN AUSTRALIAN HEIGHT DATUM (AHD)
- 2. DESIGN CONTOURS SHOWN WITH 0.5m MINOR INTERVAL AND 2.5m MAJOR INTERVAL
- 3. DESIGN CONTOURS SHOWN WITH 1.0m MINOR INTERVAL AND 5.0m MAJOR INTERVAL
- 4. THIS DRAWING IS PART OF THE SET AS DEFINED ON DRG TW16001-G-001

PRELIMINARY ONLY
NOT FOR CONSTRUCTION



NOTES

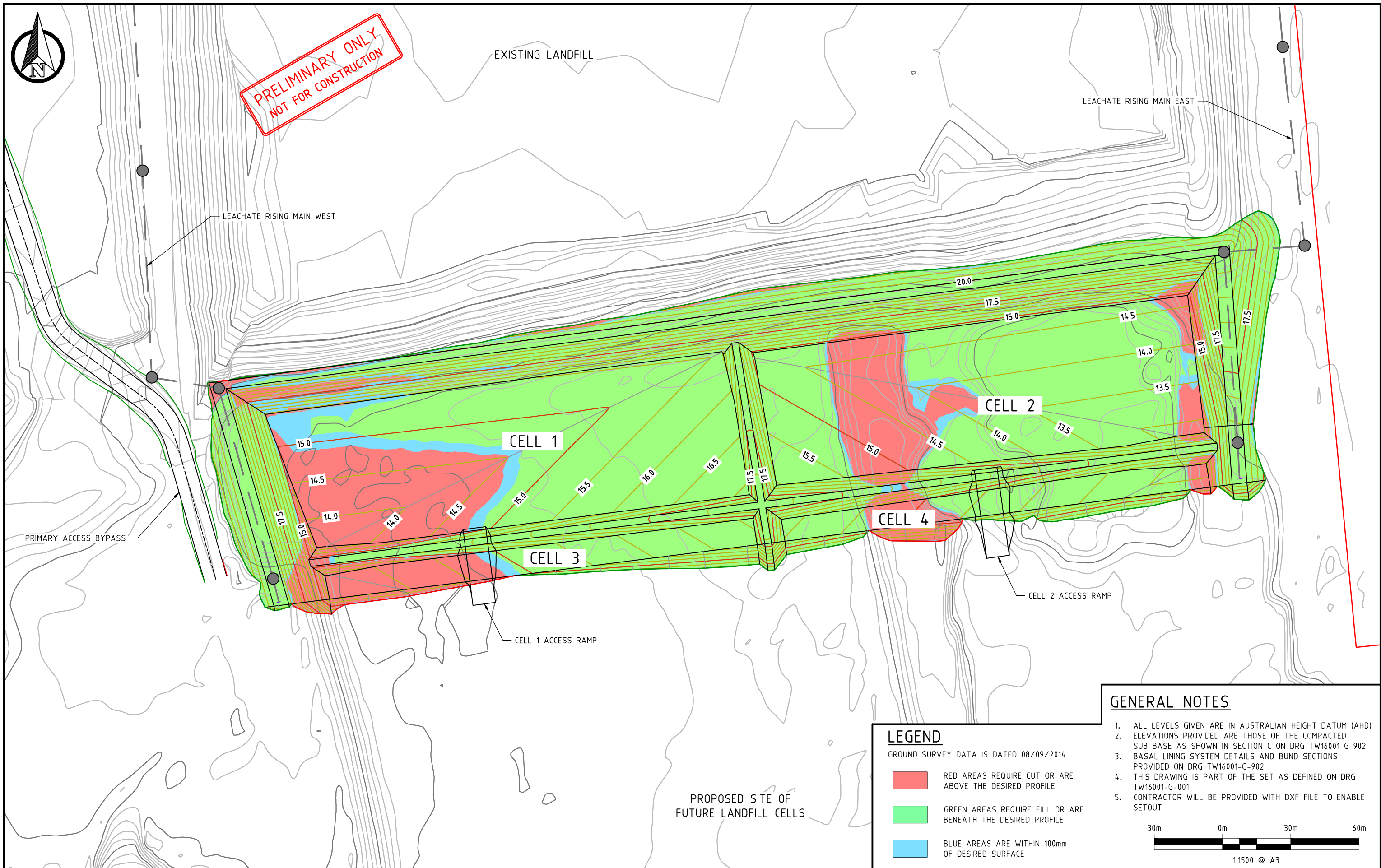
- 1. This drawing is the property of Talis Consultants Pty Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
- 2. All levels refer to Australian Height Datum.
- 3. DO NOT SCALE, use figured dimensions only, if in doubt please contact Talis Consultants.

No.	Date	Drawn By	Amendment / Issue	App.
C	14.06.17	CDB	ADDED CELL 2	
B	04.10.16	CDB	RE-ISSUED FOR CLIENT REVIEW	
A	30.06.16	CDB	ISSUED FOR CLIENT REVIEW	

Project: **SEVEN MILE WASTE
FACILITY - KARRATHA**

Title: **OVERVIEW OF WORKS**

Drawn by:	CDB	Job No:	TW16001
Checked by:	LM	File No:	TW16001-G-011
Approved by:		Drg. No:	G-011
Scale:	1:4000 @ A3	Rev:	C
Date:	14.06.2017		



GENERAL NOTES

1. ALL LEVELS GIVEN ARE IN AUSTRALIAN HEIGHT DATUM (AHD)
2. ELEVATIONS PROVIDED ARE THOSE OF THE COMPACTED SUB-BASE AS SHOWN IN SECTION C ON DRG TW16001-G-902
3. BASAL LINING SYSTEM DETAILS AND BUND SECTIONS PROVIDED ON DRG TW16001-G-902
4. THIS DRAWING IS PART OF THE SET AS DEFINED ON DRG TW16001-G-001
5. CONTRACTOR WILL BE PROVIDED WITH DXF FILE TO ENABLE SETOUT



LEGEND

GROUND SURVEY DATA IS DATED 08/09/2014

- RED AREAS REQUIRE CUT OR ARE ABOVE THE DESIRED PROFILE
- GREEN AREAS REQUIRE FILL OR ARE BENEATH THE DESIRED PROFILE
- BLUE AREAS ARE WITHIN 100mm OF DESIRED SURFACE

PROPOSED SITE OF
FUTURE LANDFILL CELLS

NOTES

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No.	Date	Drawn CDB	Amendment / Issue	App.
C	14.06.17	CDB	ADDED CELL 2	
B	04.10.16	CDB	RE-ISSUED FOR CLIENT REVIEW	
A	22.06.16	CDB	ISSUED FOR CLIENT REVIEW	

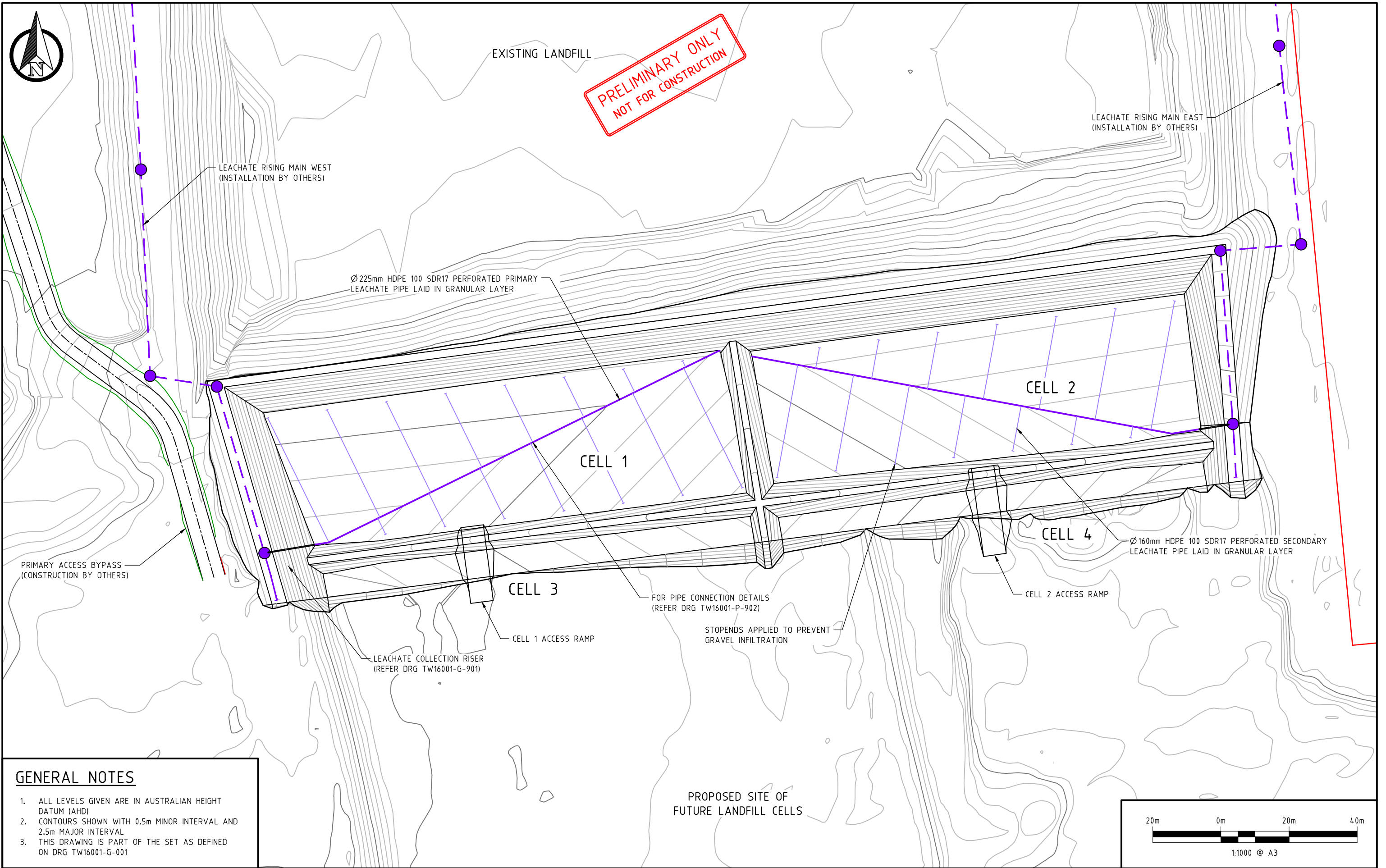
Project:

**SEVEN MILE WASTE
FACILITY - KARRATHA**

Title:



**DEVELOPMENT OF
LANDFILL CELL 1 & 2**

Drawn by:	CDB	Job No:	TW16001
Checked by:	LM	File No:	TW16001-C-001
Approved by:		Drg. No:	C-001
Scale:	1:1000 @ A3	Rev:	C
Date:	14.06.2017		



GENERAL NOTES

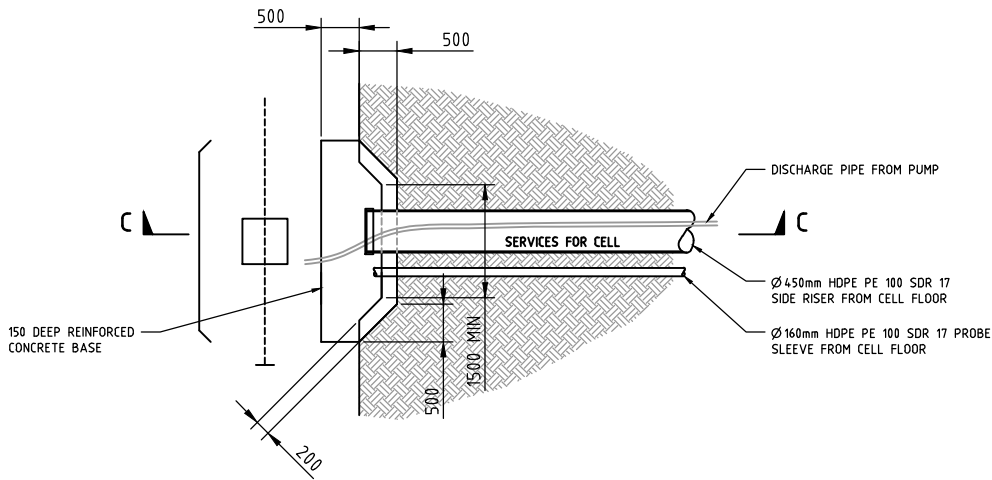
1. ALL LEVELS GIVEN ARE IN AUSTRALIAN HEIGHT DATUM (AHD)
2. CONTOURS SHOWN WITH 0.5m MINOR INTERVAL AND 2.5m MAJOR INTERVAL
3. THIS DRAWING IS PART OF THE SET AS DEFINED ON DRG TW16001-G-001

 www.talisconsultants.com.au T: 1300 251 070	 Client:	NOTES 1. This drawing is the property of Talis Consultants Pty Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent. 2. All levels refer to Australian Height Datum. 3. DO NOT SCALE, use figured dimensions only, if in doubt please contact Talis Consultants.	D	24.07.17	LA	ROAD & LEACHATE MAIN BY OTHERS	Project: SEVEN MILE WASTE FACILITY - KARRATHA	Title: LEACHATE COLLECTION AND MANAGEMENT LANDFILL CELL 1 & 2	Drawn by:	CDB	Job No:	TW16001	
			C	14.06.17	COB	LA			ADDED CELL 2	Checked by:	LM	File No:	TW16001-C-002
			B	04.10.16	COB	LA			RE-ISSUED FOR CLIENT REVIEW	Approved by:		Drg. No:	C-002
			A	30.06.16	COB	LA			ISSUED FOR CLIENT REVIEW	Scale:	1:1000 @ A3	Rev:	D
			No.	Date	Drawn by:	Amendment / Issue			App.	Date:	24.07.2017		

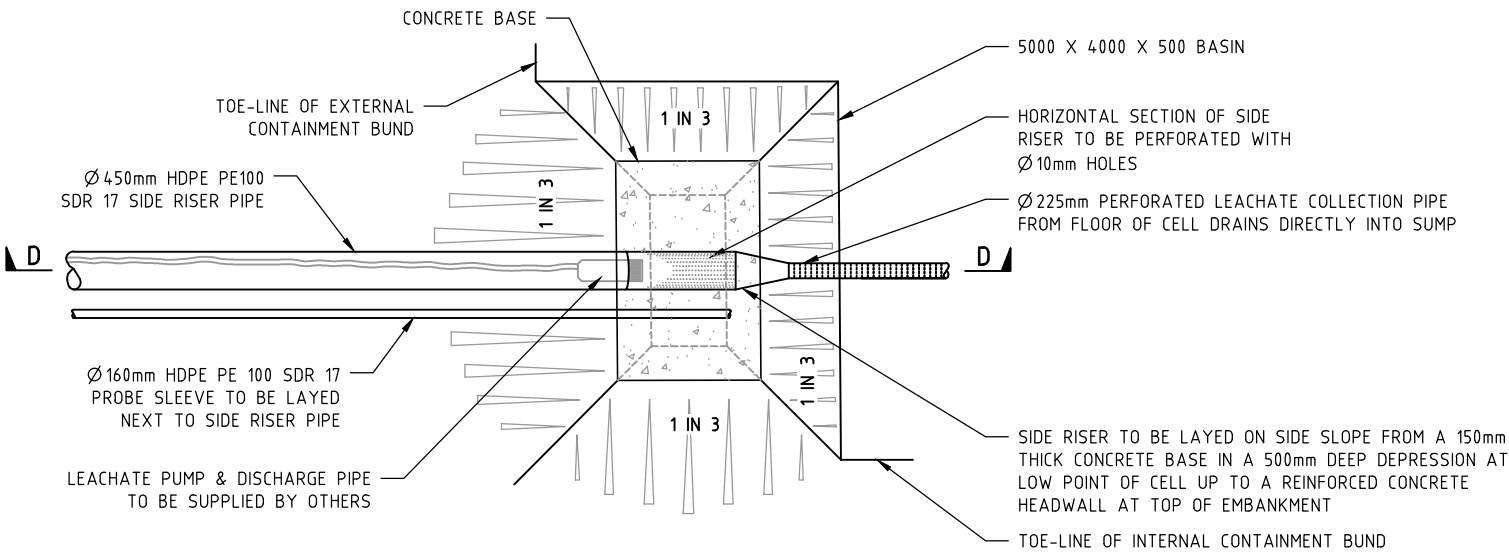
PRELIMINARY ONLY
NOT FOR CONSTRUCTION

LEGEND

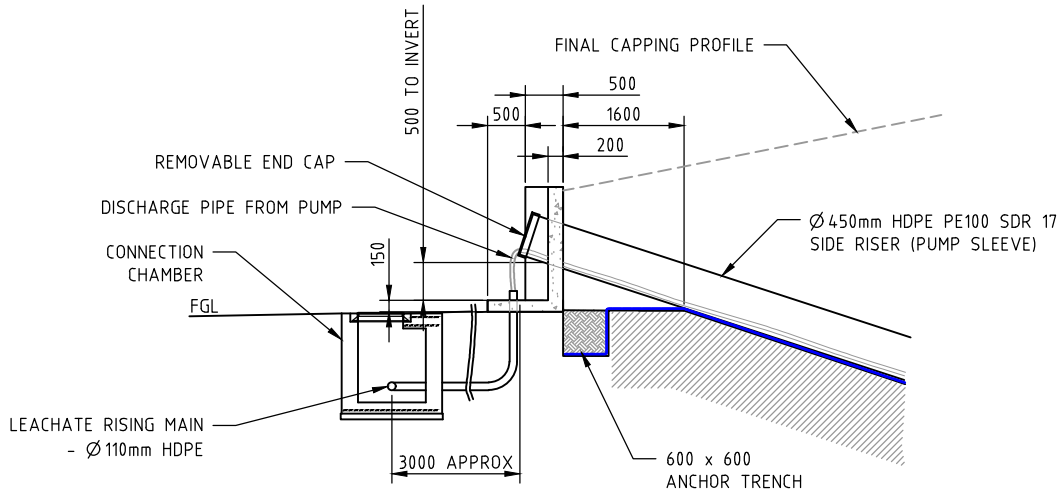
- LINER - HDPE (HIGH DENSITY)
- LINER - GCL (CLAY COMPOSITE)
- GEOTEXTILE - PROTECTIVE LAYER
- GEOTEXTILE - SEPARATION LAYER



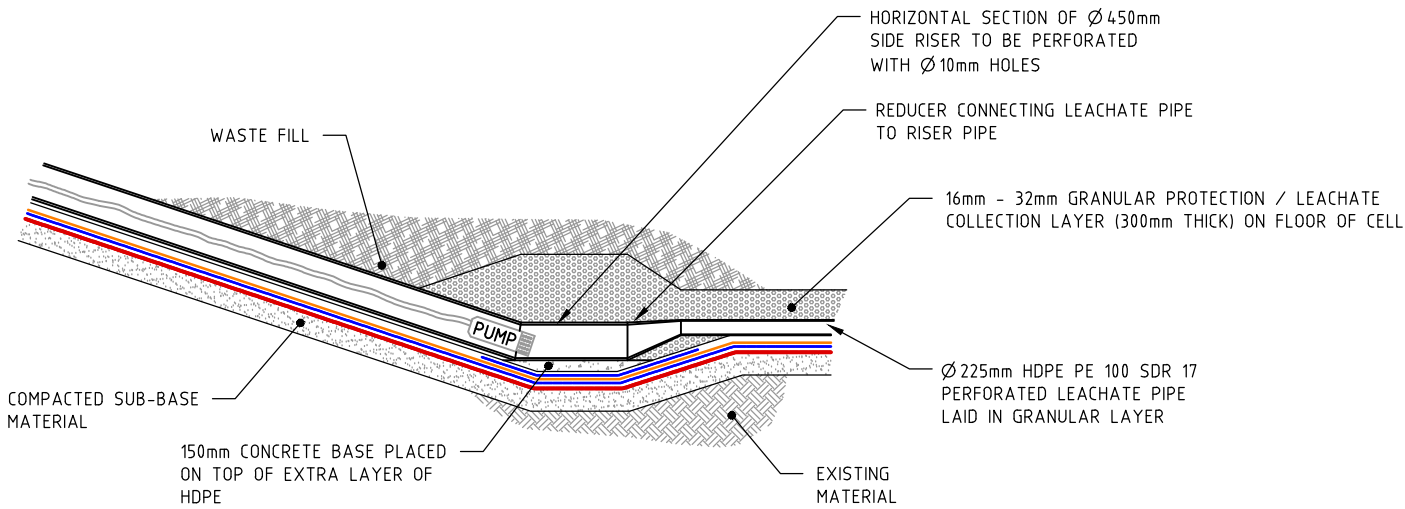
A TYPICAL PLAN - SIDE RISER HEADWALL
SCALE: NTS



B TYPICAL PLAN - LEACHATE COLLECTION SUMP
SCALE: NTS



C TYPICAL SECTION - SIDE RISER HEADWALL
SCALE: NTS



D TYPICAL SECTION - LEACHATE COLLECTION SUMP
SCALE: NTS



ASSET MANAGEMENT
CIVIL ENGINEERING
ENVIRONMENTAL SERVICES
SPATIAL INTELLIGENCE
WASTE MANAGEMENT

Level 1 660 Newcastle Street,
Leederville WA 6007
PO Box 454, Leederville WA 6903

Client:



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No.	Date	Drawn By	Checked By	Amendment / Issue	App.
C	24.07.17	CDB	LM	SIDE RISER HEADWALL SINGLE BARREL	
B	04.10.16	CDB	LM	RE-ISSUED FOR CLIENT REVIEW	
A	14.06.16	CDB	LM	ISSUED FOR CLIENT REVIEW	

Project:

SEVEN MILE WASTE
FACILITY - KARRATHA

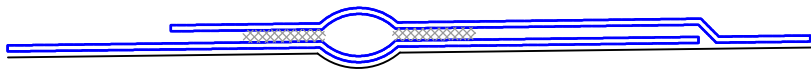
Title:

LEACHATE COLLECTION SUMP
AND EXTRACTION DETAILS

Drawn by:	CDB	Job No:	TW16001
Checked by:	LM	File No:	TW16001-G-901
Approved by:		Drg. No:	G-901
Scale:	NTS	Rev:	C
Date:	24.07.2017		

JOINT DETAIL:

JOINT BETWEEN HDPE LINER ON SIDE SLOPES AND LINER ON CELL FLOOR.
JOINT TO BE FORMED ON CELL FLOOR
A MINIMUM OF 1.5m IN FROM BOTTOM OF SIDE SLOPE

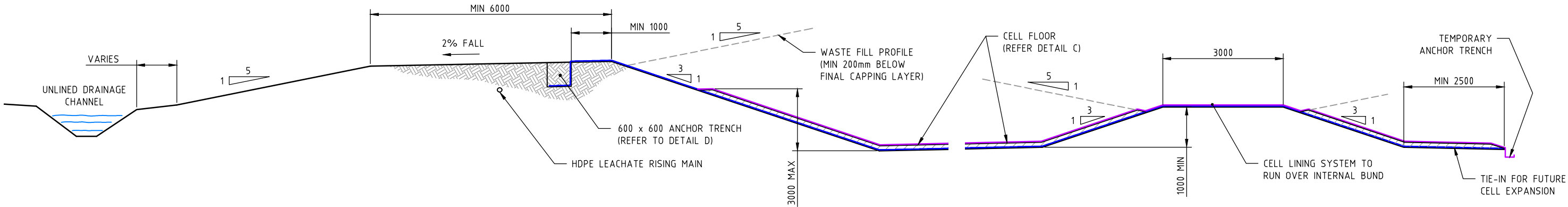


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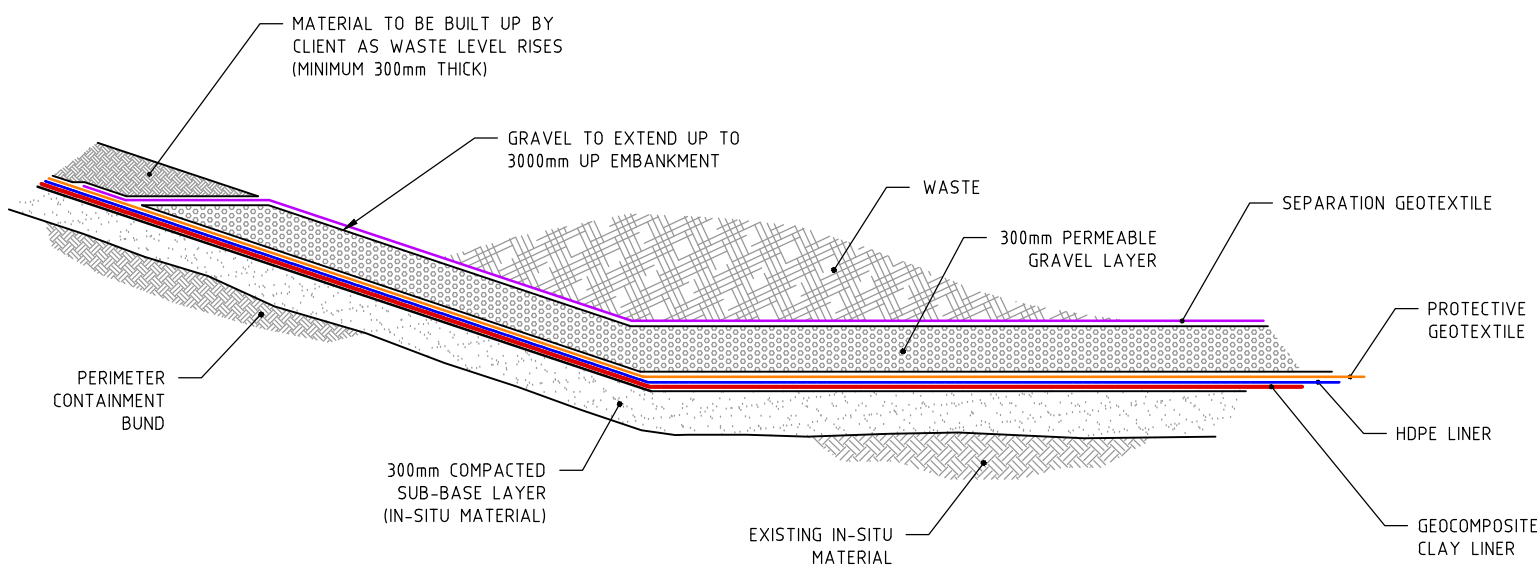
LEGEND

- LINER - HDPE (HIGH DENSITY)
- LINER - GCL (CLAY COMPOSITE)
- GEOTEXTILE - PROTECTIVE LAYER
- GEOTEXTILE - SEPARATION LAYER

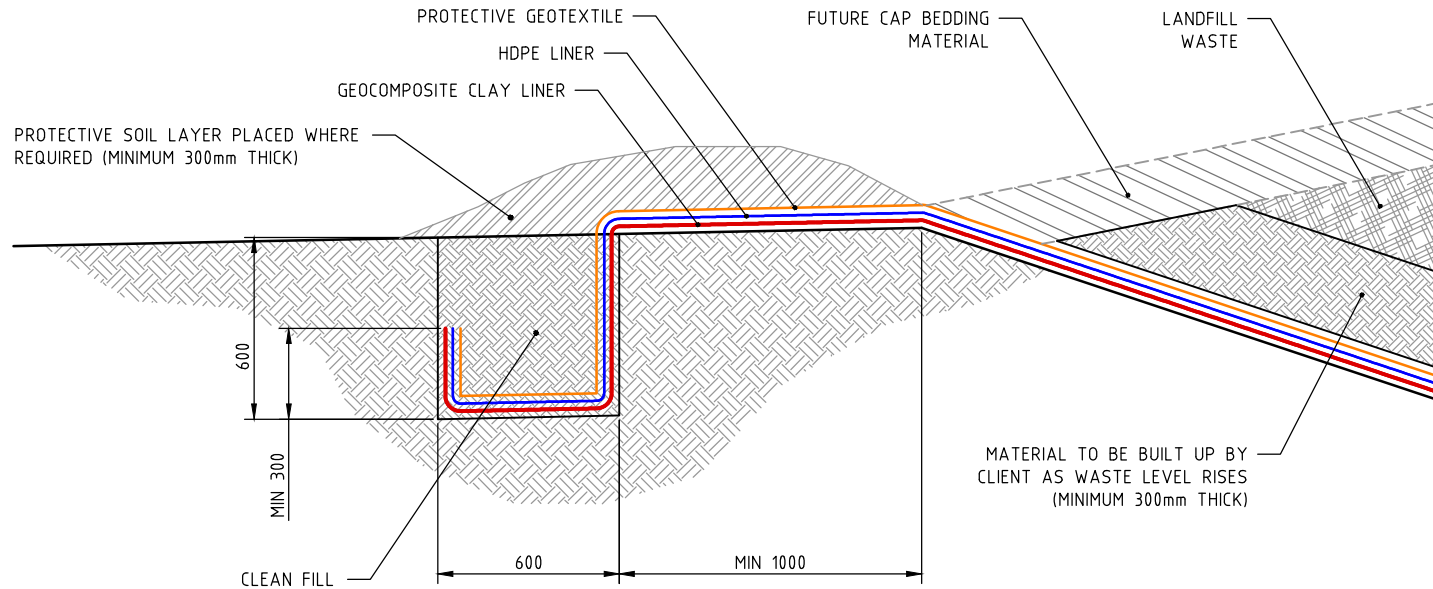
A TYPICAL DETAIL - FUSION WELD WITH TEST CHANNEL
SCALE: NTS



B TYPICAL SECTION - CONTAINMENT BUND
SCALE: NTS



C TYPICAL SECTION - BASAL CELL LINING
SCALE: NTS



D TYPICAL DETAIL - ANCHOR TRENCH
SCALE: NTS

NOTES

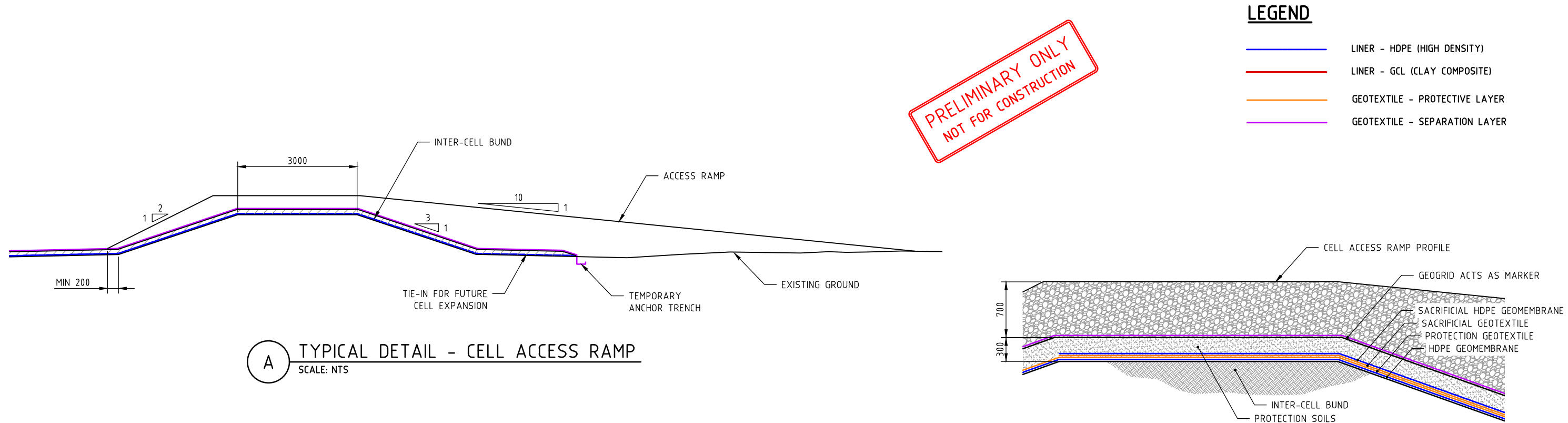
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No.	Date	Amendment / Issue	App.
C	14.06.17	GR LN LEACHATE COLLECTION MATERIALS	
B	04.10.16	GR LN RE-ISSUED FOR CLIENT REVIEW	
A	15.07.16	GR LN ISSUED FOR CLIENT REVIEW	

Project: **SEVEN MILE WASTE FACILITY - KARRATHA**

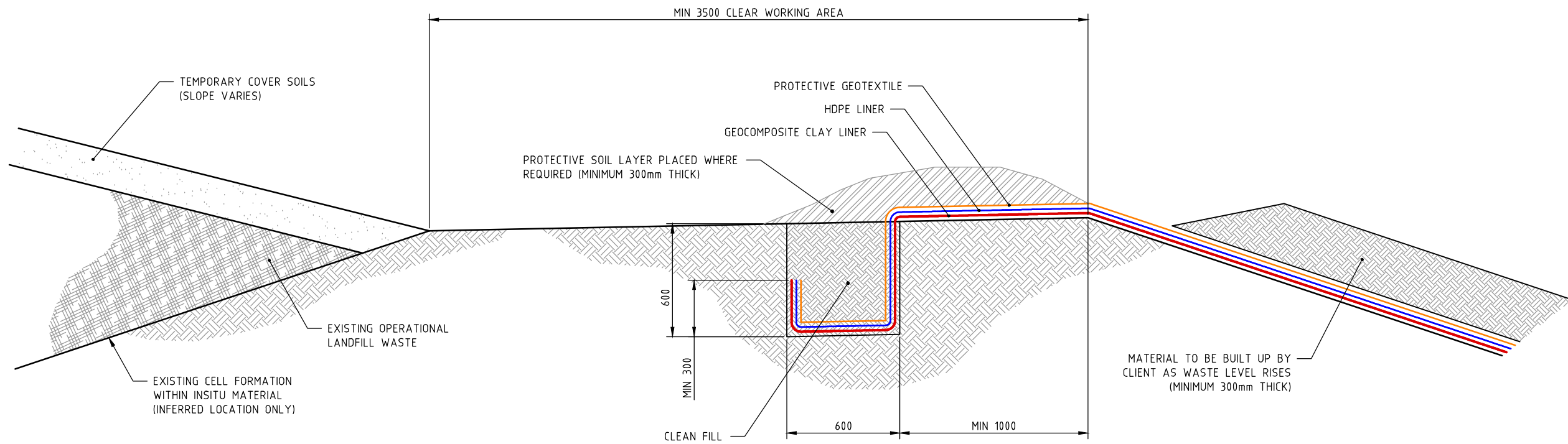
Title: **BUND AND BASAL LINING DETAILS**

Drawn by:	CDB	Job No:	TW16001
Checked by:	LM	File No:	TW16001-G-902
Approved by:		Org. No:	G-902
Scale:	NTS	Rev:	C
Date:	14.06.17		



A TYPICAL DETAIL - CELL ACCESS RAMP
SCALE: NTS

B CELL ACCESS RAMP CONSTRUCTION DETAIL
SCALE: NTS



C TYPICAL DETAIL - TIE-IN ADJACENT TO EXISTING CELL
SCALE: NTS

NOTES

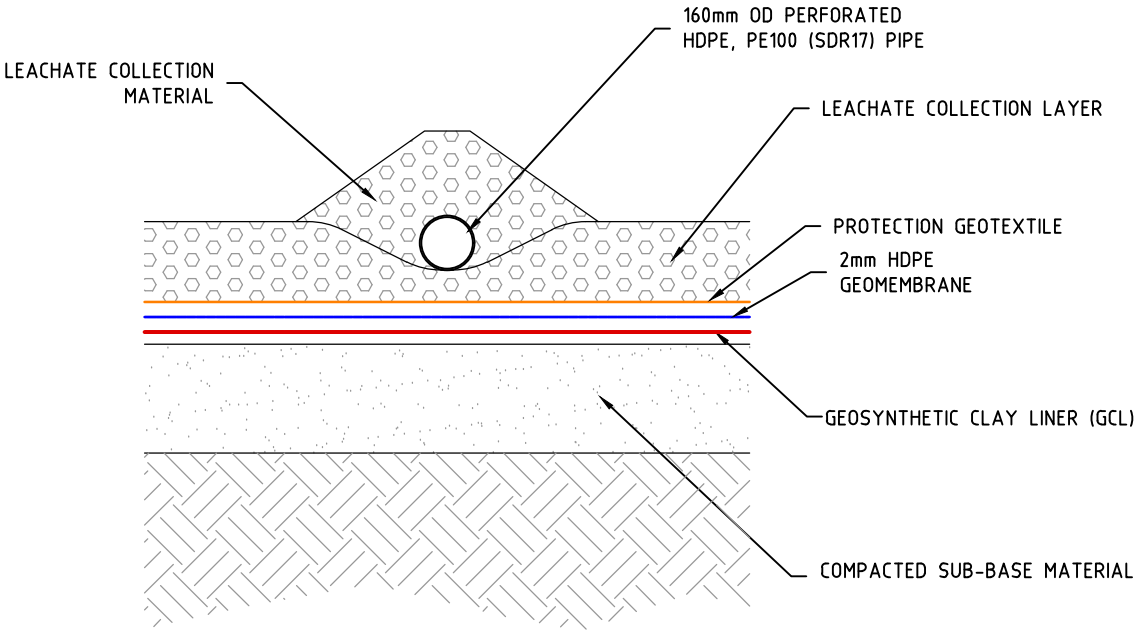
1. This drawing is the property of Talis Consultants Pty Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels refer to Australian Height Datum.
3. DO NOT SCALE, use figured dimensions only, if in doubt please contact Talis Consultants.

No.	Date	Amendment / Issue	App.
A	24.07.17	ISSUED FOR CLIENT REVIEW	

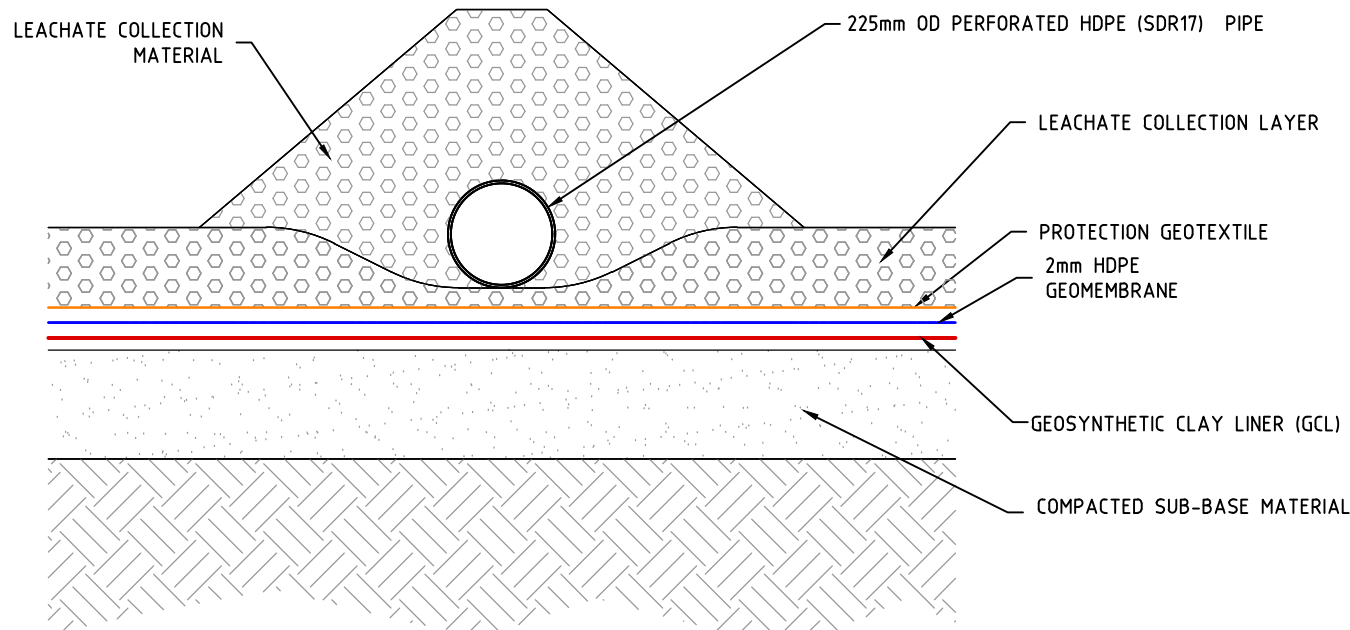
Project: **SEVEN MILE WASTE FACILITY - KARRATHA**

Title: **ACCESS RAMP AND EXISTING CELL TIE-IN DETAILS**

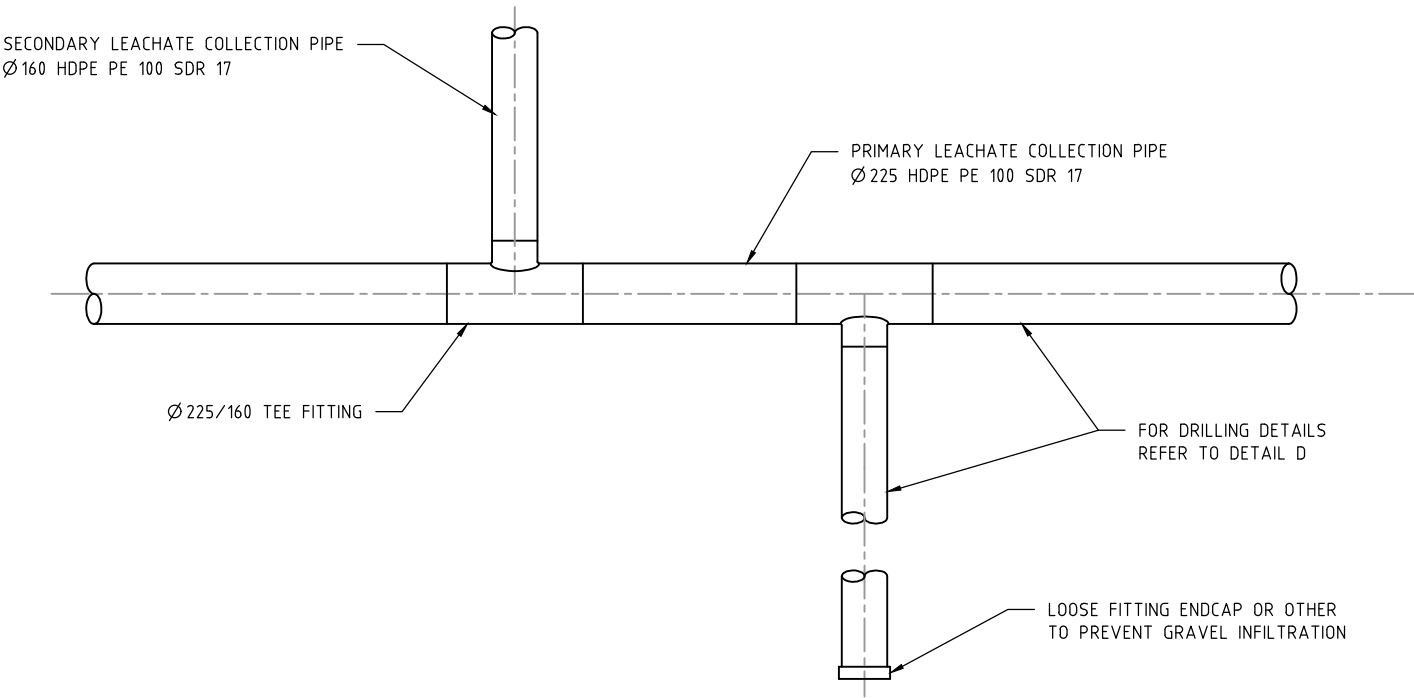
Drawn by:	CDB	Job No:	TW16001
Checked by:	LM	File No:	TW16001-G-903
Approved by:		Dr. No:	G-903
Scale:	NTS	Rev:	A
Date:	24.07.17		



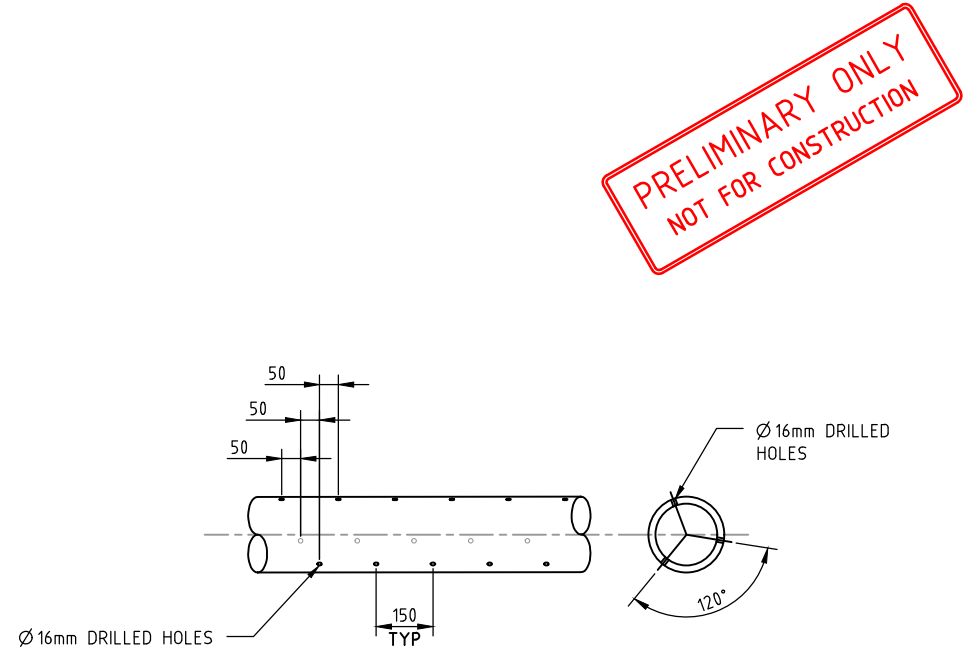
A TYPICAL SECTION THROUGH SECONDARY LEACHATE DRAIN
SCALE: NTS



B TYPICAL SECTION THROUGH PRIMARY LEACHATE DRAIN
SCALE: NTS



C TYPICAL DETAIL - LEACHATE COLLECTION PIPES
SCALE: NTS



D TYPICAL SECTION - LEACHATE COLLECTION DRILLING
SCALE: NTS



Appendix B : **Design Safety Report**



Asset Management | Civil Engineering | Environmental Services | GIS & Spatial Intelligence | Waste Management

Design Safety Report

Seven Mile Waste Facility – Cell Development Works



Prepared for City of Karratha

October 2016

Project Number TW16001



DOCUMENT CONTROL

Version	Description	Date	Author	Reviewer
0a	Internal Review	14/01/15	SC	RC
1a	Released to Client	17/08/16	LM	RC

Approval for Release

Name	Position	File Reference
Ronan Cullen	Director and Waste Management Section Leader	TW16001 - Design Safety Report.1a

Signature



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- Table 4-1: Reference Risk Matrix
- Table 4-2: Risk Management Measures with Probability, Consequence and Risk Rating
- Table 4-3: Risk Matrix for Revised Risk Ratings



1 Introduction

The City of Karratha (the City) has commissioned Talis Consultants Pty Ltd (Talis) to prepare a Design Safety Report for the Seven Mile Waste Facility, Cell Development Works.

In accordance with Regulation 295 of 'Safe Design of Structures Code of Practice – Safe Work Australia', Talis as designers of the proposed Works are required to:

'...provide a written report to the person conducting a business or undertaking who commissioned the design that specified the hazards relating to the design of the structure that, so far as the designer is reasonably aware:

- create a risk to persons who are to carry out the construction work; and*
- are associated only with the particular design and not with other designs of the same type of structure.'*

This Safety Report details the health and safety management measures and controls necessary to avoid, reduce or mitigate the health and safety impacts during the proposed works.

1.1 Site Specific Specification

This Safety Report is to be read in conjunction with the Technical Specification of the Contract Documents. It also describes the systems and tools that will be used by Contractor and a works supervisor and the environmental management responsibilities of the City of Karratha and Contractor during construction of the proposed works.

1.2 Objective

This Safety Report includes information about:

- any hazardous material or construction features and the designer's assessment of the risk of injury or illness to construction workers arising from those hazards; and
- the designer's recommendations for safety and health management measures and controls necessary to avoid, reduce or mitigate the safety and health impacts.

The Contractor, in preparing their Contract Risk Assessment and Safety Management Plan, shall have regard to the information provided in this Safety Report along with the information in the Contract Documents.

The risk assessment provided in this Safety Report shall be further developed by the Contractor prior to commencement of works on site.



2 Description of Proposed Works

The works to be carried out under this Specification include, but are not limited to the following:

- Earthworks to create new cells south of the existing landfill;
- Supply and installation of basal lining system to Cell 1 comprising:
 - Compacted sub-base;
 - Geosynthetic Clay Liner (GCL);
 - 2mm High Density Polyethylene (HDPE) Geomembrane;
 - Protection Geotextile;
 - Leachate Collection Layer - 300mm highly permeable low calcareous gravel; and
 - Separation Layer with high permeability geotextile;
- Supply and installation of a leachate management system to Cell 1 comprising:
 - 225mm slotted pipework;
 - Header pipe; and
 - 450mm HDPE side riser pipe.



3 Hazard Identification

The potential hazards which may arise from the various activities involved in conducting the Site works have been identified and are shown in **Table 3-1**.

Table 3-1: Hazard Identification

Activity	Number	Hazard	Comment
General	1	Dehydration	Due to the physical nature of the works, anticipated weather conditions and degree of Personal Protective Equipment that may be required, maintaining adequate hydration will be important to avoid detrimental physical effects during the works.
	2	Fatigue	The physical nature of the works, anticipated weather conditions and degree of Personal Protective Equipment that may be required may result in physical fatigue of workers. Personnel will be required to undertake the works in an uncovered area of the site.
	3	Rodents	Due to the nature of the Site it is anticipated that rodents will be present. Rodents can carry diseases such as leptospirosis and typhus fever, contaminate food and generate unpleasant odours.
	4	Breathing difficulties due to dust	If significant dust is generated during the works this may be inhaled by workers potentially resulting in breathing difficulties and/or coughing. This may be particularly severe for workers with existing lung conditions such as asthma.
	5	Skin lesions or abrasions	Contact with sharp or rough objects may result in personnel suffering skin lesions or abrasions.
	6	Personal injury when handling materials, equipment & plant	The works on site will require personnel to use materials, equipment and plant. The use of such items may lead to risks and injury.
	7	Risk from accidental or deliberate actions by the external public	There is a risk that unauthorised personnel may access the site. Any actions taken by unauthorised personnel on site may hinder the safety of staff.
	8	Risk of security of site facilities, plant & equipment from unauthorised access	There is a risk that unauthorised personnel may access the site. This causes risks of security breach to the site facilities, plant and equipment on Site.
	9	Risk of live services above and below ground being affected by Site works	There is a risk that there will be live services above or below ground. If a live service wire or other is disrupted during the works it can cause potential harm to personnel.

Activity	Number	Hazard	Comment
	10	Risk of personal injury to site staff and testers due to vehicles	There will be numerous of vehicles operating on Site. It is possible for vehicles to collide with staff, structures or other vehicles.
	11	Risk of poor design of traffic flow and operations of the work sites	A poor design of traffic flow and operations can lead to unpredictable traffic routes and create safety hazards for staff on Site.
	12	Storage of fuels, chemicals and hazardous materials on work site	Different fuels or chemicals can contain flammable, poisonous or hazardous substances. Exposure to the chemicals can cause serious health implications and possible fire hazards.
	13	Risks associated with personnel using drugs and alcohol	Staffs under the influence of alcohol or drugs that affect alertness or awareness can create safety concerns for all staff on Site.
	14	Injuries to public from unauthorised access to workplace	Unauthorised public that access the site do not have any of the site specific training needed. They could be unaware of certain threats, hazards and safety risks which could result in injury to themselves or others.
	15	Exposure to landfill waste or leachate	Personnel on site may be exposed to landfill waste or leachate. Skin exposure is unlikely to be harmful. Health impacts from ingestion are unpredictable but likely to be minimal.
	16	Interaction with traffic from landfill operations	Landfill Operations will continue at the same time as the landfill construction works. Vehicular movements can cause collisions.
	17	Interaction with public vehicles	The Contractor will have to use public roads for access to the Site increasing risks of collisions along public roads.
	18	Working on steep side slopes (<1:5)	The stockpiles have slopes that exceed a 1:5 gradient so caution should be taken when dealing in this area.
Excavation works of borrow pits	19	Risk of fall into open trenches or excavations	Personnel on Site will be working on excavations and steep slopes. Risks of falling and serious injury arises.
	20	Risk associated with loading and unloading of plant and equipment	Loading and unloading plant and materials manually can cause risk to personal safety and health. Additionally, loading and unloading of plant creates risks of materials slipping and impacting with personnel, plant or equipment.
	21	Risk of trench collapse associated with earthworks	Collapsing of trenches or open excavation areas create unpredictable ground movements. This can be dangerous to staff inside the trench or in close proximity.
	22	Risks associated with uncovered holes during general earthworks	Uncovered holes are a potential hazard for personnel to fall or trip. This can be particularly dangerous if staff are carrying heavy, sharp or dangerous materials.
	23	Risks associated	Impacts of heavy vehicles or plant with other

Activity	Number	Hazard	Comment
		with heavy vehicle/plant movement impacts during general earthworks	vehicles or structures on site pose safety risks to drivers and all personnel in the proximity.
	24	Risk of dust during earthworks	Exposed dust on site poses breathing risks to personnel.
	25	Risks associated with general earthworks on sloping ground	The landfill is being capped with a sloped finished level. Working on slopes can increase the risk of vehicles overturning.
	26	Risks associated with inappropriate plant and equipment used during general excavations	Inappropriate plant or equipment may not be suitable for the working conditions and may be unsafe.
Installation of Geosynthetic Lining	27	Slips, trips and falls from installation	Personnel are at risk of injuries related to heavy lifting, slipping, tripping or falling.
	28	Personnel injury when deploying geosynthetics	Personnel are at risk of injuries related to heavy lifting, slipping, tripping or falling, knife cuts.
	29	Injury from heavy lifting	The nature of the work requires heavy manual lifting. This can cause muscular and skeletal damage to personnel, especially if they're already pre-exposed.
	30	Exposed waste material	Waste or its particulates become airborne and escape the environment area immediately surrounding the landfill causing mainly visual impact.
	31	Risk of operating welding machines/small tools	Personnel are at risk of injuries related to cutting, grinding, welding and hot equipment.
Installation of Landfill Leachate Management System	32	Risk of operating welding machine	Personnel are at risk of injuries related to cutting, grinding, scraping, welding and hot equipment.
	33	Injury from heavy lifting of HDPE pipes and well head installations	Personnel not using correct lifting techniques are at risk of injury.
Installation of Surface Water Management System	34	Risk associated with excavator arm and chain for installation of precast or prefabricated or reinforced units	There are risks involved with objects falling or swinging. Personnel in close proximity are at risk of being struck.
	35	Injury from heavy lifting	Personnel not using correct lifting techniques are at risk of injury.
	36	Injury from releasing load too soon	Releasing loads too soon is dangerous to staff that are not yet prepared or expecting.



Activity	Number	Hazard	Comment
	37	Risks from concrete pours (concrete splashing into eyes; concrete burns; whiplash from hoses)	Concrete pours have a risk of concrete, aggregates or admixtures splashing into eyes or exposed skins of personnel. Also, concrete burns and whiplash from hoses are other risks associated with dealing with concrete.
	38	Injury from heavy lifting of formwork assembly and dismantling	Formwork, hoses and other concrete ancillaries require heavy physical work from personnel. This can create injuries of back and elsewhere if incorrect lifting techniques are used.
	39	Injury from impact with exposed starter bar or steel reinforcement	Personnel can injure themselves if they step on, fall on, or in any way have impact with exposed steel bars or wires.
Dismantling of existing and Erection of post and mesh fence	40	Injury from heavy lifting	Personnel not using correct lifting technique are at risk of injury.
	41	Skin lesions or abrasions	Contact with sharp or rough objects may result in personnel suffering skin lesions or abrasions.

4 Risk Analysis and Management

4.1 Risk Analysis and Rating

To assess the various risks, the potential hazards identified in **Table 3-1** were classified according to the Reference Risk Matrix, shown in **Table 4-1**.

Table 4-1: Reference Risk Matrix

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Probability	Almost Certain	High	High	Very High	Very High	Very High
	Likely	Moderate	Moderate	High	Very High	Very High
	Possible	Low	Moderate	High	High	Very High
	Unlikely	Low	Low	Moderate	Moderate	High
	Rare	Low	Low	Low	Low	Moderate

As shown in **Table 4-1**, hazards are classified by their probability of occurring and the severity of their consequences. These two criteria are used to give the hazard an overall risk rating of either Very High; High; Moderate; or Low as shown in **Table 4-1**.

The probability, consequence and risk rating of each hazard is identified in **Table 4-2**.

4.2 Risk Management Measures

Risk management measures refers to the key management strategies identified during the Design that should be adopted on site to ensure that all hazards and potential risks identified previously are controlled to an appropriate level, and that strategies are in place to react to any potential incidents or accidents that may occur. These risk management measures decrease the probability and/or consequence of identified hazards.

The developed management measures and revised probability and consequence for each identified hazard are shown in **Table 4-2**.

Table 4-2: Risk Management Measures with Probability, Consequence and Risk Rating

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
General	1	Dehydration	Likely	Major	Very High	<ul style="list-style-type: none"> Regular breaks, particularly during hot weather conditions Contractor to provide sufficient drinking water to personnel 	Unlikely	Major	Moderate
	2	Fatigue	Possible	Major	High	<ul style="list-style-type: none"> Regular breaks, particularly during hot weather conditions Contractor to provide sufficient drinking water to personnel 	Unlikely	Major	Moderate
	3	Rodents and other animal pests	Likely	Minor	Moderate	<ul style="list-style-type: none"> Secure food in sealed containers away from rodent infested areas Wash hands thoroughly Any personnel bitten by a rodent should consult their doctor promptly 	Unlikely	Minor	Low
	4	Breathing difficulties due to dust	Unlikely	Moderate	Moderate	<ul style="list-style-type: none"> Contractor to prepare Dust Management Plan Utilise a water cart for larger occurrences 	Rare	Moderate	Low

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
	5	Skin lesions or abrasions	Possible	Minor	Moderate	<ul style="list-style-type: none"> Personnel to utilise appropriate PPE First aid kit to be provided on site to treat minor injuries 	Unlikely	Minor	Low
	6	Personal injury when handling materials, equipment & plant	Possible	Major	High	<ul style="list-style-type: none"> Contractor should plan the work site and lay down areas to ensure plant and equipment can be accessed from non-congested areas Utilise job rotations and rest periods 	Unlikely	Major	Moderate
	7	Risk from accidental or deliberate actions by the external public	Possible	Major	High	<ul style="list-style-type: none"> Contractor to provide security fencing around construction site where required to limit unauthorised access 	Unlikely	Major	Moderate
	8	Risk of security of site facilities, plant & equipment from unauthorised access	Possible	Major	High	<ul style="list-style-type: none"> Contractor to conduct risk assessment Contractor to provide security fencing around construction site where required to limit unauthorised access 	Unlikely	Major	Moderate
	9	Risk of live services above and	Rare	Major	Low	<ul style="list-style-type: none"> Contractor should use Dial Before You Dig services to 	Rare	Major	Low

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
		below ground being affected by Site works				establish locations and depths of underground services			
	10	Risk of personal injury to site staff and testers due to vehicles	Likely	Major	Very High	<ul style="list-style-type: none"> Traffic Management Plan to be prepared and carried out by the Contractor. 	Rare	Major	Low
	11	Risk of poor design of traffic flow and operations of the work sites	Possible	Major	High	<ul style="list-style-type: none"> Superintendent to monitor the operation of traffic management plan 	Rare	Major	Low
	12	Storage of fuels, chemicals and hazardous materials on work site	Possible	Major	High	<ul style="list-style-type: none"> Hazardous Chemicals and Storage Procedure to be implemented by the Contractor 	Unlikely	Major	Moderate
	13	Risks associated with personnel using drugs and alcohol	Possible	Major	High	<ul style="list-style-type: none"> Contractor to ensure staff do not work under the influence of drugs or alcohol Contractor to ensure no alcohol or drugs are consumed on or near the Site 	Unlikely	Major	Moderate
	14	Injuries to public from unauthorised access to	Possible	Major	High	<ul style="list-style-type: none"> Contractor to provide security fencing around construction site 	Unlikely	Major	Moderate

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
		workplace				where required to limit unauthorised access			
	15	Exposure to landfill waste or leachate	Likely	Minor	Moderate	<ul style="list-style-type: none"> Wear Gloves/ Protective Clothing make operator's aware of risks 	Possible	Minor	Moderate
	16	Interaction with traffic from landfill Operations	Possible	Major	High	<ul style="list-style-type: none"> Contractor to consult with Operations and agree on TMP 	Possible	Moderate	High
	17	Interaction with public vehicles	Possible	Major	High	<ul style="list-style-type: none"> Contractor to prepare a TMP 	Unlikely	Major	Moderate
	18	Working on steep side slopes (<1:5)	Unlikely	Major	Moderate	<ul style="list-style-type: none"> Plant operators to be appropriately trained All plant and equipment to be appropriate for use 	Rare	Moderate	Low
Excavation works of borrow pits and stockpiles	19	Risk of fall into open trenches or excavations	Possible	Catastrophic	Very High	<ul style="list-style-type: none"> Barriers where necessary Demarcation Backfilling where possible Operator training Apply COP Excavation 	Rare	Catastrophic	Moderate
	20	Risk associated with loading and unloading of plant and	Possible	Major	High	<ul style="list-style-type: none"> Contractor to ensure appropriately trained personnel Supplier to manage loading activities 	Unlikely	Major	Moderate

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
		equipment							
	21	Risk of trench collapse associated with earthworks	Possible	Major	High	<ul style="list-style-type: none"> Contractor to prepare and implement Safe Work Method Statement (SWMS) Toolbox talks Mechanised rather than use manpower Engage qualified personnel 	Unlikely	Major	Moderate
	22	Risks associated with uncovered holes during general earthworks	Possible	Major	High	<ul style="list-style-type: none"> Contractor to use appropriate barriers Contractor to adhere to Excavations Safety Code of Practice 	Unlikely	Major	Moderate
	23	Risks associated with heavy vehicle/plant movement impacts during general earthworks	Possible	Major	High	<ul style="list-style-type: none"> Contractor to prepare a Traffic Management Plan 	Unlikely	Major	Moderate
	24	Risk of dust during earthworks	Possible	Major	High	<ul style="list-style-type: none"> Contractor to put in place dust management plan 	Unlikely	Major	Moderate
	25	Risks associated with general earthworks on	Likely	Major	Very High	<ul style="list-style-type: none"> Contractor to employ appropriate planning and design Contractor to ensure 	Unlikely	Major	Moderate

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
		sloping ground				qualified and experienced operators			
	26	Risks associated with inappropriate plant and equipment used during general excavations	Possible	Moderate	High	<ul style="list-style-type: none"> Contractor to use list of approved equipment Personnel to be plant inducted, suitably qualified and experienced 	Unlikely	Moderate	Moderate
Installation of geosynthetic Lining	27	Slips, trips and falls from installation	Likely	Moderate	High	<ul style="list-style-type: none"> Personnel to access the placed liner from where the grade is least 	Unlikely	Moderate	Moderate
	28	Personnel injury when deploying geosynthetics	Possible	Moderate	High	<ul style="list-style-type: none"> Installer to follow manufactures guidelines Installers to wear appropriate PPE, gloves/goggles etc. Liner not to be deployed in windy or wet conditions 	Possible	Moderate	Moderate
	29	Injury from heavy lifting	Possible	Moderate	High	<ul style="list-style-type: none"> All personnel to use correct lifting technique Utilise machinery rather than manpower 	Unlikely	Moderate	Moderate
	30	Exposed waste material	Possible	Moderate	High	<ul style="list-style-type: none"> Appropriate PPE to be worn 	Possible	Minor	Moderate

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
	31	Risk of operating welding machines/ small tools	Possible	Moderate	High	<ul style="list-style-type: none"> Appropriate PPE to be worn Operators to be trained Operator's to follow SWMS 	Possible	Minor	Moderate
Installation of Landfill Leachate Management System	32	Risk of welding machine	Possible	Moderate	High	<ul style="list-style-type: none"> Appropriately trained personnel SSW to be employed Use of appropriate PPE 	Possible	Minor	Moderate
	33	Injury from heavy lifting of HDPE pipes	Possible	Moderate	High	<ul style="list-style-type: none"> Contractor to ensure correct lifting techniques using appropriate plant or equipment where necessary Contractor to request Special Waste layout plan from Shire prior to drilling 	Unlikely	Moderate	Moderate
Installation of Surface Water Management System	34	Risk associated with excavator arm and chain for installation of precast or prefabricated or reinforced units	Possible	Catastrophic	Very High	<ul style="list-style-type: none"> Operator must check ground for stability Operator not to exceed recommended loading Appropriately trained personnel and banksmen 	Rare	Catastrophic	Moderate
	35	Injury from	Possible	Moderate	High	<ul style="list-style-type: none"> Contractor to ensure 	Unlikely	Moderate	Moderate

Activity	#	Hazard	Probability	Consequence	Risk Rating	Management Measures	Revised Probability	Revised Consequence	Revised Risk Rating
		heavy lifting				correct lifting techniques using appropriate plant or equipment where necessary			
	36	Injury from releasing load too soon	Unlikely	Major	Moderate	<ul style="list-style-type: none"> Only certified staff permitted to release the load 	Rare	Major	Low
	37	Risks from concrete pours (concrete splashing into eyes; concrete burns; whiplash from hoses)	Unlikely	Major	Moderate	<ul style="list-style-type: none"> All personnel to wear appropriate PPE Appropriately trained personnel 	Rare	Major	Low
	38	Injury from heavy lifting of formwork assembly and dismantling	Possible	Moderate	High	<ul style="list-style-type: none"> Contractor to ensure all personnel to use correct lifting technique Utilise machinery rather than manpower 	Unlikely	Moderate	Moderate
	39	Injury from impact with exposed starter bar or steel reinforcement	Possible	Major	High	<ul style="list-style-type: none"> Contractor to ensure capping of all exposed steel reinforcement and starter bars and restrict access where possible 	Unlikely	Major	Moderate

4.3 Revised Risk Ratings

The number of each hazard, identifying its risk ratings are shown in **Table 4-3** before and after the consideration of the proposed risk management measures.

Table 4-3: Risk Matrix for Revised Risk Ratings

		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Probability	Almost Certain					
	Likely		3, 15	27	1, 10, 25	
	Possible		5 <u>15, 30, 31, 32</u>	26, 28, 29, 30, 31, 32, 33, 35, 38 <u>16, 28,</u>	2, 6, 7, 8, 11, 12, 13, 14, 16, 17, 20, 21, 22, 23, 24, 39	34
	Unlikely		<u>3, 5</u>	4 <u>26, 27, 29, 33, 35, 38</u>	18, 36, 37 <u>1, 2, 6, 7, 8, 12, 13, 14, 17, 20, 21, 22, 23, 24, 25, 39</u>	19
	Rare			<u>4, 18</u>	9 <u>9, 10, 11, 36, 37</u>	<u>19, 34</u>

Note: Black numbers denote a potential risk rating prior to consideration of risk management measures
Blue underlined numbers denote the revised risk rating after risk management measures



Appendix C : **Geotechnical** **Investigation Report**



Appendix D : **Construction Quality Assurance (CQA) Plan**



Asset Management | Civil Engineering | Environmental Services | GIS & Spatial Intelligence | Waste Management

Construction Quality Assurance Plan

Seven Mile Landfill - Cell Development



Prepared for City of Karratha

October 2016

Project Number: TW16001



DOCUMENT CONTROL

Version	Description	Date	Author	Reviewer
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1a	Released to Client	17/08/16	LM	RC
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Approval for Release

Name	Position	File Reference
Ronan Cullen	Director and Waste Management Section Leader	TW16001 - CQA Plan.1b

Signature



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1 Introduction

The purpose of the Construction Quality Assurance Plan (CQA) Plan is to detail the testing methods and quality assurance procedures to supply and install the Cell Development at Seven Mile Landfill, Karratha, including:

- Earthworks to create new cells south of the existing landfill;
- Supply and installation of basal lining system comprising:
 - Compacted sub-base;
 - Geosynthetic Clay Liner (GCL);
 - 2mm High Density Polyethylene (HDPE) Geomembrane;
 - Protection Geotextile;
 - Leachate Collection Layer - 300mm highly permeable low calcareous gravel; and
 - Separation geotextile;
- Supply and installation of a leachate management system to comprising:
 - 225mm slotted pipework;
 - Header pipe; and
 - 450mm HDPE side riser pipe.

This plan shall be read in conjunction with the Technical Specification (the Specification) and the Drawings for the Works. Further detailed and specific construction procedures and requirements are outlined in the Specification and Drawings. This document does not replace the Specification or Drawings.



2 Definitions

For the purposes of the CQA Plan guidelines, the following terms are defined below:

'Construction Quality Assurance' (CQA) – A planned system of activities that provide assurance that materials or construction activities are undertaken and installed as specified in the design.

'Construction Quality Control' (CQC) - The process of measuring and controlling the characteristics of the item/product in order to meet the manufacturers or project specifications.

'The Principal' shall be as defined in the Conditions of Contract and for this Project will be the City of Karratha.

'The Contractor' shall mean the future company contracted by the Principal to execute the Works and complete the project; and

'The Superintendent' shall be as defined in the Conditions of Contract and for this Project will be the City of Karratha's appointed representative.

2.1 Material Definitions

'Geosynthetic Clay Liner' (GCL). A factory-manufactured hydraulic barrier consisting of sodium bentonite clay supported by geotextiles held together by needling, stitching, or adhesives.

'Geotextile'. Any permeable textile woven or non-woven, used with foundation, soil, rock, earth, or any geotechnical engineering related material as an integral part of a human-made project, structure, or system.

'Geonet'. A factory manufactured synthetic drainage material manufactured from polypropylene/polyethylene resins, geotextiles (and composites thereof) to transmit fluids and gases uniformly under many field conditions.

'Geomembrane'. A geomembrane is very low permeability synthetic membrane liner or barrier used with any geotechnical engineering related material so as to control fluid (or gas) migration in a human-made project, structure, or system.

'Minimum Average Roll Value' (MARV). The minimum average value of a particular physical property of a material, for 95 percent of all of the material in the lot.

'Overlap'. Where two adjacent geosynthetic panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

3 Roles of Participants

The participants and/or parties that have been identified as key personnel in the delivery of this Project include, but are not necessarily limited to Principal and Superintendent; Design Engineer; CQA Consultant; Contractor; Resin Supplier; Geosynthetics Manufacturer; Geosynthetics Installer; and Soils Testing Laboratory. The roles and responsibilities of the participants and/or parties are detailed below.

3.1 Superintendent

During the construction, the Superintendent acting on behalf of the Principal will serve as a single point of contact for the design engineer, Contractor and CQA consultant during construction.

3.2 Design Engineer

The design engineering services for the earthworks and capping for the Phase 1 works will be provided by Talis. The design engineer reviews and approves any proposed changes in design during construction.

3.3 CQA Consultant

The CQA consultant is an independent party not affiliated with the contractor, subcontractors, suppliers or manufacturers. The CQA consultant may be the design engineer. The CQA consultant has the overall responsibility for managing, coordinating and implementing the CQA activities and confirming that the Contractor's construction quality control activities are performed in accordance with the CQA Plan, construction drawings and technical specifications. Critical activities related to the construction, manufacture and installation of the earthwork, geosynthetics, civil improvements and other project components will be monitored and documented by the CQA consultant. The CQA consultant will be responsible for issuing a Final Certification Report containing CQA documentation sufficient to satisfy regulatory requirements and the requirements of this CQA Plan.

3.4 Contractor

The Contractor is responsible for the timely construction of the project, as delineated in the Drawings and Technical Specifications and in accordance with this CQA Plan. The Contractor is also responsible for the CQC. In particular, the Contractor shall ensure that:

- Only materials meeting the requirements set forth in the Technical Specifications and Drawings are used; and
- The materials are installed in full conformance with the Technical Specifications and Design Drawings.

3.5 Resin Supplier

The resin supplier produces and delivers the resin to the geosynthetics manufacturer. Qualifications of the resin supplier are specific to the manufacturer's requirements.

3.6 Geosynthetic Manufacturer

The geosynthetic manufacturer is responsible for the production of finished material from appropriate raw materials. The geosynthetic manufacturer reports to the geosynthetics installer.



3.7 Geosynthetic Installer

The geosynthetics installer is the Contractor. The geosynthetics installer is responsible for field handling, storage, placement, seaming, loading or anchoring against wind uplift and other aspects of the geosynthetic material installation. The geosynthetic installer will be trained and qualified to install geosynthetic materials of the type specified for this Project.

3.8 Materials Testing Laboratory

In the performance of the CQA activities, the CQA consultant may engage a materials testing laboratory independent from the Contractor, subcontractors, or any material supplier or manufacturer. The testing laboratory will conduct tests on representative samples to evaluate their properties and compliance with the technical specifications.



4 Description of Works

The works to be carried out under this Specification include, but are not limited to the following:

- Earthworks to create new cells south of the existing landfill;
- Supply and installation of basal lining system comprising:
 - Compacted sub-base
 - Geosynthetic Clay Liner (GCL);
 - 2mm High Density Polyethylene (HDPE) Geomembrane;
 - Protection Geotextile;
 - Leachate Collection Layer - 300mm highly permeable low calcareous gravel; and
 - Separation Layer with high permeability geotextile;
- Supply and installation of a leachate management system 1 comprising:
 - 225mm slotted pipework;
 - Header pipe;
 - 450mm HDPE side riser pipe;

5 Daily Reporting and Documentation

5.1 General

An effective CQA Plan recognises all construction activities that should be monitored and assigns responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA consultant will document that all quality assurance requirements have been satisfied. The CQA consultant will also maintain at the job site a complete file of Construction Drawings, Technical Specifications, CQA Plan, test procedures, daily logs and other pertinent documents.

5.2 Daily Record Keeping

Standard reporting procedures will include preparation of daily CQA documentation which, at a minimum, will consist of:

- Field notes, including memoranda of meetings and/or discussions with the design engineer or construction manager;
- CQA consulting logs and testing data sheets; and
- Construction problems and solution summary sheets.

This information will be reviewed by the CQA consultant, signed and transmitted to the construction manager on a daily basis.

Monitoring logs and testing data sheets will be prepared daily. At a minimum, these logs and data sheets will include the following information:

- An identifying sheet number for cross referencing and document control;
- Date, project name, location and other identification;
- Data on weather conditions;
- A site plan showing work areas and locations selected for random CQA testing;
- Descriptions and locations of ongoing construction;
- Equipment and personnel in each work area;
- Location where in-site CQA tests and samples were taken;
- A summary of test results;
- Calibration of test equipment;
- Decisions made regarding acceptance of units of work and/or corrective actions to be taken; and
- Signature of CQA consultant representative.

5.3 Construction Issues

The Installer will be informed by the CQA consultant about any significant recurring non-conformance with the Construction Drawings, Technical Specifications, or CQA Plan. The cause of the non-conformance will be determined and appropriate changes in procedures of Specifications may be recommended. These changes will be submitted to the design engineer for approval. When changes are made, they will become part of the construction documents.



5.4 Photographic Records

Photographs will be taken by the CQA consultant and documented in order to serve as a pictorial record of work progress, problems and mitigation activities. The basic file will contain colour prints and they will be identified with the date, time and location of the photograph.

5.5 Design and/or Specification Change

Design and/or specification changes may be required during construction. In such cases, the CQA consultant will notify the design engineer and Construction Manager.



6 Requirements of CQA Validation Report

At the completion of the work, the CQA consultant will submit to the Superintendent a signed final certification report. This report will document that:

- Work has been performed in compliance with the construction documents;
- Physical sampling and testing has been conducted at the appropriate frequencies specified in the CQA Plan; and
- The required CQA documentation has been completed.

At a minimum, this report will include:

- Geosynthetic manufacturers quality control documentation;
- A summary describing the CQA activities and indicating compliance with the Drawings and Technical Specifications;
- A summary of CQA testing, including failures, corrective measures and retest results;
- Geosynthetic panel layout drawings with test locations (where applicable);
 - Roll numbers deployed; and
 - Repairs.
- Records of sample and resample locations, the name of the individual conducting the tests, and the results of the tests;
- Daily inspection reports;
- Plant and labour;
- Records of site meetings;
- Progress photographs;
- Any other relevant information; and
- As built drawings (see below)

The as-built drawings must detail the following:

- construction details including levels and slope angles for the Geosynthetic layer;
- locations and identification marks of each Geosynthetic panel ;
- locations of damaged areas;
- locations of samples; and
- locations of penetrations.

The validation report must contain a statement by the CQA Consultant that the works have been carried out in accordance with the CQA Plan (and specifications attached to it) and that the validation report (including the drawings and appendices) represent a fair and accurate record of the works.



Appendix E : **Bill of Quantities**

E.1: PREAMBLE TO THE BILL OF QUANTITIES

E.2: General

The following Bill of Quantities forms part of the Contract only to the extent provided in the Contract and the Tenderer shall apply a rate to all items shown to arrive at an amount which shall be added up to form the Tendered Sum.

1. The Bill of Quantities has been compiled generally accordance with the **Method of Measurement of Civil Engineering Work AS1181 – 1982**.
2. The Bill of Quantities is to be read in conjunction with the Conditions of Tendering, General and Special Conditions of Contract, Specification and Contract Drawings.
3. The Bill of Quantities has been measured in a form which is considered to be a suitable base for compiling bids given the type of construction and when read in conjunction with the Specification and Contract Drawings.
4. A nil amount will be considered as indicating the price for the Works has been included elsewhere.
5. The completed Bill of Quantities is to be forwarded with the Tender Form and associated Schedules.
6. The Bill of Quantities and the Total carried forward to the Tendered Sum shall be exclusive of GST.
7. Prices inserted by Tenderers are to be for the full inclusive costs of the works described, fixed, placed or constructed in its final position including allowances for all Preliminary Items and testing.
8. The tendered rate shall be deemed to include the costs of complying with all conditions, obligations and liabilities in the Contract Documents, and the supply of all plant, labour, materials and transportation required to complete the item of work.
9. Unless scheduled separately, all tendered rates shall include allowances for miscellaneous items, accommodation, supervision, normally expected risks, transport of equipment, temporary works, setting-out, inspections, reporting, attendances at meetings, communications, programming, records, quantity measurement, claims for payment, testing and quality control measures, permits, administration, plus on-Site overheads and off-Site overheads and profit.
10. It is the Tenderer's responsibility to check and ensure that the items and quantities measured are an accurate reflection of the work required to complete the Contract. Should any items be omitted or quantities incorrect for the works shown on the Drawings, the Tenderer shall include and/or modify the measured Bill of Quantities to relate to their Tendered Sum.
11. If a Bill of Quantities omits an item which should reasonably have been anticipated by an experienced and competent Contractor to be necessary for the satisfactory completion of the works, and such omitted item is not inserted by the Tenderer, then the cost of such item shall be deemed to be included within other items of the Bill of Quantities.
12. The Contractor shall not rely on the quantities provided in the Bill of Quantities for ordering materials.
13. No allowance shall be made for over excavation, laps, cutting, waste etc. unless specifically stated.

E.3: Item Specific Notes

1. **Items 1.14 & 6.14** shall be deemed to include all in situ and laboratory testing of materials in accordance with the requirements of the Specification, excluding GCL testing (**Item 1.15 & 6.15**).
2. **Items 3.02 to 3.05, 3.11, 8.02 to 8.05 & 8.11** inclusive shall be deemed to include all necessary grading, levelling, trimming and compacting of reduced surfaces.
3. **Items 3.02 to 3.05, 3.11, 8.02 to 8.05 & 8.11** inclusive shall be deemed to include compacting and finishing in accordance with the Specification.
4. **Items 3.06 to 3.10 & 8.06 to 8.10** shall be deemed to include geosynthetic overlaps.
5. **Items 3.11 & 8.11** shall include welding, excavation and backfilling of anchor trenches or pegging.
6. **Items 5.01 to 5.07 and 10.01 to 10.07** shall include excavation, bedding, backfilling, levelling off and disposal of surplus soil.
7. **Items 3.07 and 8.07**, the Contractor shall be deemed to have allowed for all precautions as deemed necessary including welding at night (if required) for all general seaming and tie-in welds, to minimise the propagation of wrinkles and tensions during installation, due site temperature differential and the expansion/contraction of the geomembrane.
8. **Items 3.11 and 8.11**, backfilling of anchor trenches on site should only occur when contracting geomembrane (due to lowering daily temperatures) will not cause tension/stress build-up in the liner

Table App E-1

Item	Description	Unit	Quantities	Rate	Total Amount (\$)
1 Preliminaries					
1.01	Mobilisation to Site	Item	1	\$ -	\$ -
1.02	Insurance as required under AS4000	Item	1	\$ -	\$ -
1.03	Survey and Site Setting-Out	Item	1	\$ -	\$ -
1.04	As-Constructed Drawings	Item	1	\$ -	\$ -
1.05	Quality Management System - Establishment and Administration	Item	1	\$ -	\$ -
1.06	Environmental Management Plan - Establishment and Administration	Item	1	\$ -	\$ -
1.07	Occupational Health and Safety Plan - Establishment and Administration	Item	1	\$ -	\$ -
1.08	Traffic Management Plan - Establishment and Administration	Item	1	\$ -	\$ -
1.09	Establishment of Contractor Accommodation, Equipment and Storage Facilities	Item	1	\$ -	\$ -
1.10	Establishment of Superintendent/CQA Accommodation Facilities	Item	1	\$ -	\$ -
1.11	Establishment of Water supply	Item	1	\$ -	\$ -
1.12	Establishment of Power supply	Item	1	\$ -	\$ -
1.13	Establishment of Telecommunications	Item	1	\$ -	\$ -
1.14	All in-situ and laboratory testing in accordance with the Specification	Item	1	\$ -	\$ -
1.15	Geosynthetic Clay Liner, Geomembrane & Geotextile Conformance Testing in accordance with Specification	Item	1	\$ -	\$ -
1.16	Site Clean-up on Completion of Works	Item	1	\$ -	\$ -
1.17	Temporary Site Fencing	Item	1	\$ -	\$ -
1.18	Demobilisation from Site	Item	1	\$ -	\$ -
1.19	Supervision	Item	1	\$ -	\$ -
1.20	Site Recurring Costs	Item	1	\$ -	\$ -
1.21	Dust Suppression	Item	1	\$ -	\$ -
1.22	Provisional Item - Demobilisation and remobilisation	Item	1	\$ -	\$ -
				Sub-total	\$ -
2 Cell 1 Site Clearance and Demolition					
2.01	Site clearance and rationalising surface, including disposal of vegetation to onsite landfill stockpile	m ²	27800	\$ -	\$ -
				Sub-total	\$ -
3 Cell 1 Excavation and Filling					
3.01	General removal of soil	m ³	0	\$ -	\$ -
3.02	Excavation & fill within cell works footprint	m ³	5125	\$ -	\$ -
3.03	Excavate haul, and place fill from Borrow, to subgrade surface	m ³	34875	\$ -	\$ -
3.04	Excavate & fill to internal bunds	m ³	2950	\$ -	\$ -
3.05	Prepare surface to receive GCL	m ²	27160	\$ -	\$ -
3.06	Supply and install GCL	m ²	27160	\$ -	\$ -
3.07	Supply and install 2mm textured HDPE geomembrane	m ²	27160	\$ -	\$ -
3.08	Supply and install protection geotextile	m ²	27160	\$ -	\$ -
3.09	Supply and install 300mm leachate collection layer	m ³	4770	\$ -	\$ -
3.10	Supply and install separator geotextile (to include for sandbag surcharge)	m ²	15900	\$ -	\$ -
3.11	Excavate anchor trenches for Geosynthetics and backfilling following installation	m	680	\$ -	\$ -
3.12	Supply and install 225mm HDPE perforated primary pipe (to include for twice pipe diameter of stone cover and all joints, T piece/reducers to 160mm secondary pipes, and end cap)	m	205	\$ -	\$ -
3.13	Supply and install 160mm HDPE perforated secondary leachate drainage pipe (to include for twice pipe diameter of stone cover, joints and end caps)	m	490	\$ -	\$ -
3.14	Supply and install 450mm HDPE inclined riser	m	25	\$ -	\$ -
3.15	Supply and install 160mm HDPE inclined dipping point	m	25	\$ -	\$ -
3.16	Supply and install 450 headwall for inclined riser	No	1	\$ -	\$ -
3.17	Supply and install 450mm perforated HDPE leachate collection sump (to include for concrete base, 450mm elbow and reducer to 225mm primary drain)	No	1	\$ -	\$ -
				Sub-total	\$ -
4 Cell 1 Miscellaneous					
4.01	Undertake Geomembrane Leak Detection Survey on completed Cell drainage blanket material, in accordance with specification & reporting	Item	1	\$ -	\$ -
4.02	Installation of ramp access to landfill cells including excavation and fill of all materials and sacrificial liners.	Item	1	\$ -	\$ -
				Sub-total	\$ -
	Cell 1 Construction Total			Total	\$ -

Table App E-1

Item	Description	Unit	Quantities	Rate	Total Amount (\$)
6 Preliminaries					
6.01	Mobilisation to Site	Item	1	\$ -	\$ -
6.02	Insurance as required under AS4000	Item	1	\$ -	\$ -
6.03	Survey and Site Setting-Out	Item	1	\$ -	\$ -
6.04	As-Constructed Drawings	Item	1	\$ -	\$ -
6.05	Quality Management System - Establishment and Administration	Item	1	\$ -	\$ -
6.06	Environmental Management Plan - Establishment and Administration	Item	1	\$ -	\$ -
6.07	Occupational Health and Safety Plan - Establishment and Administration	Item	1	\$ -	\$ -
6.08	Traffic Management Plan - Establishment and Administration	Item	1	\$ -	\$ -
6.09	Establishment of Contractor Accommodation, Equipment and Storage Facilities	Item	1	\$ -	\$ -
6.10	Establishment of Superintendent/CQA Accommodation Facilities	Item	1	\$ -	\$ -
6.11	Establishment of Water supply	Item	1	\$ -	\$ -
6.12	Establishment of Power supply	Item	1	\$ -	\$ -
6.13	Establishment of Telecommunications	Item	1	\$ -	\$ -
6.14	All in-situ and laboratory testing in accordance with the Specification	Item	1	\$ -	\$ -
6.15	Geosynthetic Clay Liner, Geomembrane & Geotextile Conformance Testing in accordance with Specification	Item	1	\$ -	\$ -
6.16	Site Clean-up on Completion of Works	Item	1	\$ -	\$ -
6.17	Temporary Site Fencing	Item	1	\$ -	\$ -
6.18	Demobilisation from Site	Item	1	\$ -	\$ -
6.19	Supervision	Item	1	\$ -	\$ -
6.20	Site Recurring Costs	Item	1	\$ -	\$ -
6.21	Dust Suppression	Item	1	\$ -	\$ -
				Sub-total	\$ -
7 Cell 2 Site Clearance and Demolition					
7.01	Site clearance and rationalising surface, including disposal of vegetation to onsite landfill stockpile	m ²	23640	\$ -	\$ -
				Sub-total	\$ -
8 Cell 2 Excavation and Filling					
8.01	General removal of soil	m ³	0	\$ -	\$ -
8.02	Excavation & fill within cell works footprint	m ³	3735	\$ -	\$ -
8.03	Excavate haul, and place fill from Borrow, to subgrade surface	m ³	45765	\$ -	\$ -
8.04	Excavate & fill to internal bunds	m ³	1950	\$ -	\$ -
8.05	Prepare surface to receive GCL	m ²	21910	\$ -	\$ -
8.06	Supply and install GCL	m ²	21910	\$ -	\$ -
8.07	Supply and install 2mm textured HDPE geomembrane	m ²	21910	\$ -	\$ -
8.08	Supply and install protection geotextile	m ²	21910	\$ -	\$ -
8.09	Supply and install 300mm leachate collection layer	m ³	4830	\$ -	\$ -
8.10	Supply and install separator geotextile (to include for sandbag surcharge)	m ²	16100	\$ -	\$ -
8.11	Excavate anchor trenches for Geosynthetics and backfilling following installation	m	490	\$ -	\$ -
8.12	Supply and install 225mm HDPE perforated primary pipe (to include for twice pipe diameter of stone cover and all joints, T piece/reducers to 160mm secondary pipes, and end cap)	m	205	\$ -	\$ -
8.13	Supply and install 160mm HDPE perforated secondary leachate drainage pipe (to include for twice pipe diameter of stone cover, joints and end caps)	m	430	\$ -	\$ -
8.14	Supply and install welded 110mm HDPE leachate rising main pipe (to include trenching)	m	930	\$ -	\$ -
8.15	Supply and install welded 450mm HDPE inclined riser	m	26	\$ -	\$ -
8.16	Supply and install welded 160mm HDPE inclined dipping point	m	26	\$ -	\$ -
8.17	Supply and install headwall for inclined riser and dipping point	No	1	\$ -	\$ -
8.18	Supply and install 450mm perforated HDPE leachate collection sump (to include for concrete base, 450mm elbow and reducer to 225mm primary drain)	No	1	\$ -	\$ -
				Sub-total	\$ -
9 Cell 2 Miscellaneous					
9.01	Undertake Geomembrane Leak Detection Survey on completed Cell drainage blanket material, in accordance with specification & reporting	Item	1	\$ -	\$ -
9.02	Installation of ramp access to landfill cells including excavation and fill of all materials and sacrificial liners.	Item	1	\$ -	\$ -
				Sub-total	\$ -
	Cell 2 Construction Total			Total	\$ -

Table App E-2

		Cell 1	Cell 2	Total
Item	Description	Amount	Amount	Amount
1	Preliminaries	\$ -	\$ -	\$ -
2	Site Clearance and Demolition	\$ -	\$ -	\$ -
3	Excavation and Filling	\$ -	\$ -	\$ -
4	Miscellaneous	\$ -	\$ -	\$ -
Construction Tender Sub-total (Excl. GST)		\$ -	\$ -	\$ -

Tenderer

E.4: Schedule of Dayworks Rates for Variations

The unit rates stated in this Schedule shall be applicable to additions to or deletions from the Scope of Work where rates and prices provided in the Bill of Quantities (**Table App E-1**) are not deemed applicable by the Superintendent.

These rates shall not be subject to rise and fall in costs of labour, materials and other items and shall be deemed to include the cost of all consumables, construction facilities, professional and technical services, royalties, taxes, transport, equipment, labour and other charges necessary to perform the work.

The successful Tenderer shall not be entitled to any allowance above the unit rates stated in the Schedule.

E.5: Dayworks

Pursuant to Clause 41 of the General Conditions of Contract variations to Scope of Work for which a lump sum price has not been agreed prior to the commencement of work on the variations shall be regarded as dayworks and shall be paid for at the rates nominated in this Schedule.

The successful Tenderer shall perform dayworks only when authorised in writing by the Superintendent. All labour, plant and materials used on dayworks shall be approved daily in writing by the Superintendent. Changes in resources employed on any items of daywork may be made only with the written approval of the Superintendent.

E.6: Labour

Payment for labour shall be at the rates nominated in this Schedule (**Table App E-3**). These rates shall not be subject to rise and fall in costs and shall be deemed to include the cost of wages, the successful Tenderer's profit, overhead, Superintendent (including Foremen), insurance, accommodation, time-keeping and all clerical and office work as well as transport about the Site, and the use of all hand-operated (as distinct from power-operated) tools or plant and all incidental charges whatever. Wages for plant/operator/driver, however, shall be included in the rates for dayworks plant variations.

Table App E-3 Schedule of Rates for Variations - Labour

Labour Rates per hour			
Labour	Trade/Personnel	Ordinary Site Working Hours	Overtime Site Working Hours
	Foreman*	\$	\$
	Labourer*	\$	\$
	Surveyor*	\$	\$
		\$	\$
		\$	\$
		\$	\$
		\$	\$
		\$	\$
		\$	\$
		\$	\$
		\$	\$

*Trades Listed above are examples only. Tenderer to list others as appropriate

Table App E-4 Schedule of Rates for Variation - Materials (Onsite)

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E.8: Plant

This Schedule (Table App E-5) sets forth the hourly rates for the various classes of plant which the Tenderer proposes to use on the Site in performance of the scheduled work and which may be required the Superintendent to perform variation work.

The rates stated and agreed apply to the Tenderer's plant, exclusive of attendants, but inclusive of Driver/Operator's wages, fuel, consumable stores, maintenance, depreciation, overheads and profit.

Plant operating time where authorised in writing by the Superintendent plus reasonable movement time to and from the work site will be paid for at the rates stated in this Schedule. Standby rates shall be included for all items of plant, which the Tenderer proposes to use during the Works. In the event that items of plant may be caused to stand by for periods of time due to reasons attributable to the Superintendent and beyond the control of the successful Tenderer, then the successful Tenderer shall be entitled to compensation for the duration at the applicable standby rate stated in this schedule.

Table App E-5 Schedule of Rates for Variation

Item No.	Equipment	Ordinary Site Working hours (Rate \$ per hour)	Overtime Working Hours (Rate \$ per hour)	Standby (Rate \$ per hour)
Tender to list plant. Rates to include operator as required				
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$
		\$	\$	\$

Talis Consultants

**Level 1, 660 Newcastle Street,
Leederville,
Western Australia 6007**

**PO Box 454,
Leederville,
Western Australia 6903**

**Phone: 1300 251 070
Email: info@talisconsultants.com.au**

