Armidale Regional Landfill – Contract #3
Landfill Cell #1 and Associated Infrastructure

Section 5 – Technical Specification

5. Technical Specification

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TABLES

5.1. SCOPE OF WORK

These Technical Specifications have been prepared for the construction of the initial Landfill Cell 1 for the Armidale Landfill, located approximately 12km east of Armidale, off Waterfall Way. The Technical Specification shall be read in conjunction with the Drawings.

The scope of work to be undertaken under the Contract is indicated on the Drawings and in the Specific Requirements and Technical Specification. The Works include the following:

Physical Work

- Site establishment.
- Erect protective bollards around underground water sampling boreholes

- Topsoil stripping and stockpiling.
- Site clearing and grubbing.
- Excavation in all classes of material, temporarily stockpiling material and re-profiling of existing landfill surface to achieve the landfill base liner and storage basin subgrade levels.
- Subgrade preparation works including removal and replacement or treatment of unsuitable materials
- Construction of a low permeability landfill base liner comprising clay fill sourced from on-site excavations, Geosynthetic Clay Liner (GCL) and HDPE geomembrane layers.
- Construction of a landfill leachate collection system comprising slotted PE pipework, drainage gravel and geotextile layers.
- Construction of a leachate storage pond using embankment fill materials including a low permeability base liner comprising clay fill sourced from on-site excavations, and HDPE layers.
- Installation of leachate gravity and rising mains from the landfill to the leachate storage pond.
- Construction of a sedimentation basin and dry basin using excavated embankment fill materials.
- Construction of basin inlet channels, overflow spillways and outlet dissipation structures.
- Construction of clean and dirty water stormwater drainage channels with rock rip-rap, recycled conveyor belt or shotcrete lining where required.
- Construction of landfill access, internal and perimeter road formations and gravel pavements.
- Topsoiling and vegetation of drainage channels and embankment batters, as required.
- Establishment and removal upon completion of the Contractor's facilities and laydown areas.
- Site clean-up and restoration works.

Management Activities

- Planning and managing the Works including management of excavated materials for reuse in the Works
- Preparing and implementing the Contractor's Integrated Management Plan.
- Procuring, mobilising and removing on completion the necessary equipment and materials to complete the Works.
- Ensuring that the Works is constructed in accordance with the conditions and obligations of the Approvals.
- Coordinating the activities of the Contractor's personnel and its sub-contractors, suppliers and consultants.
- Meeting with the Superintendent's Representative to administer the Contract.

- Reporting in accordance with the Contract requirements.
- Undertaking all necessary surveys and investigations required to carry out the Works.
- Providing quality assurance with respect to the Works.
- Ensuring that the performance of the Works is in accordance with all legislative requirements.
- Provide quality assurance documentation at completion of the Works including works-as-executed drawings.
- All other works necessary for the complete and proper execution of the Works.

The Contractor is to allow for and co-operate with the presence of concurrent additional work on the landfill, shown on the Drawings as 'by others', should this work be undertaken by another contractor.

5.2. DEFINITIONS

Unless the context requires otherwise, the following meanings and interpretations apply in the Technical Specification:

Approved: "Approved", "reviewed", "directed", "rejected", "endorsed" and similar expressions mean "approved, reviewed, directed, rejected, endorsed" in writing by the Superintendent's Representative".

Coarse Component: The fraction of the material that does not pass the AS 0.425mm sieve.

Coefficient of Permeability: A proportionality constant to determine the flow velocity of water through soils.

Site: Works area that the Contractor has possession of under the Contract.

Install: Set out, erect, mount, align, fix, connect, adjust, test and commission and hand over in proper working order and shall also include, unless stated clearly to the contrary, supply of the item(s).

Manufacturer: The party responsible for manufacturing products specified on the Drawings.

Other than Rock: All other soil or geological material except rock as defined below.

Rock: For a definition of what constitutes rock under the Contract refer to Clause 5.12.4

Rock Fill: A layer of large un-coursed stones, broken rock or precast blocks placed in a random fashion on an embankment or in a channel.

Subgrade: The trimmed or prepared portion of the formation on which the landfill capping layers are to be constructed.

Supply: Purchase, obtain, store off site as necessary, deliver to site, and off load, position, store and protect on site.

Topsoil: Surface soil that contains organic matter, root zone material and supports plant life.

5.3. CODES AND STANDARDS

Work carried out and testing performed under the Technical Specification must comply with the requirements of the following standards and authority requirements, to the extent that they are

relevant and not overridden by the Technical Specification or Drawings. All documents shall be read together to define the Scope of Work required under the Contract.

Where the edition of any Australian Standard or other standard is stated in the Technical Specification, that edition shall apply for the whole of the Contract period including the defects liability period.

Where the edition of any Australian Standard or other standard referred to in the Technical Specification, or relevant in accordance with this Clause is not stated in the Technical Specification, the edition current at the time of tender closing shall apply for the whole of the Contract period including the defects liability period.

Unless otherwise specified in the Technical Specification, the transport, storage, handling and installation of all materials shall be in accordance with the manufacturer's recommendations.

The Contractor shall undertake the Works in accordance with the standards expressly stated in these Technical Specification. To the extent that standards are not expressly stated, the Contractor shall carry out the Works in accordance with relevant Australian Standards. The requirements of the Australian Standards do not amend, revise or supersede any standard expressly stated in the Technical Specification except where any legislative of statutory obligation requires that they prevail.

5.3.1. Australian Standards

AS 1152 - Specification for test sieves

AS 1289 - Methods of testing soils for engineering purposes

AS 1289.2.1.1 - Determination of the moisture content of a soil; oven drying method

AS 1289.3.1.1 - Soil classification tests; Calculation of the plasticity index of a soil

AS 1289.3.2.1 – Methods of testing soils for engineering purposes; Soil classification tests; Determination of the plastic limit of a soil - Standard method

AS 1289.3.3.1 – Methods of testing soils for engineering purposes; Soil classification tests Calculation of the plasticity index of a soil

AS 1289.4.1.1 – Methods of testing soils for engineering purposes; Soil chemical tests; Determination of the organic matter content of a soil

AS 1289.3.6.1 - Soil classification tests; Determination of the particle size distribution of a soil; Standard method of analysis by sieving

AS 1289.3.6.3 - Soil classification tests; Determination of the particle size distribution of a soil; Standard method of fine analysis using a hydrometer

AS 1289.3.8.1 - Soil classification tests; Dispersion; Determination of Emerson class number of a soil

AS 1289.5.1.1 - Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort.

AS1289 5.4.1 - Methods of testing soils for engineering purposes - Soil compaction and density tests; Compaction control test; Dry density ratio, moisture variation and moisture ratio

AS 1289.5.5.1 - Determination of the Minimum & Maximum Dry Density of a Cohesionless Material (Standard Method).

AS 1289.5.6.1 - Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material

AS 1289.5.7.1 - Soil compaction and density tests - Compaction control test – Hilf density ratio and Hilf moisture variation (rapid method)

AS 1289.5.8.1 - Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge

AS1289.6.1.1 - Methods of testing soils for engineering purposes - Soil strength and consolidation tests - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen

AS 1289.6.7.1 - Determination of the permeability of a soil – Constant head method for a remoulded specimen AS 1289.6.7.2 - Determination of the permeability of a soil – Falling head method for a remoulded specimen

AS1289.6.7.3 - Determination of the permeability of a soil – Constant head method using a flexible wall permeameter

AS1725.1 - Chain link fabric fencing - Security fences and gates - General requirements

AS 3798 - Guidelines on earthworks for commercial and residential developments.

AS 4130 - Polyethylene (PE) pipes for pressure applications

AS 4419 - Soil for landscaping and garden use

5.3.2. Laws, Other Standards and Guidelines

5.3.2.1. Environment and Protection Authority Requirements

The Contractor through its environmental and integrated management plans shall fulfill the intent of the following;

- All NSW Government approval conditions relating to the new Landfill.
- Construction Environmental Management Plan.
- Construction Quality Assurance Plan (CQAP).
- Water Quality Management Plan.
- Leachate Management Plan.
- Any Department of Environment and Climate Change Requirements Landcom “Managing Urban Stormwater Soils and Construction” (Blue Book), Workplace Health and Safety (WHS) Act and WHS Regulations 2011, Workcover Authority Codes, Procedures and Instructions.

5.3.2.2. Compliance with Authorities’ Requirements, Codes and Standards

All work performed shall comply fully with the rules, regulations and by-laws of any Federal, State or local authority having jurisdiction over the Works.

If the Contractor considers that there is conflict between the requirements of any Authority and the design documents the Contractor shall give notice to the Superintendent’s Representative

and shall not commence work affected by the conflict until the Superintendent's Representative has given direction.

5.4. CONSTRUCTION WORK

The construction works are as outlined in Section 5.1.

The Contractor is to implement effective temporary drainage and erosion and sedimentation control measures in accordance with the approved plan contained in the Contractor's Environmental Management Plan in advance of, or in conjunction with, any clearing and grubbing operations.

5.5. SITE ESTABLISHMENT

The Contractor shall undertake all activities required to establish its personnel, construction plant and equipment and materials for the Works. The Contractor's site establishment shall include the following:

- Establishment of offices and parking facilities for its personnel at a location(s) to be determined on site and approved by the Superintendent's Representative.
- Establishment of a laydown area(s) for its construction plant and materials at a location to be determined on site and approved by the Superintendent's Representative along with a bunded fuel storage and refuelling facility for plant.
- Provision of worker amenities in accordance with the Workplace Health and Safety Code of Practice.
- Mobilisation to site of all personnel, construction plant and materials required to undertake the Works.
- Preparation of access and haul roads.
- Provide for the Superintendent's Representative; a powered reverse cycle air-conditioned site office, one office desk and drawers, a gas lift office chair, a magnetic whiteboard (1000mm x 1500mm) secured to the wall, a new lockable filing cabinet, a plan table and eight chairs for meetings, a fridge, pipe connected potable water to an inside sink and a cabinet benchtop for storage.
- Provide site telephone service, electricity, water and toilet facilities .

The Contractor shall not be permitted to make connection to existing utilities at the site,

The Contractor may establish fuel storage facilities at the site. The Contractor shall be responsible for obtaining any necessary permits and/or licences in accordance with the Dangerous Goods Safety Management Act 2001 and the Dangerous Goods Safety Management Regulation 2001 and shall provide copies of the permits and/or licences to the Superintendent's Representative prior to establishment of fuel storage at the site. Such facilities must comply with AS1940.

5.6. CLEAN UP AND RESTORATION

Upon completion of all Works, the clean up and restoration of the site must be completed by the Contractor to the satisfaction of the Superintendent's Representative.

As part of the clean up and restoration of the site, the Contractor must undertake the following:

- Dismantle and remove from site all buildings and construction facilities; remove fixed and mobile plant.
- Clean up the Works area which must be left free of all loose earth, rock, rubbish, pegs, temporary fencing and other debris.
- Restoration of haul roads.
- Remove any rubbish or debris produced or exposed by or during the Contractor's operations from the Works area, and manage in accordance with the Contractor's Environmental Management Plan.
- Make good any damage or disturbance caused by the operations during the period of the execution of the Works.
- Carry out any restoration work required in accordance with the Conditions of Contract and the direction of the Superintendent's Representative.
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- On completion of any areas disturbed by the Contractor during the period of the execution of the Works, reinstate the area to a condition no less than the pre-disturbed condition.
- Ensure all necessary sediment and erosion controls required for the Defects Liability Period are in place and other temporary controls are removed.

Any subsidence or surface erosion must be made good by the Contractor at its own expense and to the satisfaction of the Superintendent's Representative.

5.7. CLEARING AND GRUBBING

5.7.1. General

Under the terms of the approval for the construction of the landfill Council is to keep the clearance of existing flora to the minimum. This requirement is to be considered when undertaking setting out.

Except in areas specifically identified for clearing and grubbing, do not remove or clear any vegetation without approval from the Superintendent's Representative.

5.7.2. Site Clearing and Grubbing

The Contractor shall undertake the clearing and grubbing required to enable construction of the Works or for the establishment of temporary site facilities.

Where clearing and grubbing is required to enable construction of the Works, the extent of clearing and grubbing shall be as shown on the Drawings or the minimum required to construct the Works plus an additional three metres or one machine width for future maintenance access.

The Contractor shall clearly mark the limits of clearing and grubbing and notify the Superintendent's Representative prior to the commencement of clearing and grubbing. The limits of clearing and grubbing shall be subject to modification during the Superintendent's Representative' inspection to allow for trees that the Superintendent's Representative and the Contractor's Representative consider would impede construction activities.

Clearing and grubbing for all work shall include the following:

a) Remove trees and shrubs and the stumps and roots of trees and shrubs to a depth not less than 300mm below the natural surface. The removal of stumps and roots shall ensure that no material with any dimension greater than 100mm, 20mm under sealed roads, remains.

b) Disposal of organic cleared and grubbing materials shall be to the mulch stockpile as indicated on the Drawings. Other non-organic cleared and grubbing materials shall be disposed in the temporary unsuitable material stockpile areas at the locations indicated on the Drawings.

All clearing and grubbing work shall be subject to supervision by the project ecologist (spotter catcher).

5.7.3. Survey and Setting Out

The Contractor shall be responsible for all survey work required to set out the limits of the area to be cleared using initial location points provided by Council.

The outside of the cleared area shall generally be based on the limits of clearance shown on the Drawings. However, the actual limit shall take into account conditions on the ground, for example peripheral trees which might be retained or a more direct clearance line.

The Superintendent will be available for consultation during the setting out process to approve the final boundary line.

No additional payment will be made for additional clearing and grubbing outside the initial limits.

5.7.4. Establishment of the Clearance Boundary

The Contractor shall mark the boundary of the area to be cleared using stakes, tape and/or temporary fencing material as approved by the Superintendent. Peripheral trees that are not to be disturbed during clearance shall also be marked and protected from damage if necessary.

Prior to the commencement of work the Superintendent and the project ecologist will walk the clearance limits to ensure that they are adequately marked. The Contractor shall not undertake any clearance activities before to obtaining approval of the boundary line.

5.7.5. Habitat Trees

The project ecologist will mark any trees within the area to be cleared that are deemed to be habitat trees requiring special treatment as specified in Clause 5.7.6.

5.7.6. Initial Vegetation Removal

Prior to the start of under scrubbing, i.e. the removal of ground vegetation and shrubs, the Contractor is to relocate existing piles of dead logs and any snags into the designated biodiversity offset area. The relocated log piles are to be spread out to avoid providing habitat for rabbits.

Following this activity, under scrubbing and the removal of non-habitat, non-hollow trees and stumps will take place. Removal of these trees should provide the incentive for fauna to move from the habitat/hollow bearing trees and allow any fauna rescue efforts by the spotter/catcher to be concentrated on trees that are most likely to be inhabited.

Trees designated as possible habitat trees shall be individually removed after a minimum 24 hours delay or after being checked for fauna by the spotter/catcher. After felling these trees will be inspected by the spotter/catcher prior to further processing.

The Contractor shall be responsible for the grubbing and disposal to the designated area of tree roots down to a depth of 500mm below the natural surface. Holes left following grubbing shall be back filled and compacted promptly with sound material, sourced from within the site, to prevent the infiltration and ponding of water.

5.7.7. Disposal of Material

On completion of clearing and grubbing within a designated area the Contractor shall dispose of the cleared and grubbed material as shown below.

i. Hollow trees, dead logs and snags to the biodiversity offset area.

ii. Vegetation matter to the organic stockpile.

iii. Trees shall be converted to mulch and stockpiled in the designated area.

iv. Tree roots shall also be converted to mulch and stockpiled.

5.7.8. Erosion Control

The Contractor shall take all measures necessary to prevent soil erosion from the site during clearing and grubbing by the use of sediment fencing, straw bales and other prevention measures in accordance with the approved Sediment and Erosion Control Plan.

On completion of the clearing and grubbing the Contractor shall install sediment fencing as shown on the Drawings or as directed by the Superintendent's Representative.

5.8. STOCKPILES

All stockpiles shall be located so that drainage from the stockpile flows into the site sedimentation basins. Where a stockpile cannot be located such that drainage flows into the site's erosion and sediment control measures, the stockpile shall have a drainage swale placed on the uphill side of the stockpile to divert surface water from the stockpile area and sediment traps at its base to capture sediment running off the stockpile. These drainage measures shall be constructed as per the Landcom's Managing Urban Stormwater: Soils and Construction – Volume 1 (4th Ed., 2004), informally known as the "Blue Book".

5.9. SOIL STOCKPILES

5.9.1. Location

A semi permanent soil stockpile is to be located as shown on the Drawings. Topsoil stripped from the site to be used in the reinstatement of the Works, or to remain for topsoiling of the landfill on closure, should be stored here. The Superintendent's Representative may reject topsoil not considered suitable for these purposes.

Where the Contractor's activities require temporary stockpiling of soils, the Contractor shall place material in locations approved by the Superintendent's Representative.

5.9.2. Placement of Soil Stockpiles

All stockpiled material shall be placed in layers not greater than 500mm and track rolled. The finished stockpile shall be neat, stable and free-draining. Stockpiles shall be constructed with a batter slope not greater than 1V:3H and with a minimum surface grade of 5%. Stockpiles shall be not greater than 3 metres in height, unless otherwise approved by the Superintendent's Representative. In addition, all stockpiles shall:

- have rounded shoulders and base of batters to minimise wind and water erosion; and
- have a filter fence along the lower boundary and the sides.

5.9.3. Topsoil Stripping

Topsoil and organic material must be stripped from within the footprint of the Works including formation areas of buildings, roads, embankments, drains, pipelines, pathways and miscellaneous pavements, inclusive of batters. Topsoil must be conserved for the topdressing of surfaces, berms and batters to the specified depth, or where no depth is specified to a minimum depth of 150mm. The Contractor shall adopt procedures which prevent contamination of topsoil during stripping and handling, and stage stripping where possible to avoid wetting up of subgrades during periods of rainfall.

The Contractor should note that when stripping topsoil for 20 metres on either side of the two creeks across the access road it is a requirement of the Construction Environmental Management Plan that an aboriginal observer be present. The Local Aboriginal Land Council will provide advice on who to contact. The cost of the observer will be borne by Contractor.

The Contractor must remove and stockpile all topsoil materials within the topsoil stockpile as shown on the Drawings, in heaps or windrows to a maximum height of 3.0 m, outside of hazard areas such as drainage depressions.

The Contractor must not allow traffic on the stockpiles. If a stockpile is to remain for more than four weeks, the Contractor must sow completed areas of the stockpile with grass. The Contractor must as far as practicable protect the topsoil stockpile from contamination by other excavated material, weeds and construction debris.

5.10. UNSUITABLE MATERIAL

5.10.1. Identification of Unsuitable Material

Materials that are unsuitable to be used as fill materials for earthworks include the following:

a) Material which in the opinion of the Superintendent's Representative cannot be incorporated into the Works even if worked, treated or conditioned.

b) Burning material and material capable of spontaneous combustion.

c) Vegetative material, including logs, stumps and roots.

d) Any other material designated by the Superintendent's Representative as being material that is unsuitable to be incorporated within the completed works.

5.10.2. Construction Requirements

The Contractor should seek to manage surface and subsurface moisture, by moisture conditioning dry materials and draining/drying back materials that have become excessively wet. The Contractor shall identify any unsuitable material and shall either remove and replace it with suitable material, or treat the material so that it can be incorporated into the Works.

5.10.3. Disposal of Surplus and Unsuitable Material

The Contractor shall dispose of all surplus and unsuitable material at the temporary material and unsuitable material stockpile at the locations indicated on the Drawings.

All surplus and/or unsuitable material from any area on the site shall be placed in temporary stockpiles that comply with clause 5.10.2.

5.11. EXCAVATION AND SUBGRADE PREPARATION WORKS

5.11.1. General

The Contractor shall excavate to the lines, levels, grades and dimensions indicated on the Drawings. The Superintendent's Representative may instruct the Contractor to remove any unsuitable material, soft spots, or organic material exposed after final trimming below the lines and levels of excavation indicated on the Drawings.

All slopes and batters formed must be maintained to provide a safe excavation under all weather conditions during construction.

Notwithstanding the above requirements, the Contractor shall construct excavations to the minimum dimensions necessary to enable the safe construction of the Works. The Contractor shall perform all temporary works necessary to maintain the stability and integrity of all excavations and to provide safe working conditions for its personnel working in or near any excavation.

5.11.2. Materials to be Excavated as Found

The Contractor alone will assume full responsibility for the interpretation of any or all subsurface site information and must allow for the excavation of any and all material encountered in the excavations irrespective of any description or classification contained therein. Geotechnical information and interpretations supplied by Council are for information purposes only, and no guarantee is given by Council as to its adequacy, accuracy or completeness.

Council will provide access to the site for the Contractor to undertake it's own site investigations during the Tender period to supplement and/or confirm the information provided so as to allow it to fully inform itself of the subsurface conditions likely to be encountered during construction in accordance with the contract.

Earth fill materials must not be placed until the Contractor has demonstrated to the Superintendent's Representative' satisfaction that these materials conform to the requirements of these Technical Specifications. The Contractor should do its own classification of the respective onsite soil types and manage the same according to a quality assurance lot identification plan. Each lot is to be representatively sampled and tested to confirm material properties, and confirm material classification prior to any material treatment and or placement and compaction according to plans. After placement of each layer of the cell and dam lining, the Contractor is to resample and retest for both required material properties and required compaction prior to the placement of subsequent layers.

No additional payments will be made for failure by the Contractor to make it's own interpretations of the subsurface conditions, to make any and all necessary allowances required to complete the work based on those interpretations, or to appropriately manage and/or treat the materials.

5.11.3. Excavation of Material for Site Roads

The Geotechnical Reports indicate that material suitable for the subbase and base of gravel site roads may be found along the line of the site access road,

It is anticipated that normal excavation for the access road will produce enough suitable fill material for the gravel roads. Should additional material be required Council is prepared to authorize the widening of cuttings on the access road so that sufficient material can be obtained.

Contractors are required to make their own interpretations of the Geotechnical Reports and to make suitable allowance in their Tender to use either material won from onsite excavations or to import suitable material.

5.11.4. Excavation in Rock

Rock is monolithic natural material with volume greater than 0.5 m^3 which cannot be removed until broken up by rippers at a ripping production rate less than the rate indicated in the table below for various classes of crawler tractor, equipped with a heavy duty single tine parallelogram ripper approved by the tractor manufacturer for use with that tractor.

Boulders measuring 0.4 m^3 or more in volume removed in trench excavation will be classified as rock. Isolated boulders each greater than 0.8 m^3 in volumes shall be defined as rock excavation.

Table 1 Crawler Tractor Production Rates

Class of Crawler Tractor (Table 10.1 of AS 2868)	Production Rate m3/h
150C	50
200C	75
300C	150

In rock cuttings, a 150mm compacted thickness subgrade layer shall be constructed using embankment material to the requirements for subgrade preparation, Clause 5.11.7. The surface of the exposed rock shall be trimmed to allow free drainage to the table drains prior to the placement of subgrade. Rock cuttings and exposed rock surfaces adjacent to the roadway shall be trimmed to provide a natural appearance similar to local cliff faces.

No additional payments will be made for the preparation of rock foundations

5.11.5. Over-Excavation

If the Contractor has exceeded the section area of excavation, as shown on the Drawings, in consequence of injudicious working, slips, falls, or for any other cause then the Contractor must remove such extra materials, make good and back fill in the extra excavation with general fill in accordance with Clause 5.13.2. All work of this nature is at the Contractor's expense.

5.11.6. Reinstatement of Excavated Areas

In those areas where the Contractor has undertaken excavation for the purpose of using the excavated material elsewhere on the Works, e.g. clay or gravel, then the Contractor shall be responsible for reinstating those areas to the satisfaction of the Superintendent's Representative. This shall include topsoiling and revegetation where appropriate. Although the excavated areas will not necessarily have to be reinstated to the original contours, the formation of dips or hollows that contain standing water, or of ground features that impede the previous surface water flow patterns, will not be allowed.

Should the Contractor source clay from the landfill cell or the leachate pond, by excavate to a depth greater than the finished levels shown on the Drawings, then the Contractor shall infill those areas to the finished levels using suitable excavated material from site in accordance with Clause 5.12.5 to the satisfaction of the Superintendent's Representative.

The cost of reinstatement shall be deemed to be included in rate submitted for the provision of the material excavated.

5.11.7. Subgrade Preparation for Filling

Following surface excavation works, the Contractor shall carry out compaction of the base of excavations and stability testing prior to any filling works. Stability will be gauged via a proof roll with a 15 tonne plus multi-tyred roller passing over the foundation and the subgrade foundation showing no noticeable signs of movement.

The Contractor shall, prior to the placement of fill, remove any surface material that would prevent the satisfactory placement of fill layers, including loose or unsuitable material, debris and organic matter. Local holes and depressions shall be filled with general fill in accordance with Clause 5.12.2.

The surface, other than in rock, on which fill will be placed shall be ripped to a minimum depth of 150mm and compacted to achieve the density requirements specified in the table below. The Contractor shall adjust the moisture content of the ground surface on which fill is to be placed as necessary to achieve the required compaction.

Where the ground surface on which fill placement is to be undertaken has a slope greater than 3H:1V, the Contractor shall prepare the surface for fill placement by excavating benches that are generally horizontal, but remain free draining, and have a vertical height not less than 300mm.

Table 2 Minimum Subgrade Compaction Requirements

Material	Minimum Compaction Requirements	Moisture Content	Layer Thickness
Base of excavations including clay liner subgrade	**Cohesive Soil:** 95% Standard Maximum Dry Density or 95% Relative Compaction Hilf Rapid Method **Non Cohesive Soil:** 90% Density Index	90% to 98% of OMC	Not applicable

The final subgrade surface, prior to placement of fill material, shall be proof-rolled by at least four passes of a minimum 15 tonne non-vibrating pad-foot roller The use of a pneumatic tyred roller is unacceptable. Proof rolling testing shall be undertaken in the presence of the Superintendent's Representative. Any loose or collapsed areas shall be filled and compacted to provide a uniform surface that does not show any compaction, visible local deflection, wide scale movement, creep or cracking during rolling. The finished surface shall be firm, unyielding, smooth and uniform.

No further materials shall be placed on the subgrade surface until proof rolled and approved by the Superintendent's Representative.

5.11.8. Treatment of Unsuitable Ground Conditions

5.11.8.1. General

The Superintendent's Representative may provide advice, but not direction, to the Contractor on the effective treatment of unsuitable foundations before placing fill material.

The required treatment could comprise the excavation and removal of the unsuitable subgrade followed by the backfill, spread and compact, in 150mm layers, with site won gravel pavement material (CBR >15), up to 450mm thick, including the supply and laying of A39 geo-fabric at the base of the excavation. Alternatively the Contractor could recommend an in-situ treatment of the unsuitable material that achieves the same result for the approval of the Superintendent's Representative.

The treatment of unsuitable material shall be in accordance with Clause 5.10.2 and will be at the Contractor's risk.

The length and width of treatment will be subject to the approval of the Superintendent's Representative.

5.11.8.2. Inspection and Testing

The Contractor shall carry out inspection testing during excavation works in accordance with the requirements specified in the table below. The Contractor shall undertake testing at a frequency greater than or equal to the minimum.

Table 3 Testing and Frequency of Excavation Works

Material	Test	Test Frequency
Excavated Surface Subgrade Preparation (beneath Clay Liner)	Standard Compaction Test	Minimum of 1 test per 1,500m^2
	Moisture Content	
Excavated Surface Subgrade Preparation (beneath sealed or gravel road pavements, structural slabs, foundations)	Standard Compaction Test Moisture Content CBR (4 day soak)	Minimum of 1 test per 1000m^2

5.12. FILL MATERIAL PROPERTIES

5.12.1. General

A summary of the fill materials to be used in the Works are provided below:

- General Fill
- Embankment Fill
- Anchor Trench Fill
- Select Fill
- Clay Fill

The above materials shall be selectively sourced from on-site excavations of the cell1 landfill, leachate pond, sedimentation basin and dry basin and from the temporary material stockpiles located on site as indicated on the Drawings.

The investigation, sampling and testing of the in-situ materials are documented in the Geotechnical Interpretive Report, the Supplementary Geotechnical Report and the Additional Geotechnical Investigation. Notwithstanding, the Contractor shall undertake it's own in-situ testing to confirm the location, depth and suitability of the required fill materials and to prepare a Materials Management Plan to appropriately recover and manage the use of all excavated material, including by blending and segregating, and to optimise the volumes of each class of material for use in the permanent works.

No additional payments will be made to the Contractor for failure to implement the above requirements and which may consequently result in the requirement to import additional material or borrow from off site and or other areas on site, if approved. Regardless of where materials are sourced, material quality adherence to specification and material source is the Contractor's responsibility and risk.

The above fill materials shall not contain any of the following:

- peat, vegetation, waste, organic, soluble or perishable material,
- actual or potential acid sulphate soils,
- organic clays and silts,
- dangerous or toxic materials or
- material susceptible to combustion.

5.12.2. General Fill

General Fill shall be used in the Works as general filling to achieve the finished base liner subgrade levels (base of clay fill layer) and other general filling works as shown on the Drawings. General fill shall be selectively sourced from on-site excavations and the temporary material stockpiles located on site as indicated on the Drawings.

General fill shall not contain high plasticity clays. General fill shall be well graded in accordance with AS1726 and comply with the criteria specified in the table below.

Table 4 General Fill Material Compliance Criteria

Material Property	Minimum	Maximum
Liquid Limit	-	50
Plasticity Index – under roads - elsewhere	8 15	15 40
Particle Size Distribution – Soil content passing 37.5mm sieve – Soil content passing 75µmm sieve	 100% 30%	 -
Emerson Class	≥ 4	-

5.12.3. Embankment Fill

Embankment fill shall be used for construction of the dry basin, sedimentation basin and leachate pond embankments as shown on the Drawings. Embankment fill shall be selectively sourced from on-site excavations and temporary material stockpiles located on site or imported if needed.

Embankment fill shall be well graded in accordance with AS1726 and comply with the criteria specified in table below.

Table 5 Embankment Fill Material Compliance Criteria

Material Property	Minimum	Maximum
Liquid Limit	-	50*
Plasticity Index	10	40
Particle Size Distribution – Soil content passing 37.5mm – Soil content passing 75µmm sieve	 100 30%	 - -
Emerson Class	≥ 4	-

*Higher plasticity clay material, i.e. liquid limit >50%, could be used but require a construction procedure on the methodology of placing and compacting the material.

5.12.4. Anchor Trench Fill

Anchor trench fill shall be used as backfill within the liner anchor trench as shown on the Drawings.

Anchor Trench Fill shall be selectively sourced from on-site excavations and temporary fill stockpiles located on site.

Anchor Trench Fill shall not contain high plasticity clays. Anchor Trench Fill shall be well graded in accordance with AS1726 and comply with the compliance criteria specified in table below.

Table 6 Anchor Trench Fill Material Compliance Criteria

Material Property	Minimum	Maximum
Liquid Limit	-	50
Plasticity Index	8	40
Particle Size Distribution – Soil content passing 37.5mm sieve – Soil content passing 2.36mm sieve – Soil content passing 75µmm sieve	 100% 95% 40%	 - - 70%
Emerson Class	≥ 4	-

5.12.5. Select Fill

Select fill shall be used for the construction of subgrade layers beneath road pavements or concrete slabs as shown on the Drawings.

Select fill shall ideally be selectively sourced from on-site excavations and temporary material stockpiles located on site, but should the quantities available on site be insufficient then additional material may be imported at the Contractor's cost.

Select fill shall not contain high plasticity clays. Select fill shall be well graded in accordance with AS1726 and comply with the criteria specified in the table below.

Table 7 Select Fill Material Compliance Criteria

Material Property	Minimum	Maximum
Liquid Limit	-	30
Plasticity Index	-	12
Particle Size Distribution - Soil content passing 37.5mm sieve - Soil content passing 19mm sieve - Soil content passing 6.7mm sieve	 90% 50%	 100% 70%
- Soil content passing 2.36mm sieve	35%	55%
Emerson Class	≥ 4	-
CBR (4 day soak)	15%	-

5.12.6. Clay Fill

Clay fill shall be used to construct the clay fill liner of the landfill and leachate pond base as shown on the Drawings and shall be selectively sourced from on-site excavations and the temporary material stockpiles located on site.

Clay fill shall be well graded in accordance with AS1726 and comply with the criteria specified in table below.

Table 8 Clay Fill Material Compliance Criteria

Material Property	Minimum	Maximum
Coefficient of Permeability	-	$1x10^{-9}$ m/s
Liquid Limit	25	65*
Plasticity Index	15	50
Moisture content when placed at 95% SMDD	3% dry of OMC	0% dry of OMC

Particle Size Distribution - Maximum particle size - Soil content passing 19mm sieve - Soil content passing 75µmm sieve - Soil content passing 2µmm sieve	 - 70% 40% 15%	 50mm 100% 50% 50%
Organic Content	-	<=2%
Emerson Class	≥ 4	-
Cation Exchange Capacity	10 mEq/100g	
Classification	SC, CI, CH	

Permeability testing is to be undertaken on remoulded samples compacted to 95% standard maximum dry density at optimum moisture content with an applied cell pressure of 250kPa. A test using 50,000 ppm NaCl solution as well as fresh water should also be undertaken.

If and where necessary, the Contractor may elect to treat excavated material to achieve the above requirements, or to import suitable material, at no additional cost to Council.

5.13. PLACING AND COMPACTING FILL MATERIALS

5.13.1. General

This section relates to the placement and compaction requirements for the following earth fill materials:

- General Fill
- Embankment Fil
- Anchor Trench Fill
- Clay Fill for Liner
- Select Fill

All earth fill material must be placed and compacted in successive horizontal layers for the full width of the cross section. Each layer shall be spread evenly and thoroughly mixed to obtain a near uniform condition in each layer. In areas of excess lift thickness, regrading of the surface to the maximum lift thickness will be completed prior to construction of additional lifts. The maximum compacted layer thickness must not exceed the compacted layer thicknesses specified in Clause 5.13.7. The final lift thickness chosen must reflect the performance of the Contractor's selected method of compaction and the results of compaction testing. A pad-foot roller of sufficient weight and adequate pad depth must be used to ensure suitable compaction and bonding into underlying fill layer.

The full depth of fill must, as far as practicable, be constructed in a continuous operation. The surface of intermediate fill lifts must be kept damp to eliminate the risk of desiccation and cracking prior to overlaying successive lifts. Should drying and/or cracking of the surface occur, the surface must be scarified, moisture-conditioned and re-worked prior to placement of the next lift of fill. The fill to be placed must be benched into the existing face/edge such that no continuous alignment of 'vertical' joints occurs.

Equipment must be properly weighted and sufficient passes are to be made to attain the compaction specified. In areas, which are not suitable for rolling with power equipment the Contractor must use mechanical hand tampers to the satisfaction of the Contractor's geotechnical engineer.

Compaction by inundation or flooding is not allowed.

Fill material must be compacted in layers to the requirements of the Technical Specification as soon as practicable after placing and in a manner appropriate to the location and to the material to be compacted.

At the completion of each day's work and at any time during a shift when a delay to work appears imminent on account of rain, all fill deposited is to be spread, graded and lightly rolled to form a surface sufficiently dense and shaped to shed surface water. Upon resumption of work in those areas which have not been fully compacted, material must be ripped to its full depth, cut to shape and processed as newly deposited fill.

Material which has been moisture softened following rainfall must be removed, modified/treated or dried as appropriate, replaced and compacted, all to the satisfaction of the Superintendent's Representative, prior to placing additional fill. Such moisture impacted areas shall not be bridged over with working platforms or left to consolidate beneath clay liners.

Fill must be compacted in such a manner that structures or services are not disturbed or damaged.

It is essential that the compacted fill layer not dry out after compaction otherwise severe desiccation can occur. This causes shrinkage cracks to appear in the compacted clay. These can act as conduits for flow. At the discretion of the Superintendent's Representative, compacted clay shall be removed and re-compacted after conditioning with additional moisture if shrinkage cracks appear prior to the placement of overlying material. Clay liners exposed for more than seven days before placement of overlying materials should be covered or protected from drying out.

For specific compaction requirements, refer to Clause 5.13.7.

5.13.2. Treatment of Failed Lots

If, at any time during the progress of the Works, tests performed by the Contractor show that the specified degree of compaction is not being achieved, the Contractor must review the compaction method and if necessary change the plant or compaction methodology or both.

Lots in which the failed tests occurred shall be reworked as instructed by the Superintendent's Representative and retested, all at the Contractor's expense.

All tests shall be reported, including for lots where testing was commenced and subsequently abandoned for any reason before completion. These lots shall also be classified as failed lots.

5.13.3. Preparation of Surfaces before Fill Placement

Before any fill material is placed, the whole of the surface upon which any fill is to be constructed must be prepared by draining any surface water and or saturated areas. The surface must be ripped and compacted to 150mm thickness to ensure that the fill material can be compacted to the specified dry density ratio and that there will be no perceptible movement of the fill under compaction equipment.

The Contractor must advise the Superintendent's Representative when initially specified preparation has been completed before proceeding with further preparation for filling or with the placing of fill.

Should the surface material require draining or preparation to accept subsequent fill then this shall be undertaken by the Contractor at no cost to Council.

Where fill is to be constructed on a surface having a slope greater than 1V:3H, the surface must be excavated to provide a continuous series of horizontal terraces of heights varying between 0.3 metres and 0.6 metres and the fill constructed in uniform layer thicknesses.

5.13.4. Clay Fill Liner Field Trials

The Contractor shall conduct a field trial of the compacted clay fill prior to construction of the clay liner, for each source of clay material. This includes the clay liner to be installed under the GCL.

The trial shall be developed in consultation with the Contractor's geotechnical engineer. The purpose of the field trial is to evaluate the Contractor's proposed placement and compaction procedures and the performance of the construction equipment to be used for soil blending, processing, placement, and compaction.

The field trial may be constructed within the proposed liner area, or in an area approved by the Superintendent's Representative. If the fill is constructed in the liner area, the Contractor shall maintain or recondition the compacted clay layer, prior to installation of subsequent layers. The field trial shall include a section on the landfill base as well as on the perimeter side slopes.

The field trial or demonstration fill shall measure approximately 25 by 25 metres and may be carried out on an area that will form part of the compacted clay. Should the Superintendent's Representative approve construction of the field trial outside of the proposed clay liner area, the Contractor shall construct the field trial on an area consistent with those for the landfill cell and shall be constructed using the methods, materials and equipment to be employed during construction of the actual compacted clay liner layer.

In order to evaluate the adequacy of the Contractor's methods and equipment, the Contractor shall provide field verification test results of the moisture, density and permeability relationships as specified in the Technical Specification. The following aspects of the compacted clay installation will be evaluated for the field trial:

- material workability, handling and placement requirements,
- finalise layer thickness requirements on base and batter,
- compaction equipment and procedures across the base and up the batter slopes, and
- the number of passes of equipment necessary to achieve the required results.

Prior to construction of the field trial, the Contractor shall submit for the CQA Engineer's review, the proposed location of the demonstration fill area, the equipment to be used, and the methods to be employed for processing and placement.

Testing of the compacted clay shall be undertaken after each lift has been placed and compacted. A minimum number of three lifts shall be constructed. The Contractor may propose to alter the minimum number of lifts contingent on approval and provision of evidence and supporting documentation (i.e. test results), which confirm compliance with the moisture, density and permeability requirements of the Technical Specification.

The field trial area shall be divided into four quadrants. On completion of the field trial, the Contractor shall provide from random locations in each quadrant of each lift certified test results measuring the in-situ density and moisture content of the compacted clay fill. Two undisturbed samples from each quadrant shall be taken and tested for laboratory permeability in accordance with Clauses 5.14.3 and 5.13.6.

The Contractor shall employ appropriately qualified construction quality control personnel and shall be responsible for undertaking all field and laboratory tests associated with the field trial and shall provide certified copies of all test results to the Superintendent's Representative within 24 hours from receipt of the test results by the Contractor.

If the results of field trials are satisfactory, the area may be incorporated into the permanent works provided that the Contractor maintains the integrity of the low permeability layer in accordance with the Technical Specification. If unsatisfactory, the field trial area shall be excavated and removed. The Contractor shall then submit proposals for a revised procedure for approval before continuing with further field trials.

All aspects of the subgrade preparation and fill construction shall be in accordance with the Technical Specification. The Contractor shall allow two weeks from the date of completion of the field trial and provision of test results for the Superintendents review of test results and final procedures. During that period, the Contractor may proceed with other items of work such as general excavation/fill and subgrade preparation. Scheduling of such items shall be at the discretion of the Contractor, and no additional contract time shall be allotted as a result of the two week review period.

When the test area compaction and tested permeability are achieved to the satisfaction of the CQA engineer, the Contractor shall issue the final Construction Procedure for the clay liner construction. The Construction Procedure shall outline the proposed method for construction of the remaining clay liner area and must incorporate all methodologies and processes used in the trials including the following:

- nominated clay liner material source,
- nominated spreading and compaction plant,
- maximum loose layer thickness,
- layer watering and mixing requirements and methodology,
- minimum number passes of nominated compaction plant, and
- batter slope Construction Procedure.

The Construction Procedure shall be approved by the Superintendent's Representative prior to the commencement of clay liner construction works.

5.13.5. Clay Liner Construction

The Contractor shall place and compact the compacted clay layer materials using the approved Construction Procedure for the clay fill liner based on the preliminary field trials undertaken in accordance with Clause 5.13.4.

The Contractor shall trim and compact the surface of the compacted clay layer using a grader and smooth drum roller to provide a smooth, uniform, free draining, firm surface immediately prior to installation of subsequent geomembrane layer. The Contractor shall ensure the finished

surface is free of any stones, defects or imperfections that may result in damage to the overlying layers or other objects which could puncture or damage the geomembrane layer.

The Contractor shall apply rounding at the top and bottom of batters and other changes of grade, with a radius greater than 300mm.

The Contractor shall maintain the integrity of the compacted clay layer by sprinkling the surface with water, or other means, and shall maintain the moisture content within the specified range at all times prior to installation of geomembrane layer.

The Contractor shall repair any damage to the surface of the compacted clay layer which occurs after final trimming of the surface.

The surface of the compacted clay layer shall be inspected daily by the Contractor to evaluate desiccation or erosion of the material. The Contractor shall carry out any necessary works to rectify desiccation observed during its inspection or otherwise as directed by the Superintendent's Representative. If shrinkage cracks occur the clay surface shall be reworked by lightly ripping up to 100mm depth, moisture conditioning and re-compacting using a smooth drum roller.

Immediately before placing of the geosynthetic clay liner (landfill cell) or the geomembrane liner (leachate pond) the final clay fill liner surface shall be proof-rolled by at least four passes of a minimum 15 tonne wheeled roller or fully laden water cart as approved by the Superintendent's Representative. The use of a rubber tyre roller is unacceptable. Proof rolling testing shall be undertaken in the presence of the Superintendent's Representative. Any loose or collapsed areas shall be filled and compacted to provide a uniform surface that does not show any compaction, excessive local deflection, wide scale movement, creep or cracking during rolling. The finished surface shall be firm, unyielding, smooth and uniform.

No further materials shall be placed on the clay fill liner surface until proof rolled and approved by the Superintendent's Representative.

The finished surface of the compacted clay shall exhibit the following characteristics:

- The compacted clay shall be smooth, flat, and unyielding to the satisfaction of the Superintendent's Representative before the surface is finally trimmed and rolled with a final pass of the smooth drum roller.
- The surface of the compacted clay shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks and sudden changes in grade.
- The Contractor shall seal surfaces by smooth drum rolling at the end of each day to minimise the penetration of water, provide erosion protection measures and ensure drainage systems, both permanent and temporary, are maintained.
- The surface of the compacted clay is to be maintained at sufficient moisture content to prevent desiccation during the Works until the deployment of the geomembrane.
- Any voids resulting in the compacted clay due to extraction from tube samples for testing requirements, shall be filled with water and then backfilled with sodium bentonite pellets, hand rammed into the void.

5.13.6. Rock Rip Rap

Rock rip-rap for scour protection must be placed in one layer parallel to the final finished surface. Rock fill must not be compacted but placed to ensure a densely placed well-graded mixture with all interstices between large rocks filled with rock of progressively smaller sizes.

Rock rip-rap shall be placed not to rip, tear or damage the underlying geotextile separation layer.

5.13.7. Fill Compaction Requirements

All earth fill material must be placed and compacted to the minimum dry densities and moisture contents specified in the table below unless noted otherwise on the Drawings or approved by the Superintendent's Representative.

Table 9 Minimum Fill Compaction Requirements

Material	Minimum Compaction Requirement	Moisture Content (%)	Max. Compacted Layer Thickness (mm)
General Fill for general filling up to Subgrade Level	95% Standard Maximum Dry Density or 95% Relative Compaction Hilf Rapid Method	60% to 90% of OMC	200mm
Embankment Fill	95% Standard Maximum Dry Density or 95% Relative Compaction Hilf Rapid Method	-2% to 2% of OMC	200mm
Anchor Trench Fill	95% Standard Maximum Dry Density or 95% Relative Compaction Hilf Rapid Method	-2% to 2% of OMC	150mm
Clay Fill Liner	95% Standard Maximum Dry Density or 95% Relative Compaction Hilf Rapid Method	0% to 3% of OMC	150mm
Select Fill (Road Pavements)	**Top 300mm road pavement** 100% Standard Maximum Dry Density or 95% Relative Compaction Hilf Rapid Method **Below 300mm road pavement** 98% Standard Maximum Dry Density or 95% Relative Compaction Hilf Rapid Method	60% to 90% of OMC	150mm

5.14. QUALITY CONTROL REQUIREMENTS

5.14.1. Construction Records of Compacted Fill

The Contractor shall maintain a register of in-situ test results, which shall record the following details:

- Test number
- Description of the soil
- Co-ordinates of the tests and the lot
- Density ratio
- Moisture content
- Method of testing in accordance with AS 1289.

All tests shall be reported, including those for lots where testing was commenced and subsequently abandoned for any reason before completion.

Where tests fail to meet the Technical Specification requirements, retests shall be undertaken and these shall be clearly identified in the register.

5.14.2. Source Material and Acceptability

Samples are to be taken from the proposed source in accordance with the Technical Specification and tested prior to approval of the material for use in the Works, to demonstrate that the material meets the criteria provided in the Technical Specification.

5.14.3. Inspection and Testing

The Contractor shall carry out inspection and testing during fill placement and compaction works in accordance with the requirements specified in the table below. The Contractor shall undertake testing at the frequency which is the greater of the minimum testing frequency and the minimum number of tests.

Table 10 Minimum Testing and Frequency of Fill Placement and Compaction

Material	Test	Test Frequency	
		Pre Construction (Compliance) At Source	During Construction At Site
General Fill	Particle Size Distribution	Greater of: 1 per 5,000m^3 of material or minimum of 3 per source	1 per 1,000 m³
	Atterberg Limits		
	Emerson Class		
	Standard Compaction Test	N/A	Greater of: 1 per 500m^3 of material, or 4 tests per 2,500m^2
	Moisture Content		
Embankment Fill	Particle Size Distribution	Greater of: 1 per 5,000m^3 of material or minimum of 3 per source	1 per 1,000 m³
	Atterberg Limits		
	Emerson Class		
	Standard Compaction Test	N/A	Greater of:

	Moisture Content		1 per 500m^3 of material, or 4 tests per 2,500m^2
Anchor Trench Fill	Particle Size Distribution	Greater of: 1 per 500m^3 of material or minimum of 3 per source	1 per 50 m³
	Atterberg Limits		
	Emerson Class		
	Standard Compaction Test	N/A	1 per 50 linear metres per lift of material.
	Moisture Content		
Select Fill	Particle Size Distribution	Greater of: 1 per 1,000m^3 of material or minimum of 3 per source	1 per 500 m³
	Atterberg Limits		
	Emerson Class		
	CBR (4 day soak)		
	Standard Compaction Test	N/A	Greater of: 1 per 500m^3 of material, or 1 test per 250m^2 or 1 per Lot.
	Moisture Content		
Clay Fill Liner	Remoulded Permeability	Greater of: 1 per 5,000m^3 of material or minimum of 3 per source	N/A
	Particle Size Distribution		1 per 1,000 m³
	Atterberg Limits		
	Organic Conte		1 per 2,000 m³
	Emerson Class		
	CEC		N/A
	In-situ Permeability (Undisturbed)	N/A	1 per 2,000 m^2
	Standard Compaction Test	N/A	Greater of: 1 per 500m^3 of material, or 5 tests per 2,500m^2.
	Moisture Content		

5.14.4. Quality Assurance Requirements

The Contractor shall provide the CQA Engineer with a copy of all quality compliance documentation and test certificates demonstrating compliance with the Technical Specification. The CQA Engineer shall review the documentation provided by the Contractor and shall provide approval, or otherwise, for use of the materials in construction of the Works.

The CQA Engineer shall undertake inspections and perform independent laboratory and field testing of compacted clay fill liner materials in accordance with testing and frequency specified in the Contractor's Quality Assurance Plan and in the table below.

Table 11 Minimum Quality Testing and Frequency of Clay Fill Liner Compaction

Material	Test	Minimum Test Frequency	
		Pre Construction (Compliance)	During Construction
		At Source	At Site
Clay Fill Liner	Re-moulded Permeability	1 per 5 tests	N/A
	Liquid Limit		
	Plasticity Index		
	Particle Size Distribution		
	Emerson Class		
	Standard Compaction Test	N/A	1 per 5 tests
	Moisture Content		
	In-situ Permeability * (Undisturbed)	N/A	1 per 10 tests

- In-situ testing means taking cores from the clay liner after compaction and testing them in the laboratory in accordance with AS1289 Method 6.73 Clause 7.2 Undisturbed Sample.

5.15. GEOSYNTHETIC CLAY LINER

5.15.1. Materials

The geosynthetic clay liner (GCL) material shall be a reinforced multi-layered system comprising two layers of geotextile encapsulating a layer of dry sodium bentonite. The GCL shall comprise a woven or composite woven plus non-woven carrier geotextile, and a non-woven cover geotextile, and shall be needle punched across the bentonite layer, and be thermally locked. The GCL shall comply with the physical properties detailed in Table 12 below.

All GCL rolls shall have a minimum 300mm bentonite pre-treatment on the longitudinal edge of the roll to allow for the use of overlapped joins on the longitudinal edge between GCL panels. The width of the pre-treatment shall be marked on the GCL.

The roll length of GCL shall be sufficient to enable the Contractor to comply with the requirements of Section 5.15.4.7 in respect of transverse joins on slopes. The Contractor shall be responsible for any necessary consultation with the GCL supplier procure any special order materials that may be required to comply with the Technical Specification.

Table 12 GCL Physical Properties

Physical Property	Test Method	Criteria (minimum average roll value)
Cover geotextile mass	ASTM D5261	2 200 g/m²
Bentonite layer mass (measure at 0% moisture content)	ASTM D5993	2 3700 g//m²
Carrier composite geotextile mass, including woven geotextile	ASTM D5261	2 110 g/m²
Strip Tensile Strength (roll direction)	ASTM D6768	2 8 kN/m
CBR Elongation (both directions)	AS3706.4	2 20 %
Permeability	ASTM D5887	≤ 5 x 10^{-11} m/s
Swell Index	ASTM D5890	2 24 mL/2 g
Peel Strength	ASTM D6496	2 300 N/m

5.15.2. Packaging and Identification

The Contractor shall ensure that each roll of GCL is labelled with the manufacturer's name, GCL type, lot number, roll number, and roll dimensions (length, width and gross weight) and the date manufactured.

All GCL rolls shall be packaged in an opaque waterproof layer of plastic wrapping during shipment and storage. The plastic wrapping shall be placed around the GCL roll in the manufacturing facility and shall not be removed until installation.

5.15.3. Transport, Handling and On-site Storage

Handling of GCL shall comply with the manufacturer's recommendations. The Contractor shall handle the GCL materials in a manner which avoids damage to the GCL or in any manner that may affect its compliance with the requirements of the Technical Specification.

The Contractor shall provide enclosed on-site storage for GCL products necessary to comply with the manufacturer's recommendations and protect the products from degradation. On-site storage shall comply with the following requirements:

- GCL shall not be subjected to extremes of either hot or cold temperatures, and with the manufacturer's protective cover undisturbed.
- GCL shall be protected from abrasion and puncture.
- Mud, wet concrete, epoxy, or other deleterious materials shall be prevented from coming in contact with and affixing to GCL materials.
- GCL materials shall be protected from construction equipment, sparks and flames.

The Contractor shall provide the Superintendent's Representative with a copy of all manufacturer's quality assurance documentation and test certificates for GCL delivered to the site. The Superintendent's Representative shall review the documentation provided by the Contractor and shall provide approval, or otherwise, for use of the materials in construction of

the Works. The Contractor shall not proceed with installation of the GCL prior to obtaining written approval from the Superintendent's Representative.

The Contractor shall remove from site any GCL rolls that are delivered without the necessary manufacturer's quality assurance documentation and test certificates, or that do not comply with the requirements of the Technical Specification or are damaged or otherwise unsuitable to be incorporated in the Works.

5.15.4. Installation of Geosynthetic Clay Liner

5.15.4.1. General

The Contractor shall install the GCL in accordance with the manufacturer's recommendations. The Contractor shall notify the Superintendent's Representative prior to commencement of GCL installation.

The GCL shall not be covered with subsequent layers until the Superintendent's Representative is satisfied that all information related to the installed works has been recorded and meets the requirements of the Technical Specification.

The entire works required for installation of the GCL is to be witnessed by the CQA Engineer or designate.

5.15.4.2. Panel Nomenclature and Roll Traceability

The Contractor shall individually identify on a drawing the location of each GCL panel, being any continuous GCL sheet that is to the joined in the field, whether a full roll or portion of a roll. The Contractor shall nominate a unique identification code for each panel and each join, and a system of record keeping that will allow the Contractor to record the roll number of the material used for each panel at the time of installation.

The GCL panel code shall be used by the Contractor to identify the location of all quality assurance records and tests.

5.15.4.3. Survey Prior to installation

The Contractor shall, prior to the installation of GCL, survey the prepared surface and provide the survey to the Superintendent's Representative. The Contractor shall not proceed with the installation of the GCL prior to approval of the survey.

5.15.4.4. Surface Preparation

The Contractor shall ensure that the clay liner surface upon which the GCL is to be deployed has been prepared in accordance with the requirements of Section 5.13.5 prior to deployment of the GCL. The Contractor shall also ensure that the clay comprising the liner under the GCL has not been treated with hydrated lime or any other substance that could compromise the integrity of the GCL.

The Contractor shall obtain the approval of the surface on which the GCL is to be laid from the Superintendent's Representative prior to deployment of any GCL.

5.15.4.5. GCL installation Requirements

The GCL shall be installed at the locations and to the lines, grades and dimensions shown on the Drawings. Panel layout and deployment shall be such that all seams required on batters run down the batter slope and are oriented perpendicular to the top of slope. The seam orientation for batter slopes shall continue for a distance not less than 10 metres from the top and/or toe of the batter slope, unless indicated otherwise on the Drawings. GCL panels placed on any batter shall extend a minimum horizontal distance not less than 2 metres beyond the top and/or toe of the batter unless otherwise approved by the Superintendent's Representative. Transverse joins between GCL panels shall not be permitted in any sump or other depression.

The Contractor shall prepare and submit a detailed GCL panel layout plan for approval by the Superintendent's Representative not less than seven days prior to installation of the GCL. The GCL layout plan shall detail the following:

- The layout of GCL panels indicating the location of joins.
- The location of temporary perimeter anchoring of the GCL.
- Detail of any anticipated departures from the Drawings.

The GCL shall be clean and free of all foreign material prior to placement.

The Contractor shall install GCL materials only in dry weather conditions. The Contractor shall not deploy GCL during rain or when excessive moisture conditions exist, including during fog or dew, or in high winds or other adverse climatic conditions.

The Contractor shall, at all times, ensure that the handling and placement of GCL rolls and panels does not cause degradation of the materials.

5.15.4.6. Procedure for the Deployment of GCL

The Contractor shall deploy the GCL in a manner that complies with the following requirements:

The Contractor shall only remove from onsite storage the amount of GCL that they can reasonably expect to install the same day.

The GCL shall be dry upon installation.

The GCL shall be installed with the woven or composite woven plus non-woven carrier geotextile in contact the prepared surface.

The Contractor shall transport and deploy the GCL with a spreader bar that is capable of controlled deployment of the GCL under constant tension, and which ensures the GCL is installed without folds, wrinkles or creases.

The Contractor shall ensure that the GCL is not damaged during deployment and is not strained to conform to the prepared surface; the Contractor shall install joins as necessary to allow the GCL to conform to the prepared surface

The Contractor shall ensure that the GCL is free of tension at completion of deployment

The Contractor shall ensure that the GCL is not damaged in any way during installation. The Contractor must protect the GCL from damage, shrinkage or water absorption, and must replace any damaged material.

5.15.4.7. Joins Between GCL Panels

The Contractor shall install the GCL to provide a minimum 300mm overlap on longitudinal edge of each GCL panel and a minimum 600mm overlap of each transverse edge. The Contractor shall not be permitted to construct transverse joins on slopes steeper than 1V:10H.

The Contractor shall notify the Superintendent's Representative prior to commencement of any transverse joins in the GCL.

Transverse joins shall be sealed using bentonite paste in accordance with the manufacturer's recommendations. The bentonite paste shall penetrate the cover geotextile of the underlying GCL panel and sufficient bentonite paste shall be retained on the surface of the underlying GCL panel to seal the overlap.

5.15.4.8. Repair of Folds, Wrinkles and Creases

The Contractor shall repair all folds, wrinkles or creases in the GCL that are greater than 50mm in height and otherwise as directed by the Superintendent's Representative.

Folds, wrinkles and creases shall be repaired as follows:

- The Contractor shall cut the fold, wrinkle or crease along its crest.
- The area shall be separated to produce an overlap between the two sides of the cut area.

The Contractor shall apply a priming layer of low viscosity bentonite paste to the underlying part of the overlap; the bentonite paste shall penetrate the cover geotextile.

The Contractor shall apply a 10mm thick layer of high viscosity bentonite paste to the underlying part of the overlap and shall lap and compress the two parts to form an overlapped join.

The Contractor shall apply a 20mm thick layer of high viscosity bentonite paste over the overlapped join, extending not less than 100mm beyond the edges of the join. The area shall be covered with separation geotextile and compressed.

5.15.4.9. Protection of GCL Following Installation

The Contractor shall install the geomembrane in accordance with Section □immediately upon installation of the GCL, and in any case not more than one day following deployment of the GCL. The exposed edges of deployed GCL shall be protected by HDPE film at the completion of work each day.

The Contractor shall prevent overland flow and/or ponding of rainfall runoff in any area of the GCL prior to completion of installation of the geomembrane in accordance with Section 5.11 and placement of leachate drainage layer in accordance with Section 5.18.

The Contractor shall not traverse the GCL with construction plant or equipment.

5.15.5. Quality Assurance Requirements

5.15.5.1. Installation Records

The Contractor shall provide to the Superintendent's Representative a drawing showing the layout of its GCL panels and a schedule of its panel code and roll numbers in accordance with Clause 5.15.4.5.

5.15.5.2. Manufacturer's Quality Assurance Documentation and Test Certificates

The Contractor shall provide product data sheets listing the physical properties, expressed as minimum average roll value, for each GCL type prior to shipment. The Contractor shall submit manufacturer's quality assurance documentation and test certificates to the Superintendent's Representative not less than seven days prior to the installation of the GCL.

The certification shall include the following:

- A list of the materials that comprise the GCL.
- Quality control certificates issued by the bentonite supplier to the manufacturer.
- Details of testing conducted by the manufacturer to verify that the resin used to manufacture the GCL complies with the requirements of the Specification./
- Details of the testing conducted by the manufacturer to verify that the GCL complies with the requirements of the Technical Specification.
- Written certification that minimum values given in the Technical Specification are guaranteed by the GCL manufacturer as minimum average roll values.
- Quality assurance certificates, including the sample identification, testing procedure and test results
- Written certification that the manufacturer has continuously inspected the GCL for the presence of needles and found the GCL to be needle free.

Quality assurance testing and certification shall be carried out by the manufacturer from batch-based samples to be supplied to site in accordance with the requirements table below. Once delivered to site, the CQA Engineer shall also undertake conformance quality assurance.

Table 13 Minimum Sampling and Test Frequencies for Manufacturer Product Testing and Certification

Physical Property	Test Method	Minimum Test Frequency	
		By Manufacturer	Delivered CQA Conformance
Cover geotextile mass	ASTM D5261	1 test per production lot	N/A
Bentonite layer mass (measure at 0% moisture content)	ASTM D5993	1 test per 2,500 m^2	
Carrier composite geotextile mass, including woven geotextile	ASTM D5261	1 test per production lot	
Strip Tensile Strength (roll direction)	ASTM D6768	1 test per 10,000 m^2	Refer CQA Plan

CBR Elongation (both directions)	AS3706.4	1 test per 40,000 m^2	
Permeability	ASTM D5887	1 test per 40,000 m^2	
Swell Index	ASTM D5890	1 test per 40,000 m^2	
Peel Strength	ASTM D6496	1 test per 2,500 m^2	
Total Mass per Unit Area		1 test per 2,500 m^2	

5.15.5.3. CQA Conformance Testing

Upon delivery of the rolls of GCL, the Contractor shall obtain CQA conformance test samples from the shipped on-site GCL. These samples shall then be forwarded to a NATA accredited and approved laboratory for testing to ensure conformance to the Technical Specification.

The following conformance tests shall be conducted upon delivery of the GCL to the site as specified in the table above and specified in the CQAP:

- Total Mass
- Peel Strength
- Swell Index
- Permeability
- CBR Elongation
- Tensile Strength

These conformance tests shall be performed in accordance with the test methods in the Technical Specification. The rolls to be sampled shall be selected by the CQA Engineer. Samples shall be taken across the entire width of the roll and shall not include the first metre. Unless otherwise specified, samples shall be 500mm long by the roll width. The CQA Engineer shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the CQA Engineer from non-consecutively numbered rolls based on a review of all roll information including quality control documentation and manufacturing records. Unless otherwise specified, samples shall be taken at a rate of one per lot, but should not to be less than the minimum conformance test frequency specified in the CQAP.

All conformance test results shall be reviewed and accepted or rejected by the CQA Engineer. Any GCL laid prior to the receipt of the test results shall be at the Contractor's own risk. The CQA Engineer shall examine all results from laboratory conformance testing and shall report any non-conformance to the Superintendent's Representative. The CQA Engineer shall be responsible for checking that all test results meet or exceed the property values listed in the Technical Specification.

If a test result is in non-conformance then, at the option of the Superintendent's Representative, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the Technical Specification. This procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot. Material proven as non-

conforming will not be used in the Works unless agreed by the Superintendent's Representative. Re-testing shall be done at the expense of the Contractor.

A lot, with the agreement of the CQA Engineer, may also consist of rolls that are not consecutively produced or numbered. The CQA Engineer will take samples for conformance testing from these lots. If a test is a non-conformance then the procedure will be as detailed above, although the rolls are not consecutively numbered.

If the Contractor has reason to believe that failing tests may be the result of the testing laboratory incorrectly conducting the tests, they may request that the sample in question be re-tested by the laboratory with a technical representative of the manufacturer present during the testing. This re-testing shall be done at the expense of the Contractor. Alternatively, the Contractor may have the sample re-tested at two different laboratories approved by the CQA Engineer and at the expense of the Contractor. If both laboratories produce passing results, the material shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CQA Engineer.

5.15.5.4. Acceptance of the GCL

Where discrepancies between the documentation supplied and the rolls delivered arise, or if rolls appear damaged or otherwise out of specification, the CQA Engineer shall advise the Contractor accordingly.

The CQA Engineer will refuse individual rolls to be accepted for delivery if:

- The manufacturer's documentation shows discrepancies with the materials actually delivered to site.
- The manufacturer's quality assurance documentation indicates rolls out of conformance.
- The physical condition of the materials indicates evidence of inappropriate handling or storage prior to arrival at site.

If, subsequent to delivery, defects in the GCL become apparent or rolls are damaged due to poor handling or storage, the CQA Engineer may refuse to allow affected materials to be incorporated in the Works.

The CQA Engineer shall advise the Contractor of any materials that are refused for incorporation in the Works, either on delivery or subsequently, and shall require the Contractor to remove the materials from the site as soon as reasonably practicable. Such materials shall be clearly marked as refused for incorporation in the Works and shall be 'quarantined' in an area to be agreed before removal from the site.

The Contractor shall not place any GCL until the Superintendent's Representative has approved the material.

5.15.6. GCL repair

The Contractor shall record the location and details of any defects in the GCL and shall reference the Contractor's panel code. The Contractor shall repair folds, wrinkles and creases in accordance with Section 5.15.4.8. The Contractor shall repair rips and tears in the GCL and premature hydration in accordance with Section 5.15.6.1 and Section 5.15.6.2 respectively, and shall repair any other defects as directed by the Superintendent's Representative.

5.15.6.1. Repair of Rips and Tears

The Contractor shall completely expose the damaged area, shall remove all deleterious material, including soil material, and shall place a patch of GCL of the same specification over the damaged area plus an additional 500mm in all direction. The GCL patch shall be installed with bentonite paste applied as follows:

- a priming layer of low viscosity bentonite paste to the underlying part of the overlap; the bentonite paste shall penetrate the cover geotextile;
- a 10mm thick layer of high viscosity bentonite paste to the underlying part of the overlap and shall lap and compress the two parts to form a overlapped join; and
- a 20mm thick layer of high viscosity bentonite paste over the perimeter of the patch, extending not less than 100mm beyond the edges of the join.

5.15.6.2. Repair of Premature Hydration

The Contractor shall notify the Superintendent's Representative if the GCL becomes hydrated prior to placement of the geomembrane and the leachate drainage gravel. The Superintendent's Representative shall nominate the required repair or replacement of the material. The Contractor shall not be entitled to additional payment for repair work performed at the direction of the Superintendent's Representative.

5.16. GEOMEMBRANE LINER

5.16.1. Contractor's Personnel

The Contractor shall nominate in the respective Tender Schedule a geomembrane sub-contractor who has specialist experience in the installation of geomembrane liners comparable those specified for this project.

In accordance with AS2124 the Contractor shall not vary the nominated geomembrane sub-contractor.

The Contractor shall designate the sub-contractor's personnel prior to the commencement of the installation of the geomembrane liner for approval by the Superintendent's Representative.

The Contractor shall demonstrate, to the satisfaction of the Superintendent's Representative that the geomembrane sub-contractor's personnel have an average of not less than two years experience in the installation of geomembranes.

The sub-contractor shall appoint a head seamer, who shall be responsible for the direct supervision of the personnel undertaking the geomembrane installation.

5.16.2. Observation by the Superintendent's Representative

The Contractor shall undertake all work in a manner that enables the Superintendent's Representative and/or the CQA Engineer to observe the work and carry out all of their obligations under the Contract.

5.16.3. Materials

5.16.3.1. General

The geomembrane shall comprise a co-extruded, unreinforced high density polyethylene (HDPE) with double sided smooth or texturing to the extents and locations as delineated on the Drawings. The geomembrane shall be manufactured from the same source of virgin premium quality polythene resin and shall be manufactured specifically for the purpose of liquid containment.

5.16.3.2. Base Resin

The geomembrane base resin shall be newly manufactured and shall be suitable for the intended purpose. The geomembrane base resin shall comply with the following requirements:

- Specific gravity shall be not less than 0.93 g/m3, determined in accordance with ASTM D792.
- Base resin content shall be not less than 97%.
- Carbon black content shall be not less than 2%.
- The recycled resin content shall not exceed 2%.
- The combined additives content, including but not limited to antioxidants, heat stabilisers, fillers and extenders shall not exceed 3%.

5.16.3.3. Physical Appearance of the Geomembrane

The geomembrane shall not have striations, pinholes or bubbles on the surface of the geomembrane sheet. The geomembrane shall be produced free of holes, blisters, undispersed raw materials, or signs of contamination by foreign matter. All geomembrane shall be supplied in rolls. The edges of the sheets shall be straight and free from nicks and cuts.

The geomembrane installed on batter slopes shall be textured both sides (0.25mm roughness height). Texturing on the surface of the geomembrane shall be uniform and homogeneously distributed.

5.16.3.4. Physical Properties of the Geomembrane

Geomembrane shall comply with the physical properties detailed in table below for both smooth and textured types.

Table 14 Physical Properties for Smooth and Textured HDPE Geomembrane Liner

Physical Property	Test Method	Minimum Criteria (minimum average roll value)	
		Smooth	Textured
Thickness	ASTM D 5994	2 mm ±10 %	2 mm ±10 %
Lowest individual roll thickness	ASTM D 5994	1.8 mm	1.8 mm
Asperity height	ASTM D 7466	n/a	0.4 mm

Density	ASTM D 1505	0.94 g/cm^3	0.94 g/cm^3
Melt Flow Index	ASTM D 1238	< 1.0 g/10 min	< 1.0 g/10 min
Carbon Black Content (range)	ASTM D 4218	2 – 3%	2 - 3%
Carbon Black Dispersion (rating)	ASTM D 5596	90 % Cat. 1 or 2 10% Cat 3	90 % Cat. 1 or 2 10% Cat 3
Tensile Properties (each direction):	ASTM D 6693 Type IV		
Strength at Yield		21 kN/m	21 kN/m
Strength at Break		53 KN/m	21 kN/m
Yield Elongation		12%	12%
Break Elongation		700%	100%
Tear Resistance	ASTM D 1004	249 N	249 N
Puncture Resistance	ASTM D 4833	640 N	534 N
Stress Crack Resistance	ASTM D 5397	500 hr	500 hr
Oxidative Induction Time (OIT): Standard OIT and High Pressure OIT	 ASTM D 3895 ASTM D 5885	 100 min 400 min	 100 min 400 min
Oven Aging at 85°C - High Pressure Oxidative Induction Time	ASTM D 5721 ASTM D 5885	80% retained after 90 days	80% retained after 90 days
UV Resistance - High Pressure Oxidative Induction Time	ASTM D 5885	50% retained after 1600 hours	50% retained after 1600 hours

5.16.4. Packaging and Identification

The Contractor shall ensure that each roll of geomembrane is labelled with the manufacturer's name, geomembrane type, thickness, lot number, roll number, and roll dimensions (length, width and gross weight) and the date manufactured.

All geomembrane rolls shall be packaged in an opaque waterproof layer of plastic wrapping during shipment and storage. The plastic wrapping shall be placed around the geomembrane roll in the manufacturing facility and shall not be removed until installation.

5.16.5. Transport, Handling and Onsite Storage

Handling of geomembrane shall comply with the manufacturer’s recommendations. The Contractor shall handle the geomembrane materials in a manner which avoids damage to the geomembrane or in any manner that may affect its compliance with the requirements of the Technical Specification.

The Contractor shall provide enclosed onsite storage for geomembrane products necessary to comply with the manufacturer’s recommendations and protect the products from degradation. Onsite storage shall comply with the following requirements:

- Geomembrane shall not be subjected to extremes of either hot or cold temperatures.
- The manufacturer's protective cover shall be undisturbed.
- Geomembrane shall be protected from abrasion and puncture.
- Mud, wet concrete, epoxy, or other deleterious materials shall be prevented from coming in contact with and affixing to geomembrane materials
- Geomembrane materials shall be protected from construction equipment, sparks and flames.

The Contractor shall visually inspect the surface area of every roll of material delivered to the site for obvious visual flaws, such as damaged portions, tears, punctures, cracks, clear variations in thickness or mass from the specified values.

The Contractor shall provide the CQA Engineer with a copy of all manufacturer's quality assurance documentation and test certificates for geomembrane delivered to the site. The CQA Engineer shall review the documentation provided by the Contractor and shall provide approval, or otherwise, for use of the materials in construction of the Works. The Contractor shall not proceed with installation of the geomembrane prior to obtaining written approval from the Superintendent's Representative.

The Contractor shall remove from site any geomembrane rolls that are delivered without the necessary manufacturer's quality assurance documentation and test certificates, or that do not comply with the requirements of the Technical Specification or are damaged or otherwise unsuitable to be incorporated in the Works.

5.16.6. Quality Assurance Requirements

5.16.6.1. Installation Records

The Contractor shall provide to the Superintendent's Representative a drawing showing the layout of its geomembrane panels and a schedule of its panel code and roll numbers in accordance with Clause 5.16.7.1.

5.16.6.2. Manufacturer's Quality Assurance Documentation and Test Certifications

The Contractor shall provide manufacturer's product data sheets listing the physical properties, expressed as minimum average roll value, for each geomembrane type prior to shipment. Product data sheets for the HDPE resin, listing the density, melt index, low temperature brittleness and environmental stress crack resistance, shall be provided for each resin type prior to shipment.

The Contractor shall submit manufacturer's quality assurance documentation and test certificates to the Superintendent's Representative not less than seven days prior to the installation of the geomembrane. The certification shall include the following:

- Details of the resin supplier and resin production plant, and identification and production date of the resin,
- Details of the proportion of the following materials that comprise the geomembrane, expressed as percent by weight: base resin; carbon black: other additives,
- Quality control certificates issued by the resin supplier to the manufacturer,

- Details of testing conducted by the manufacturer to verify that the resin used to manufacture the geomembrane complies with the requirements of the Technical Specification,
- Details of the testing conducted by the manufacturer to verify that the geomembrane complies with the requirements of the Technical Specification,
- Written certification that minimum values given in the Technical Specification are guaranteed by the manufacturer as minimum average roll values,
- Quality assurance certificates, including the sample identification, testing procedure and test results. Quality assurance testing and certification shall be carried out by the manufacturer from batch-based samples to be supplied to site in accordance with the requirements table below. Once delivered to site, the CQA Engineer shall also undertake conformance testing of the material on site in accordance with the requirements in the table below.

Table 15 Minimum Sampling and Test Frequency for Geomembrane Liner

Physical Property	Test Method	Minimum Test Frequency	
		Source (Manufacturer)	Delivered (Quality Conformance)
Thickness	ASTM D 5994	1 test per roll	1 test per roll
Lowest individual roll thickness	ASTM D 5199	1 test per roll	N/A
Asperity height (textured geomembrane only)	ASTM D 7466	Second roll or each roll if not in production sequence	N/A
Density	ASTM D 792	One test per manufacture batch, resin type, or geomembrane type	1 test per 5000m^2 or every 5 rolls delivered to site, whichever is the greatest number of tests.
Melt Flow Index	ASTM D 1238	One test per manufacture batch, resin type, or geomembrane type	N/A
Carbon Black Content (range)	ASTM D 1603	One test per 2,000m^2	1 test per 5000m^2 or every 5 rolls delivered to site, whichever is the greatest number of tests.
Carbon Black Dispersion (rating)	ASTM D 5596	Every 10 rolls	
Tensile Properties (each direction): Strength at Yield Strength at Break Yield Elongation Break Elongation	ASTM D 638 (50 mm/min)	1 test per roll	
Tear Resistance	ASTM D 1004	1 test per roll	1 test per 5000m^2 or every 5 rolls delivered to site, whichever is the greatest number of tests.
Puncture Resistance	ASTM D 4833	1 test per roll	
Melt Flow Index	ASTM D 1238	One test per manufacture batch, resin type, or geomembrane type	N/A

Stress Crack Resistance	ASTM D 5397	One test per manufacture batch, resin type, or geomembrane type	1 test per 10,000m^2, or resin type or manufacturing run. **Note** – Due to lead time OIT test samples from actual production batch to be supplied by manufacturer to Contractor
Oxidative Induction Time (OIT): Standard OIT **and** High Pressure OIT	ASTM D 3895 ASTM D 5885	One test per manufacture batch, resin type, or geomembrane type	
Oven Aging at 85°C - High Pressure Oxidative Induction Time	ASTM D 5721 ASTM D 5885	One test per manufacture batch, resin type, or geomembrane type	1 test per 10,000m^2, or resin type or manufacturing run.
UV Resistance - High Pressure Oxidative Induction Time	ASTM D 5885	One test per manufacture batch, resin type, or geomembrane type	

The CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the Superintendent's Representative. The Quality Consultant shall verify that:

- Property values certified by the manufacturer meet all of its minimum specification.
- Measurements of properties by the manufacturer are properly documented and that the test methods used are acceptable.
- Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
- Rolls are appropriately labelled.
- Certified minimum properties meet the Technical Specification.

5.16.6.3. Quality Conformance Testing

Upon delivery of the rolls of geomembrane, the Contractor shall ensure that quality conformance test samples from the shipped geomembrane are obtained in accordance with Section 5.16.6.2. These samples shall then be forwarded to a National Association of Testing Authorities, Australia accredited and approved laboratory for testing to ensure conformance to the Technical Specification.

The following quality conformance tests shall be conducted upon delivery of the geomembrane to the site as specified in the table above and specified in the CQAP:

- Thickness
- Density
- Puncture resistance

- Tear resistance
- Carbon black content
- Carbon black dispersion
- Stress crack resistance
- Tensile properties.

These conformance tests shall be performed in accordance with the test methods in the Technical Specification. The rolls to be sampled shall be selected by the CQA Engineer. Samples shall be taken across the entire width of the roll and shall not include the first metre unless otherwise specified. Samples shall be 0.5 metres long by the roll width. The CQA Engineer shall mark the machine direction on the samples with an arrow.

The Contractor shall undertake Oxidative Induction Time (standard and high pressure) testing, on batch-based samples provided by the manufacturer prior to delivery to the site, and submitted to an independent National Association of Testing Authorities, Australia accredited laboratory for testing and the test results forwarded to the CQA Engineer for quality compliance.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the CQA Engineer from non-consecutively numbered rolls based on a review of all roll information including quality control documentation and manufacturing records. Unless otherwise specified, samples shall be taken at a rate of one per lot, but not to be less than the minimum conformance test frequency specified in the CQAP.

All conformance test results shall be reviewed and accepted or rejected by the CQA Engineer. Any geomembrane laid prior to the receipt of the test results shall be at the Contractor's own risk. The CQA Engineer shall examine all results from laboratory conformance testing and shall report any non-conformance to the Superintendent's Representative. The CQA Engineer shall be responsible for checking that all test results meet or exceed the property values listed in the Technical Specification.

If a test result is in non-conformance then, at the option of the Superintendent's Representative, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the Technical Specification. This procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot. Material proven as non-conforming will not be used in the Works unless agreed by the Superintendent's Representative. Re-testing shall be done at the expense of the Contractor.

A lot, with the agreement of the CQA Engineer, may also consist of rolls that are not consecutively produced or numbered. The CQA Engineer will take samples for conformance testing from these lots. If a test is a non- conformance then the procedure will be as detailed above, although the rolls are not consecutively numbered.

If the Contractor has reason to believe that failing tests may be the result of the testing laboratory incorrectly conducting the tests, they may request that the sample in question be re-tested by the laboratory with a technical representative of the manufacturer present during the testing. This re-testing shall be done at the expense of the Contractor. Alternatively, the Contractor may have the sample re-tested at two different laboratories approved by the CQA

Engineer and at the expense of the Contractor. If both laboratories produce passing results, the material shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CQA Engineer.

5.16.6.4. Acceptance of the Geomembrane

Where discrepancies between the documentation supplied and the rolls delivered arise, or if rolls appear damaged or otherwise out of specification, the CQA Engineer shall advise the Contractor accordingly.

The CQA Engineer will refuse individual rolls to be accepted for delivery if:

- The manufacturer's documentation shows discrepancies with the materials actually delivered to site.
- The manufacturer's quality assurance documentation indicates rolls out of conformance.
- The physical condition of the materials indicates evidence of inappropriate handling or storage prior to arrival at site.

If, subsequent to delivery, defects in the geomembrane become apparent or rolls are damaged due to poor handling or storage, the CQA Engineer may refuse to allow affected materials to be incorporated in the Works.

The CQA Engineer shall advise the Contractor of any materials that are refused for incorporation in the Works, either on delivery or subsequently, and shall require the Contractor to remove the materials from the site as soon as reasonably practicable. Such materials shall be clearly marked as refused for incorporation in the Works and shall be 'quarantined' in an area to be agreed before removal from the site.

The Contractor shall not place any geomembrane until the Superintendent's Representative has approved the material.

5.16.7. Installation of Geomembrane

The completed geomembrane shall not be covered with subsequent layers until the Superintendent's Representative is satisfied that all information related to the installed works has been recorded and meets the requirements of the Technical Specification.

The entire works required for installation of the geomembrane is to be witnessed by the Superintendent's Representative or CQA Engineer.

5.16.7.1. Panel Nomenclature and Roll Traceability

The Contractor shall individually identify on a drawing the location of each geomembrane panel, being any continuous geomembrane sheet that is to the seamed in the field, whether a full roll or portion of a roll. The Contractor shall nominate a unique identification code for each panel and each seam, and a system of record keeping that will allow the Contractor to record the roll number of the material used for each panel at the time of installation.

The geomembrane panel code shall be used by the Contractor to identify the location of all quality assurance records and tests.

5.16.7.2. Geomembrane Installation Requirements

The geomembrane shall be installed at the locations and to the lines, grades and dimensions shown on the Drawings. Panel layout and deployment shall be such that all seams required on batters run down the batter slope and are oriented perpendicular to the top of slope. The seam orientation for batter slopes shall continue for a distance not less than 10 metres from the top and/or toe of the batter slope, unless indicated otherwise on the Drawings. Geomembrane panels placed on any batter shall extend a minimum horizontal distance not less than two metre beyond the top and/or toe of the batter unless otherwise approved by the Superintendent's Representative.

The Contractor shall prepare and submit a detailed geomembrane panel layout plan for approval by the Superintendent's Representative not less than seven days prior to installation of the geomembrane. The geomembrane layout plan shall detail the following:

- The layout of geomembrane panels.
- The location of field seams.
- The location of temporary perimeter anchoring of the geomembrane.
- The location of wind ballast to be placed on the liner.
- Detail of any anticipated departures from the Drawings.

The geomembrane shall be clean and free of all foreign material prior to placement. The Contractor shall not deploy geomembrane during rain, when excessive moisture conditions exist, including fog or dew or during high winds or other adverse climatic conditions. Geomembrane shall not be deployed during ambient temperatures below 5°C or above 40°C, when measured approximately 50mm above the prepared surface. The geomembrane panels shall be unrolled and deployed in a manner which minimises wrinkles and prevents the occurrence of folds and creases.

The Contractor shall, at all times, ensure that the handling and placement of geomembrane rolls and panels does not cause degradation of the materials.

5.16.7.3. Surface Preparation

The geomembrane shall be laid on the completed clay liner following proof rolling in accordance with Clause 5.13.5. The Contractor shall ensure that the surface on which the geomembrane is to be installed is free of debris or other objects which could puncture, abrade or tear the geomembrane. The Contractor shall notify the Superintendent's Representative prior to placement of the geomembrane and shall not proceed with placement without approval.

5.16.7.4. Procedure for Deployment of Geomembrane

The Contractor shall deploy the geomembrane in a manner that complies with the following requirements:

- The amount of geomembrane that is deployed at any given time shall be no more than can be reasonably expected to be seamed to the adjacent panels on the day of deployment.

- Geomembrane rolls shall be unrolled in accordance with the instructions and recommendation of the manufacturer. Geomembrane rolls shall not be released to unroll freely down slopes.
- The Contractor's personnel shall not smoke or wear footwear that could cause damage to the geomembrane, or engage in any other activities which could cause damage to the geomembrane.
- Geomembranes shall be cut with an approved knife with a retractable hooked blade. Foldable bladed knives shall not be permitted. Cutting tools shall not be placed on the geomembrane surface. All cutting tools shall be stored in secure containers to prevent damage to the geomembrane.
- The Contractor shall place temporary ballast loading on the geomembrane in accordance with the requirements in Clause 5.16.7.5.
- The method of deployment shall not crimp the geomembrane and shall not result in excessive scratches or wrinkles.
- The geomembrane shall be adequately protected by suitable materials in areas where trafficking by plant and equipment cannot be avoided.

5.16.7.5. Temporary Ballast Loading

The Contractor shall ensure adequate loading is placed over the geomembrane panels during installation to prevent uplift by wind. Temporary ballast loading shall be in addition to the perimeter anchoring. Sufficient temporary ballast loading shall be placed along panel edges, in particular, as needed to minimise the risk of wind flow under the panels. Continuous loading shall be provided at all panel edges during days off, at night, and whenever inclement or stormy weather is anticipated.

Temporary ballast loading shall consist of sand filled bags, or similar approved. Bags used for containing sand shall be resistant to degradation by ultraviolet rays, shall contain the selected material without leakage, and shall be approved by the Superintendent's Representative. Ballast material shall not be placed on the geomembrane panels unless it is completely within bags.

The Contractor shall submit a complete description and details of the proposed temporary wind ballast not less than seven days prior to geomembrane installation.

5.16.7.6. Field Trial Seams

Trial seams shall be made on fragments of geomembrane liner to verify that conditions are adequate for production seaming. Trial seams shall be at least 0.3 metre wide and 1.5 metres long for fusion welds or 1.0 metre long for extrusion welds with 125mm overlap, with the weld centred length-wise along the long side. Such trials shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Each operator shall make at least one trial seam per seaming period, minimum two per day. The date, time, speed, setting and temperature of the seaming unit, the number of the seaming unit and the name of the operator, shall be marked on the trial seam by the CQA Engineer or geosynthetic sub-contractor. An unsuccessful trial seam will be deemed to be when the specimens fail in the weld, when subject to both peel and shear tests in the field tensiometer.

The successful trial seam sample shall be cut into three pieces, one to be retained by Council, one to be given to the geomembrane sub-contractor, and one to be retained by the CQA Engineer for possible laboratory testing. Each portion of the sample shall be assigned a number, and the speed setting and temperature setting of the seaming unit marked accordingly by the CQA Engineer, who shall also log the date, time, number of seaming unit, number or name of operator, and pass or fail description.

Specimens of 25mm width and at a maximum of 150mm apart will be cut from the trial seam by the geomembrane sub-contractor. The specimens will be tested in peel and shear using a field tensiometer. If any specimen fails, the entire operation will be repeated. If any of the additional trial seams fail the seaming apparatus and welder will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive passing trial seams are achieved.

If agreed upon by the Superintendent's Representative and documented by the CQA Engineer in their daily report, the remaining portion of the trial seam sample can be subjected to destructive testing. If a trial seam sample fails a test conducted by the testing laboratory, then a destructive seam test sample shall be taken from each of the seams completed by the same operator/machine during the shift related to the considered trial seam. These samples shall be forwarded to the testing laboratory and, if they fail the tests, the procedure indicated shall not apply. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has been taken and has passed.

5.16.7.7. Geomembrane Field Seams

The Contractor shall ensure all field seams necessary for installation of a geomembrane panel are constructed on the day of placement of the panel. Welding of field seams shall not take place during unsuitable ambient weather conditions.

The Contractor shall not undertake geomembrane seaming during rain, when excessive moisture conditions exist, including fog or dew, or during high winds or other adverse climatic conditions. Seaming of geomembrane shall not be undertaken at an ambient air temperature below 5°C or above 40°C.

All geomembrane panels shall be continuously and tightly bonded using continuous extrusion fillet welds or double wedge fusion welds and automated welding equipment approved by the Superintendent's Representative. The Contractor shall nominate the equipment to be used, by make and model, and the process to be employed (i.e. either extrusion or double wedge) for approval by the Superintendent's Representative. The Contractor shall not construct any seam using equipment which has not been approved by the Superintendent's Representative.

Field seaming shall be conducted on the dry prepared surface and in such a manner to prevent foreign material from being included in the seam.

Geomembrane panels shall be overlapped a minimum of 75mm for extrusion welding and 125mm for fusion welding by lapping the edges of the adjoining panels. The overlap shall not exceed 150mm for double-wedge fusion welds. In all cases, the lower edge of each panel overlaps the higher edge of the panel immediately down-grade.

Prior to the construction of welds, the Contractor shall ensure the edges to be welded are cleaned thoroughly, in accordance with the manufacturer's recommended procedure, to remove any contaminants, dirt, dust, moisture or other foreign materials.

All field seams must be uniform in appearance, width and properties, and shall not exhibit warping due to overheating from welding. The materials used for construction of field seams shall comply with the requirements detailed in Section 5.16.3. The physical properties of the seams shall comply with the requirements in the table below.

Table 16 Physical Properties for Field Seams in Geomembrane

Physical Property	Test Method	Criteria
Shear Strength	ASTM D 6392	≥ 701 N/25 mm
Shear Elongation	ASTM D 6392	50% minimum
Peel Strength (Fusion Welds)	ASTM D 6392	≥ 530 N/25 mm
Peel Strength (Extrusion Welds)	ASTM D 6392	≥ 455 N/25 mm
Max Adhesion Failure (peel separation)	ASTM D 6392	25% maximum

The Contractor shall ensure that any temporary bonding of adjacent panels does not cause damage to the geomembrane. The Contractor shall not use solvent or adhesive bonding agents unless approved by the Superintendent's Representative.

The following specific requirements shall apply for fusion welding:

- Automated, vehicular-mounted fusion welding apparatus shall be used which produces a double-track seam with enclosed airspace.
- The seaming apparatus shall be equipped with gauges indicating applicable temperatures and pressures.
- One spare operable seaming apparatus shall be maintained on-site at all times.
- The equipment used for seaming shall not damage the geomembrane. The Contractor shall protect the geomembrane from damage in trafficked areas.
- The Contractor shall use a movable protective layer directly below each overlap of the geomembrane that is to be seamed to prevent build-up of moisture between the sheets.

The following specific requirements shall apply for extrusion welding:

- Welding apparatus shall be equipped with gauges giving the temperature in the apparatus and at nozzle.
- The Contractor shall provide documentation regarding HDPE extrudate and certify that the extrudate complies with the Technical Specification.
- The Contractor shall purge the extruder until all heat degraded material is has been removed from the barrel prior to commencing a seam.
- One spare operable seaming apparatus shall be maintained on-site at all times.
- The equipment used for seaming shall not damage the geomembrane. The Contractor shall protect the geomembrane from damage in trafficked areas.
- The electricity generator for the welding and testing equipment shall not be placed on the geomembrane.

- Grinding or preparation for seaming shall be completed not more than one hour prior to seaming.
- Copper wire shall be incorporated in the prepared seam.
- The grinding of the sheet shall be carried out perpendicular to the line of the weld. In no instance shall exposed grinding marks extend more than 6mm from the seamed area and these shall be covered with extrudate.
- No solvent or adhesive shall be used without the prior written approval of the Superintendent's Representative.
- The procedure used to temporarily bond adjacent panels together should not damage the geomembrane. In particular, the temperature of hot air at the nozzle of any temporary welding apparatus shall be controlled such that the geomembrane does not become damaged or degraded.

All wrinkles and other irregular openings at the location of a seam shall be cut to achieve a flat and smooth overlap. If the cutting results in overlap between the adjoining panels which does not comply with the requirements of the Technical Specification, the Contractor shall construct a round or oval patch to cover an area not less than 150mm in all directions beyond the cut using the same geomembrane material.

The CQA Engineers or Superintendent's Representative shall be in attendance during the seaming and verify that the above seaming procedures are followed.

5.16.8. Non-Destructive Field Testing

The Contractor shall undertake non-destructive testing of field seams over the full length of all seams and shall identify any discontinuity of the seam. The Contractor shall undertake non-destructive testing continuously as the field seams are constructed. The testing shall be undertaken within a period not greater than four hours after construction of the field seam being tested.

The Contractor shall undertake vacuum testing for extrusion welded seams and air pressure testing for fusion welded seams.

5.16.8.1. Vacuum Testing

Vacuum testing shall be carried out in accordance with ASTM D 5641.

The CQA Engineer or the Superintendent's Representative shall be in attendance during vacuum testing and independently note and follow up with the Contractor failed tests.

The vacuum test equipment shall comply with the following requirements:

- a vacuum box assembly consisting of rigid housing with transparent viewing window, neoprene gasket attached to the bottom, port hole or valve assembly, and vacuum gauge;
- steel vacuum tank and pump assembly equipped with pressure controller and pipe connections;
- rubber pressure/vacuum hose with fittings and connections;
- bucket and wide paint brush; and
- soapy solution.

The Contractor shall undertake vacuum testing as follows, unless otherwise approved by the Superintendent's Representative:

- Energise the vacuum pump and reduce the tank pressure to approximately 35 kPa,
- Wet a strip of geomembrane approximately 0.3 metres wide by 1.2 metres long with soapy solution,
- Place the box over the wetted area,
- Close the bleed valve and open the vacuum valve,
- Place the vacuum box on the seam and ensure that a seal is created between the vacuum box and the geomembrane, and
- Examine the geomembrane through a viewing window for the presence of soap bubbles for a period not less than 30 seconds.

The results of the vacuum test shall be conforming if, upon examination of the geomembrane, no bubbles were formed in the soapy solution. The appearance of any bubbles formed in the soapy solution shall indicate non-conforming work. Non-conforming work shall be marked by the Contractor, a Non Conformance Report (NCR) raised by the Contractor noting location of bubbles, then repair effected in accordance with the requirements of Section 5.16.10.

The Contractor shall undertake vacuum testing on the adjacent sections of the seam ensuring a minimum overlap between adjacent tests of not less than 75mm.

The documented results of tests including NCR closure shall be provided to the Superintendent's Representative not more than seven days following completion of each test.

5.16.8.2. Air Pressure Testing

Air pressure testing shall be carried out in accordance with ASTM D 5820.

The CQA Engineer or Superintendent's Representative shall be in attendance during the air pressure tests to spot audit the results and process being undertaken for follow up as needed.

The equipment for air pressure testing shall comply with the following requirements:

- an air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining pressure up to 250kPa,
- rubber hose with fittings and connections, and
- sharp hollow needle or other approved pressure feed device.

The Contractor shall undertake air pressure testing as follows:

- seal both ends of the seam to be tested,
- insert needle or other approved pressure feed device into void created by the double fusion weld, taking care not to puncture the base sheet of the seam,
- energise the air pump to pressure between 200 and 230kPa, close valve, allow for pressure to stabilise for not less than two minutes, and
- sustain pressure within the void for approximately 5 minutes.

The results of the air pressure test shall be conforming if, upon completion of the pressure test procedure, there is no observable loss of pressure. Any loss of pressure indicates non-conforming work. Non-conforming work shall be marked by the Contractor and a Non

Conformance Report (NCR) raised, noting the location of pressure loss. This area is to be repaired in accordance with the requirements of Section 5.16.10.

The documented results of tests including NCR closure shall be provided to the Superintendent's Representative not more than seven days after the completion of each test.

5.16.8.3. Spark Testing

The Contractor shall conduct spark testing on all extrusion welded seams in addition to vacuum testing.

The CQA Engineer or Superintendent's Representative shall be in attendance during spark testing pressure to spot audit results and process being undertaken for follow up as needed.

The equipment for spark testing will comprise a continuous coil high frequency spark tester with a voltage adjustable in the range 15 kV to 30 kV. The Contractor shall, at the location of and immediately prior to undertaking any spark testing, monitor the presence of any explosive gases. Under no circumstances shall the Contractor undertake spark testing if explosive gases are detected.

The Contractor shall allow completed seams to cool prior to undertaking spark testing. The integral copper wire shall be connected to ground and the test equipment adjusted to provide a voltage of approximately 10 kV per millimetre of geomembrane thickness being tested. The probe shall be passed along either side and the centre of the bead of extrudate and the presence of sparks shall be observed.

The presence of sparks shall indicate non-conforming work. Non-conforming work shall be marked by the Contractor and a NCR raised, noting the location of the spark. This area is to be repaired in accordance with the requirements of Section 5.16.10.

The documented results of tests including NCR closure shall be provided to the Superintendent's Representative not more than seven days after the completion of each test.

5.16.8.4. Procedure for Inaccessible Seams

The Contractor shall notify the Superintendent's Representative if the Contractor cannot properly access geomembrane seams to carry out non-destructive testing. The Superintendent's Representative shall nominate the work required, which may include, at the discretion of the Superintendent's Representative, either of the following:

- Construction of an extrusion welded cap strip over the seam. The width of the cap strip shall be not less than 300mm.
- Non-destructive testing using vacuum testing and/or air pressure testing in accordance with Clause 5.16.8.1 and Clause 5.16.8.2, respectively, prior to the final installation of the geomembrane.

The Contractor shall notify the Superintendent's Representative prior to the construction of cap strips and the Superintendent's Representative shall observe the construction of all cap strips. The Contractor shall ensure that the construction of cap strips is uniform and continuous and shall undertake any necessary repair of the cap strips if directed by the Superintendent's Representative.

5.16.9. Destructive Field Seam Testing

Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

5.16.9.1. Location and Frequency

The CQA Engineer shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

- A minimum frequency of one test location per 150 metres of seam length performed by each welder. This minimum frequency is to be determined as an average taken throughout the entire area.
- Test locations shall be determined during seaming at the CQA Engineer's discretion. Selection of such locations may be prompted by suspicions of overheating, contamination, offset welds, or any other potential cause of imperfect welding.
- The geomembrane sub-contractor shall not be informed in advance of the locations where the seam samples will be taken.

5.16.9.2. Field and Laboratory Testing

The Contractor shall undertake sampling and destructive seam testing for samples cut from completed sections of the geomembrane liner. The minimum frequency of sampling and destructive testing shall be one test per 150 metres of seam. The Superintendent's Representative may nominate the location for the Contractor to obtain samples.

The Contractor shall undertake sampling and destructive testing using the following procedures::

- Cut samples of seams immediately upon completion of the subject seam. The Contractor shall identify the sample number and indicate the location of the sample on the Contractor's geomembrane layout plan. The cut samples shall be not less than 400mm wide and 1,200mm long in the direction of the seam. The seam shall be centred on the sample.
- Cut one 25mm field test strip from each end of the cut sample and shall test these in the field, by tensiometer, for peel and shear. The field test strips shall not fail at the seam.
- Cut the remaining cut sample into three equal test samples. The Contractor shall retain one test sample for the destructive testing to be carried out by the Contractor and shall provide two test samples to the Superintendent's Representative. The Superintendent's Representative will direct the CQA Engineer to undertake laboratory testing of one sample in accordance with the CQAP and will retain the second sample as a record of the sampling.
- Undertake the laboratory testing necessary to confirm that the test sample complies with the requirements of Clause 7 and shall provide the results of laboratory testing to the Superintendent's Representative within seven days of obtaining the cut sample.

A field test strip which fails the field test or a test sample which does not comply with any requirement in Clause 5.16.7.6 and 5.16.7, whether by the Contractor's laboratory tests or the laboratory testing undertaken by the CQA Engineer in accordance with the CQAP, shall indicate

non-conforming work. The Contractor shall undertake the following sampling and destructive testing for non-conforming work:

- The Contractor shall reconstruct the seam between the location of the non-conforming field test strip or test sample and an adjacent conforming test location on the same seam, or
- Obtain a cut sample of the weld, in accordance with the above procedure, at a location five metres in both directions from the location of the non-conforming work and undertake field testing and laboratory testing in accordance with the above procedure. The seam shall be reconstructed between conforming test results. The procedure shall be repeated if the test results indicate non-conforming work.

The Contractor shall obtain a cut sample from the reconstructed seam and undertake the necessary field and laboratory testing, if required to ensure the minimum frequency of sampling and testing is maintained.

The Contractor shall ensure that all seams are bounded by two test locations indicating the seams conform to the requirements of the Technical Specification.

5.16.10. Geomembrane Repair

5.16.10.1. Identification

The geomembrane sub-contractor and CQA Engineer shall examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter.

As light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane sub-contractor shall clean the geomembrane surface if the presence of dust or mud inhibits examination.

5.16.10.2. Evaluation

Each suspect location, both seam and non-seam areas, shall be tested using the methods described in Clauses 5.16.8 and 5.16.9 as appropriate.

Each location that fails the non-destructive testing shall be marked by the Contractor and repaired by the geosynthetic sub-contractor. Subsequent work, which will cover locations that have been repaired, shall not proceed until appropriate non-destructive and laboratory test results, with passing values, are available.

The Contractor shall carry out all repairs necessary to correct non-conforming work and restore the locations from which cut samples were removed for destructive testing.

5.16.10.3. Repair Procedures

The Contractor shall nominate its proposed repair method and obtain approval by the Superintendent's Representative prior to the commencement of any repair work. Repair work may include the following:

- Repair of defective seams by reconstruction,
- Repair tears or pinholes by seaming or patching and,

- Repair blisters, larger holes, undispersed raw materials, and contamination by foreign matter by patches. The Contractor shall ensure that surfaces of HDPE to be patched are abraded not more than one hour prior to the repair. Patches shall be round or oval in shape and shall consist of the approved geomembrane and shall extend not less than 150mm beyond the edge of defects. Seams used for the construction of repair patches shall be extrusion welded and shall comply with the requirements of the Technical Specification.

The Contractor shall undertake repair to seams as follows:

- **For extrusion welded seams;** the Contractor shall remove the existing seam by grinding and construct a new seam.
- **For fusion welded seams;** the Contractor shall cut the existing seam, remove the seam strip and construct a replacement strip. The replacement strip shall extend not less than 200mm beyond the edges of the removed seam strip.

The Contractor shall test each repair using non-destructive methods and determine conformance or non- conformance of the work in accordance with Section 5.16.8.

The CQA Engineer or Superintendent's Representative shall observe all non-destructive testing of repairs and the both the Contractor and Superintendent's Representative shall record the number of each repair, date, and test outcome. Formal quality assurance documentation of passing tests and NCR close outs shall be provided to the Superintendent's Representative by the Contractor within seven days of a test.

5.16.11. Protection

Following installation, the geomembrane surface shall be protected or covered as soon as practicable to prevent damage from ultraviolet light, rain, wind and other weather-related occurrences. The surface of finished tested work shall be protected or covered with the overlying protection geotextile and gravel leachate layer over the geotextile within ten days of placement of the geomembrane.

5.16.12. Geomembrane Leak Location Survey

Council will appoint a Leak Detection Consultant (LDC) to carry out a Geomembrane Leak Location Survey (GLLS) in accordance with Clause 5.16.12, after the leachate drainage layer has been placed on the new landfill cell, and prior to the placement of any waste.

5.17. GEOTEXTILES

A separation geotextile layer is to be installed above the gravel leachate drainage layer in the landfill cell and below the rock rip-rap and rock mattress layer within drainage channels. A protection geotextile layer is to be installed between the gravel leachate drainage layer and the geomembrane liner.

5.17.1. Materials

5.17.1.1. General

All geotextile materials shall comply with the following requirements:

- Geotextiles shall be chemically stable and the geotextile filaments shall exhibit low water absorbency.

- Geotextiles shall be free of any defects that would have an adverse effect on the physical and/or mechanical properties of the geotextile.
- Geotextiles shall be not exhibit degradation of mass or reduction in any physical or mechanical properties greater than 50% from exposure to ultraviolet radiation when tested in accordance with AS3706.11-2012 after 672 hours exposure.
- Geotextiles shall be packaged in waterproof ultraviolet protective sheeting.

5.17.1.2. Separation Geotextile

The separation geotextile shall be a non-woven needle punched continuous filament polyester, polyethylene or polypropylene fabric that complies with the properties in table below.

Table 17 Material Properties for Separation Geotextile

Property	Test Method	Value (MARV)
Trapezoidal Tear	AS 3706.3	≥ 400 N
CBR Burst Strength	AS 3706.4	≥ 3000 N
Grab Tensile Strength	AS 3706.2	≥ 1200 N
Ultraviolet Stability	AS 3706.11	≥ 50 Str Ret @ 500 lt. hrs
Flow Rate Q_{100}	AS 3706.9	≥ 150 L/s per m^2

5.17.1.3. Protection Geotextile

The protection geotextile shall be a non-woven needle punched continuous filament polyester, polyethylene or polypropylene fabric that complies with the properties in table below.

Table 18 Material Properties for Protection Geotextile

Property	Test Method	Value (MARV)
Mass per unit area	AS 3706.1, AS 2001-2.13	≥ 500 g/m^2
Trapezoidal Tear	AS 3706.3	≥ 800 N
CBR Burst Strength	AS 3706.4	≥ 6000 N
CBR Puncture Strength	AS 3706.5	≥ 3800 N
Grab Tensile Strength	AS 3706.2	≥ 2600N

MARV = Mean Average Roll Value representing a confidence level that 97.5% of test results meet the required value

The geotextile shall be UV stabilised to retain at least 50% of the trapezoidal tear strength when tested for 500 hours exposure in accordance with ASTM D 4355 (2002), where the geotextile is exposed to sun during construction works for less than two weeks. Where the geotextile is proposed to be exposed to the weather longer than two weeks, the geotextile supplied shall be suitable for long term exposed conditions and subject to approval in writing by the Superintendent.

Notwithstanding the minimum requirements specified in table above, the Contractor shall perform a geotextile liner protection evaluation (pressure plate test) using a method approved

by the Superintendent's Representative. The Contractor shall provide the results of the liner protection evaluation prior to its procurement of protection geotextile.

The liner protection evaluation shall be performed with the test parameter and materials specified in the table below.

Table 19 Test Parameters and Materials for Liner Protection Evaluation

Test Parameter / Materials	Requirement
Test pressure	600kPa
Test duration	24 hours
Geomembrane material	Smooth and textured geomembrane conforming with the requirements of Clause 4.12.3 (i.e. one test per geomembrane type)
Gravel material	Leachate drainage layer material conforming to the requirements of Clause 4.14.2.1.
Geotextile material	Protection geotextile conforming with the requirements of Clause 4.13.1.3

The maximum strain recorded in the liner protection evaluation shall be 6%. The Contractor shall provide protection geotextile, or a combination of geotextiles, to achieve the specified maximum strain criteria, notwithstanding the minimum requirements specified in Table 19 above.

5.17.1.4. Sacrificial Geotextile

Sacrificial geotextile, if required, shall be a non-woven needle punched continuous filament polyester, polyethylene or polypropylene fabric. No further properties are specified for sacrificial geotextile.

5.17.2. Packaging and Identification

The Contractor shall ensure that each roll of geotextile is labelled with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width and gross weight) and the date manufactured.

All geotextile rolls shall be packaged in waterproof ultraviolet protective sheeting during shipment and storage. The plastic sheeting shall be placed around the geotextile roll in the manufacturing facility and shall not be removed until installation.

Copies of all documentation and certificates for rolls of geotextile accepted to the site will be forwarded to the CQA Engineer for approval prior to their use in the construction works at the site.

5.17.3. Transport, Handling and Onsite Storage

Handling of geotextile shall comply with the manufacturer's recommendations. The Contractor shall handle the geotextile materials in a manner which avoids damage to the geotextile or in any manner that may affect its compliance with the requirements of the Technical Specification.

The Contractor shall provide enclosed on-site storage for geotextile products necessary to comply with the manufacturer's recommendations and protect the products from degradation. On-site storage shall comply with the following requirements:

- Geotextile shall not be subjected to extremes of either hot or cold temperatures, and with the manufacturer's protective cover undisturbed.
- Geotextile shall be protected from abrasion and puncture.
- Mud, wet concrete, epoxy, or other deleterious materials shall be prevented from coming in contact with and affixing to geotextile materials.

  Geotextile materials shall be protected from construction equipment, sparks and flames.

The Contractor shall visually inspect the surface area of every roll of material delivered to the site for obvious visual flaws, such as damaged portions, tears, punctures, cracks, clear variations in thickness or mass from the specified values.

The Contractor shall provide the CQA Engineer with a copy of all manufacturer's quality assurance documentation and test certificates for geotextile delivered to the site. The CQA Engineer shall review the documentation provided by the Contractor and shall provide approval, or otherwise, for use of the materials in construction of the Works. The Contractor shall not proceed with installation of the geotextile prior to obtaining written approval from the Superintendent's Representative.

The Contractor shall remove from site any geotextile rolls that are delivered without the necessary manufacturer's quality assurance documentation and test certificates, or that do not comply with the requirements of the Technical Specification or are damaged or otherwise unsuitable to be incorporated in the Works.

5.17.4. Quality Control Documentation

5.17.4.1. Delivery and Storage

Geotextiles shall be delivered to site clearly labelled and shall include a manufacturers batch reference number. Geotextiles shall be supplied with protective cover. The cover shall be waterproof, opaque and protect the geotextile from UV light. Every roll delivered to site shall have a delivery ticket included within the packaging.

5.17.4.2. Manufacturer's Quality Assurance Documentation and Test Certificates

The Contractor shall provide product data sheets listing the physical properties, expressed as minimum average roll value, for each geotextile type prior to shipment.

The Contractor shall submit manufacturer's quality assurance documentation and test certificates to the Superintendent's Representative not less than seven days prior to the installation of the geotextile. The certification shall include the following:

- Copies of the quality control certificates issued to the manufacturer by the fibre supplier, providing information on the origin, identification and production date of the fibres used to manufacture the geotextile.
- Reports on tests conducted by the manufacturer to verify that the quality of the fibre used to manufacture the geotextile meets the manufacturer's specifications.
- Reports on quality control tests conducted by the manufacturer to verify that the geotextile manufactured for the project meets the Technical Specification and relevant quality control certificates that demonstrate compliance with the requirement of the Technical Specification.

- A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.
- A specification for the geotextile which includes all properties contained in the Technical Specification, measured using the appropriate test methods.
- Written certification that minimum average roll values specified in the Technical Specification are guaranteed by the manufacturer.
- For non-woven geotextiles, written certification that the manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

Quality assurance testing and certification shall be carried out by the manufacturer from batch-based samples to be supplied to site in accordance with the requirements table below. Once delivered to site, the Contractor shall conduct its own quality assurance spot audit testing of materials in accordance with Table 20 to verify material quality compliance. The CQA Engineer may also undertake conformance testing of the material on site.

Table 20 Minimum Sampling and Testing Frequency for Geotextile Materials

Material/Property	Minimum Test Frequency	
	Source (Manufacturer)	Delivered (Quality Conformance)
Geotextile Protection Layer Thickness Mass per unit area	1 test per 90,000m^2	1 per 2,500 m^2
Trapezoidal Tear CBR Burst Strength CBR Puncture Strength Grab Tensile Strength		1 per 5,000 m^2
Geomembrane protection test efficiency	1 per source per geomembrane type	N/A
Geotextile Separation Layer CBR Burst Strength Trapezoidal Tear Grab Tensile Strength Flow Rate Ultraviolet Stability	1 test per 90,000m^2	1 test per 10,000m^2

The CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the Superintendent's Representative. The Contractor shall verify that:

- Property values certified by the manufacturer meet all of its guaranteed specifications.
- Measurements of properties by the manufacturer are properly documented and that the test methods used are acceptable.
- Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls to which it relates.

- Roll packages are appropriately labelled.
- Certified minimum average roll properties meet the Technical Specification.

5.17.4.3. Quality Conformance Testing

Upon delivery of the rolls of geotextile, the Contractor shall ensure that Quality conformance test samples are obtained from the delivered geotextile in accordance with Section 5.17.4.2. These samples shall then be forwarded to a laboratory for testing to ensure conformance to the Technical Specification. These conformance tests shall be performed in accordance with the test methods specified in the Technical Specification. Unless otherwise specified, samples shall be taken at a rate of one per lot, but not to be less than the minimum conformance test frequency in the table above and as specified in the CQAP.

The rolls to be sampled shall be selected by the CQA Engineer or the Superintendent's Representative. Samples shall be taken across the entire width of the roll and shall not include the first metre. Unless otherwise specified, samples shall be 0.5 metres long by the roll width. The CQA Engineer or the Superintendent's Representative shall mark the machine direction on the samples with an arrow.

All conformance test results shall be reviewed and accepted or rejected by the CQA Engineer. Any geotextile laid prior to the receipt of the test results shall be at the Contractor's own risk.

The CQA Engineer shall examine all results from laboratory conformance testing and shall report any non-conformance to the Superintendent's Representative. The CQA Engineer will be responsible for checking that all test results meet or exceed the property values listed in the Technical Specification.

If a test result is non-conforming then, at the option of the Superintendent's Representative, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the Technical Specification. This procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line. If both additional tests pass, the roll that represents the initial failed test shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot. Material proved to be non-conforming will not be used in the Works unless agreed to by the Superintendent's Representative. Re-testing shall be done at the expense of the Contractor.

A lot, with the agreement of the CQA Engineer, may also consist of rolls that are not consecutively produced or numbered. The CQA Engineer will take samples for conformance testing from these lots. If a test is in non-conformance then the procedure will be as detailed above, although the rolls are not consecutively numbered.

If the Contractor has reason to believe that failing tests may be the result of the testing laboratory incorrectly conducting the tests, they may request that the sample in question be re-tested by the laboratory with a technical representative of the manufacturer present during the testing. This re-testing shall be done at the expense of the Contractor. Alternatively, the Contractor may have the sample re-tested at two different laboratories approved by the CQA Engineer and at the expense of the Contractor. If both laboratories produce passing results, the material shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the CQA Engineer or the Superintendent's Representative.

5.17.5. Installation of Geotextiles

5.17.5.1. General

The Contractor shall not remove the packaging of geotextiles until immediately prior to their use. Geotextiles shall be unrolled along the placement area and loosely laid, without stretching, in such a manner that it conforms to the surface irregularities when material is placed on or against it. Geotextiles shall be laid smooth without wrinkles or folds on the prepared surface unless folding and overlapping is necessary to allow proper placement in designated areas. The Contractor shall not deploy geotextile during rain, when excessive moisture conditions exist, including fog or dew or during high winds or other adverse climatic conditions.

The amount of geotextile that is deployed at any given time shall be no more than can be reasonably expected to be joined to the adjacent panels on the day of deployment.

Geotextiles shall be oriented in a manner that minimises joints and overlaps and shall be deployed such that the orientation of geotextile panels is down the batter slope and perpendicular to the toe of the slope. Geotextile panels shall be placed with a minimum overlap of 600mm and shall be secured to maintain the overlap.

Until sewn joints are effected in the case of the protection geotextile layer, and in the case of the separation geotextile layer placement of overlying covering materials, geotextiles shall be weighted down using sand bags. Sand bags shall be removed prior to placement of the permanent covering material. The ends of the geotextile layers shall be buried in an anchor trench as shown on the Drawings.

The Contractor's vehicles or equipment shall not be allowed directly onto the fabric at any time during the installation and backfilling.

The Contractor shall only use geotextile cutter (hook blade) for cutting geotextile materials. If in place, the Contractor shall protect underlying materials from damage that may be caused by cutting of the geotextiles.

The Contractor shall take all necessary precautions to prevent damage to underlying geomembrane during installation (including joining) of the geotextile.

5.17.6. Joins in Separation Geotextile

Joins in separation geotextile shall be overlapped joins.

The geotextile shall be joined by overlapping a minimum of 600mm in both the longitudinal transverse directions and shall be secured against the underlying foundation material. The up-slope geotextile shall overlap the abutting down-slope geotextile.

5.17.7. Joins in Protection Geotextile

Joins in protection geotextile shall be sewn joins.

The geotextile shall be joined by machine sewing using thread material meeting the chemical requirements for the geotextile fibres or yarn. The sewing thread shall be of contrasting colour to the geotextile. The sewn overlap shall be a minimum of 150mm and the sewing shall consist of two parallel stitched rows at spacing of approximately 25mm and shall not cross, except for any required re-stitching.

The stitching shall be a lock-type stitch. Each row of stitching shall be located a minimum of 25mm from the geotextile edge. The seam type and sewing machine to be used shall produce

seam strength, in the specified geotextile, that provides not less than 100% of the specified grab strength.

The geotextile shall be temporarily secured during placement of overlying materials to prevent slippage, folding, wrinkling, or other displacement of the geotextile. Methods of securing shall not cause punctures, tears or other openings to be formed in the geotextile.

5.17.8. Temporary Ballast Loading on Separation Geotextile

The Contractor shall ensure adequate loading is placed over the entire completed separation geotextile surface following installation to prevent uplift by wind, until landfill waste is placed within the landfill cell. Temporary ballast loading shall be in addition to the perimeter anchoring. Sufficient temporary ballast loading shall be placed along the geotextile panel edges, in particular, as needed to minimise the risk of wind flow under the panels. Continuous loading shall be provided at all panel edges during and after installation works, i.e. to remain intact until future landfill waste is placed in the cell.

Temporary ballast loading shall consist of sand filled bags, or similar approved. Bags used for containing sand shall be resistant to degradation by ultraviolet rays, shall contain the selected material without leakage, and shall be approved by the Superintendent's Representative. Ballast material shall not be placed on the geotextile panels unless it is completely within bags.

The Contractor shall submit a complete description and details of the proposed temporary wind ballast not less than seven days prior to separation geotextile installation.

5.17.9. Protection

Following installation, the protection geotextile surface shall be protected or covered as soon as practicable to prevent damage from ultraviolet light, rain, wind and other weather-related damage. The surface shall be protected or covered within seven days of placement of the geotextile.

The Contractor shall submit a complete description and details of the proposed protection system not less than seven days prior to filter geotextile installation.

5.17.10. Geotextile Repair

The Contractor shall carry out any necessary repair of geotextiles as follows:

- The Contractor shall remove any material penetrating the geotextile.
- The Contractor shall apply a patch made from the same geotextile and shall provide not less than 600mm overlap to the edge of the penetration in every direction. Such patches shall be appropriately bonded/ connected consistent with manufacturer recomendations.
- The Contractor should remove and replace any geotextile material where the penetration exceeds 10% of the width of the roll.

5.18. LEACHATE COLLECTION SYSTEM

5.18.1. Leachate Collection Pipes

5.18.1.1. Materials

The materials for leachate collection pipes within the landfill cell shall be as indicated on the Drawings and shall comply with the requirements of AS4130-2009.

All connections and fittings must be manufactured from the same material and strength class as the pipe and must be solid wall units.

The pipes shall be perforated with drill holes in accordance with the Drawings. The perforated pipe shall be installed with the holes oriented as per the Drawings, with no holes located at the spring, invert or overt of the pipe. The ends of the leachate collection pipes shall be provided with HDPE end caps.

Bends must be manufactured long radius bends. Bend radii must be no less than 3 times the external diameter of the pipe.

5.18.1.2. Construction

Construction shall conform to the requirements of WSA-01 (Polyethylene Pipeline Code). Pipes shall be joined together by butt fusion welding methods undertaken by an approved welder or by electrofusion of couplings in accordance with the requirements of WSA-01.

The leachate collection and riser pipes shall be perforated by drilling holes into the pipe as detailed on the Drawings prior to welding up the sections of pipe. The orientation of the holes shall be maintained during installation as far as practical at 45º to the vertical. Care shall be taken when welding the sections to maintain the orientation of the holes in the pipeline. All drilling swarf shall be removed prior to welding. The Pipe Installer shall propose a joining method for consideration and approval by the Superintendent's Representative for the joins of the cross pipe. The pipes shall be welded next to the cell ready to be rolled or the welded pipe pulled into place by hand and winch. The leachate pipes shall not be welded in situ.

The pipes must be joined to one another, to polyethylene fittings and to flange connections by means of thermal butt-fusion or electrofusion welds.

All pipe joins and junctions shall be formed using the same type and strength of pipe as the leachate collection pipes, and shall be solid wall units. The upper ends of the leachate collection pipes, once installed in the cell, shall be closed using end caps manufactured of polyethylene.

The Contractor shall propose a procedure for placing the welded pipes onto the protection geotextile. The Contractor shall ensure by survey that the leachate collection pipes are placed in accordance with the Drawings.

5.18.1.3. Quality Control Requirements

The Contractor shall provide the CQA Engineer with a copy of all manufacturer's quality assurance documentation and test certificates demonstrating compliance with AS4130-2009.

The CQA Engineer shall review the documentation provided by the Contractor and shall provide approval, or otherwise, for use of the materials in construction of the Works. The Contractor shall not proceed with installation of the leachate collection pipes prior to obtaining written approval from the Superintendent's Representative.

There shall be no requirement to carry out conformance testing of the pipework, unless suspect materials or installation procedures are observed during handling, storage and installation of the materials.

5.18.2. Leachate Drainage Layer

5.18.2.1. Materials

Leachate drainage gravel shall be used to construct the leachate drainage layer as shown on the Drawings and shall be sourced from an approved off-site source.

Leachate drainage gravel shall satisfy the following requirements:

- Clean, hard, strong, durable aggregate free of organic matter, lumps of clay and other objectionable or deleterious material with a relatively uniform grading.
- A natural material with a rounded or sub-rounded particle shape in accordance with AS1726-1993.
- Shall have no limestone or other calcareous material that would be subject to chemical attack.
- Calcium carbonate content must not exceed 8.5% by weight to prevent encrustation (note that recycled crushed concrete is not suitable).
- Do not use material derived from argillaceous rock such as shales and claystone or other friable materials.
- Leachate drainage gravel shall comply with the compliance criteria specified in the table below, or other equivalent material subject to approval in writing by the Superintendent's Representative.

Table 21 Leachate Drainage Gravel Material Compliance Criteria

Material Property	Minimum	Maximum
Particle Size Distribution -passing 37.5mm sieve	100%	
-passing 19mm sieve	0%	10%
- passing 0.075mm sieve	0%	2%
Coefficient of Permeability	-	1 x 10^{-3} m/s
Angularity Number	-	4
Particle Density	2,400 kg/m^2	
Water Absorption	-	2.5%
Wet/dry strength variation	-	35%
Sodium sulphate soundness	-	2.5%

5.18.2.2. Placement of Leachate Drainage Layer

The Contractor shall carry out placement of the drainage layer material in the presence of the Superintendent's Representative or CQA Engineer.

The leachate drainage gravel shall be placed in a uniform layer of 300mm thickness. It is essential that this placement operation be carried out such that the underlying geomembrane is not subject to excessive strain.

The Contractor shall take into account temperature effects, loads imposed by construction plant and drainage material placement techniques.

The Contractor shall employ a ramp and spill method to place the drainage layer material over the geotextile covered geomembrane. The Contractor shall place the material when the geomembrane is cool, at maximum strength and with least wrinkles.

Equipment utilised to spread the leachate drainage gravel shall have a maximum ground contact pressure not exceeding 50kPa and be rubber tyred or rubber tracked. The plant shall operate over at least 300mm thickness of material at all times.

The Contractor shall ensure that operation of the plant and equipment during placement of the leachate drainage gravel complies with the following requirements:

- The plant shall not take large cuts into heaped material, which may result in rear track drift and dig into the material causing potential abrasion or rupture of the geomembrane.
- The plant shall not slew or brake suddenly unless over a designated temporary haul road or tipping area where the drainage layer material is maintained at a minimum thickness of 900mm as measured from the bottom of the deepest ruts to the surface of the geomembrane.
- Under no circumstances shall the liner be caused to fold by the placement of the drainage layer.
- The drainage gravel on the side slopes of the cell shall be placed by excavator with flat plate bucket with no teeth.
- Placement of the drainage layer shall be from the base of the batter up the slope.

5.18.2.3. Inspection and Testing

The Contractor shall carry out inspection and testing of the Leachate Drainage Gravel in accordance with the requirements specified in the table below.

Table 22 Testing and Frequency of Leachate Drainage Gravel

Material	Test	Test Frequency	
		Pre Construction (Compliance)	During Construction
		At Source	At Site
Leachate Drainage Gravel	Particle Size Distribution	Greater of: 1 per 5,000m^3 of material or minimum of 3 per source	1 per 500m^3
	Coefficient of Permeability		1 per 1,000 m^3
	Angularity number		1 per 500 m^3
	Particle density and water absorption		
	Wet strength and wet/dry strength variation		
	Sodium sulphate soundness		

5.18.3. Quality Assurance Requirements

The Contractor shall provide the CQA Engineer or Superintendent's Representative with a copy of all quality compliance documentation and test certificates demonstrating compliance with the Technical Specification.

The CQA Engineer shall review the documentation provided by the Contractor for use of the materials in construction of the Works. The Contractor shall not proceed with installation of the leachate gravel layer prior to obtaining written approval from the Superintendent's Representative.

There shall be no requirement to carry out quality assurance testing of the leachate gravel layer, unless suspect materials are observed by the CQA Engineer or Superintendent's Representative during handling, storage and installation.

5.19. GEOMEMBRANE LEAK LOCATION SURVEY

Council will appoint a leak detection consultant (LDC) to carry out a geomembrane leak location survey, in accordance with the requirements of the CQAP, after the leachate drainage layer has been placed to new landfill cell, and prior to the placement of any waste in the new landfill cell.

The Contractor will provide attendance on the LDC and will be responsible for preparing the site for survey in accordance with the CQAP.

5.20. SURFACE DRAINAGE WORKS

5.20.1. Clean Water Diversion Drains

- Construct the diversion drains to the grades and levels shown on the Drawings.
- Place the designated lining or topsoil layer as detailed on the drainage lining schedule, drawing CI-0332.
- Place the erosion control matting as soon possible after the topsoil layer is placed as outlined in the Technical Specification.

5.20.2. Dirty Water Diversion Drains

- Construct the diversion drains to the grades and levels shown on the Drawings
- Place the designated lining or topsoil layer as detailed on the drainage lining schedule, drawing CI-0332.

5.20.3. Recycled Material Lining

5.20.3.1. General

Recycled conveyor belt 7mm thick with 40mm diameter holes at 100mm centres, Andromeda Industries Enviro Belt 40 or similar approved, shall be used for the protection of the clean and dirty water diversion drains in lieu of concrete lining.

5.20.3.2. Installation

Form the drainage ditches to their final shape prior to application of the designated projection layer. Place a layer of mulch 100mm thick over the whole the surface to be protected. Lay the lining material on top of the mulch and stake it to the underlying surface using galvanised bar staples 300 x 100 x 300mm U-shaped staples at centres recommended by the supplier for the

length of drain being lined.

5.20.4. Rock Rip-Rap Lining

Rock rip-rap materials shall be used for scour protection of the clean and dirty water diversion drains and drainage outlet works and shall be installed to the lines, levels and dimensions shown on the Drawings.

5.20.4.1. Rock Rip-Rap Material

Rock rip-rap shall be sourced from an approved off-site source. Rock rip-rap material must not contain any of the following:

- Peat, vegetation, timber, organic, soluble or perishable material.
- Dangerous or toxic material or material susceptible to combustion.
- Metal, rubber, plastic or synthetic material.
- Construction debris.

Rock rip-rap shall comprise clean, hard, angular stones of generally uniform size which free of cracks, seams and other defects that would accelerate their destruction by water action.

Rock rip-rap shall comply with the compliance criteria specified in the tables below.

Table 23 Rock Rip Rap Material Compliance Criteria (Size)

Properties (Size)	Requirement
$2D_{50}$	100% Passing by Mass
D_{50}	50% Passing by Mass
$0.5D_{50}$	< 5% Passing by Mass
D_{50} / D_{90} Ratio	80% Minimum

Note: D50 is as shown on the Drawings for each design element.

Table 24 Rock Rip Rap Material Compliance Criteria (Strength)

Properties (Source Rock)	Requirement
Aggregate Wet Strength	>100 kN
Aggregate Dry Strength	>200 kN
Wet/Dry Strength Variation	<35 %

5.20.4.2. Construction

- Rock to be placed in a single continuous layer.
- Rock layer to be tampered down with excavator bucket (or similar) to ensure interlocking with adjacent boulders.
- Do not place rock fill by dumping or other methods that cause segregation of rock sizes.
- Take care not to damage or dislodge the underlying geotextile when placing the rock.

5.20.5. Quality Assurance Requirements

The Contractor shall carry out inspection and testing of the rock fill material in accordance with the requirements specified in the table below.

Table 25 Rock Rip Rap Material Testing Frequency

Material	Test	Test Frequency	
		Pre Construction (Compliance) At Source	During Construction At Site
Rock Rip Rap	Particle Size Distribution	Minimum of 3 per source	1 per 500 m³
	Aggregate Wet Strength		
	Aggregate Dry Strength		
	Wet/Dry Strength Variation		

5.21. SHOTCRETE FOR DRAINAGE WORKS

5.21.1. Scope

This section specifies the requirement for the supply and application of shotcrete for the lining of clean water drains.

5.21.2. Materials

Cement to be type 50 sulphate resistant Portland to AS3792.

Shotcrete material to comply with ASTM C1436-13 and C1480/C1480-07 (2012).

5.21.3. Inspection and Testing

The Contractor will carry out inspection and testing of shotcrete and shotcrete materials for the purposes of quality control. The Superintendent's Representative may also perform testing for the purposes of quality assurance.

The minimum tests required for quality control shall be:

- air content and slump shall be tested every batch until specifications are met and then once every third batch thereafter.
- concrete strength shall be tested by taking three cylinders for every 50 m^3 placed, with a minimum of one set completed length of drain. They shall be field cured. One cylinder to be broken at seven days and the remaining two at 28 days.

For the purpose of quality control, the Superintendent's Representative may, from time to time, require the Contractor to shoot test panels of fibre reinforced shotcrete for flexural and toughness testing.

The Contractor shall inform the Superintendent's Representative, at least three days in advance of start up of all shotcrete operations.

The Superintendent's Representative may take additional test samples during cold weather concreting. Cure samples on site under same conditions as the concrete that they represent.

Non-destructive methods for testing concrete shall be in accordance with AS1012.

If the tests performed by the Contractor or the Superintendent's Representative indicate that shotcrete fails to meet the specified requirements, then adopt such remedial measures as the Superintendent's Representative may require, at no expense to Council.

Toughness strength requirements will be considered satisfactory or unsatisfactory on the same basis as compressive strength requirements in AS1012.

5.21.4. Submissions

A minimum of 14 working days before commencing work, the Contractor shall supply the following:

- Information on all equipment to be used.
- Proposed mix-designs and test results for shotcrete, including brand-names of admixtures.
- Names and resumes of foremen and nozzle operators.

5.21.5. Trial Mix Testing Program

The Contractor shall retain a National Association of Testing Authorities, Australia qualified laboratory to independently take samples and test shotcrete during the development of the mix design.

Ten working days before start of shotcreting, the Contractor will perform full-scale shotcrete test using intended equipment. In the presence of the Superintendent's Representative shoot on plywood panels to minimum 100mm thickness, both horizontally and on a 2:1 slope the proposed shotcrete mix to be used in the Works.

Take samples of and test the above trial specimens of shotcrete.

The CQA Engineer may do simultaneous testing during the development of this mix design.

5.21.6. Preparation

Shotcrete placed directly on freshly excavated ground requires no surface preparation other than removal of loose material and the control of water.

Any water that is running or seeping into the surface to be covered with shotcrete will be drained away from the working area before shotcrete is placed.

5.21.7. Proficiency of Workers

Nozzlemen shall have previous experience on at least one comparable project in the past five years or shall work under the immediate supervision of a foreman with such experience. Each crew shall demonstrate to the Superintendent acceptable proficiency in the application of shotcrete to test panels before beginning production work.

5.21.8. Placings

Shotcrete application shall comply with the Concrete Institute Australia recommended practice for shotcreting.

Pre-dampened mix shall be used 60 minutes after initial contact with water.

Thoroughly mix shotcrete used in wet mix equipment for a period of at least 1½ minutes prior to use.

Any shotcrete that is not used within 60 minutes after initial mixing shall be wasted and the mixer washed out with clean water. The slump for wet mix shotcrete shall be between 60 and 100mm.

Apply shotcrete to provide a dense, smooth, firmly adhering coating at no point less than the thickness required by the Drawings. Each layer shall be applied before the shotcrete in the preceding layer has set completely. Rebound shall be kept clear of the shotcrete being placed.

5.21.9. Cold Weather Requirements

No shotcrete shall be placed when the temperature is below 10°C.

During cold weather, all materials stored outside shall be pre-heated throughout their bulk to 10°C or above, before delivery to the shotcrete equipment.

Any chemical additives that may be affected by cold shall be stored in an above freezing environment throughout its life until used in the shotcrete.

5.21.10. Curing

Normal set shotcrete shall be troweled to obtain smooth surface.

All permanent finished shotcrete surfaces shall be cured using a curing compound or any other suitable method approved by the Superintendent's Representative. Curing shall extend for a period of at least seven days following the date on which curing commences. No curing compound shall remain on surfaces that will be subsequently covered with additional layers of shotcrete.

5.21.11. Clean Up and Repair

Rebound and waste shall be disposed of off-site.

Water contaminated with any toxic or potentially toxic chemicals shall be collected and removed from the site. The Contractor shall make suitable arrangements for separate disposal of this material as and when it becomes necessary.

Damage to the shotcrete liner shall immediately be repaired to the satisfaction of the Superintendent's Representative.

5.21.12. Safety Measures

Alkali hydroxides and other chemicals contained in shotcrete admixtures and moderately toxic and can cause skin and respiratory irritation unless adequate safety measures are undertaken. In applying shotcrete containing toxic admixtures the nozzlemen and helpers shall wear appropriate hoods equipped with respiratory masks, gloves and necessary protective clothing. Eye baths shall be readily available in the immediate vicinity of shotcrete application.

The Contractor is totally responsible for implementation of a safety program for the project. Nothing in the Technical Specification relieves the Contractor of that responsibility.

5.22. STORMWATER PIPELINES AND CULVERTS

5.22.1. Materials

All pipes must be of first quality manufacture, free from damage and/or distortion and capable of withstanding the prescribed proof loadings. All fittings must be of similar manufacture and of commensurate quality.

5.22.1.1. Precast Reinforced Concrete Pipes

The materials for precast concrete culverts including pipes, end structures and headwalls shall be as indicated on the Drawings and shall comply with the requirements of AS4058:2007 Precast concrete pipes.

Types of pipe joints must be as indicated on the Drawings or, where the joint type is not indicated on the Drawings, must be of a spigot and socket rubber ring joint type.

Rubber rings for joints in concrete pipes and fittings must comply with the requirements of AS1646.

The culvert component size, class and/or wall thickness shall be as specified on the Drawings. All components shall be of the same class.

5.22.2. Pipe Backfilling

Excavated trench material may be used provided that it is in accordance with Clause 5.22.2.1 subject to compliant grading.

5.22.2.1. Bedding Material

All bedding material must be free of soluble salts and organic matter.

Bed zone and haunch zone material must consist of sand and/or gravel complying with the grading in the table below.

Table 26 Required Grading of Bedding Materials

AS Sieve Size (mm)	% Passing by mass
19 mm	100
2.36 mm	50 – 100
600 mm	20 – 90
300 mm	10 – 60
150 mm	0 – 25
75 mm	0 – 10

The Plasticity Index of the material must be 0.

5.22.2.2. Side Zone Material

The following backfill requirements shall apply.

Side zone material must conform to the grading in Table 25.

Table 27 Required Grading of Side Zone Materials

AS Sieve Size (mm)	% Passing (by mass)
50 mm	100
9.5 mm	50 - 100
2.36 mm	30 - 100
600 mm	15 - 50
75 mm	0 – 25

The Plasticity Index of the material must be less than 6.

5.22.2.3. Materials to be Used in Zones

The following backfill requirements shall apply except in the bedding zone.

The materials used in the back filling zones, according to the pipe support types indicated on the Drawings and to the locations of drains, must be as set out in the table below.

Fill materials for drainage applications are to be supplied by the Contractor. Excavated material, provided that it is in accordance with this Clause, may be used.

All fill materials must be free of soluble salts and organic matter. Materials to be used in zones shall be as shown in the table below.

Table 28 Materials to be Used in Zones

Zone	Material	Reference Clause
Bedding	Bedding Material	Clause 5.22.2.1
Haunch Zone	Bedding Material	Clause 5.22.2.1
Side Zone	Side Zone material or Bedding Material	Clause 5.22.2.2 or Clause 5.22.2.1
Overlay Zone (other than beneath existing or proposed roads or pavements)	General Fill (modified as follows), Select Fill material or Bedding Material It must not contain any stones larger than 150 mm, or more than 20% with a size between 75 mm and 150 mm subject to being able to be compacted to the nominated density.	Clause 5.12.2 or Clause 5.12.5 or Clause 5.22.2.1
Overlay Zone (beneath existing and proposed roads or pavements)	Select Fill material modified as follows; It must not contain any stones larger than 100 mm nor more than 20% with a size between 50 mm and 100 mm or Bedding Material .	Clause 5.12.5 or Clause 5.12.2

5.22.2.4. Back Fill Material

The following backfill requirements shall apply.

Back fill above the overlay zone must be accordance with Clause 5.22.2.3.

Back fill material used in the top 100mm of any trench, outside the area where Topsoil has been stripped, is to be material set aside from the top 100mm of trench excavation.

5.22.3. Installation of Buried Pipes

5.22.3.1. Pipes

RCP pipe drains must be constructed by trench installation unless noted otherwise on the Drawings. Fill must have been completed to not less than 600mm above the level of the top of the pipe, or to the finished surface of the fill, whichever is the lower, before any pipe is constructed.

If for any drain, the support type is not indicated on the Drawings or specified in the Technical Specification, the support shall be Type HS3.

At no time must the total length of trench for drains of any type opened up and not back filled exceed 300 metres. The construction of each drain must be commenced at its lower end.

Reinforced and fibre reinforced concrete pipes shall be installed in accordance with AS3500, AS3725, and AS3725 Supplement 1 with support type HS3, in trenches or side cuts made in solid ground, or compacted fill. Trenches for pipes shall be parallel with the inverts of the pipes.

5.22.3.2. Excavation

The Contractor is to excavate all classes of materials encountered for each pipeline to a width not greater than the maximum allowable width indicated on the Drawings and to a depth below the pipeline invert levels indicated on the Drawings sufficient to permit the construction of the Bed Zone. The minimum trench width must be the outer diameter of the pipe plus 600mm. Excavation for trenches must be in accordance with this Clause and Section 5.10.

Should unsuitable material be discovered and is not considered effective in providing the necessary side support during trench excavation, the Contractor is to excavate to a width directed by the Superintendent's Representative up to a maximum of 6 times the nominal pipe diameter. In areas where Topsoil has not been stripped material excavated from the top 300mm of trench excavation is to be set aside for use in back filling. No extra payments will be made for removal and replacement of unsuitable trench foundations.

Below the level of the top of the overlay zone the sides of the trench must be vertical.

The Contractor's Workplace Health and Safety management system must provide for the safety of persons in and near all trenches. The Contractor must provide any timbering or other support necessary for the prevention of damage to the Works and injury to workers or to others. Such timbering or other support is to be withdrawn as refilling proceeds.

The Contractor must ensure that the trench is drained at all times and to that end is to construct drains, banks and other protective works and provide and, for example operate pumps, as may be necessary.

The Contractor must advise the Superintendent's Representative when excavation has been carried out to the depth specified before placing bedding material.

If the Superintendent's Representative directs that a greater depth of bed zone, i.e. on account of poor quality foundation, than that indicated on the Drawings be provided, then the Contractor shall excavate to not less than the extra depth, over the length and width directed. The additional excavation must be filled with bedding material or with select fill material, as the Superintendent's Representative may direct.

Excavated material shall be used or disposed of as specified in Clause 5.11.3.

Any overbreak beyond the depth specified in this Clause 5.22.3.3 or directed by the Superintendent's Representative must be filled at the Contractor's expense with bedding material or select fill material.

5.22.3.3. Bed Zone

The bed zone extends for the full width of any trench and at least to 300mm each side beyond the external diameter of the pipe. The Superintendent's Representative may direct that a greater depth of bed zone than is indicated on the Drawings be provided and may direct that select fill material be used instead of bedding material in part or all of the bed zone.

The bed zone must be placed so as to attain the final required compacted thickness of 100mm in material other than rock and 175mm in rock. The bed material is to extend over the full width of the trench and must be compacted by tamping, rolling and/or vibration to a minimum Density Index of 70%.

The surface of the bed zone is to be shaped so that the pipes fall uniformly for the full length of the reach of drain, with line and levels as shown on the Drawings. The pipes must rest upon the bedding material for the full length of their barrels. If necessary, for pipes with sockets protruding beyond the barrel outside surface, chases must be dug into the bed and foundation in the appropriate positions so that each pipe is supported along the full length of the barrel and the socket is not subjected to concentrated loading.

5.22.3.4. Laying

Pipes must be laid and bedded to form a straight barrel, with the invert falling continuously to the lower end of the reach of drain and with the pipes closely jointed together. Pipes marked "TOP" shall be laid with that mark at the top. Pipes with a lifting hole are to be laid with the lifting hole at the top. Where rubber ring jointed or other socketed pipes are used they must be laid with the socket ends upstream.

If two or more classes of pipe are specified for different lengths of the one pipeline, they are to be placed in the positions indicated. No individual length of pipe less than 1.25 metres long is to be used directly beneath traffic loads unless the depth of fill over the pipe is 1.0 metre or more.

Pipes must be cut as required to give the lengths of drains indicated on the Drawings and to provide for skewed connections into structures, provided that in no case is the shortest remaining length of wall of any pipe to be used is less than one metre.

Cut ends of pipes must be incorporated into drainage structures or, in the case of socket and spigot pipes, may be the spigot in a joint provided that adequate depth of engagement can be retained all round and that the strength of the completed joint is not reduced.

Refer to Clause 5.22.4.3 for construction tolerances.

Refer to Figure 1 below and the Drawings for typical HS3 trench zone locations.

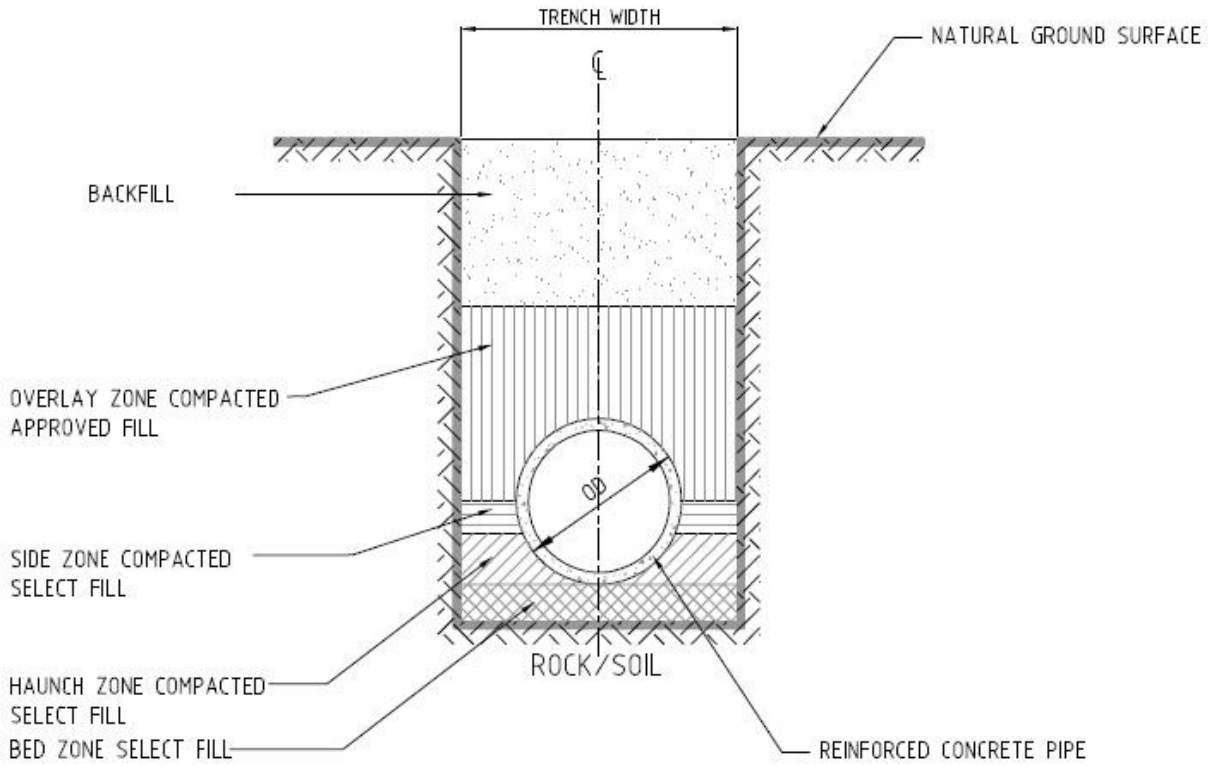


Figure 1 Typical HS3 Stormwater Pipe and Culvert Trench Fill Zones

All pipes are to be laid in such a manner that the pipe barrels have solid bearing throughout their length. After laying, pipes must be flushed internally with clean water to remove any loose materials or fines, and left free from debris on completion.

5.22.3.5. Jointing

Joints between pipes must be of the type specified in the Technical Specification and/or shown on the Drawings and must be made in accordance with the appropriate Australian Standard and in accordance with the manufacturer's recommendations.

Joint space is to be filled for the full circumference of the pipe. Lifting holes in pipes are to be filled with cement mortar. Prior to forming the joint, the pipes are to be thoroughly cleaned and correctly aligned.

5.22.3.6. Haunch Zone

The following backfill requirements shall apply to the haunch zone.

The Contractor must notify the Superintendent's Representative before commencing the construction of the haunch zone.

The haunch zone must extend from the top of the bed zone up to 0.3 times pipe outside diameter and is to be fill material with the requirements for the bed zone.

The haunch zone must be constructed in layers not more than 150mm compacted thickness, on both sides of single pipes and between multiple pipes, extending for the full width of the trench.

Each layer of material in the haunch zone must be compacted by conventional methods or compacted in one operation by saturation and vibration before the material for the next layer above is placed.

The material in the haunch zone must be compacted to a minimum density index not less than 70%.

5.22.3.7. Side Zone

The following backfill requirements shall apply to the side zone.

The Contractor must notify the Superintendent's Representative before commencing the construction of side zone.

The side zone must extend from the top of the haunch zone up to 0.7 times pipe outside diameter above the top of the bed zone and is to consist of select fill material and be constructed in layers not more than 150mm compacted thickness, on both sides of single pipes and between multiple pipes, extending for the full width of the trench.

Each layer of material in the side zone must be compacted before the material for the next layer above is placed. The material in the side zone must be compacted by tamping, rolling or vibration to a density index not less than 95% (standard compaction).

5.22.3.8. Overlay Zone

The following backfill requirements shall apply to the overlay zone.

In this clause and in Clause 5.22.3.9, the requirements for materials and construction in pipelines crossing roads or pavements apply to the overlay zone and back fill between planes intersecting the edge of pavement or back of kerb at pavement surface level and sloping at 1.4V:1H away from the pavement.

The Contractor must notify the Superintendent's Representative before commencing the construction of the overlay zone.

The overlay zone extends from the top of the haunch or side zone to 300mm above the top of the pipe and around the pipe measured radially from any point and must be fill material consisting of material from the excavation or elsewhere. It must not contain stones larger than 15mm, nor more than 20% with a size between 50mm and 100mm. Where pipelines are constructed under roads, pavements, paving and building platforms overlay zone material must not contain stones larger than 100mm, nor more than 20% with a size between 50mm and 100mm.

The overlay zone must be constructed in layers not more than 150mm compacted thickness, on both sides of single pipes and between multiple pipes, extending for the full width of the trench.

Each layer of material in the overlay zone must be compacted before the material for the next layer above is placed.

The material must be compacted to the following relative densities:

Table 29 Overlay Zone Material Relative Density Requirements

Location	Compaction Requirement
Roads, Pavements, Paving and Building Platforms	100% SMDD or 100% Relative Compaction Hilf Rapid Method
Elsewhere	95% SMDD or 95% Relative Compaction Hilf Rapid Method

5.22.3.9. Back Fill

The Contractor must notify the Superintendent's Representative before commencing the installation of back fill.

The following backfill requirements shall apply.

Only excavated material approved by the Superintendent's Representative may be used as fill in accordance with Clause 5.22.2.4. Back fill must be constructed in layers not thicker than the maximum thickness specified for the adjacent fill and in any case not more than 150mm compacted thickness for drains, extending for the full width of the trench.

Where pipes are laid below heavy duty pavements, the back fill and overlay zone material must be a controlled low-strength material (CLSM) with a 28-day compressive strength of 5 Mpa. Types GB or GP cement in accordance with AS3972 must be used in the production of CLSM. Aggregates in the CLSM must be free of reactive or expansive materials

For pipe trenches under roads and building platforms, back filling must be with select fill. Compaction of back fill material is to be to 100% SMDD. The Sand and filter material back fill must be capped with a 300mm layer of 4% lime stabilised Select Fill material by dry weight, placed directly below subgrade level. This material is to be compacted to dry densities of minimum 100% of Standard Maximum Dry Density. Alternatively, the 300mm capping layer may be DGB20 compacted to 100% SMDD.

For pipe trenches not under roads or building platforms the material should be compacted as necessary to prevent excessive settlement in the ground surface level over the installed pipeline.

Each layer of material in the back fill must be compacted before the material for the next layer above is placed.

5.22.4. Inspection and Testing

5.22.4.1. Installation Records

The Contractor shall provide to the Superintendent's Representative a drawing showing the layout of the precast concrete culverts and a schedule of its panel code and roll numbers.

5.22.4.2. Bedding and Backfill Material

The Contractor shall carry out inspection and testing of bedding and backfill material placement in accordance with the requirements specified in Section 5.22.5.

5.22.4.3. Tolerances

Pipes must be laid to the alignments and grades shown within the following tolerances:

Table 30 Pipe Tolerance Requirements

Pipe Diameter (mm)	Line Tolerance (mm)	Level Tolerance (mm)
< 300	± 10	± 5
300 – 900	± 10	± 5
> 900	± 10	± 5
NO REVERSE FALLS ARE PERMITTED		

Tolerances stated are conditional on falls to outlets being maintained, and no part of a pipeline being at less than the required gradient. Nowhere are pipes to be outside any limits on the location of stormwater drains indicated on the Drawings or encroach on any land reserved for other services and purposes.

5.22.4.4. Clean-Up

Pipelines must be cleaned of all spilt concrete and mortar, loose soil, silt and other obstructions to the flow of water. Pipelines must be flushed clean. In particular, all internal formwork must be removed.

5.22.5. Quality Assurance Requirements

5.22.5.1. Manufacturer's Quality Assurance Documentation and Test Certifications

The Contractor shall provide product data sheets listing the physical properties for each precast concrete culvert component prior to shipment.

The Contractor shall submit manufacturer's quality assurance documentation and test certificates to the Superintendent's Representative not less than seven days prior to the installation of the precast concrete culvert components. The certification shall include the following:

- Details of the concrete supplier and concrete production plant, and identification and production date of the resin concrete.
- Details of the proportion of the materials that comprise the precast concrete culvert components.
- Quality control certificates issued by the resin supplier to the manufacturer.
- Details of testing conducted by the manufacturer to verify that the precast concrete culvert components complies with the size and class requirements of the Technical Specification.
- Written certification that the size and class requirements of the Technical Specification are guaranteed by the manufacturer.
- Quality assurance certificates, including the sample identification, testing procedure and test results.

5.22.5.2. Testing and Frequency

The Contractor shall carry out testing of the pipe installation works in accordance with the requirements specified in the table below.

Table 31 Testing and Frequency of Stormwater Pipe Installation Works

Material	Test	Test Frequency
Geometrics	Horizontal	Geometrics: 1 per 50 m and at access chambers
	Vertical	
Bedding and Backfilling	Particle Size Distribution	One test per 500 m^3
	Atterberg Limits	
	Standard Compaction Test	1 test per 50 linear metres per layer of 150 mm thickness per material type
	Moisture Content	
Drainage Structures Pits, headwalls, slabs, concrete lining	Concrete – compressive strength	1 sample per 25m^3 or one sample per pour whichever results in the most samples (where one sample consists of a slump test and minimum of 2 cylinder specimens for strength testing). Additional sampling may be required to allow for early strength tests where required for stripping of formwork or backfilling of structures.

5.23. ACCESS AND INTERNAL ROADS

5.23.1. General

5.23.2. Unbound or Modified Pavement Courses

5.23.2.1. Site Stockpile

Delivery of unbound material or material to be modified to site stockpiles must comply with the following requirements:

- That loss of material does not occur.
- The material must be kept suitably damp to prevent segregation or loss of fines during transit.
- The material must, at the time of delivery, have a moisture content (uniformly distributed) not greater than the optimum moisture content as determined by AS 1289.5.1.1 or AS 1289.5.7.1.
- Material delivered which is unsuitable for reasons such as segregation, contamination or non-homogeneity is deemed to be nonconforming and must not be used in the Works.

Stockpiles must be of uniform shape with side slopes neither steeper than 1.5V:1H nor flatter than 3H:1V. The total height of any stockpile must not exceed 4 metres, unless otherwise approved by the Superintendent's Representative.

5.23.2.2. Submission of Proposed Mix and Materials Details

Provide the Superintendent, at least 14 days before commencement of work, with details of the proposed mix and each proposed constituent material, together with a signed statement of conformity that matches representative test results for current or most recent production against specification requirements, verifying that the proposed mix meets the requirements of the Technical Specification.

Provide evidence from quality records to demonstrate that:

- each of the constituent materials can be supplied from a source of consistent quality; and,
- the proposed mix can be delivered at a consistent quality.

5.23.2.3. Requirements for Unbound Material and Material to be Modified

Table 32 Particle Size Distribution Requirements for Dense Graded Materials

Property	Unbound Materials or Material To Be Modified		Materials To Be Bound	Council Supplied Recycle crushed concrete.
Particle Size Distribution Passing AS Sieve (% by mass)	DGB 20	DGS 20	MB 20	Recycled concrete
	Base	Subbase	Base/Subbase	Subbase
75.0mm	-	-	-	This information is for
53.0mm	-	-	-	ITT only.
37.5mm	-	-	-	
26.5mm	100	100	100	100
19.0mm	95-100	95-100	95-100	95-100
13.2mm	78-92	70-90	70-90	70-90
9.5mm	63-83	58-80	60-80	58-80
4.75mm	44-64	43-65	-	43-65
2.36mm	33-49	30-55	30-50	30-55
425 µm	14-23	10-30	10-25	10-30
75 µm	7-14	4-17	4-12	4-17
13.5 µm	3-7	2-10	-	

Table 33 Plasticity Requirements for Dense Graded Materials

Property	Unbound Materials/Material To Be Modified		Materials To Be Bound
	DGB 20	DGS 20	MB 20
	Base	Subbase	Base/Subbase
Plasticity Index (PI) For applicable Traffic Category D (Light-ESA < or = 10^6)	Max 8	-	Max 10
Liquid Limit (if material non-plastic) For Traffic Category D	Max 23	Max 23	-
Plastic Limit (if plastic)	Max 20	Max 20	-

Table 34 Cohesion, Soundness and Strength Requirements for Dense Graded Materials

Property	Unbound Materials/ Material To Be Modified		Materials To Be Bound
	DGB 20	DGS 20	MB 20
	Base	Subbase	Base/Subbase
Max Dry Compressive Strength on fraction passing 19mm sieve (only applies if PI < 2) (MPa). For applicable Traffic Category D (Light-ESA < or = 10^6)	Min 1.7	Min 1.0	-
Unconfined Compressive Strength (UCS) (MPa)	Max 1.0	-	-
Particle Shape by Proportional Calliper. % mis-shapen (2:1)	Max 35	Max 35	Max 35
Aggregate Wet Strength (kN): For applicable Traffic Category D	Min 70	Min 50	Min 70
Wet/Dry Strength Variation % = (D – W)/D % For applicable Traffic Category D	Max 35	Max 40	Max 35

Table 35 Pavement Compaction Requirements

Pavement Layer	Minimum CBR	Minimum Thickness	Compaction Requirements
Base Course	80%	100mm	102% Standard
Sub-Base Course	40%	100mm	102% Standard

Table 36 Minimum Testing Requirements For Pavement Materials, Compaction CBR, Insitu Density, Maximum Wet and Dry Density, Field Moisture Content

Specified Relative Compaction (%)	Minimum Testing Frequency for Lot Area of:				
	>5000 m^2	1000 – 5000 m^2	500 – 1000 m^2	50 – 500 m^2	< or = 50 m^2
< or = 90.0	1 per 3000 m^2	1 per 2000 m^2 (min. 2)	1	1	1
>90.0 but < or = 95.0	1 per 2000 m^2	1 per 1000 m^2 (min. 3)	1 per 250 m^2 (min. 3)	2	1
>95.0 but < or = 98.0	1 per 2000 m^2 (min. 6)	5	4	3	1
>98.0 but < or = 100.0	1 per 2000 m^2 (min. 6)	5	4	3	1
>100.0	1 per 1000 m2 (min. 10)	1 per 500 m^2 (min. 5)	4	3	1

5.23.2.4. Recycled Crushed Concrete

There is a provisional item in the Tender Breakdown Schedule that requires tenderers to price for the use of Council supplied recycled crushed concrete in lieu of DGS 20. If Council chooses to proceed with this option, the Contractor must comply with all the above requirements as they apply to DGS 20.

Recycled crushed concrete may be supplied and loaded by Council at the existing Long Swamp Road Waste Transfer Station at no cost to the Contractor. However, the Contractor will be required to provide trucks to transport the crushed concrete to the site.

Results of tests carried out on available recycled crushed concrete are given in Table 35 for Tenderers information.

Table 37 Test Results on Recycled Crushed Concrete.

Property	Sample A	Sample B	Sample C
Maximum Dry Density (t/m^3)	1.84	1.86	1.82
OMC (%)	15.0	15.5	15.5
Compaction type	Standard	Standard	Standard
Accelerated curing (days)	7	7	7
Condition after curing	moist	moist	moist
Dry Density (t/m^3)	1.88	1.86	1.80
UCS (4 hr soak) (MPa)	0.2	0.2	0.3
% Retained 37.5 / 19.0 mm sieve	0	0	0
Wet / Dry Strength variation (%)	11 (A + B + C combined and tested)		

CBR Value @ 5.0mm Penetration (%)	50	40	70

Particle size distribution *complies* with the requirements of Table 35 above.

5.23.2.5. Sprayed Bituminous Surfacing

a) Scope of Works

The Contractor is responsible for the design, supply of all materials and the application of the 10mm class 170 bituminous Primerseal surfacing in accordance with RMS QA Specification R106.

The scope of works includes the following:

- Supply and delivery of all materials.
- Storage and handling of raw materials.
- Pre-coating of aggregate – maximum lot size is limited to 250 m^3.
- Preparation of pavement surfaces.
- Preparation of bitumen binder.
- Application of primer binder.
- Application and incorporation of aggregate.
- Removal of loose aggregate.

The Primerseal must not peel, pluck, strip, flush or bleed and aggregate must not crush during the period of 12 months after practical completion. It must be uniform in colour and texture.

b) Submission of nominated design.

Submit the nominated design to the Superintendent's Representative, together with certification for the nominated materials, at least seven days prior to the commencement of sprayed bituminous surfacing works.

Include the following details in the submission:

(i) Each constituent material;

- Test results for all nominated materials, including stripping and initial adhesion for the combination of nominated materials;
- aggregates - source, geological type, particle size distribution, nominated average least dimension (ALD);
- precoating agent and bitumen adhesion agent - types and proportions;
- bitumen - refinery source;
- cutback bitumen - refinery source of bitumen, source of cutter oil;
- cutter oil / flux oil - type and source.

If you propose to change the source of supply of any constituent material, submit a new nominated design and details of the change to constituent material.

(ii) Verification of conformity of the nominated materials;

- Submit test results to verify conformity to Clauses 2 and 3 of RMS QA Specification R106 each constituent material proposed for the use in the Works, including stripping and initial adhesion for the combination of nominated materials.
- Carry out the sampling and testing of a nominated material within the six months period prior to the date of submission to the Superintendent. Perform all phases of any particular test at one laboratory.

(iii) Endorsement

Submit a signed statement stating that each design and its constituent materials meet the requirements of Clauses 2 and 3 of RMS QA Specification R106. The statement must include National Association of Testing Authorities, Australia endorsed test results for all specified tests. Attach a copy of your completed verification checklist.

5.23.2.6. Jute Mesh

Jute mesh is a biodegradable open weave erosion control mesh suitable for short term erosion protection to batters and open drains. Jute mesh helps retain moisture and allows water and light infiltration to encourage vegetation growth.

Installation Instructions

1) Prepare the area to be treated to a smooth even grade. Remove all protruding rocks, roots and stumps and treat the soil to promote maximum plant growth. Spread topsoil, apply seed, fertilizer directly to soil prior to installing jute mesh.
2) Lay the jute mesh rolls from top to bottom of steep batters. Adjoining rolls should be overlapped by a minimum of 100mm.
3) Jute mesh should be overlapped away from prevailing wind and water flow direction.
4) A trench, no less than 200mm deep, should be dug around the whole area including bottom, sides and top of work area, this will protect the edges from being lifted during rain or flooding events.
5) Lay mesh into trench, pin the mesh, backfill the trench and compact.
6) Depending on the steepness of the slope, Jute mesh should be pinned with approximately two pins per m^2. On steeper batters, flooding areas or areas prone to high wind and unstable subsoils a higher pinning rate should be used.
7) Pin down the nettings as above using 200mm U shaped galvanized steel retaining pins.
8) Maintain and water the site as required to promote the growth of vegetation.

Table 38 Typical Properties of Jute Mesh

Property	Jute Mesh
Material	100% Jute Fibre (woven weave)
Bale Quantity	1.22m x 548m bale (670sq.m per bale)
Gross Weight	345 kg/bale

5.23.2.7. Subsoil Drainage

Provide a certificate of compliance verifying that the corrugated perforated drainage pipe complies with the requirements of the Technical Specification together with test results reported on National Association of Testing Authorities, Australia endorsed test documents. The certificate is for tests not more than six months old.

Excavate for, supply and install subsoil drain at cuttings 1 metre beneath the table drain consisting of 100mm diameter perforated pipe with sock surrounded in 10mm aggregate including Bidim A14 geotextile in trench and construction of outfall all as shown in Drawing 922-002 sheets 6 and 7.

5.24. MINOR CONCRETE WORKS

5.24.1. Scope

This Section applies to minor concrete works includes:

- Reinforced concrete lined drains, excluding shotcrete.
- Spillways and overflows.

Concrete workmanship and materials must be in accordance with AS3600 – Concrete Structures Code.

5.24.2. Inspection

The Contractor must notify the Superintendent's Representative so that an inspection can be made at the following stages of the work:

- Detailed excavation.
- Foundation subgrade.
- Completed formwork.
- Reinforcement fixed in place.
- Placing of concrete.

5.24.3. Formwork

5.24.3.1. General

The materials, design and construction of formwork must comply with AS3610 and Section 19 of AS3600. The Contractor must design, fabricate, erect and strip formwork. Refer to Section 2 of AS3610.

The types of formwork must be determined by the Contractor to achieve the surface finishes and the shapes, lines, levels and dimensions of the concrete work required by the Drawings and the Technical Specification.

Unless shown otherwise on the Drawings, forms must be filleted for corners. The face of the bevel in each case must be 20mm and must form a straight line at 45 degrees to the faces of the forms. Drip grooves must be provided continuously around soffit edges to the dimensions and locations as detailed on the Drawings.

All materials to be used in the formwork must comply with the appropriate Australian Standards or in their absence the appropriate American or British Standards.

5.24.3.2. Void Formers

The material and construction used for the forming of voids, blockouts and the like must be of sufficient strength to prevent deformation or destruction under the load of wet concrete and construction loads and such as to prevent leakage of wet concrete or water into the voids. The formers must be so positioned and secured that they will not be dislodged during the concreting and will produce the required void within the tolerances stipulated in the Technical Specification. Care must be taken to resist the buoyancy effects of the wet concrete on the formwork.

If the void former is to remain in place it must be of lightweight construction not heavier than allowed for in the design of the element and unless fully surrounded and protected by concrete or the ground, it must also be incombustible.

Void formers used to form a space to allow for differential movement between structural elements must be of adequate strength to support the weight of the wet concrete and must have sufficient plasticity to permit the movement specified. Void formers must not be manufactured from absorbent material.

Void formers must be removed from the poured concrete by the Contractor leaving a clean penetration as shown on the Drawings and in accordance with the deviances nominated by the Technical Specification. After the removal of void formers the concrete which forms the extent of the void must be within 10mm of its theoretical position.

5.24.3.3. Permanent or Lost Formwork

Where it is not possible or practicable to remove formwork from formed surfaces, permanent or lost formwork must be used. Such formwork must be of sufficient strength and rigidity to support the weight of the wet concrete and construction loads and must be incombustible.

Permanent formers containing Calcium Chloride must not be used.

Where such formwork is also acting as a part of a construction joint it must be capable of transmitting any shear at the joint by indentation, penetration or the like.

The Superintendent's Representative must agree to the use of permanent or lost formwork.

5.24.3.4. Minimum Formwork Stripping Times

Refer to Section 5 of AS3610 and Section 19 of AS3600.

The requirements for minimum formwork stripping times are as set out in AS3610 and Section 19 of AS3600 where these are more stringent than the relevant requirements of AS3610.

5.24.3.5. Stacked Materials

Materials must not be stacked on formwork or on concrete work supported by formwork.

5.24.3.6. Restraint of Formwork

Formwork must not be braced against previously cast concrete. Framed bracing must be constructed between formwork supports.

5.24.3.7. Construction Joints

Refer to Section 5.24.6 of the Technical Specification.

5.24.3.8. Sequence of Pours

The proposed sequence of pours must be submitted to the Superintendent's Representative for approval.

5.24.3.9. Inserts and Penetrations

Inserts or penetrations not specifically detailed on the Drawings must not be located without the approval of the Superintendent's Representative.

5.24.3.10. Permanent Formwork

Formwork that is required to remain permanently in the structure must be incombustible and must be free from calcium chloride.

5.24.3.11. Critical Face of Elements

The critical face must be the surface exposed to view.

5.24.3.12. Surface Finishes

Refer to Section 3 of AS3610. The following surface finishes must be achieved:

Table 39 Concrete Surface Finishes

Area	Surface Finish
Areas viewed as a whole, e.g. exposed external walls and internal walls of stormwater drainage structures	3
Areas concealed from view, e.g. hidden external walls, backs of stormwater drainage structures	4
Totally concealed areas where the only requirement is structural adequacy, i.e. footings	5

5.24.3.13. Construction

Refer to Section 5 of AS3610.

5.24.3.14. Tolerances for Structures and Formwork

Refer to Section 19.5 of AS3600 and Section 5 of AS3610.

For formed surfaces the tolerances given in AS3610 take precedence, unless those in Section 19.5 of AS3600 are more stringent. For unformed plane surfaces, the flatness tolerances must not be greater than the relevant values in Clause 19.5.2 of AS 3600 and the methods for measuring them must be in accordance with AS3610.

5.24.4. Reinforcement

Refer to Section 19 of AS3600.

5.24.4.1. Samples

The Contractor must supply samples of materials when requested by the Superintendent's Representative and after agreement all subsequent work must be identical in appearance and quality to the reviewed sample.

5.24.4.2. Materials

5.24.4.3. Reinforcing Bar, Wire or Fabric

Reinforcing bar, wire or fabric must conform to the requirements of AS/NZS4671 as appropriate to the particular type and grade of reinforcement.

5.24.4.4. Identification and Testing of Reinforcement

Reinforcement must be readily identifiable as to grade and origin.

Copies of manufacturer's test certificates as required by and in accordance with AS/NZS4671 as appropriate to the type and grade of reinforcement must be provided, if requested.

Reinforcement which does not conform to the Technical Specification must be rejected.

(c) Incidental Materials – Bar Chairs, Spacers, Stools and Tie Wire

Bar chairs, spacers or stools must be made of plastic, concrete or of welded hard-drawn steel wire provided with plastic tips.

Tie wire must be black annealed 1.25mm diameter wire, or alternatively approved clips may be used. Sufficient quantities of the above must be supplied by the Contractor and delivered with the reinforcement.

5.24.4.5. Fabrication

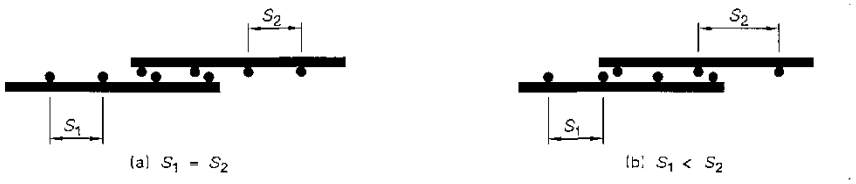
5.24.4.6. Bending, Splicing and Welding of Reinforcement

Reinforcement must be bent or straightened in a manner that will not damage it and to the requirements of Clause 19.2.3 of AS3600.

The dimensions of splices, hooks and bends must conform to Clause 19.2.3.2 of AS3600.

When splices not already shown on the Drawings are found necessary, the details of the proposed splices must be submitted for review by the Superintendent's Representative before use.

A lapped splice for welded mesh in tension shall be made so the two outermost cross-bars spaced at not less than 100mm or 50mm apart for plain or deformed bars, respectively, of one sheet of mesh overlap the two outermost cross-bars of the sheet being lapped as shown in the figure below. The minimum length of the overlap shall equal 100mm.



Reinforcement must not be welded nor shall the use of tack welding be permitted in the manufacture of reinforcement cages without the specific agreement of the Superintendent's Representative. This Clause 5.24.4.5 does not apply to welding during manufacture of the wire fabric.

Reinforcing bar which has been supplied bent must not be subject to further cutting or bending without approval of the Superintendent's Representative. The use of heat for bending or rebending of galvanised reinforcement will not be permitted.

Heating or welding of reinforcement must be carried out only if agreed to by the Superintendent's Representative. Welding of reinforcing bars must satisfy the requirements of AS1554.3.

Where reinforcement is shown staggered no more than 50% of the reinforcement must be lapped at any one section unless otherwise specified.

(d) Fabrication Tolerances

Reinforcement must be fabricated to the shape and dimensions shown on the Drawings and within the tolerances specified in Clause 19.2.2 of AS3600.

(e) Surface Condition

The surface condition of reinforcement must be supplied free from loose mill scale, loose rust, clay, mud, oil, grease and other coatings that would reduce the bond between the concrete and the reinforcement.

(f) Protective Coated Reinforcement

Unless otherwise shown on the Drawings, if an element is specified to contain protective coated reinforcement, the same coating type must be applied to all that elements' reinforcement and embedded ferrous metal items, including tie wires, stools, spacers, plates, ferrules and the like.

(g) Galvanised Reinforcement

Where shown on the Drawings, reinforcement must be hot dipped galvanised in accordance with AS4680. Reinforcement to be galvanised must be passivated in a 0.2% sodium dichromate solution applied by the galvaniser or alternatively chromium trioxide must be added to the concrete mix in the ratio of 300 ppm by weight of mixing water (0.3 grams per litre).

The galvanised coating must conform to AS4680 and must have a minimum coating of 700 grams/square metre. Where galvanised reinforcement is welded it is to be descaled and regalvanised following the recommendation contained in Appendix F of AS4680.

The use of heat for bending or re-bending of galvanised reinforcement will not be permitted.

5.24.4.7. Delivery, Unloading and Storage

(a) Delivery

Fabricated reinforcing steel must be bundled and securely tied to ensure that it does not sustain damage during delivery or unloading.

Each bundle or piece must be identified by a wired-on metallic tag showing the 'mark' of that bundle. The 'mark' must refer to the bending schedule.

A different coloured tag must be used to identify each of the separate modules on the project.

(b) Unloading and Storage on Site

Fabricated reinforcing steel must be unloaded and stored on site in such a manner that it does not sustain damage or become contaminated by material liable to influence its effectiveness as reinforcing in concrete.

(c) Bending Schedules

Bending schedules must be prepared by the Contractor, indicating shapes, dimensions and details of bar reinforcement.

(d) Reinforcement Development Lengths

Unless noted otherwise on Drawings, the reinforcement development and cog lengths must be as below:

Table 40 Reinforcement Development Lengths

Bar Size	Development of Lap Length (mm)	Cog Length (mm)
N12	400	200
N16	500	250
N20	650	300
N24	850	350
N28	1150	400
N32	1400	450
N36	1700	550

5.24.4.8. Placing of Reinforcement Steel

(a) Tolerances

Reinforcement must be placed within the tolerances specified in Clause 17.5.3 of AS3600, the Drawings and the Technical Specification.

(b) Alignment

Reinforcement must be free from bends not required on the Drawings, kinks and similar defects and must be securely fastened and maintained in position.

(c) Support of Reinforcement

Reinforcement must be securely held in position by using spacers or stools made of plastic or plastic tipped metal, by metal hangers or by other agreed means. Reinforcement must not be held in position by bare steel supports that extend to the surface of the concrete. Reinforcement must not be supported on pieces of wood, brick, aggregate or like material.

Sufficient means of support must be provided to ensure that the reinforcement does not sag between supports and to allow the reinforcement to be walked upon without damage.

The concrete cover to reinforcement nominated on the Drawings and the Technical Specification must be maintained at all times.

Reinforcement must be tied at intersections with black annealed 1.25mm diameter iron wire. The free ends of the wire must be bent inwards toward the centre of the section of the concrete.

Reinforcement in suspended slabs and in concrete pavements must be supported by bar chairs, stools or spacers at a maximum spacing of 750mm.

Reinforcement for concrete slabs poured on ground in conjunction with a vapour barrier must be supported on bar chairs which are supported on spreader plates sufficient to prevent the bar chair puncturing the vapour barrier.

In reinforcement in the form of a mat, each bar must be secured at alternate intersections and at other points as required.

Lifting of reinforcement through wet concrete will not in any circumstances be permitted.

5.24.4.9. Cores and Embedments

The supply and fixing of cores and embedments is included in other sections of the Technical Specification. Reinforcement must not be cut to provide space for core holes or embedments. Reinforcement may be moved slightly to allow fitting of cores. Agreement from the Superintendent's Representative must be obtained.

5.24.4.10. Protection of Other Works

The Contractor is responsible at all times for the protection of work completed by others throughout the duration of the Works.

Special care must be taken by the Contractor to protect formwork during any oxy acetylene activities.

5.24.4.11. Inspections

The Contractor must give a minimum 24 hours notice to the Superintendent's Representative of the reinforcement, forms and embedments being completed and ready for inspection prior to pouring of concrete.

The inspection of the reinforcement does not relieve the Contractor of its responsibility to carry out its own inspection and to ensure compliance with the Contract.

The Contractor must allow sufficient time for these inspections and time to complete any necessary rectification work and subsequent re-inspection.

5.24.4.12. Concrete

The following Clause must be read in conjunction with the Drawings and the applicable specifications and relevant Australian Standards.

(a) Schedule of Concrete Mixes

Unless otherwise noted on the Drawings, concrete mixes must be as shown in the table below:

Table 41 Concrete Mix Schedule

Element/Location	Class/Grade	f'c at 28 days (Mpa)	Aggregate size (mm)	Slump (mm)
Drainage pits and headwalls	N32	32	20	80 +/- 15
Drain concrete lining	N32	32	20	80 +/- 15

(b) Concrete Supply and Placement

The Contractor must select materials and design concrete mixes. The Contractor must design and produce finished concrete and concrete work that is in accordance with the Technical Specification.

Materials:

- Cement: must be Type GP - General Purpose Portland Cement complying with AS3972.
- Fly Ash: must not be used as an additive to cement, unless it can be established to the satisfaction of the Superintendent's Representative that aggregates for the concrete mix are unlikely to have the potential to create an environment for an aggregate/alkali reaction. The proportion of fly ash must be 25% by weight of the total combined weight of fly ash and cement. Fly ash must satisfy the requirements of AS3582.1 and AS3583.
- Fine and Coarse Aggregates: must satisfy the requirements of AS1141 and AS2758.1. The maximum coarse aggregate size must be 20mm.
- Water: The water used in mixing concrete must be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances and must be of potable quality.
- Admixtures: Chemical admixtures in concrete may be used only with the written acceptance of the Superintendent's Representative. Admixtures may satisfy the requirements of AS1478. Fly ash is not considered an admixture.

5.24.5. Concrete Mix Design

The concrete mix design including details of the materials must be submitted to and agreed by the Superintendent's Representative prior to pouring of any concrete.

The following certificates from a laboratory registered with National Association of Testing Authorities, Australia must be produced by the Contractor, upon request by the Superintendent's Representative.

- Cement - certificates as in Appendix A of AS1315. Certificates of results of Autoclave Expansion Test as in ASTM C151.
- Aggregates - certificates of results of tests set out in AS2758 Part 1.
- Admixtures and fly ash - Certificates that the admixture or fly ash complies with the requirements of AS1478 or AS3582, respectively for acceptance testing and uniformity.

Calcium chloride compounds will not be accepted under any circumstances.

5.24.5.1. Ready Mixed Concrete

Ready mixed concrete, either pumped or placed, may be used, provided that it satisfies the requirements of the Technical Specification and of AS1379.

(a) Identification certificate

Certificates as per Clause 1.7.3 of AS1379 are required for:

- Characteristic compressive strength at 28 days.
- Slump prior to addition of super plasticiser.
- Shrinkage values after 56 days.
- Values for modulus of rupture (if requested).
- Abrasion resistance - Chaplin Testing (if requested).

(b) Water

If not from a potable water supply, evidence is required from the Contractor that the water contains no matter harmful to concrete, reinforcement or other embedded

5.24.5.2. Site Mixed Concrete

Site mixed concrete must not be used without the prior approval of the Superintendent's Representative.

5.24.5.3. Grout

Grout must consist of Portland cement and water or of Portland cement, sand and water.

An additive designed to produce fluidity and for expansion of the grout may be used, subject to the Superintendent's Representative' agreement, provided that additives containing aluminium powder, chlorides or nitrates are not be used.

Sand, if used, must satisfy the requirements of AS2758 except that the grading may be modified to obtain increased workability. The water content must be the minimum necessary for proper placement.

5.24.5.4. Mixing and Delivery

(a) General

The mix designs must conform to the requirements set in Section 5.24.5.

(b) Concrete Quality

All concrete produced must conform to the Technical Specification and to the referenced standards.

The characteristic compressive strengths at 28 days, and types of concrete, slump and maximum size of aggregates required for the various parts of the work must be as shown on the Drawings. The characteristic compressive strength at 28 days shall be denoted by the symbol f'c. Any required early age mean strength shall be shown on the Drawings and denoted by fcm.

All concrete mixes must be designed to achieve or exceed 45% of the 28 day characteristic compressive strength at three days and 75% of the 28 day characteristic compressive strength at seven days.

The mass per unit volume of hardened concrete shall be in the range from 2400 kg/m3 to 2500 kg/m3 when determined in accordance with AS1012 Part 12.

The proportions of aggregate and cement for the concrete must be such as will produce a mix which will work readily into corners and angles of the forms and around reinforcement with the method of placement employed on the work but without permitting the material to segregate, or excess free water to collect on the surface.

The proportioning must be such as to ensure that the resultant concrete will be sound, dense, durable and of the strength and other properties specified.

The Contractor must submit for agreement with the Superintendent's Representative, a minimum of 14 days prior to the placement of the concrete, the proposed mix proportions for each grade of concrete to be used in the project along with test results indicating that the proposed mix will satisfy the requirements of the Technical Specification.

Information to be supplied for assessment must include:

- Source of supply of all materials including cement, aggregates, fly ash and any admixtures.
- Mix proportion by weight per cubic metre of all constituents including water and the water/cement ratio.
- Characteristic compressive strength at 28 days, f'c.
- Early age mean strength, fcm (if applicable).
- Slump.
- Shrinkage of concrete at 56 days.
- Assessment of maximum long term shrinkage values.
- Suitability of aggregates to meet specified abrasion resistance requirements (if required).
- Hardened concrete density values.
- Time available between mixing and placing concrete to ensure design parameters are met.
- Structural elements being poured.

After all ingredients of the concrete have been mixed no further water is to be added.

5.24.5.5. Sampling and Testing

All concrete will be subject to both production and project assessment in accordance with AS1379. Sampling and testing of concrete for compliance must be in accordance with AS1379.

All sampling must be carried out in accordance with Section 5 and Appendix B of AS1379 by a person approved by National Association of Testing Authorities, Australia for this purpose.

Testing and curing of samples must be carried out in a laboratory registered with National Association of Testing Authorities, Australia for this purpose and agreed to by the Superintendent's Representative.

Slump tests must be undertaken in accordance with AS1379.

A slump cone and at least two test cylinder moulds and other necessary equipment must be maintained on Site. Concrete must not be discharged into formwork whilst slump or other tests are being performed which could result in its rejection.

5.24.6. Concrete Placing

5.24.6.1. Conditions for Placement

Concrete placement must be carried out under the direct supervision of a capable foreman, employed by the Contractor and approved by Superintendent's Representative, experienced in reinforced concrete construction and familiar with the relevant Standard Codes and Specifications. The Contractor shall notify the Superintendent's Representative at least 24 hours prior to concrete placement.

Concrete must not be placed when the following conditions occur:

- The temperature of the concrete is less than 10ºC or exceeds 35ºC.
- The outdoor shade temperature is likely to be greater than 35ºC during placement, or within 2 hours subsequent to placement, unless special precautions, to the approval of the Superintendent's Representative, are undertaken. Notwithstanding that such special precautions are taken, concrete must not be placed when the outdoor shade temperature exceeds 38ºC.
- Where the concrete temperature is less than 32ºC, concrete must reach its final position in the forms within 30 minutes after the introduction of water to the cement and aggregate, or the cement to the aggregate, except in the case of concrete which is continuously agitated in a truck mixer, when 1.5 hours may elapse between introduction of water and final placing. In hot weather where the concrete temperature is greater than 32ºC the above times must be reduced to 15 minutes and 45 minutes respectively.

The concrete slump must be 80 ±15mm at the construction Site unless noted otherwise.

The Contractor must not cover up formwork and reinforcement by placing concrete without the prior approval of the Superintendent's Representative.

Concrete must not be placed except in the presence of the Superintendent's Representative.

Concrete must not be placed unless materials for curing unformed surfaces are at the Site and ready for use. Before concrete is placed, the formwork and the space into which the concrete is to be placed must be free of contaminants and free of water.

Concrete is to be brought to the forms and placed in such a manner that there is to be no segregation of the concrete mix. Internal vibrators must not be used to move concrete within the forms.

Concrete must not be exposed to rain during mixing, transport or placing, until it has set.

5.24.6.2. Equipment

Hoppers, skips, barrows and the like must be of such design that concrete does not segregate in them. Sufficient numbers of such equipment must be available to ensure a satisfactory rate of placing concrete.

Chutes must be so designed that concrete flows readily and does not segregate.

Barrow runs and pump lines must be supported off the formwork, not the reinforcement and must be agreed to by the Superintendent's Representative. The Contractor is responsible for the design and installation of high rise pump lines. All fixings must be removed and the structure made good after detachment of the pump lines.

Except for slabs on ground compaction must be achieved by the use of high frequency immersion type vibrators. One spare vibrator which is in full operating condition must be on hand during concrete placement.

Vibrators mounted on screed boards must be used for the compaction of slabs on ground when the width of pour permits. Vibrating screeds must be supplemented by immersion vibrators.

5.24.6.3. Cleaning

All items of equipment used for carrying, holding and working with concrete must have dry mortar, mud and other deleterious matter removed from them.

Water puddles which may form by whatever means must be removed before pouring concrete. All slab, beams and column forms must be cleaned of foreign material. The cleanliness of formwork must be inspected and accepted by the Superintendent's Representative prior to placement of concrete. The Contractor must ensure that the release agent does not puddle due to excessive application and so cause staining or retardation of the concrete surface. No part of the reinforcement or construction joints shall be coated with the release agent.

Reinforcement, including starter bars, which have become contaminated by oil, mud, mortar or other coatings other than a firm rust layer must be cleaned to the acceptance of the Superintendent's Representative prior to placing concrete.

5.24.6.4. Transport of Concrete

Concrete must be transported in such a manner that it is not caused to segregate or spill, or be contaminated.

5.24.6.5. Concrete Placement

Immediately prior to placement of concrete the forms must be wetted. Excess water from this process must be removed before commencing concrete placement to the agreement of the Superintendent's Representative.

The concrete must not be placed if the specified slump as measured in accordance with the Technical Specification is not within the required limits.

The specified slumps refer to on-site delivery slumps. For pumping and placement purposes the specified slump is to be a maximum of 80mm ± 15mm using a super plasticiser which conforms and is added in accordance with AS1478. At no stage from the time of mixing must water or admixture be added to the concrete to increase workability.

Where concrete is to be placed by pumping all excess slurry used to prime equipment and all material surplus must be discharged to waste, not into forms, and must be removed from the site by the Contractor.

Pumping equipment must be arranged so that no vibrations that may damage freshly placed concrete shall result. Concrete must be deposited as near as practicable to its final position. It must not be dumped away from its final position and worked along the forms.

Where concrete is to be pumped, line stools must be used. Provide bases to stools to prevent damage to formwork, post-tensioning ducts, reinforcement, cast-ins and other associated items.

Concrete must be placed at a rate that will permit proper compaction and must not be placed to a depth greater than 300mm before compaction of the concrete below. Carry out placing in such a manner as will ensure that concrete which is partially set is not subsequently disturbed.

The concrete shall be placed in such a manner as to avoid segregation or loss of materials. To achieve this in the placing of concrete in thin walls in excess of 1.5 metres in height it may be necessary to pour the concrete through enclosed chutes or access hatches. These chutes must be kept as vertical as possible during the placing operation.

Where it is proposed that concrete be placed from a height in excess of 3.5 metres, the Contractor must submit for acceptance details of the proposed placing procedure by the Superintendent's Representative. Such procedures may only be proposed for use where forms have been designed to be adequate to resist all consequent forces.

The concrete placing must be carried out continuously between the construction joints and in such a manner that a plastic edge is maintained, at all times.

5.24.6.6. Compaction

All concrete must be fully compacted by mechanical vibration using internal vibrators and/or vibrating screeds and/or vibrators fixed to the formwork. The vibration method used by the Contractor must minimise segregation of the concrete.

5.24.6.7. Joints

In general, concrete must be placed and compacted against unset previously-placed concrete such that the finished work is monolithic and uniform in strength and appearance.

Construction joints may be made only where indicated on the Drawings and otherwise in such locations and in such a manner as may be accepted by the Superintendent's Representative, who may direct the Contractor to scabble or otherwise remove laitance and provide for bond and to provide keys, steps and other means of load transfer. Any such provision, whether indicated on the Drawings or directed by the Superintendent's Representative, is at the Contractor's expense.

5.24.6.8. Concrete Poured on Natural Ground

Where shown on the Drawings, all concrete slabs cast on ground require a minimum 50mm thick N20 concrete blinding.

5.24.6.9. Concrete Poured on Rock

Surfaces of rock that will be in contact with concrete must be free of loose materials. Except where concrete is placed on a vapour barrier, the rock must be thoroughly wetted prior to pouring of concrete. Water used for cleaning such excavations must not lie in puddles at the time of placing concrete.

5.24.6.10. Concrete Poured on Fill or other Porous Material

Except where concrete is placed on a vapour barrier, formed surfaces of earth, fill, roadbase or hardcore must be thoroughly wetted to a depth of at least 75mm prior to pouring concrete. Water must not lie in puddles on the surface at the time of pouring concrete.

Where shown, a vapour barrier consisting of a 0.3mm thick layer of polythene sheeting must be supplied and laid on the sub-grade or fill by the Contractor. Adjoining sheets must be lapped 250mm at the sides and ends and taped for the full length of the lap. The sheeting must be taped to pipes and other embedments. The vapour barrier must be turned up the full thickness of the slab at free edges, walls and the like. Further treatment of the vapour barrier must be as detailed.

5.24.6.11. Finish at Edges of Slabs on Ground

Finishes at edges of slabs on ground include:

- At edges of slabs - unless specifically shown otherwise on the Drawings, concrete must be finished flush with the top of the formwork with square corners.
- Where slabs are poured against existing slabs - concrete must be poured and screeded flush with existing concrete and the corners left square.
- Joints - generally the treatment of joints for slabs on ground must be as specified on the Drawings.

5.24.6.12. Unformed Surface Finishes

Unformed surfaces must be constructed to a smooth even surface and finished with a wooden float. Finish unformed surfaces, unless otherwise specified, by hand or power driven equipment.

Commence finishing operations as soon as the screeded surface has stiffened sufficiently and produce a surface that is free from screed marks and uniform texture.

5.24.6.13. Curing

All concrete work must be cured.

For unformed surfaces curing must be commenced immediately finishing is complete.

The curing period from the time of placing concrete is to be continuous and must be not less than the following:

- Portland cement concrete - seven days.
- Cements with fly ash or pozzolanic materials - 10 days.

The curing method must include one or a combination of the following methods:

- Ponding or continuous sprinkling with water.
- Use of a curing compound that is in accordance with the recommendations of AS3799.
- Use of an absorptive cover kept continuously wet.
- Use of an impermeable membrane.

The Superintendent's Representative may direct that any curing method not be used. The concrete shall be protected from damage during the curing period.

5.24.6.14. Protection

Load application on newly poured surfaces shall comply with AS3610.

The concrete must be protected from damage due to overload, heavy shocks and excessive vibration particularly during the curing period.

All finished concrete surfaces must be protected from damage caused by construction equipment, materials, or methods and by rain or running water.

Self-supporting structures must not be loaded in such a way as to overstress the concrete.

5.24.6.15. Rejection of Concrete

Plastic and hardened concrete that does not meet the requirements of the Technical Specification and of AS3600, AS3610 or AS1379 is not in accordance with the Contract.

5.24.6.16. Repairs of Concrete

Where repair of concrete is necessary and permitted, such repairs must be performed by skilled workers and must be completed within 24 hours after removal of formwork or, in the case of unformed concrete, within 24 hours after placing of concrete. All repair of concrete work must be in accordance with AS3600.

The materials and techniques of repair that the Contractor proposes to use must be notified to the Superintendent's Representative prior to commencement and are subject to the agreement of the Superintendent's Representative.

The repairs will be at no cost to Council.

5.25. PIPELINES

5.25.1. Scope

The works covered under this section include the supply and installation of the watermain into the site, the leachate gravity and rising mains, and water return mains, as shown on the Drawings.

The watermain into the site shall be installed in a trench of 600mm minimum depth from Council's tapping point on the Gara main.

The gravity and rising mains must be constructed to the lines, grades and levels and at the locations shown on the Drawings.

The mains must be constructed in accordance with the requirements of Water Services Association (WSA)-02. All mains are to consist of manufactured pipe as shown on the Drawings and as specified herein and must be installed in accordance with the Technical Specification and the relevant standards.

5.25.2. Materials for Pipelines

5.25.2.1. General

Pipe materials and pressure ratings must be as specified on the Drawings or as may be specifically accepted in writing by the Superintendent's Representative.

5.25.2.2. Polyethylene (PE) Pipes and Fittings

Polyethylene pipes must be in accordance with the following:

- Manufactured to AS/NZS4130 from AS/NZS4131 material.
- Installation must conform to the requirements of WSA-01 (Polyethylene Pipeline Code).
- Water mains must be constructed as shown on the Drawings in compliance with WSA 04 – 2005, other relevant standards and as described in the Technical Specification.
-

5.25.2.3. Joints

Pipes must be joined together by butt fusion welding methods undertaken by an approved welder or by the electrofusion of couplings and be in accordance with the requirements of WSA-01 (Polyethylene Pipeline Code) or to the manufacturer's recommendation.

Where pipe connects into flange fittings, such as for valves and tees, it must have a thermal butt fusion flange assembly and consist of polyethylene stub-end butt-fused to the end of pipe and metal slip-on flanges. The internal bead or flashing must be removed to improve the hydraulic performance of the pipeline, except when joining long strings of pipe. Metal backing, bolts nuts and washers must be stainless steel grade 316 or equivalent. Appropriate isolation must be provided between dissimilar metals where required.

5.25.3. Valves, Fittings and Specials

5.25.3.1. Stop Valves

Isolation valves must be full-bore, non-fouling type suitable for sewage application. Gate valves must be a metal wedge type.

Stop valves are to be manufactured in accordance with the following features and properties:

- Metal seated valves must comply with AS2638.1 - Gate Valves for Waterworks Purposes - Metal Seated and Section SP20 of the WSA-02, except that metal seated valves less than DN 600 must be acceptable when specified for high pressure situations (contrary to Table 5.4 of SP20).
- Resilient seated valves complying with AS2638.2 - Gate Valves for Waterworks Purposes - Resilient Seated and Section SP21 of the WSA -02 HWA.
- Suitable for manual operation by a removable key.
- Valves close when the stem is turned in a clockwise direction, looking on the top of the valve.
- Suitable for the fitting of an extension spindle or bevel gearing.
- Flanged ends with flanges and drilling in accordance with AS4087.

- Valves to be Class 16 unless otherwise specified.
- Do not use grey cast iron for valves.
- Valve stems of stainless steel to AS2837 grade 431 or 316.
- Wedge nut of gunmetal to AS1565 grade C83600.
- Copper based alloys conform to the dezincification requirements of AS2345.
- Internal and external fastenings of stainless steel to AS2837 grade 316 passivated in accordance with AS4998 or high tensile bolts fully encapsulated to provide isolation from both internal and external environments.
- Stem caps to the main stem and, for geared valves, to the reduction input shaft.
- For resilient seated valves, fully encapsulated wedges with thoroughly bonded rubber, except for wedges manufactured from gunmetal or brass where all sealing surfaces shall have a thoroughly bonded rubber coating while the remainder of the wedge may remain uncoated.

5.25.3.2. Air Valves

Valve bodies and covers must be cast iron. Floats must be plastic while seats and all moving parts must be of Type 316 stainless steel.

5.25.3.3. Non-Return Valves

Must comply with the following:

- Valve body and cover - ductile iron.
- Discs - bronze faced cast iron or solid bronze.
- Hinge pins, bolts and nuts - grade 316 stainless steel.
- Washers and other small fittings - grade 304 stainless steel.

Non-return valves must comply with requirements of AS4794. Non-return valves must be swing check type and provision must be made for pigging where required.

5.25.3.4. Surge Protection Valves

Surge protection valves must be in accordance with anti-slam air valve Type 1 valve with anti-slam floats complying with AS4883.

5.25.4. Installation of Buried Pipework

All pipework must be installed and tested in accordance with the Technical Specification, all relevant Australian Standards, and instructions supplied by the Superintendent's Representative or the pipe manufacturers or suppliers. All pipes must be tested for soundness before laying or installation and defective pipes marked and rejected.

5.25.4.1. Excavation

The Contractor must carry out a search for existing services prior to any excavation.

Trenches must be excavated to a minimum depth of 600mm or to the levels indicated on the Drawings with an allowance for variation in bedding depth of ±50mm.

Over excavation of the required trench depth must be replaced with bedding material compacted to the same density as specified for the bedding at no cost to Council. In the event of over-excavation of width refer to the Superintendent's Representative for instruction.

The Contractor must ensure that the excavation remains free from water until the pipe has been installed and trench fill placed to sufficient depth to prevent flotation of the pipe.

5.25.4.2. Safety

A safe working environment must be maintained at all times, ensuring that the sides of the trench are stable, providing bracing as required. The Contractor must ensure that any surcharge loads from nearby plant, stockpiles or other items do not compromise the integrity of the excavation.

5.25.4.3. Bedding

Bedding and fill materials are to be supplied by the Contractor and may include excavated material provided that excavated material meets the provisions of bedding material outlined in the Technical Specification.

5.25.4.4. Properties of Materials

All bedding and fill materials must be free of soluble salts and organic matter.

The properties of bedding and trafficable area fill material are to be as set out in the table below.

Table 42 Leachate Pipe Trench Material Properties

Material	General Description	Classification*	Grading Limits	
			AS Sieve (mm)	% Passing By Weight
Bedding	Sand, crusher dust, fine to medium gravel	SP, SW, GM	19.0 2.36 0.60 0.30 0.15 0.075	100 50 – 100 20 – 90 10 – 60 0 – 25 0 – 10
Bedding alternative	Cement stabilised with unconfined compressive strength not less than 1 MPa		19.0	100
Trafficable Area Fill including pipe embedment	14:1 Sand: Cement back fill to subgrade	SP, SW, GM	19.0 2.36 0.60 0.30 0.15 0.075	100 50 – 100 20 – 90 10 – 60 0 – 25 0 – 10

The materials used in the zones of bedding and refilling, as indicated on the Drawings, are to be as set out in the table below.

Table 43 Leachate Pipe Trench Zone Materials

Zone	Material	Reference Clause
Bed Zone	Bedding Material	Clause 5.25.4.4
Haunch Zone	Bedding Material	Clause 5.25.4.4
Side Zone	Side Zone material or Bedding Material	Clause 5.22.3.7 or 5.25.4.4
Overlay Zone	General Fill (modified as follows), Select Fill material or Bedding Material It must not contain any stones larger than 150 mm, or more than 20% with a size between 75 mm and 150 mm subject to being able to be compacted to the nominated density.	Section 5.12 or Clause 5.12.5 or Clause 5.25.4.4
All zones (trafficable areas)	Select Fill (modified as follows), Trafficable Area Fill or Bedding Material It must not contain any stones larger than 100 mm, or more than 20% with a size between 50 mm and 100 mm.	Section 5.12.5 or Clause 5.25.4.4

5.25.4.5. Back Fill Material

Back fill material used in back filling any trench across an existing or proposed road or vehicular pavement, from the subgrade to the base of the trench including pipe embedment zones, must be trafficable area fill as specified above.

Back fill material used in the top 75mm of any trench outside the area where topsoil has been stripped must be material set aside from the top 100mm of trench excavation.

Back fill material must be fill material agreed to by the Superintendent's Representative.

The bedding material must extend the full width of the excavated trench and must be shaped to receive the pipe. The bedding must support the pipes over their entire length. Bedding must be relieved at the joints to ensure that pipes do not rest on collars or couplings.

5.25.4.6. Pipe Laying and Jointing

Pipes must be laid and joined in accordance with the manufacturer's recommendations.

Provision must be made for expansion and contraction of the pipe. Piping must be positioned along the trench centreline. Where the pipe alignment is curved, pipes must be joined in straight alignment prior to deflecting to the required angle. The manufacturer's maximum allowable deflection must not be exceeded.

5.25.4.7. Embedment

The embedment material must be placed and compacted evenly to the sides and top of the pipe so that distortion, ovality or movement of the pipe does not occur and damage to the pipe coating or surface is avoided. Embedment must be compacted to a density index as specified in the Technical Specification. Embedment material must be placed in layers with a thickness not exceeding 300mm maximum, 150mm if compaction is by hand.

5.25.4.8. Trench Fill

Trench fill must be placed and compacted to the surrounding ground or subgrade level. Road surfaces or existing paving must be reinstated to original condition.

5.25.5. Construction

At no time is the total length of the trench of any type opened up and not back filled to exceed 300 metres.

5.25.5.1. Trench Excavation

The Contractor must excavate all classes of material encountered for each pipe to a width not greater than the maximum allowable width indicated on the Drawings and to a depth below the pipe drain invert levels indicated on the Drawings sufficient to permit the construction of the bed zone.

In areas where topsoil has not been stripped, material excavated from the top 100mm of trench excavation shall be set aside for use in back filling.

For any installation carried out to a depth greater than the manufacturer's recommendation or where minimum cover cannot be achieved, the pipe must be concrete encased at the Contractor's expense.

Below the level of the top of the overlay zone the sides of the trench must be vertical. The minimum trench width must be the outer diameter of the pipe plus 600mm.

The Contractor's WH&S management system must provide for the safety of persons in and near all trenches. The Contractor must provide any timbering or other support necessary for the prevention of damage to the Works and injury to workers or to others. Such timbering or other support must be withdrawn as back filling proceeds.

The Contractor must ensure that the trench is drained at all times and to that end must construct collection systems, banks and other protective works and provide and operate dewatering systems as may be necessary.

The Contractor must advise the Superintendent's Representative when excavation has been carried out to the depth specified on the Drawings and must notify the Superintendent's Representative before placing bedding material.

If the Superintendent's Representative directs that a greater depth of bed zone than that indicated on the Drawings be provided, the Contractor must excavate further to a depth sufficient to permit the construction of the extra depth of bed zone directed by the Superintendent's Representative.

The Superintendent's Representative may direct that further excavation be carried out to remove unsuitable material below the depth specified in this clause and that the material so removed shall be replaced as specified in this clause at no cost to Council.

In that event the Contractor must excavate to the extra depth further, over the length and width directed by the Superintendent's Representative, the additional excavation must be filled with bedding material or select fill material and the material must be compacted to a dry density ratio not less than 90% standard compaction.

Any overbreak beyond the depth specified in this clause must be filled at the Contractor's expense with bedding material or select fill material and the material must be compacted to a dry density ratio not less than 90% standard compaction.

Excavated material must be used or disposed of as specified. Refer to Figure 2 below for typical pipe trench fill zones.

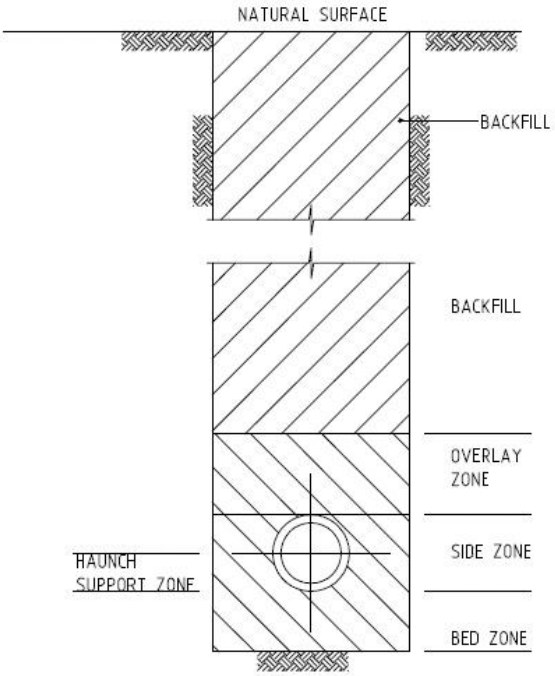


Figure 2 Pipe Trench Fill Zones

5.25.5.2. Bed Zone

The bed zone must extend for the full width of any trench and at least to 100mm each side beyond the external diameter of the pipe.

The Superintendent's Representative may direct that a greater depth of bed zone than is indicated on the Drawings be provided and may direct that select fill material be used instead of bedding material in part or all of the bed zone.

The bedding material must be compacted to a dry density index not less than 70%.

The surface of the bed zone must be shaped so that the pipes will fall uniformly for the full length of the reach of the main and so that the pipes will rest upon the bedding material for the full length.

5.25.5.3. Laying

Pipes must be laid and bedded to form a straight barrel, with the invert falling continuously to the lower end of the reach.

Pipes must be cut as required to give the lengths of sewers indicated on the Drawings and to provide for skewed connections into structures, provided that in no case must the shortest remaining length of any pipe used be less than 1 metre.

Cut ends of pipes must be incorporated into maintenance holes or structures.

5.25.5.4. Jointing

All PE pipes must be joined above ground unless otherwise approved by the Superintendent's Representative. The Contractor must excavate hand holes where required for the proper jointing of fittings.

5.25.5.5. Haunch Zone

The Contractor must notify the Superintendent's Representative before commencing the construction of the haunch zone.

The haunch zone must be constructed in layers not more than 150mm compacted thickness, on both sides of single pipes extending for the full width of the trench.

Each layer of material in the haunch zone must be compacted before the material for the next layer above is placed.

The material in the haunch zone must be compacted to a density index not less than 70%.

5.25.5.6. Side Zone

The Contractor must notify the Superintendent's Representative before commencing the construction of the side zone.

The side zone must be constructed in layers not more than 150mm compacted thickness, on both sides of single pipes extending for the full width of the trench.

Each layer of material in the side zone must be compacted before the material for the next layer above is placed. The material in the side zone must be compacted to a density index not less than 70% or to a dry density ratio not less than 95% standard compaction.

5.25.5.7. Overlay Zone

The Contractor must notify the Superintendent's Representative before commencing the construction of the overlay zone

The overlay zone must be constructed in layers not more than 150mm compacted thickness, on both sides of single pipes and between multiple pipes, extending for the full width of the trench.

Each layer of material in the overlay zone must be compacted before the material for the next layer above is placed.

The material must be compacted to the following relative densities (standard compaction):

Table 44 Overlay Zone Compaction Requirements

Location	Compaction Requirement
Roads, Pavements and Building Platforms	100% SMDD or 100% Relative Compaction Hilf Rapid Method
Elsewhere	95% SMDD or 95% Relative Compaction Hilf Rapid Method

5.25.5.8. Back Fill

The Contractor must notify the Superintendent's Representative before commencing the construction of back fill.

Back fill must be constructed in layers not thicker than the maximum thickness specified for the adjacent fill and in any case not more than 150mm compacted thickness for pipes crossing roads or pavements and 200mm compacted thickness elsewhere, extending for the full width of the trench.

Each layer of material in the back fill must be compacted before the material for the next layer above is placed. The material must be compacted to the following relative densities (standard compaction):

Table 45 Backfill Compaction Requirements

Location	Compaction Requirement
Roads, Pavements and Building Platforms	100% SMDD or 95% Relative Compaction Hilf Rapid Method
Elsewhere	90% SMDD or 95% Relative Compaction Hilf Rapid Method

5.25.6. Construction Tolerances

5.25.6.1. Horizontal Tolerances

A tolerance of ±10mm will be allowed on the horizontal alignment of the pipes, provided that the difference between the greatest positive and the greatest negative deviation from the true horizontal alignment does not exceed 10mm in any length of six metres.

5.25.6.2. Vertical Tolerances

An allowance shall be made for the nominal diameter and nominal thickness of the pipe in arriving at the invert level of the pipe. A tolerance of plus 10mm will be allowed on the invert level, provided that the difference between the greatest positive and the greatest negative deviation from the true invert level does not exceed 6mm in any length of six metres.

5.25.6.3. Settlement of Trench

Any settlement of the trench in any location occurring prior to the expiration of the defects liability period must be made good by the Contractor, using material as specified for the top layer of back fill in that location.

5.25.6.4. Inspection and Testing

All mains must be inspected and tested in the presence of the Superintendent's Representative. Pipes, fittings or other work must be pressure tested. The relevant hold point will be released once testing is deemed satisfactory.

All tests must be carried out by the Contractor at its own risk.

The Contractor must provide labour for installation and dismantling of test equipment and must supply all pumps, engines, pipes, temporary valves, plugs or flanges and other items of test equipment that may be necessary.

Such plant is to remain the property of the Contractor. The pressure gauge used for testing must have a certificate of accuracy from a National Association of Testing Authorities, Australia accredited testing provider.

Tests must be carried out as soon as possible after the completion of the various parts of the Works. Water for testing must be supplied by the Contractor.

If, in the opinion of the Superintendent's Representative, care has not been exercised in back filling trenches or covering up other work after testing, the Superintendent's Representative may direct that a fresh inspection and test be made on the work.

All injury or faults must be repaired or replaced by new work and made good, and after completion of repairs or placement, the work must be retested until deemed satisfactory to the Superintendent's Representative. Burst or defective work or pipe joints discovered prior to the expiration of the defects correction period must be cut out and replaced or remade by the Contractor at its own cost.

5.25.6.5. Hydrostatic Testing

Water tightness of pipes must be tested by a static water pressure test, low pressure, or vacuum test carried out by the Contractor. Unless the Superintendent's Representative otherwise directs, test lengths of pipes must be the lengths between successive maintenance holes or structures. The Contractor must pressure test after sealing ends and openings with approved plugs.

The water test must be completed by filling the line with water to give a hydrostatic head of two metres on the highest point of the section under test, the pressure being maintained for a period of not less than 30 minutes. The pipeline losses will be deemed acceptable if the amount of water added during test does not exceed the rate of 5 litres per 25mm of diameter per 100 metres of pipe per hour for pressure pipelines. The pressure tests of main must be 1.3 x operating pressure, or the pump shut off head whichever is greater, but not to exceed the manufacturers stated minimum test pressure.

Low pressure and vacuum tests, if used are to be undertaken in accordance with WSA 02.

On completion of the testing for watertightness the Contractor must flush all pipes with clean water and remove all clay, sand or other debris. Flushing water and debris must be trapped

and removed at the lower end of the pipeline under test. All pipelines will be inspected after flushing and must present a clear barrel free from any obstruction.

5.25.7. Quality Control Requirements

5.25.7.1. Manufacturer's Quality Assurance Documentation and Test Certifications

The Contractor shall provide product data sheets listing the physical properties for each pipe component prior to shipment.

The Contractor shall submit manufacturer's quality assurance documentation and test certificates to the Superintendent's Representative not less than seven days prior to the installation of the pipework. The certification shall include the following:

- Details of the supplier.
- Quality control certificates issued by the supplier to the manufacturer.
- Details of testing conducted by the manufacturer to verify that the pipework complies with the size and class requirements of the Technical Specification.
- Written certification that the size and class requirements of the Technical Specification are guaranteed by the manufacturer.
- Quality assurance certificates, including the sample identification, testing procedure and test results.

5.25.7.2. Testing and Frequency

The Contractor shall carry out testing of the pipe installation works in accordance with the requirements specified in the table below.

Table 46 Testing and Frequency of Leachate Pipe Installation Works

Material	Test	Test Frequency
Geometrics	Horizontal	Geometrics: 1 test per 50 metres and at access chambers
	Vertical	
Bedding and Backfilling	Particle Size Distribution	One test per material type per source
	Atterberg Limits	1 test per 50 metres per layer of 150mm thickness per material type
	Moisture Content	

5.26. REVEGETATION WORKS

5.26.1. Topsoil Layer

5.26.1.1. Material

Topsoil material hall be used to construct the topsoil layer prior to hydroseeding / hydromulching works as shown on the Drawings. Topsoil shall be sourced from designated on-site topsoil stockpile from topsoil stripping operations for the Works.

Topsoil shall satisfy the following requirements:

- be clean and free of timber, debris and other deleterious matter;
- not contain acid sulphate soils, organic clays and silt; and
- not be silt.

5.26.2. Placement

Topsoil shall be spread evenly in one layer over the designated areas and compacted lightly and uniformly so that the finished surface is smooth and free of stones or other lumps, weeds, rubbish and other deleterious material brought to the surface. Excessive compaction will be avoided.

Once placed, the topsoil surface will be thoroughly watered.

The equipment used for placing and spreading of materials must be suitable for the purpose. Low pressure tyred vehicles will be used. Graders and other high pressure tyred vehicles equipment will not be used. Vary the routes of vehicles and other plant passing over completed areas of each soil profile layer to avoid areas of excess compaction.

Prevent areas of excess compaction from being caused by constructional plant. Compact lightly and uniformly. Avoid differential subsidence and produce a finished topsoil surface which is:

- At design levels
- Smooth and free from stones or lumps of soil
- Graded to drain freely, without ponding
- Graded evenly into adjoining ground surfaces
- Ready for planting

No compaction testing is required during construction.

Hydroseeding and placement of erosion control matting layer shall not take place until the Superintendent's Representative has inspected and approved the installed topsoil layer.

5.26.3. Vegetation Cover

All disturbed areas will require a vegetative grass cover to be established by hydroseeding/hydromulching methods.

The Contractor shall install the grass cover layer in a manner that shall minimise compaction of the cover soils. Any scarifying of the topsoil to allow seeding, if required, shall be limited to a maximum of 100mm deep. Hydromulching is only required in areas with grades equal to or steeper than 1V:4H.

5.26.3.1. Seed Species

The native seed mix and proportions shall be as follows:

- 15% Windmill Grass (Chloris truncate)
- 40% Red Grass (Bothriochloa macra)
- 45% Wallaby Grass (Austrodanthonia richardsonii)

Native seed shall be sourced in accordance with the Vegetation Management Plan. The Contractor must provide the seed component in floret form.

5.26.3.2. Hydroseed / Hydromulch Mixture

The hydroseed/hydromulch mixture is to consist of a slurry of seed mixture, fertiliser, cellulose fibre mulch mixture, where applicable, and water and polymer binder.

Cellulose fibre mulch is to be produced from finely chopped sugar cane mulch, shredded paper or wood fibre from a plantation timber. Dye mulch cellulose green using a non-toxic biodegradable dye.

The polymer binder to be used in the mix is to be a slow setting anionic bitumen emulsion or a non-toxic biodegradable polymer manufactured for the intended use. An example would be 'Guar Gum'.

5.26.3.3. Mix Design

The Contractor is to provide a hydroseed/hydromulch mix design for approval by the Superintendent's Representative prior to undertaking the Works. The mix design is to include, as a minimum, the following:

- The proposed mix of seed, fertiliser, binder and where applicable fibre, including all details.
- The proposed application rate.
- The plant and equipment to be used by the Contractor in the application of the hydromulching/seeding

Details of hydromulching/seeding mix design shall be approved by the Superintendent's Representative prior to commencement of work. The Superintendent's Representative may notify the Contractor to change the proposal if any component is unsuitable.

5.26.3.4. Preparation

Scarify the area to be hydromulched to provide a firm friable seed bed. If the area is to have added topsoil, place it before scarifying.

5.26.3.5. Application

Moisten the topsoil to its full depth before applying the slurry. Apply the slurry using high pressure pumping equipment operated by trained personnel. Spray the mixed slurry under pressure, maintaining a thoroughly mixed supply, operating on a front so that the mixture is evenly distributed over the area. Complete each front before commencing the next.

Hydromulching/seeding must be carried out within seven days of soil preparation. Do not apply hydromulching/seeding when:

- the ground is too wet and surface ponding is evident;
- the average wind speed exceeds 15 km/hr;
- the temperature exceeds 35ºC or
- when heavy rain is forecast.

5.26.3.6. Watering

After sowing, the Topsoil surface shall be lightly raked to cover the surface and the area watered immediately. Water quality is to be:

- pH between 5.5 and 7.5;
- total soluble salts less than 1000 mg/L; and
- no substances that would be toxic to plant growth.

Before germination, water the hydromulched/seeded area with a fine spray until the Topsoil is moistened to its full depth. Continue watering until germination to keep the surface damp and the topsoil moist but not waterlogged.

Watering shall continue throughout the establishment period within the defect liability period. The entire area shall be protected from pedestrians or animals until the grass has established, and from vehicles or heavy plant at all times.

5.26.3.7. Specified Ground Cover

The specified ground cover is where 70% vegetation cover is achieved in 80% of samples tested by the Superintendent's Representative utilizing visual and photographic estimation of cover in a 1.0 metre square quadrant at a minimum of 12 locations randomly selected across the site.

5.26.3.8. Erosion Control Matting

Erosion control matting is required to line the stormwater drainage channels above the topsoil layer, following to minimise surface and scouring prior the revegetation.

The erosion control matting shall be:

- capable of withstanding flow velocities up to 1.5 m/s;
- constructed from 100% biodegradable and organic material; and
- have a structure that will allow seeds to germinate and grow through.

For information, Geofabric's Jutemaster FineTM synthetic matting would satisfy the above properties.

5.27. SECURITY FENCING

5.27.1. Scope

On completion of the landfill cell and the leachate pond the Contractor shall erect a 1.8 metre high security fence and gate(s) around these areas. The fence shall comply with the requirements of AS1725 Part 1 Security fences and gates.

This section covers the technical aspects of the fencing material and the erection of the fences and gates.

5.27.2. Materials

5.27.2.1. Australian Standards

The materials used for the fencing shall conform to the following Australian Standards.

- AS 1725 - Chain link fabric fencing - Part 1:Security fences and gates – General requirements
- AS 2423 - Galvanized wire fencing products

All materials to be used must be supplied and delivered to the site and installed at the Contractor's cost.

All materials used for the fencing shall be new.

5.27.2.2. Steel Posts

Intermediate posts shall be DN40 (48.3 OD); Corner posts shall be DN80 (88.9 OD); Strainer posts shall be DN50 (60.3 OD). All with galvanised steel caps.

5.27.2.3. Strainer Post

Strainer posts shall be used at all changes of direction and at specified intermediate locations. All strainer posts shall be stayed on two sides.

5.27.2.4. Bracing Stays

Bracing stays shall be DN32 (42.4 OD).

5.27.2.5. Wires and Fastener

- **High Tensile Plain Wire**: High Tensile wire shall be 2.5mm diameter galvanised. And shall be fixed to the post with 'U Clip' and tek screw.
- **Fasteners:** Fastening of the chainwire fabric to the support wires shall be by pneumatically installed circle clips.

5.27.2.6. Fabric

Fabric shall be 3.15 heavy galvanised wire, 50mm mesh, 1.8 metres high, with a knuckle / knuckle selvedge.

5.27.3. Construction

5.27.3.1. General

All fencing shall be erected in a tradesman like manner on the perimeter of the landfill cell and leachate pond as shown on the Drawings.

When completed the fence shall be sound, strong and of neat appearance. The fence shall be complete and together with the gate shall securely enclose the area.

Where minor irregularities occur in the ground the vertical alignment of the fence shall not follow these irregularities, but shall be aligned to a uniform grade between definite changes in the natural slope of the ground.

5.27.3.2. Erection of Post

Posts shall be erected vertically in predrilled holes at least 250mnm diameter to a depth of 600mm in earth and 300mm in rock.

The space around the posts shall be tightly filled with concrete.

Intermediate posts shall be at 3.0 metre intervals. Strainer posts shall be used at ends of fencing, angles and at intermediate points. Distances between strainer posts shall not exceed 60 metres.

5.27.3.3. Erection of Support Cables

All wire shall be placed as specified in AS1725. Wires shall be securely fastened and strained to an even tension, as recommended by the manufacturer, between strainer posts with an approved wire strainer. The method to be used to join lengths of wire is to be approved by the Site Superintendent prior to the start of the work.

5.27.3.4. Concrete Backfilling

All concrete backfilling shall use 20Mpa concrete which shall be placed and vibrated around the post to a level with the existing or proposed finished ground level. The verticality of the post shall be checked immediately after the concrete surround has been poured. The concrete shall be finished neatly to the circular edge of the post hole.

5.27.4. Access Gates

The access gates to the leachate pond and to the stockpile access road shall be 4.0 metre wide double leaf manually operated.

The gate to the landfill cell shall be shall be 1.8 metres high dual leaf with a clear opening of 6.0 metres. The gates are to be fully automatic, capable of operation using authorized swipe cards. A 240 volt power supply will be provided for the operation of the gate

The gates should open outwards and be to be installed by an experienced gate installer on a flat and level surface with minimum clearance under the bottom of the gates

Include permanent gate stops for the manually operated gates so that they can be kept open whilst the operator is working.

6. SUMMARY OF HOLD AND WITNESS POINTS

Reference	Description
HOLD POINTS	
Clause 4.8	Designation of work lots
	Field identification system for each lot
Clause 4.9.3	Obtain approval for correction of any non-conformance
Clause 4.9.6	Certificate of compliance test results for all construction materials
Clause 5.7.4	Acceptance of clearance boundary
Clause 5.7.5	Marking of habitat trees
Clause 5.10.2	Treatment of unsuitable material.
Clause 5.11.7	Cuttings in rock - presentation of cleaned batter and bench/floor surfaces for geotechnical inspection and joint measurements.
Clause 5.11.7	Subgrade surface proof rolling
Clause 5.13.4	After unsatisfactory clay liner field trials submit proposals for a revised procedure for approval before continuing
Clause 5.13.5	No further materials shall be placed on the clay fill liner surface until proof rolled and approved by the Superintendent
Clause 5.15.4	GCL installation
Clause 5.15.4.1	Covering GCL with subsequent layers
Clause 5.15.4.3	Survey of prepared surface prior to laying GCL
Clause 5.15.4.5	Detailed GCL panel layout plan
Clause 5.15.5.2	Submission of manufacturer's quality assurance documentation
Clause 5.15.5.4	Acceptance of GCL material
Clause 5.16.1	Contractor's geomembrane personnel – details of experience
Clause 5.16.5	Geomembrane manufacturer's quality assurance documentation and Test Certificates to be submitted

Clause 5.16.6.4	Approval of the Geomembrane material
Clause 5.16.7	All information related to the installed geomembrane to be recorded prior to installation of subsequent layers
Clause 5.16.7.1	Nomination of identification code and a record keeping system for each panel of the geomembrane
Clause 5.16.7.2	Submission of a geomembrane panel layout and installation sequence including methodology.
Clause 5.16.7.3	Surface preparation prior to geomembrane installation
Clause 5.16.7.7	Geomembrane field seam equipment (quality requirement)
Clause 5.16.10.3	Geomembrane repairs
Clause 5.17.1.3	Geotextile UV stabilisation
Clause 5.17.4.2	Geotextile manufacturer's quality assurance documentation
Clause 5.18.1.3	Leachate collection system - manufacturer's quality assurance documentation
Clause 5.18.2.1	Leachate drainage layer material compliance
Clause 5.18.3	Approval of quality compliance documentation
Clause 5.21.4	Submission of information on Shotcrete equipment
Clause 5.23.2.2	Submission of mix design and details of constituent materials modified.
Clause 5.23.2.2	Bituminous surfacing – Submission of nominated design at least seven days prior to sealing commences.
Clause 5.26.3.3	Hydro-mulching / seeding mix design
WITNESS POINTS	
Clause 5.7.3	Joint setting out of the clearance boundary
Clause 5.9.3	Commencement of placement of the topsoil on the prepared areas shall be only after receiving approval of Project Manager.
Section	Limits of site clearing and grubbing as indicated on the Drawings.
Section 5.9.3	Stripping topsoil on either side of creeks

Clause 5.11.7	Preparation prior to filling including rip and compact
Clause 5.13.2	Initial specified preparation of surfaces ready for fill
Clause 5.13.4	Location of clay fill liner field trial area
Clause 5.13.5	Inspection of clay layer surface
Clause 5.15.4.1	Commencement of GCL installation
Clause 5.15.4.6	Notification prior to commencement of transverse joints
Clause 5.16.6.4	Entire works required for the installation of the geomembrane
Clause 5.18.2.2	Placement of the leachate drainage layer
Clause 5.22.3.2	Excavation for pipe bedding material
Clause 5.22.3.6	Inspection prior to construction of the haunch zone
Clause 5.22.3.7	Inspection prior to construction of the side zone
Clause 5.22.3.8	Inspection prior to construction of the overlay zone
Clause 5.22.3.9	Inspection prior to placing backfill
Clause 5.21.3	Tests for shotcrete material
Clause 5.21.5	Testing of shotcrete trial mixes
Clause 5.24.2	Concrete forms ready for pouring
Clause 5.26.2	Inspection of the topsoil layer

End of Technical Specification

Armidale Regional Landfill

Construction Quality Assurance Plan

Revision E – 16-Nov-2016
Prepared for – Armidale Dumaresq Council – ABN: 63 781 014 253

Armidale Regional Landfill

Construction Quality Assurance Plan

Client: Armidale Dumaresq Council

ABN: 63 781 014 253

Prepared by

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16-Nov-2016

Job No.: ARLF-LEMP-RP-0011-CQAP

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document Armidale Regional Landfill

Ref ARLF-LEMP-RP-0011-CQAP

Date 16-Nov-2016

Prepared by Andrew Kielniacz

Reviewed by Michael Borman / Rowan Cossins (Revised elements)

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	01-May-2015	Draft for Review	Alex Frolich Project Manager	
B	11-May-2015	Client Reviewed and Amended	Mike Brooks ADC	
C	25-Sep-2015	For Final review	Duncan Price Project Manager	
D	20-Oct-2015	Final For EPA	Duncan Price Project Manager	
E	16-Nov-2016	Tender Revised	Alex Frolich Project Manager	

Table of Contents

1.0 Introduction

1.1 Project Background

Armidale Dumaresq Council (ADS) has obtained approval for the construction and operation of a new regional landfill facility to service the Armidale, Uralla, Walcha and Guyra Local Government Areas (LGA). The landfill facility is located on Waterfall Way, approximately 12km east of Armidale.

The Planning Assessment Commission, as delegate for the NSW Minister for Planning and Infrastructure, granted approval for the project under Section 75J of the Environmental Planning and Assessment Act 1979, subject to conditions, on 4 July 2012 (Approval 06_0220). The project involves the construction and operation of a landfill comprising five cells, each cell with a maximum volume of 211,000m³. The work under this contract comprise the construction of the initial Cell 1 plus associated infrastructure; including the Leachate Pond, Sedimentation Basin and Dry Basin, sized for all five cells.

AECOM has been engaged by Council to prepare a Construction Quality Assurance Plan (CQAP) to define the construction quality assurance requirements and procedures necessary to demonstrate compliance with the Contract Documents. This plan forms part of the project's Construction Environmental Management Plan (CEMP) as shown in Figure 1.

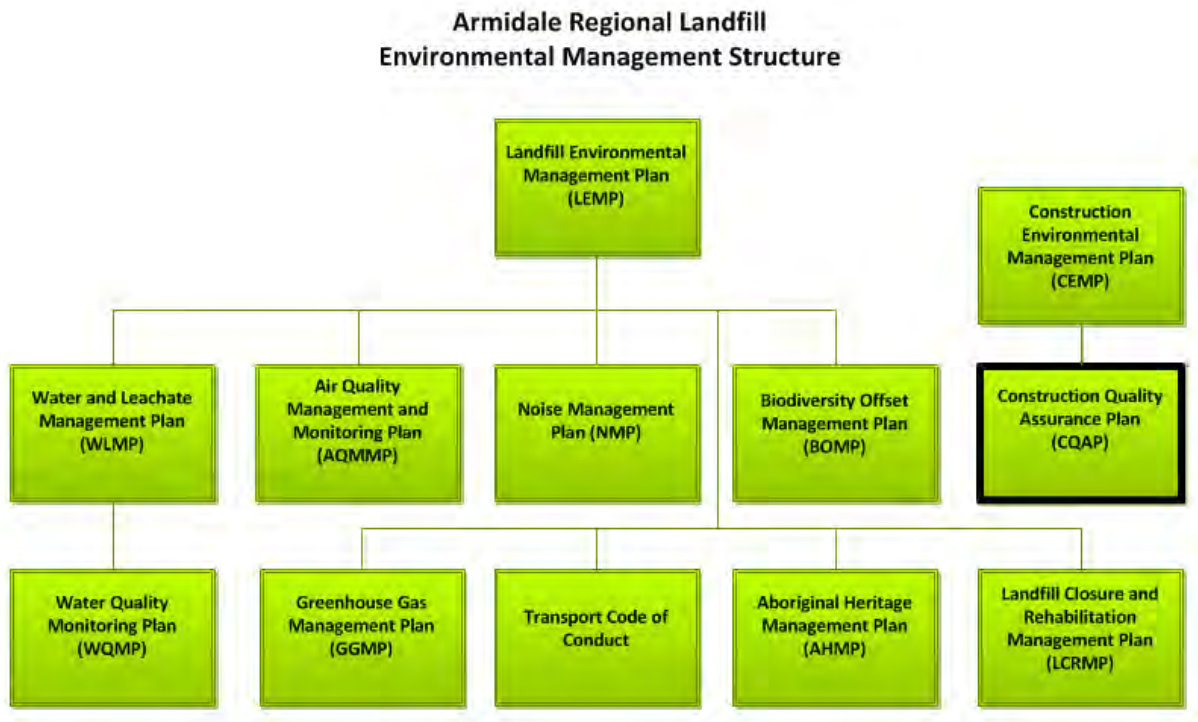

Figure 1 Environmental Management Structure

1.2 Purpose

The purpose of this CQAP is to define, for the Works, the construction quality assurance requirements and procedures necessary to demonstrate compliance with the Contract Documents. The CQAP must be read in conjunction with the Contract Documents.

The CQAP addresses the following requirements:

- Describes the roles, responsibilities and qualifications/experience of the parties involved in delivering construction quality assurance.

- Sets out the proposed testing, inspection and verification procedures to demonstrate that materials and constructed features at the landfill comply with the approved designs and specifications.
- Specifies the frequency of testing, test methods, laboratories, accreditations, applicable specifications and quality standards, data evaluation, acceptance and rejection criteria and remedial measures to be taken in the event of failure.

1.3 Scope of Work

The scope of work to be undertaken under the Contract includes the following:

- Site establishment.
- Topsoil stripping and stockpiling.
- Site clearing and grubbing.
- Excavation (and temporary stockpile) and re-profiling of existing landfill surface to achieve the landfill base liner and storage basin subgrade levels.
- Subgrade preparation works.
- Construction of a low permeability landfill base liner comprising clay fill and high-density polyethylene (HDPE) layers.
- Construction of a landfill leachate collection system comprising of slotted HDPE pipework, drainage gravel and geotextile layers.
- Construction of a Leachate Storage Pond using embankment fill materials with a low permeability base liner comprising clay fill and HDPE liner layers.
- Installation of leachate gravity and rising mains from the landfill to the Leachate Pond.
- Construction of a Sedimentation Basin and Dry Basin using embankment fill materials.
- Construction of basin inlet channels, overflow spillways and outlet dissipation structures.
- Construction of clean and dirty water drainage channels with rock rip-rap and shotcrete lining where required.
- Construction of landfill perimeter and access roads.
- Topsoiling and vegetation of drainage channels and embankment batters, as required.
- Site clean-up and restoration works.

2.0 Roles and Responsibilities

2.1 Responsible Parties

Principal

Armidale Dumaresq Council (ADC)

Superintendent (ADC):

……..

Phone: ……..…… E-mail: ……..

Design Engineer

AECOM

Contact: ……..

Phone: ……..…… E-mail: ……..

Site Superintendent / Superintendent's Representative (ADC)

Contact: ……..

Phone: ……..…… E-mail: ……..

CQA Engineer

……..

Contact: ……..

Phone: ……..…… E-mail: ……..

Contractor

……..

Contractor's Site Representative:

……..

Phone: ……..…… E-mail: ……..

Geotechnical Testing Authority

……..

Contact: ……..

Phone: ……..…… E-mail: ……..

Regulatory Authority

NSW Environment Protection Authority

Contact: ……..

Phone: ……..…… E-mail: ……..

2.2 Definitions

Approval Authority	Minister for Planning and Infrastructure.
Contract Documents	All Contract related drawings, specifications and plans including approved design modifications, relevant standards, licences and permits and Contract.
Construction Quality Control (CQC)	Quality control activities and testing undertaken by the Contractor to ensure that the Works meet the specification.
Construction Quality Assurance (CQA)	All activities and testing undertaken by or for the CQA Engineer to assure the Principal that the Contractor is constructing the Works in accordance with the specification.
Contractor	Engaged by Armidale Dumaresq Council to undertake the construction of the landfill cell.
CQA Engineer	Suitably qualified professional responsible for observing and monitoring completion of the construction quality assurance for the Works.
Design Engineer	AECOM
Geotechnical Testing Authority (GTA)	Suitably qualified firm, engaged by the Contractor, responsible for conducting all CQC testing required by the Technical Specification and the CAQP.
Leak Detection Consultant (LDC)	Suitably qualified firm, engaged by the CQA Engineer to test for leakage of the completed impermeable liners.
Principal	Armidale Dumaresq Council.
Regulatory Authority	Authority responsible for licensing the Works.
Superintendent	Person named in the contract to exercise the functions of the Superintendent under the contract and his or her appointed representatives.

2.3 CQA Responsibilities

The roles and responsibilities for key personnel necessary for the implementation of the CQAP are defined below:

2.3.1 Principal

The Principal shall ensure suitably qualified personnel are engaged for the Superintendence and CQA Engineer roles during the construction period.

2.3.2 Design Engineer

At the request of the Principal, the Design Engineer will undertake periodic on-site inspections of critical design elements during construction of the Works to ensure that the Works are constructed in accordance with the design documentation and intent. Following each inspection, the Design Engineer shall prepare an inspection report to the Site Superintendent, outlining any recommended remedial works or additional testing to be undertaken. The Design Engineer shall not instruct or issue directions to the Contractor.

2.3.3 Superintendent

The Superintendent is appointed by the Principal to administer the contract terms and conditions under the Contract including all CQC/CQA responsibilities.

2.3.4 Site Superintendent

The Site Superintendent (or Superintendent's Representative) is appointed by the Superintendent to manage the day-to-day Superintendence roles and responsibilities on site including all CQC/CQA functions under the Contract. All coordination, reporting and issues related to non-compliance shall be directed through the Site Superintendent.

At any stage throughout the Works, the Site Superintendent also may arrange for independent testing or surveying to be carried out. If that testing reveals that any of the Works are found to be not compliant with the Contract, the Site Superintendent will instruct the Contractor to undertake rectification of the non-compliant items and conduct retesting in accordance with the Contract.

2.3.5 CQA Engineer

The Principal shall engage an independent Construction Quality Assurance (CQA) Engineer to verify and report on all CQA matters. The CQA Engineer will conduct additional CQA compliance monitoring, observation, testing and documentation as required on behalf of the Principal.

The CQA Engineer shall be a professionally qualified civil or geotechnical engineer and shall have at least 5 years of experience in landfill design and construction, and be currently practising competently in this field. The CQA Engineer or an accredited Monitor (refer to Section 2.3.6) should be present at the site during the construction of the landfill and leachate pond impermeable barriers, and should be present when all samples are taken for the testing of construction materials.

The CQA Engineer shall be certified to AS/NZS ISO 9001 – 2000.

The CQA Engineer shall be responsible for assessing the compliance of the completed Works with the Contract Documents. This shall involve a range of activities that are described in this CQAP. Generally, the tasks will include:

- Review the Contract Documents, including any addendums and the CQAP.
- Review and recommend rejection or approval of site-specific documentation including Contractor submittals, work as executed surveys, manufacturers' information, installer's information and referenced standards. The Site Superintendent shall make the final decision on approval or disapproval of submittals.
- Verify construction is performed in accordance with the Contract Documents.
- Attend required meetings.
- Coordinate CQA Monitor(s) to observe CQC activities.
- Educate CQA Monitor(s) on site specific CQA/CQC requirements and procedures.
- Appoint and direct a Leak Detection Consultant (see Section 4.4.2).
- Witness, or arrange to have witnessed, all material sampling and testing undertaken by the Contractor.
- Verify calibrations of CQC testing equipment are correctly performed and recorded.
- Verify that CQC tests are properly performed and recorded and the results meet specified requirements.
- Review the qualifications of any subcontractors or personnel employed on the site after commencement of the Works to verify conformance with the Contract Documents.
- Review warranty submittals to verify compliance with the specified warranty requirements.
- Verify that the Contractor is following the approved CQCP.
- Observe the Contractor's performance of the Works and review of the Contractor's quality control documentation against the requirements of the Contract Documents.
- Procuring any additional independent CQA compliance testing and documentation required to ensure conformance with the Contract.
- Providing timely notification to the Site Superintendent of the conformance and non-conformance of works that are subject to third-party quality assurance.
- Arrange for the inspection of Witness Points important for CQA.
- Advice the Site Superintendent on the release of Hold Points as required. The Site Superintendent shall make the final decision on the release of Hold Points.

- Report any unapproved deviations from the CQAP to the Site Superintendent.
- Note any activities that could result in damage to installed Works.
- Prepare and maintain required CQA documentation.
- Review as-executed drawings at each stage of completed works.
- Prepare the Construction Quality Assurance Report in accordance with Section 5.0.

The CQA Engineer is to work with the Site Superintendent to determine whether sufficient evidence has been provided to adequately document that the Works comply with the requirements of the Contract Documents.

The CQA Engineer shall not issue directions to the Contractor.

2.3.6 CQA Monitor

The CQA Engineer will train and instruct the Site Superintendent and/or another person designated by the Principal, to act as CQA Monitor(s) on behalf of the CQA Engineer to provide a basis for concluding that the Works conform with the Contract Documents.

The CQA Monitor shall be assigned to every major construction activity related to the construction of the Works and be on-site during the relevant activities.

2.3.7 Contractor

The Contractor shall arrange and perform all inspection and CQC testing of the completed works in accordance with the minimum requirements set out in the Technical Specification and the CQAP. Copies of all test results shall be sent to the Site Superintendent within 24 hours of becoming available to the Contractor. The minimum testing frequencies shall be as nominated within the various parts of the Technical Specification.

The Contractor shall provide the CQA Engineer with reasonable access to the site at all times and shall cooperate with the CQA Engineer.

The Contractor shall provide samples to the CQA Engineer (where required) to enable the CQA Engineer to fulfil its obligations under the CQAP and as may be reasonably requested by the Site Superintendent.

The Contractor may engage sub-contractors to perform specialist trade packages in accordance with the Contract (e.g. Geosynthetic Installation Sub-Contractor).

2.3.8 Geotechnical Testing Authority

The Geotechnical Testing Authority is a firm independent from the Contractor, appointed by the Contractor and approved by the Site Superintendent and CQA Engineer. The GTA shall be responsible for conducting all testing as outlined in in the Technical Specification and the CQAP, or as otherwise directed by the Site Superintendent. Testing shall be in accordance with AS3798-2007 Level 1 Sampling and Testing. The GTA shall be responsible for providing all CQC test results as outlined in in the Specification and the CQAP.

The GTA shall be accredited by the National Association of Testing Authorities (NATA) for the tests contained within the specification and other tests as required by the Site Superintendent.

3.0 General CQAP Requirements

3.1 General

The completed Works shall conform in all respects with the requirements of the Drawings and Technical Specification. The CQAP will be used by the Principal to check that the Works are undertaken in a manner that demonstrates compliance with the Contract Documents.

General CQAP requirements as specified in the Technical Specification for the Works are outlined below.

3.2 Meetings and Communication

To guarantee the quality of the Works, and to ensure a final product that meets all relevant specifications, clear and open channels of communication are essential.

The Site Superintendent shall co-ordinate communications for the project, initiating the project inception and construction progress meetings. The Site Superintendent shall document all meetings and minutes of those meetings shall be distributed to all parties. The Site Superintendent shall regularly liaise with parties involved in the project to ensure that communications are maintained. Construction and design issues shall be reviewed on an as-needed basis and shall be resolved and documented by the Site Superintendent.

3.2.1 Project Inception Meeting

A project inception meeting shall be held prior to the commencement of the Works. Representatives from the Principal, Site Superintendent, CQA Engineer, Contractor, Design Engineer and any other attendees nominated by the Site Superintendent shall attend the meeting.

The project inception meeting shall be used to reach alignment on the scope, purpose and required outcomes from performance of the works. The agenda of the project inception meeting will be nominated by the Site Superintendent and should include:

- Overview of the project, with a focus on method and schedule.
- Design intent.
- Review of the Construction Program.
- Review any appropriate modifications to the CQA requirements.
- Review the responsibilities of all parties.
- Review of the lines of authority and communication;
- Review of any revisions or amendments to the design.
- Contractor queries on design documentation.
- Constructability issues.
- Safety hazard exposure during performance of the Works.
- Mechanisms for approvals of completed works.

The project inception meeting shall be conducted at a suitable location to be determined by the Principal. The meeting shall be minuted by the Site Superintendent and the minutes shall be copied to all parties.

3.2.2 Environmental Awareness Induction

Before a person is permitted to commence work or visit the site, including contractors, they will be given a site induction, which includes to safety, environment, quality and community content relevant to the site and the construction activities. The induction will ensure that all workers and others are aware of their environmental obligations and required mitigation measures within the landfill site.

The induction will be delivered by the Contractor's representative, or delegate, and will include:

- General site awareness, including site access, hours of work, and any relevant Council policies/rules.
- Familiarisation with the requirements of the CEMP.
- Environmental emergency response training and incident management and reporting process.
- Health and safety measures (including the specific Safety Plan provided by the contractor).
- Familiarisation with site environmental issues and their controls (for example heritage and ecology) as identified in the CEMP. In particular:
    - Measures pertaining to the Biodiversity Offset Area and key threatened species known to occur on the site (i.e. Little Eagle);
    - Avoidance of GL ISO2 Aboriginal heritage site;
    - Noise minimisation techniques;
    - Sediment and erosion control measures; and
    - Environmental incident reporting protocols.

3.2.3 Progress Meetings

Regular on-site progress meeting shall be held for the duration of the Works. Attendees will include the Site Superintendent, CQA Engineer, the Contractor, and any other personnel deemed essential. The purpose of these meetings is to discuss progress, planned activities for the next period, issues requiring resolution, and any revisions to the Works. The CQA Engineer shall report any CQA issues and deficiencies noted during the previous period.

The Progress Meeting will consider:

- Current progress against programme
- Scheduled activities for the next period
- Quality of installations to date
- Issues requiring resolution
- Revisions or amendments to the work or programme.

If any matter remains unresolved at the end of this meeting, the Site Superintendent shall be responsible for the resolution of the matter and the communication of the decision to the appropriate parties.

The Site Superintendent shall minute the progress meetings and shall provide each a copy of the minutes to the Principal and the Contractor within 7 days of each meeting.

The Site Superintendent may direct additional progress meetings to be undertaken, as necessary to provide direction to the Contractor in respect of its performance of the Works in accordance with the construction program.

3.2.4 Special Meetings

The Site Superintendent may direct additional site meetings to be conducted as required to discuss major problems or deficiencies and to formulate comprehensive solutions.

3.3 Hold and Witness Points

3.3.1 General

The Contractor shall observe Hold Points and Witness Points identified in the Technical Specification. The definitions of Hold Points and Witness Points are provided in the table below.

Table 1 Definition and Application of Hold Points and Witness Points

Type	Definition and application
Hold Point	A point in the sequence of activities to be carried out by the Contractor in the performance of the Works which the Contractor shall not proceed with any subsequent activities prior to obtaining a written direction from the Site Superintendent
Witness Point	A point in the sequence of activities to be carried out by the Contractor in the performance of the Works at which the Contractor shall provide notification to the Site Superintendent prior to proceeding with any subsequent activities

The Contractor shall not proceed with any of the works affected subsequent to any hold point prior to receiving the written direction of the Site Superintendent to proceed. The Contractor shall provide all documentation required to demonstrate that the works subject to the hold point have been undertaken in accordance with the Contract.

Where not stated otherwise, the Contractor shall notify the Site Superintendent not less than 2 days prior to undertaking any works that follow a witness point. The Contractor may undertake works subject to a witness point, whether or not the works have been witnessed by the Site Superintendent, provided that the notification period has elapsed.

3.4 Design Engineer's Requirements

The Design Engineer will make on-site inspections of critical design elements as part of their regular monthly meeting. The Principal may require the Design Engineer to be on site during the following activities if their specialist advice is needed.

- Landfill cell subgrade construction
- Compacted clay liner construction
- Installation of HDPE geomembrane liner
- Installation of leachate collection and conveyance system
- Leachate Pond, Sedimentation Basin and Dry Basin construction
- Completed works.

3.5 Regulatory Authority Requirements

The Regulatory Authority shall also be provided with the opportunity to observe key elements of the Works during construction, as listed above.

3.6 Independent CQA Conformance Testing

3.6.1 General

The Site Superintendent may direct the CQA Engineer to conduct additional independent CQA monitoring, observation, testing and documentation on behalf of the Principal. The Contractor shall cooperate fully with the Site Superintendent, CQA Engineer and all QA representatives during this process and shall assure, at all times, safe access to the Works for the purpose of monitoring, observation and CQA implementation.

If that testing reveals that any Works are found to be not compliant with the Contract, the Contractor shall undertake rectification of the non-compliant items and conduct retesting in accordance with the Contract.

3.6.2 CQA Conformance Sampling

CQA conformance samples shall be collected at locations designated by the CQA Engineer. The CQA Engineer shall collect CQA conformance samples and ensure they are collected, cut, labelled, and packaged in accordance with the Contract Documents and/or CQA Plan. CQA Conformance Testing.

Except for field tests, all CQA conformance testing shall be undertaken by authorities accredited by the National Association of Testing Authorities (NATA) to test in the relevant field. CQA testing to be performed is outlined in Section 4.0 below.

3.6.3 CQA Conformance Results

The CQA Engineer shall verify the following when reviewing CQA conformance test results:

- Borrow soils used for CQA conformance testing are identical to the materials used for full-scale construction;
- The correct conformance tests have been performed and specified test procedures have been used; and
- Test results meet the requirements of the Contract Documents.

The CQA Engineer shall immediately notify the Site Superintendent of problems with CQA conformance testing procedures or non-compliance of conformance test results.

3.6.4 Non-Conformance and Corrective Action Procedures

All non-conformances that arise from CQA compliance testing shall be duly noted and appropriately recorded by the CQA Engineer, in the form of a non-conformance report, and made available to the Site Superintendent within 24 hours.

Where a non-conformance occurs, the non-conformance report is to include the following information:

- The location of the non-conformance;
- The time of the non-conformance;
- The time that the CQA Consultant was made aware of non-conformance;
- The suspected cause of the non-conformance; and
- A description of the resulting impacts of the non-conformance.

The Site Superintendent, in consultation with the CQA Engineer, shall prepare a corrective action plan to address the non-conformance. The corrective action plan shall address the following:

- The nature of the non-conformance and its level of effect on the project;
- Determination if the non-conformance is an isolated incident or a recurring problem;
- The nature of corrective action to be applied to rectify that specific non-conformance (e.g. re-compaction and testing);
- How amendments to procedures to prevent future occurrences of the non-conformance will be implemented.

3.7 Contractor's CQC Documentation and Reporting

3.7.1 General

When the Works are completed, the following CQC documentation must be provided by the Contractor:

- "Work as Executed" surveys and drawings in accordance with the Technical Specification.
- Construction Verification Report prepared by the Contractor/GTA including all material test certificates and results in accordance with Section 3.7.2.
- A hand-marked copy of the Drawings and Technical Specification, which clearly identifies all changes to the scope and/or details of the works, as required to accurately reflecting the as-constructed status of the completed works.
- Site inspections and construction records for all compacted fill.
- Photos taken of all critical work areas and phases during the construction works.

3.7.2 Construction Verification Report

At the completion of the works, the Contractor shall provide a Construction Verification Report (based on CQC results from the GTA) for all aspects relating to the geotechnical and material parameters and testing required in the CQAP.

The Construction Verification Report shall include the following:

- Details of the works and monitoring devices installed, including surveys, work as-executed drawings and an updated site plan showing the location of the Works.
- Records from the GTA giving details of the works progress, the rate of liner or capping deployment, and any remedial actions that were taken.
- A plan of geomembrane panel deployment, showing locations of defects, repairs and tests photographs of all aspects and stages of the construction.
- Results of the leak detection testing.
- Details and results of all material testing, including data and certifications provided by manufacturers of supplied materials.
- Details of all non-conformance reports and associated sign-off of corrective action by the CQA Engineer/Site Superintendent and the Contractor.

3.8 CQA Documentation and Reporting

The CQA Engineer shall provide the following documentation to the Principal and the Site Superintendent in relation to its quality assurance activities:

- Records of its attendance on site, the Contractor's activities on the day(s) of attendance and the weather conditions.
- Weekly reports, or otherwise at a frequency agreed with the Site Superintendent, that detail the following:
  - The rate of clay liner placement;
  - The area of the lining system deployed;
  - The joins and seams completed (including the relevant inspection and testing);
  - Conformance and/or non-conformance of the Contractor's activities with the Technical Specification.
- A report detailing any non-conformance, as soon as the CQA Engineer becomes aware of a non-conformance or possible non-conformance with the Technical Specification, whether through its review of the Contractor's inspection and testing or its own.
- Weekly reports detailing the conformance and/or non-conformance of the Contractor's work methods and/or completed works and any requirement for corrective action by the Contractor.
- NATA accreditation certificates for all tests performed.
- A CQA Report that summaries all of the above reporting and incorporates all documentation compiled by the CQA Engineer in the performance of its activities.

4.0 Construction Quality Assurance Requirements

Quality assurance measures must be implemented to verify that critical features of the landfill are constructed according to the Drawings and Technical Specification (refer Appendix A). The CQA Engineer shall observe the Contractor's performance of all critical works, undertake third-party review of the Contractor's construction quality control and shall perform independent laboratory testing of materials and workmanship in accordance with the CQAP.

The specific CQA requirements for the following key construction works associated with the landfill liner system, leachate storage pond and stormwater drainage/management works are outlined in this plan:

- General earthworks;
- Compacted clay liner;
- Geomembrane liner;
- Leachate gravel drainage layer; and
- Geotextile layers.

4.1 General Earthworks

The CQA Engineer shall verify the CQA requirements described below for general earthworks construction:

Weather Conditions

- Verify that earthworks do not occur during periods of excessive rain, freezing temperatures, or if other detrimental weather conditions exist.

Excavation

- Monitor the areas to being excavated to determine whether the material being extracted conforms to the requirements of the specification and is as forecast by previous geotechnical investigations.
- Obtain advice from a geotechnical engineer and/or the Design Engineer if conditions vary substantially from those anticipated to occur.

Subgrade Preparation

During subgrade preparations verify the following:

- The subgrade is smooth, free of voids, and composed of satisfactory materials.
- The subgrade is compacted and proof rolled as specified.
- The subgrade surface is scarified as specified prior to placement of the first lift of fill.

Materials

- Check CQC borrow test results to verify that the borrow material is uniform and matches the required properties given in the Technical Specification (refer Appendix A) and based on the Geotechnical Report and Maps (refer Appendix B).
- Advise the Site Superintendent about the need to do additional borrow source assessment testing if the properties of a borrow source appear to have changed significantly.

Filling

During filling works, verify the following:

- Slippage of filling and compaction equipment is not occurring on batter.
- Loose and compacted lifts are no greater than the specified maximum allowable thickness.
- Fill contains no large clods or other prohibited material.

- The moisture of the fill is managed during placement to ensure the required moisture content level is achieved.

Construction Testing

Verify the following during testing of the in-place fill:

- Observe the Contractor's placement method for conformance with the Technical Specification.
- Confirm that the Contractor's inspection and testing of the compacted clay layer conforms to the testing frequency required by the Technical Specification.
- CQC moisture content and density tests are performed at the specified frequency in accordance with the Technical Specification.
- Additional CQC tests are taken where test results are not in compliance with the Contract Documents or the fill is visibly suspect.
- The Contractor performs corrective action as a result of failed tests in compliance with the Contract Documents and submits documentation describing the measures taken.
- The Contractor uses nuclear gauges in the direct transmission mode in conjunction with laboratory testing to measure density.

Protection

- Ensure the Contractor removes puddles and excess moisture from the fill surface prior to placement of additional fill.
- Inspect areas of erosion after each rainfall event.
- Inspect areas for damage due to freezing and/or desiccation.

Repairs

- Ensure the Contractor repairs damaged areas and re-establishes grades.
- If a fill layer does not conform to the Contract Documents, assist the Site Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.
- After repairs have been made, ensure sufficient CQC retests are performed to verify that the repaired areas are now conforming.

4.2 Compacted Clay Layer

In addition to the CQA inspection requirements described in Section 4.1 of this CQA Plan, the CQA Engineer shall verify the following during compacted clay layer works:

- Witness the clay liner field trials undertaken by the Contractor prior to the works to assess the performance of the proposed clay liner material under compactive effort and to establish relationships between dry density, moisture content and hydraulic conductivity.
- Confirm the construction is in accordance with the clay liner field trial results.
- Procure independent CQA compliance testing for compacted clay liner in accordance with the test methods and conformance criteria and minimum test frequency provided in the table below.

Table 2 Minimum CQA Testing and Frequency of Clay Fill Liner Compaction

Material	Test	Minimum Test Frequency	
		Pre Construction (Compliance)	During Construction
		At Source	At Site
Clay Fill Liner	Remoulded Permeability AS1289 6.7.1	1 per 5 CQC tests	N/A
	Liquid Limit AS1289 3.1.1	1 per 5 CQC tests	N/A
	Plasticity Index AS1289 3.2.1	1 per 5 CQC tests	N/A
	Particle Size Distribution AS1289 3.6.1 and AS1289 3.6.3	1 per 5 CQC tests	N/A
	Emerson Class AS1289.3.8.1	1 per 5 CQC tests	N/A
	Standard Compaction Test AS 1289.5.8.1 AS 1289.5.1.1 or AS 1289.5.7.1	N/A	1 per 5 CQC tests
	Moisture Content AS 1289.5.1.1 or AS 1289.5.7.1	N/A	1 per 5 CQC tests
	In-situ Permeability (Undisturbed) AS1289 6.7.3	NA	1 per 10 CQC tests

- Ensure no further material is placed on the Clay Liner surface until proof rolled and approved by the Site Superintendent.
- Ensure the finished surface is free of any stones, defects or imperfections that may puncture or damage to the overlying layers other objects which could puncture or damage the geomembrane layer.
- Ensure the compacted fill layer does not dry out after compaction and cause shrinkage cracks in the compacted clay. Should any desiccation cracking occur it shall be repaired prior to additional fill placement. Clay liners that will exposed for more than 7 days before placement of overlying materials should be covered to prevent them from drying out.

4.3 Geosynthetic Clay Liner

4.3.1 General

The CQA Engineer shall undertake the CQA requirements described below for GCL installation:

- Witness the entire works required for installation of the GCL.
- Ensure the Contractor does not deploy the GCL during wet conditions, including during fog, or when there is excessive ground moisture like heavy dew or when high winds or other adverse climatic conditions exist.
- Review the manufacturer's quality assurance documentation and test certificates for conformance with the Technical Specification and report any discrepancies.
- Observe the packaging and identification of the GCL and the Contractor's methods for transport, handling and onsite storage of the materials for conformance with the Technical Specification.

- Review the Contractor's method for panel nomenclature and roll traceability and confirm that panel and roll numbers are properly recorded in the Contractor's documentation.
- Observe the Contractors roll storage methodology and ensure the Contractor is protecting the rolls from weather exposure during storage.
- Confirm that the surface preparation for GCL installation is performed in accordance with the Technical Specification.
- Observe the Contractor's GCL installation for conformance with the Technical Specification and confirm that the installation proceeds in accordance with the Contractor's GCL layout plan.
- Observe the Contractor's overlap methods for conformance with the Technical Specification, including the use of bentonite paste.
- Review the Contractor's installation records and confirm the accuracy of those records in relation to the completed work.
- Observe the Contractor's repair of non-conforming work, defects and damage for conformance with the Technical Specification.

The CQA Engineer shall undertake CQA testing and inspections on the GCL material delivered to the site and during installation at the maximum test frequency specified in the table below.

Table 3 Minimum CQA Testing and Frequency of GCL

Physical Property	Test Method	Minimum Test Frequency	
		Pre-Construction (Compliance)	Delivered (CQA Conformance)
Strip Tensile Strength (roll direction)	ASTM D6768	1 test per 10,000 m^2	N/A
CBR Elongation (both directions)	AS3706.4		
Permeability	ASTM D5887		
Swell Index	ASTM D5890		
Peel Strength	ASTM D6496		
Total Mass per Unit Area			
Visual inspection of GCL	Tears, punctures, abrasions, indentations, thin spots,, or other faults in the material	N/A	Every roll

4.4 Geomembrane Liner

4.4.1 General

The CQA Engineer shall undertake the CQA requirements described below for geomembrane installation:

- Witness the entire works required for installation of the geomembrane.
- Ensure the Contractor does not deploy geomembrane during wet conditions, including during fog, or when there is excessive ground moisture like heavy dew or when high winds or other adverse climatic conditions exist.
- Review the manufacturer's quality assurance documentation and test certificates for conformance with the Technical Specification and report any discrepancies.

- Observe the packaging and identification of the geomembrane and the Contractor's methods for transport, handling and onsite storage of the materials for conformance with the Technical Specification.
- Review the Contractor's method for panel nomenclature and roll traceability and confirm that panel and roll numbers are properly recorded in the Contractor's documentation.
- Confirm that the surface preparation for geomembrane installation is performed in accordance with the Technical Specification.
- Observe the Contractor's geomembrane installation for conformance with the Technical Specification and confirm that the installation proceeds in accordance with the Contractor's geomembrane layout plan.
- Observe the Contractor's field seaming methods for conformance with the Technical Specification.
- Observe the Contractor's non-destructive testing of geomembrane field seams and identify conformance or non-conformance of each field seam with the Technical Specification.
- Confirm that the Contractor's destructive testing of the geomembrane conforms to the Technical Specification in respect of the testing frequency and results.
- Undertake destructive testing of geomembrane field seam samples provided by the Contractor to identify conformance or non-conformance with the Technical Specification. The test methods, conformance criteria and minimum testing frequency shall be in accordance with the table below.
- Review the Contractor's installation records and confirm the accuracy of those records in relation to the completed work.
- Observe the Contractor's repair of non-conforming work, defects and damage for conformance with the Technical Specification.

The CQA Engineer shall undertake CQA testing and inspections on the geomembrane material delivered to the site and during installation at the minimum test frequency specified in the table below.

Table 4 Minimum CQA Testing and Frequency of Geomembrane Liner

Physical Property	Test Method	Minimum Test Frequency	
		Pre Construction (Compliance)	During Construction
Thickness	ASTM D 5994	1 test per roll	N/A
Density	ASTM D 792	1 test per 5,000m^2, or every 5 rolls delivered to site, whichever is the greatest number of tests.	N/A
Carbon Black Content (range)	ASTM D 1603		
Carbon Black Dispersion (rating)	ASTM D 5596		
Tensile Properties (each direction): Strength at Yield Strength at Break Yield Elongation Break Elongation	ASTM D 638 (50 mm/min)		
Tear Resistance	ASTM D 1004		
Puncture Resistance	ASTM D 4833		

Physical Property	Test Method	Minimum Test Frequency	
		Pre Construction (Compliance)	During Construction
Stress Crack Resistance	ASTM D 5397	1 test per 10,000m^2, or resin type or manufacturing run. **Note** – Due to lead time OIT test samples from actual production batch to be supplied by manufacturer to Contractor and submitted to an independent NATA accredited laboratory for testing and the test results forwarded to the CQA Engineer.	N/A
Oxidative Induction Time (OIT)	ASTM D 5397, ASTM D 3895, ASTM D 5885		
Start-up Test Weld - Welding equipment		N/A	Check 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.
Start-up Test Weld - Weld conditions		N/A	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 – on-site, hand tensiometer in peel and shear	ASTM D 6392	N/A	Every weld
Destructive weld testing – off-site – weld seam strength in peel and shear	ASTM D 6392	N/A	Every 150m (if fusion weld), every 120m (if extrusion weld)
Non-destructive weld testing	Air pressure test – ASTM D 5820 Vacuum box rest – ASTM D 5641	N/A	All seams over full length
Visual inspection of geomembrane	Tears, punctures, abrasions, indentations, thin spots,, or other faults in the material	N/A	Every roll

Physical Property	Test Method	Minimum Test Frequency	
		Pre Construction (Compliance)	During Construction
Thickness of geomembrane	On-site	N/A	Five per 100m, 20m apart, taken at the edge of the sheet

4.4.2 Geomembrane Leak Location Survey

The Leak Detection Consultant (LDC) shall carry out a Geomembrane Leak Location Survey (GLLS) in accordance with ASTM D7007 / ASTM D6747 after the leachate drainage layer has been placed on the new landfill cell.

The Contractor will provide attendance on the LDC and will be responsible for preparing the site for survey. This will entail the following:

- Providing the LDC with drawings that show:
  - All layers constituting the lining system and details of all liner penetrations
  - Plan of the survey area
  - Peripheral details, including welds to adjacent lining systems
  - Structures and obstructions above the liner
  - Electrical equipment above the geomembrane.
- Install any necessary electrodes.
- Coordinate with the LDC to provide a survey area lined that is electrically isolated from the surrounding ground (i.e. the cover soil is not tied into the ground surface outside of the cover area). Isolation can be accomplished by open trenching or installation of a non-conductive insulator such as the liner materials.
- Provide the leak detection consultant with the liner installation schedule.
- Provide a water truck and driver, and wet the survey area prior to and during the dipole survey to ensure that there is adequate moisture in the material(s) covering the geomembrane for the dipole leak detection testing. To detect a leak, moisture must exist in the leak and be in contact with moisture in the materials above and below the liner. Therefore, the material(s) covering the geomembrane must be moistened with water prior to conducting the leak detection survey. In order to achieve uniform moisture distribution, the Contractor shall add water as the investigation progresses on and within cover layer(s). A water truck must be available at all times as it may be necessary to wet the surface just in advance of the survey, as deemed necessary by the leak detection consultant.
- The calibration process requires clearing a hole down to the surface of the geomembrane to place the artificial leaks. The Contractor is to provide hand labour to excavate the cover down to the geomembrane. Rehydrate the gravel as it is backfilled over the artificial leaks. The Contractor is also responsible for backfilling the calibration hole, and uncovering and retrieving the artificial leak apparatus, and backfilling the hole appropriately, including patching any intervening geotextiles.
- Several calibration exercises may be required, and the Contractor must be prepared to assist with each survey.
- The Contractor shall uncover and expose any leaks detected by the LDC for repair by the installer in accordance with the Technical Specifications.
- The LDC is responsible for calibrating all equipment utilised to achieve optimum data quality and sensitivity for the site conditions.
- All work shall be performed in accordance with current industry and ASTM standards.

- Manual measurements shall be made to verify leak signals after data analysis and to pinpoint the leak positions on top of the Leachate Drainage Layer for excavation while the survey personnel are on site. The Contractor shall hand excavate possible leak locations to expose the liner.
- Additional manual measurements may be made to guide the Contractor's personnel while they excavate the leak.
- After the identification and excavation of a leak, the soil around the leak location shall be tested while the leak is uncovered and cleaned to check for adjacent leaks.
- Leak locations shall be logged, visibly marked, and reported for repair.
- The LDC shall report the general results of the survey to the Site Superintendent, Contractor and CQA Engineer during the daily progress of the field work.
- Prior to the demobilisation of the survey personnel from the site, the LDC shall submit a list of locations of the leaks detected to the Site Superintendent, Contractor and CQA Engineer.
- The LDC shall submit a letter report documenting the field work and results of the surveys to the Site Superintendent, Contractor and CQA Engineer within 14 days after completion of the field work.

4.5 Leachate Gravel Drainage Layer

The CQA Engineer shall undertake the CQA requirements described below for the leachate gravel drainage layer construction:

- Have witnessed the placement of the drainage layer material.
- Review the Contractor's quality assurance documentation and test certificates for conformance with the Technical Specification and report any discrepancies.
- Observe the Contractor's placement method for conformance with the Technical Specification.

4.6 Geotextile Layers

The CQA Engineer shall undertake the CQA requirements described below for the separation and protection geotextile installation:

- Witness or have witnessed the placement of the geotextile layers.
- Review the manufacturer's quality assurance documentation and test certificates provided by the Contractor for conformance with the Technical Specification and report any discrepancies.
- Observe the packaging and identification of the geomembrane and the Contractor's methods for transport, handling and onsite storage of the materials for conformance with the Technical Specification.
- Confirm that the surface preparation for geotextile installation is performed in accordance with the Technical Specification.
- Observe the Contractor's geotextile installation for conformance with the Technical Specification.
- Observe the Contractor's field joining methods for conformance with the Technical Specification.
- Observe the Contractor's repair of non-conforming work, defects and damage for conformance with the Technical Specification.
- Ensure the Contractor has adequate loading placed over the entire completed filter geotextile surface following installation to prevent uplift by wind, until landfill waste is placed within the landfill cell.

The CQA Engineer shall undertake CQA testing and inspections on the Separation and Protection Geotextile material shipped to the site and during installation at the minimum test frequency specified in the table below.

Table 5 Minimum CQA Testing and Frequency of Separation Geotextile

Property	Test Method	Minimum Test Frequency	
		Pre Construction (Compliance)	During Construction
Trapezoidal Tear	AS 3706.3	1 test per 10,000m^2	N/A
CBR Burst Strength	AS 3706.4	1 test per 10,000m^2	N/A
Grab Tensile Strength	AS 3706.2	1 test per 10,000m^2	N/A
Flow Rate (separation geotextile)	AS 3706.9	1 test per 10,000m^2	N/A
Ultraviolet Stability	AS 3706.11	1 test per 10,000m^2	N/A
Visual inspection of geotextile	Colour, thickness, tears, holes, punctures, needle-punching, presence of needles or broken needles, and other faults in the material.		Each roll during placement

Table 6 Minimum CQA Testing and Frequency of Protection Geotextile

Property	Test Method	Minimum Test Frequency	
		Pre Construction (Compliance)	During Construction
Thickness	AS 3706.1, AS 2001-2.15	1 test per 2,500m^2	N/A
Mass per unit area	AS 3706.1, AS 2001-2.13	1 test per 2,500m^2	N/A
Trapezoidal Tear	AS 3706.3	1 test per 5,000m^2	N/A
CBR Burst Strength	AS 3706.4	1 test per 5,000m^2	N/A
Grab Tensile Strength	AS 3706.2	1 test per 5,000m^2	N/A
Visual inspection of geotextile	Colour, thickness, tears, holes, punctures, needle-punching, presence of needles or broken needles, and other faults in the material.	N/A	Each roll during placement
Thickness of geotextile	On-site	N/A	Each roll during placement. If thickness appears to be variable a check of the variability of the mass per unit area should be conducted.

5.0 Construction Quality Assurance Report

Following practical completion of the construction works, a CQA Report shall be prepared by the CQA Engineer in consultation with the Site Superintendent, giving details of the construction activities and the quality assurance measures that were implemented, utilising records prepared during construction. The report shall be retained as a permanent record of construction. The report is to provide details of the Works' construction and the quality assurance measures that were followed. The CQA Report is to be submitted by the Principal to the Regulatory Authority for approval before it can issue a permit to dispose of waste within the constructed landfill cell.

The CQA Report shall contain the following key documentation:

- A copy of the Contractor's Construction Verification Report in accordance with Section 3.7.2.
- Diary records by the CQA Engineer giving details of the works progress, the rate of liner deployment, and any remedial actions that were undertaken.
- Detailed photographs of all aspects and stages of the construction with the site designation, the date taken, the location, and a description of the activity covered by the photograph.
- Details and results of all material testing, including data and certifications provided by manufacturers of supplied materials, any independent CQA testing and details of any Design Engineer/Regulatory inspections.
- Confirmation that the CQAP was followed.
- An account of all variations from the approved design, specifications and CQAP.
- A declaration by the CQA Engineer that there is sufficient information to demonstrate that the landfill elements observed by the CQA Engineer were constructed in accordance with the approved contract documents, designs and specifications.

Appendix A

Technical Specification

Appendix B

Geotechnical Assessment and Maps

Attachment 8

Chris Nivison-Smith

From: Michael Lewis <Michael.Lewis@epa.nsw.gov.au>
Sent: Thursday, 22 December 2016 5:36 PM
To: 'Frolich, Alexandra'
Cc: 'Lindsay Fulloon'; 'Poirier, Danielle'; 'Robert O'Hern'
Subject: RE: Armidale Regional Landfill Drawings

Hi Alex,

Apologies for the delayed reply but I can confirm the EPA received your e-mail (below) dated 28 November 2016 along with the attached technical specifications/plans for the revised proposal of a GCL in place of the 900mm clay liner and has reviewed the proposed change. I can advise that the EPA does not have any objections to the proposed modifications.

While the original proposal was reviewed under the Benchmark Techniques within the 1996 Environmental Guidelines for Solid Waste Landfills the 2016 guidelines identify either option, (GCL or clay) as acceptable.

Please do not hesitate to contact me if you have any queries in relation to the above.

Regards

Michael Lewis
Regional Operations Officer – Armidale
North Branch, NSW Environment Protection Authority
+61 2 6773 7000 +61 418 208 635
michael.lewis@epa.nsw.gov.au www.epa.nsw.gov.au @EPA_NSW
Report pollution and environmental incidents 131 555 (NSW only) or +61 2 9995 5555

From: Frolich, Alexandra [mailto:Alexandra.Frolich@aecom.com]
Sent: Monday, 28 November 2016 2:42 PM

To: EPA RSD Armidale Mailbox <Armidale@epa.nsw.gov.au>
Cc: Lindsay Fulloon <Lindsay.Fulloon@epa.nsw.gov.au>; Michael Lewis <Michael.Lewis@epa.nsw.gov.au>; Poirier, Danielle <Danielle.Poirier@aecom.com>
Subject: RE: Armidale Regional Landfill Drawings

Good afternoon,

Armidale Regional Council has had a number of environmental management plans approved by the Department of Planning and Environment. These plans were also previously reviewed by the EPA.

Armidale Regional Council has recently gone to tender for the construction of the landfill (Cell 1). As part of this process, tenderers requested the ability to use a geosynthetic clay liner (GCL) in place of the previously proposed 900mm clay liner. AECOM, on behalf of Council, prepared a revision of the detailed design to incorporate this request. In addition, revision of the approved Construction Quality Assurance Plan (CQAP) has been undertaken.

The revised design and CQAP are submitted to EPA for review and comment, noting that the GCL is an alternative of the approved 900mm clay liner and consultation with the EPA is required. If you require further information or wish to meet to discuss please do not hesitate to contact me. To align with Council's tendering process, we would appreciate any comments before Monday 12 December 2016.

Many thanks,

Alex Frolich
Senior Scientist
D +61 2 8934 0273
Alexandra.Frolich@aecom.com

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From: Price, Duncan
Sent: Friday, 23 October 2015 10:11 AM
To: lindsay.fulloon@epa.nsw.gov.au
Cc: Frolich, Alexandra
Subject: Armidale Regional Landfill Drawings

Hi Lindsay

On behalf of Armidale Dumaresq Council, we have recently completed the detailed design for the Armidale Regional Landfill. Under the conditions of the landfills project approval (PA 06_0220) a number of Management Plans have been submitted for EPA review.

Within these plans selected design drawings have been provided. As the design is now complete is there a requirement for a review by the EPA of the entire drawing set?

Thanks
Duncan

Duncan Price
Principal Civil Engineer
D +61 2 8934 0662
Duncan.Price@aecom.com

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Attachment 9

ARMIDALE LANDFILL
CELL 1 WORKS

DRAWING LIST - LANDFILL (AECOM)

60011672-SHT-CI-0001	COVER SHEET AND DRAWING LIST
60011672-SHT-CI-0005	GENERAL NOTES
60011672-SHT-CI-0011	GENERAL ARRANGEMENT PLAN
60011672-SHT-CI-0012	CLEARING AND GRUBBING PLAN SHEET 1
60011672-SHT-CI-0013	CLEARING AND GRUBBING PLAN SHEET 2
60011672-SHT-CI-0016	SITE CLEARANCE AND TOPSOIL STRIPPING PLAN
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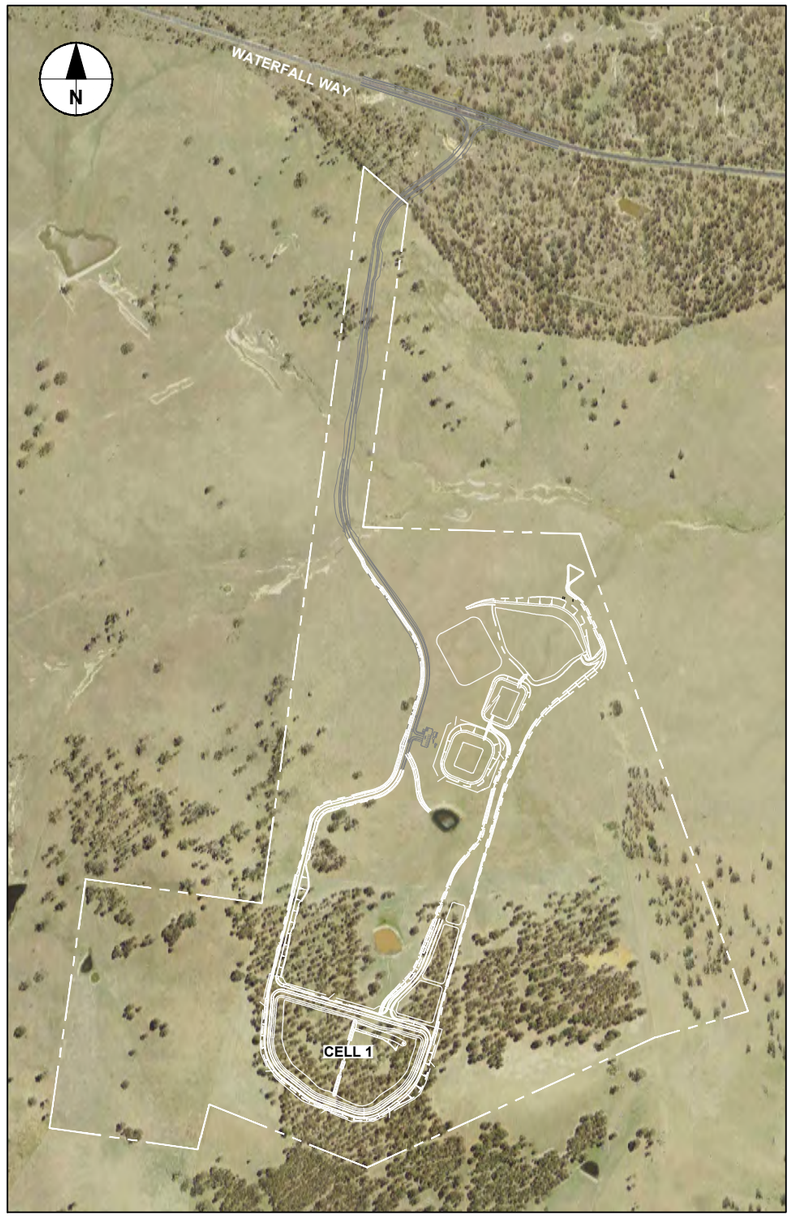
60011672-SHT-CI-0018	EROSION AND SEDIMENT CONTROL PLAN
60011672-SHT-CI-0019	EROSION AND SEDIMENT CONTROL DETAILS
60011672-SHT-CI-0021	LANDFILL CELL 1 LAYOUT PLAN
60011672-SHT-CI-0022	LEACHATE STORAGE POND LAYOUT PLAN
60011672-SHT-CI-0023	SEDIMENTATION BASIN LAYOUT PLAN
60011672-SHT-CI-0024	DRY BASIN LAYOUT PLAN
60011672-SHT-CI-0025	CLEAN WATER DRAIN OUTLET ROCK APRON LAYOUT PLAN
60011672-SHT-CI-0031	CONTROL STRING PLAN SHEET 1
60011672-SHT-CI-0032	CONTROL STRING PLAN SHEET 2
60011672-SHT-CI-0041	EARTHWORKS LONGITUDINAL SECTIONS
60011672-SHT-CI-0042	EARTHWORKS LONGITUDINAL SECTIONS
60011672-SHT-CI-0053	EARTHWORKS LONGITUDINAL SECTIONS
60011672-SHT-CI-0061	ROAD LONGITUDINAL SECTIONS
60011672-SHT-CI-0062	ROAD LONGITUDINAL SECTIONS
60011672-SHT-CI-0063	ROAD LONGITUDINAL SECTIONS
60011672-SHT-CI-0064	ROAD LONGITUDINAL SECTIONS
60011672-SHT-CI-0071	ROAD CROSS SECTIONS
60011672-SHT-CI-0072	ROAD CROSS SECTIONS
60011672-SHT-CI-0073	ROAD CROSS SECTIONS
60011672-SHT-CI-0074	ROAD CROSS SECTIONS
60011672-SHT-CI-0075	ROAD CROSS SECTIONS
60011672-SHT-CI-0076	ROAD CROSS SECTIONS
60011672-SHT-CI-0077	ROAD CROSS SECTIONS
60011672-SHT-CI-0091	CELL 1 LANDFILL TYPICAL SECTIONS SHEET 1
60011672-SHT-CI-0092	CELL 1 LANDFILL TYPICAL SECTIONS SHEET 2
60011672-SHT-CI-0101	LANDFILL PERIMETER BUND TYPICAL DETAILS SHEET 1
60011672-SHT-CI-0111	LANDFILL PERIMETER BUND TYPICAL DETAILS SHEET 2
60011672-SHT-CI-0131	LEACHATE STORAGE POND TYPICAL DETAILS SHEET 1
60011672-SHT-CI-0132	LEACHATE STORAGE POND TYPICAL DETAILS SHEET 2
60011672-SHT-CI-0141	SEDIMENTATION BASIN TYPICAL DETAILS SHEET 1
60011672-SHT-CI-0142	SEDIMENTATION BASIN TYPICAL DETAILS SHEET 2
60011672-SHT-CI-0151	DRY BASIN TYPICAL DETAILS SHEET 1
60011672-SHT-CI-0152	DRY BASIN TYPICAL DETAILS SHEET 2
60011672-SHT-CI-0155	CLEANWATER DRAIN OUTLET ROCK APRON TYPICAL DETAILS
60011672-SHT-CI-0161	LANDFILL BASE LINER TYPICAL DETAILS SHEET 1
60011672-SHT-CI-0162	LANDFILL BASE LINER TYPICAL DETAILS SHEET 2
60011672-SHT-CI-0171	ACCESS ROAD TYPICAL DETAILS
60011672-SHT-CI-0201	LEACHATE COLLECTION SYSTEM PLAN
60011672-SHT-CI-0202	SITE SERVICES PLAN
60011672-SHT-CI-0211	LEACHATE COLLECTION SYSTEM TYPICAL DETAILS SHEET 1
60011672-SHT-CI-0212	LEACHATE COLLECTION SYSTEM TYPICAL DETAILS SHEET 2
60011672-SHT-CI-0213	LEACHATE COLLECTION SYSTEM TYPICAL DETAILS SHEET 3
60011672-SHT-CI-0214	LEACHATE COLLECTION SYSTEM TYPICAL DETAILS SHEET 4
60011672-SHT-CI-0301	DRAINAGE PLAN
60011672-SHT-CI-0311	DRAINAGE CONTROL STRING PLAN SHEET 1
60011672-SHT-CI-0312	DRAINAGE CONTROL STRING PLAN SHEET 2
60011672-SHT-CI-0321	DRAINAGE LONGITUDINAL SECTIONS
60011672-SHT-CI-0322	DRAINAGE LONGITUDINAL SECTIONS
60011672-SHT-CI-0323	DRAINAGE LONGITUDINAL SECTIONS
60011672-SHT-CI-0324	DRAINAGE LONGITUDINAL SECTIONS
60011672-SHT-CI-0332	DRAINAGE LINING SCHEDULE
60011672-SHT-CI-0341	DRAINAGE TYPICAL DETAILS
60011672-SHT-CI-0351	DRAINAGE CULVERT LONGITUDINAL SECTIONS



LOCALITY PLAN
SCALE 1:5000

DRAWING LIST - ADDITIONAL DRAWINGS (ARC)

NEW LANDFILL DAM EMBANKMENT - PLAN & LONGITUDINAL SECTIONS
NEW LANDFILL DAM EMBANKMENT - CROSS SECTIONS

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Regional Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

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ISSUE/REVISION

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I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER
60011672

SHEET TITLE
COVER SHEET AND DRAWING LIST

SHEET NUMBER
60011672-SHT-CI-0001

ISO A1 594mm x 841mm

ARMIDALE LANDFILL
CELL 1 WORKS

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60011672-SHT-CI-0042	EARTHWORKS LONGITUDINAL SECTIONS
60011672-SHT-CI-0051	EARTHWORKS LONGITUDINAL SECTIONS
60011672-SHT-CI-0052	EARTHWORKS LONGITUDINAL SECTIONS
60011672-SHT-CI-0053	EARTHWORKS LONGITUDINAL SECTIONS
60011672-SHT-CI-0055	EARTHWORKS CROSS SECTIONS
60011672-SHT-CI-0056	EARTHWORKS CROSS SECTIONS
60011672-SHT-CI-0061	ROAD LONGITUDINAL SECTIONS
60011672-SHT-CI-0062	ROAD LONGITUDINAL SECTIONS
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60011672-SHT-CI-0324	DRAINAGE LONGITUDINAL SECTIONS
60011672-SHT-CI-0332	DRAINAGE LINING SCHEDULE
60011672-SHT-CI-0341	DRAINAGE TYPICAL DETAILS
60011672-SHT-CI-0351	DRAINAGE CULVERT LONGITUDINAL SECTIONS
60011672-SHT-CI-0352	TEMPORARY SUBCELL B SPILLWAY

LOCALITY PLAN
SCALE 1:5000

DRAWING LIST - ACCESS ROAD (ADC)

COVER SHEET
ACCESS ROAD SCHEMATIC PLAN
WATERFALL WAY INTERSECTION PLAN & DETAILS
WATERFALL WAY CENTRELINE LONGITUDINAL SECTION
WATERFALL WAY WIDENING CROSS SECTIONS CH 0.000 TO CH140.000
WATERFALL WAY WIDENING CROSS SECTIONS CH160.000 TO CH260.000
WATERFALL WAY WIDENING CROSS SECTIONS CH280.000 TO CH356.757
ACCESS ROAD LONGITUDINAL SECTION CH 0.000 TO CH200.000 & CROSS SECTIONS CH 0.000 TO CH 46.847
ACCESS ROAD CROSS SECTIONS CH60.000 TO CH160.000
ACCESS ROAD CROSS SECTIONS CH180.000 TO CH200.000
ACCESS ROAD PLAN & DETAILS CH 0.000 TO CH400.000
ACCESS ROAD PLAN & DETAILS CH400.000 TO CH920.000
ACCESS ROAD PLAN & DETAILS CH920.000 TO CH1240.000
ACCESS ROAD LONGITUDINAL SECTION CH 0.000 TO CH680.000
ACCESS ROAD LONGITUDINAL SECTION CH680.000 TO CH1276.506
ACCESS ROAD CROSS SECTIONS CH60.000 TO CH160.000
ACCESS ROAD CROSS SECTIONS CH180.000 TO CH280.000
ACCESS ROAD CROSS SECTIONS CH291.510 TO CH460.000
ACCESS ROAD CROSS SECTIONS CH480.000 TO CH680.000
ACCESS ROAD CROSS SECTIONS CH700.000 TO CH786.307
ACCESS ROAD CROSS SECTIONS CH794.879 TO CH940.000
ACCESS ROAD CROSS SECTIONS CH954.024 TO CH1076.919
ACCESS ROAD CROSS SECTIONS CH1080.000 TO CH 1180.000
ACCESS ROAD CROSS SECTIONS CH1187.512 TO CH1276.506
SITE OFFICE ROAD LONGITUDINAL SECTION, CROSS SECTIONS & CULVERT DETAILS
ACCESS ROAD CH16.847 CULVERT DETAILS
ACCESS ROAD CH616.774 CULVERT DETAILS
ACCESS ROAD CH796.774 CULVERT DETAILS
WATERFALL WAY SIGNS AND LINEMARKING
ACCESS ROAD SETOUT COORDINATES
SEDIMENT & EROSION CONTROL TYPICAL DETAILS

DRAWING LIST - ADDITIONAL DRAWINGS (ARC)

NEW LANDFILL DAM EMBANKMENT - PLAN & LONGITUDINAL SECTIONS
NEW LANDFILL DAM EMBANKMENT - CROSS SECTIONS
DEPARTMENT OF TRANSPORT STANDARD DRAWINGS No. 1303
DEPARTMENT OF TRANSPORT STANDARD DRAWINGS No. 1316

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Dumaresq Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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SAFETY IN DESIGN INFORMATION
ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?
☒ NO
☐ YES

REGISTRATION

NOT FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A	28.11.2014	PRELIM. DETAILED DESIGN
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER
60011672

SHEET TITLE
COVER SHEET AND DRAWING LIST

SHEET NUMBER
60011672-SHT-CI-0001

Last saved by: WONGJ3(2017-01-23) Last Plotted: 2017-01-23
Filename: P:\600X\60011672\5. CAD\02-SHEETS\60011672-SHT-CI-0001.DWG

GENERAL

1 THE INFORMATION CONTAINED IN THESE DRAWINGS PRODUCED BY AECOM IS SOLELY FOR THE USE OF ARMIDALE REGIONAL COUNCIL FOR THE PURPOSE FOR WHICH IT HAS BEEN PREPARED. AECOM AUSTRALIA PTY LTD UNDERTAKES NO DUTY TO OR ACCEPTS NO RESPONSIBILITY TO ANY THIRD PARTY WHO MAY RELY UPON THIS DOCUMENT.
2 THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE SPECIFICATION AND WITH SUCH OTHER WRITTEN INSTRUCTIONS, AS MAY BE ISSUED DURING THE COURSE OF THE CONTRACT.
3 ANY DISCREPANCIES BETWEEN THESE NOTES, DRAWINGS, SPECIFICATION AND DETAILS, THE SPECIFICATION AND DETAILS WILL TAKE PRECEDENCE.
4 ANY DISCREPANCIES OR OMISSIONS FROM THESE DOCUMENTS SHALL BE REFERRED TO THE SUPERINTENDENT FOR A DECISION BEFORE PROCEEDING WITH THE WORK.
5 ALL WORKMANSHIP AND MATERIALS TO COMPLY WITH THE BUILDING CODE OF AUSTRALIA AS AMENDED AND THE APPROPRIATE AND CURRENT AUSTRALIAN STANDARDS OR LOCAL STATUTORY AUTHORITY GUIDELINES.
6 ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL CHAINAGES AND LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.
7 ALL DIMENSIONS RELEVANT TO SETTING OUT OR OFF-SITE WORK SHALL BE VERIFIED BY THE CONTRACTOR BEFORE CONSTRUCTION AND FABRICATION HAS COMMENCED.
8 DO NOT SCALE FROM DRAWINGS.
9 ORIGIN OF LEVELS - AHD
COORDINATES TO MGA - MAP GRID AUSTRALIA
10 WHERE NOTED ON DRAWINGS THAT WORKS ARE TO BE CARRIED OUT BY OTHERS, THE CONTRACTOR WILL BE RESPONSIBLE FOR THE COORDINATION OF THESE WORKS AND THIS WORK WILL NOT QUALIFY FOR DELAY CLAIMS.
11 WHERE A PROPRIETARY ITEM (OR EQUIVALENT) IS SPECIFIED, AND AN EQUIVALENT ITEM IS PROPOSED, THE CONTRACTOR SHALL PROVIDE MANUFACTURERS SPECIFICATIONS FOR BOTH PRODUCTS TO THE PRINCIPAL'S REPRESENTATIVE FOR APPROVAL, AND DEMONSTRATE THAT THE PRODUCT PERFORMANCE OF ANY ALTERNATIVE IS EQUIVALENT OR BETTER, PRIOR TO USE.
12 ALL PROPRIETARY PRODUCTS ARE TO BE INSTALLED FIXED AND TESTED IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.

SURVEY

THE EXISTING SITE CONDITIONS SHOWN ON THE FOLLOWING DRAWINGS IS BASED ON LEVELS BY TOPOGRAPHICAL SURVEY BY HAWKINS HOOK & Co. DATED 11.07.2005. THE INFORMATION IS SHOWN TO PROVIDE A BASIS FOR DESIGN. AECOM DOES NOT GUARANTEE THE ACCURACY OR COMPLETENESS OF THE SURVEY BASE OR ITS SUITABILITY AS A BASIS FOR CONSTRUCTION DRAWINGS. SHOULD DISCREPANCIES BE ENCOUNTERED DURING CONSTRUCTION BETWEEN THE SURVEY DATA AND ACTUAL FIELD DATA, CONTACT THE SUPERINTENDENT.

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
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E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

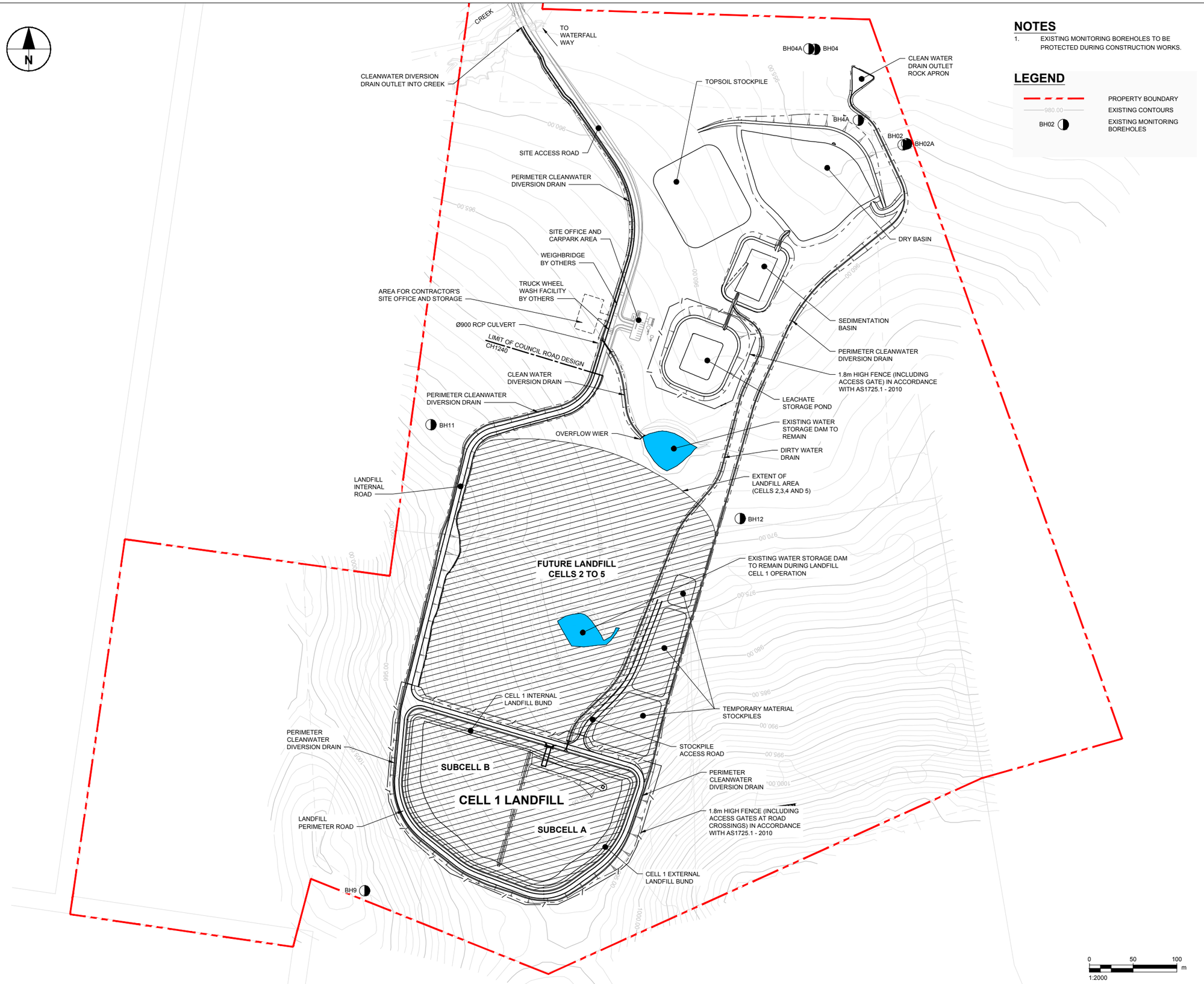
60011672

SHEET TITLE

GENERAL NOTES

SHEET NUMBER

60011672-SHT-CI-0005



NOTES

1. EXISTING MONITORING BOREHOLES TO BE PROTECTED DURING CONSTRUCTION WORKS.

LEGEND

- PROPERTY BOUNDARY
- 980.00 EXISTING CONTOURS
- BH02 EXISTING MONITORING BOREHOLES

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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- [x] NO
- [ ] YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

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G	21.10.2015	REISSUED FOR TENDER
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E	29.06.2015	ISSUED FOR TENDER
D	24.03.2015	DETAILED DESIGN
C	02.03.2015	DETAILED DESIGN
B	13.02.2015	PRELIM. DETAILED DESIGN

KEY PLAN

PROJECT NUMBER

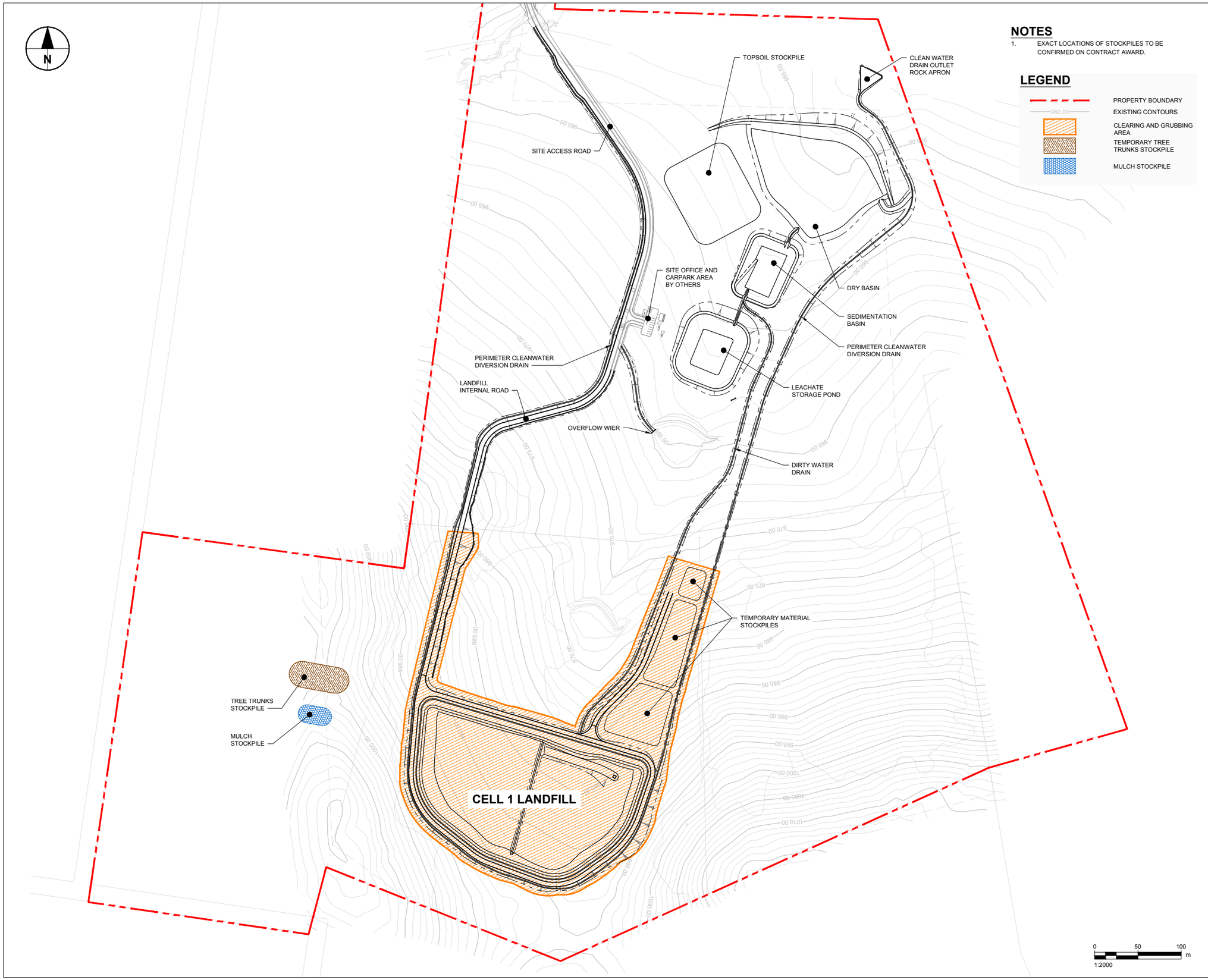
60011672

SHEET TITLE

GENERAL ARRANGEMENT PLAN

SHEET NUMBER

60011672-SHT-CI-0011



NOTES

1. EXACT LOCATIONS OF STOCKPILES TO BE CONFIRMED ON CONTRACT AWARD.

LEGEND

- PROPERTY BOUNDARY
- EXISTING CONTOURS
- CLEARING AND GRUBBING AREA
- TEMPORARY TREE TRUNKS STOCKPILE
- MULCH STOCKPILE

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
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SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C		NOT ISSUED
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

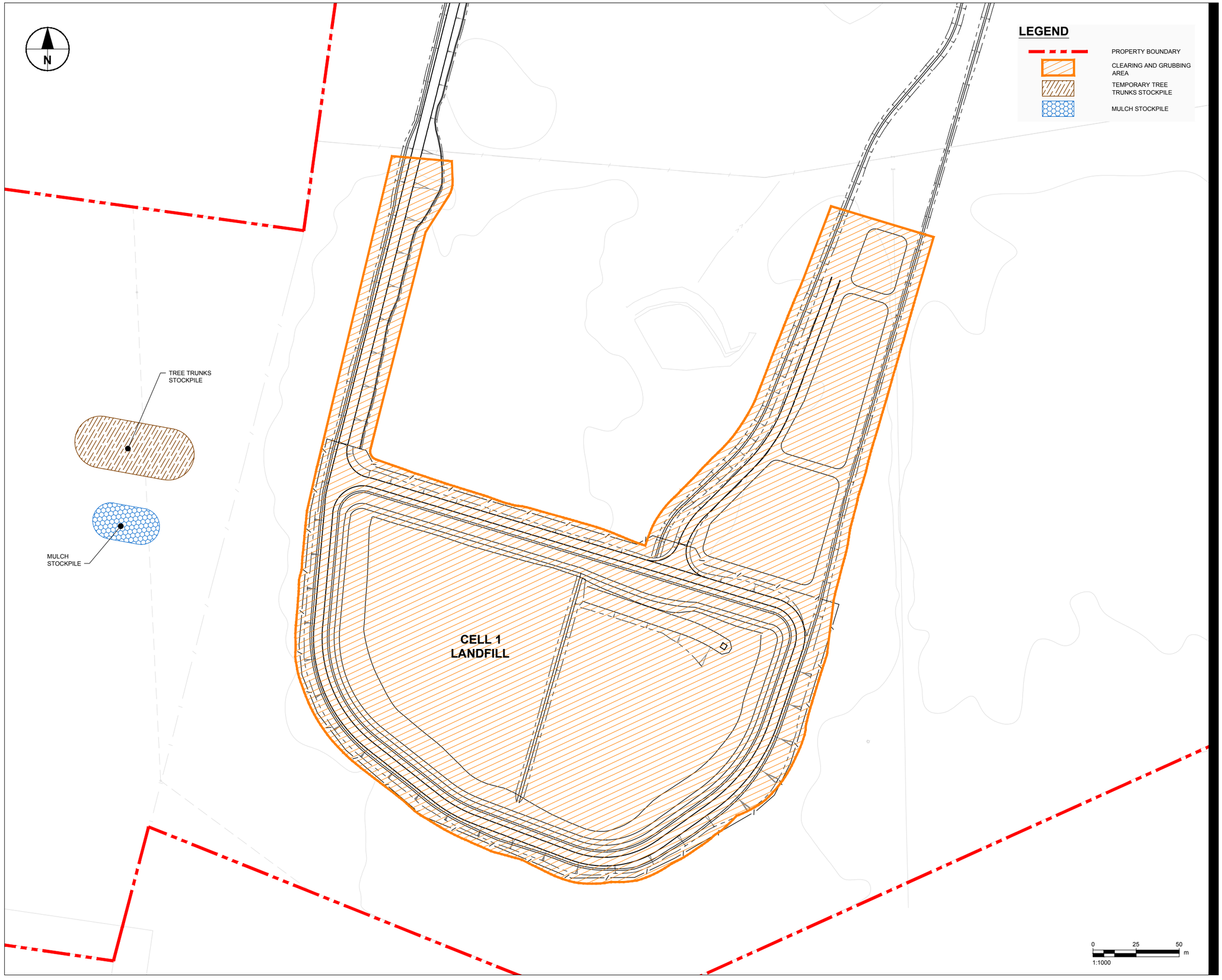
60011672

SHEET TITLE

CLEARING AND GRUBBING PLAN
SHEET 1

SHEET NUMBER

60011672-SHT-CI-0012



AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

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F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C		NOT ISSUED
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

60011672

SHEET TITLE

CLEARING AND GRUBBING PLAN
SHEET 2

SHEET NUMBER

60011672-SHT-CI-0013

NOTES

1. ALL ROADS AND DRAINS TO BE CLEARED AND TOPSOIL STRIPPED JUST PRIOR TO CONSTRUCTION.

LEGEND

- PROPERTY BOUNDARY
- 980.00 EXISTING CONTOURS
- MINIMUM EXTENT OF SITE CLEARANCE AND TOPSOIL STRIPPING

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PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

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SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

- [x] NO
- [ ] YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B	13.02.2015	PRELIM. DETAILED DESIGN
A	28.01.2015	PRELIM. DETAILED DESIGN

KEY PLAN

PROJECT NUMBER

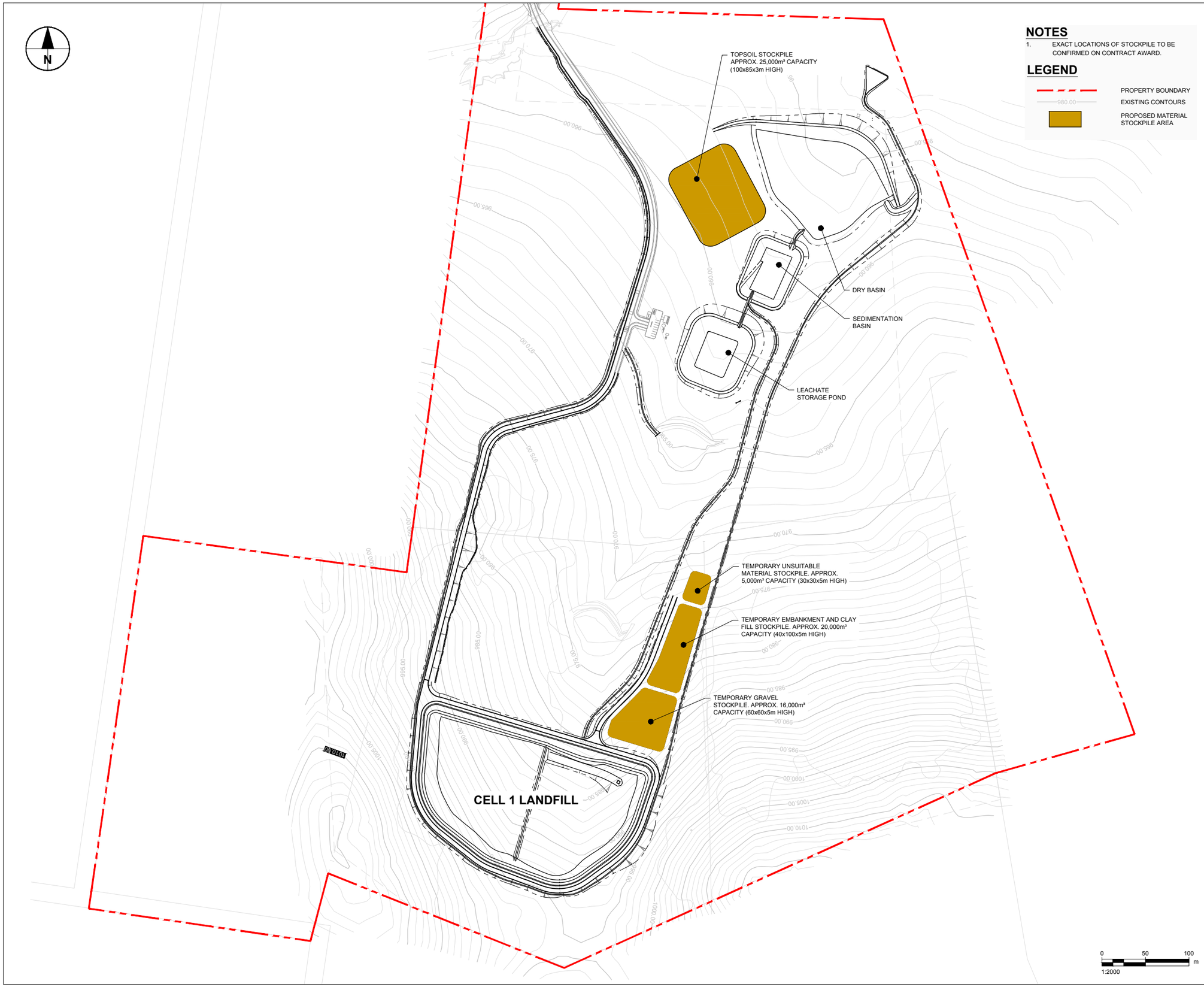
60011672

SHEET TITLE

SITE CLEARANCE AND TOPSOIL STRIPPING PLAN

SHEET NUMBER

60011672-SHT-CI-0016



NOTES

1. EXACT LOCATIONS OF STOCKPILE TO BE CONFIRMED ON CONTRACT AWARD.

LEGEND

- PROPERTY BOUNDARY
- EXISTING CONTOURS
- PROPOSED MATERIAL STOCKPILE AREA

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

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SAFETY IN DESIGN INFORMATION

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- [x] NO
- [ ] YES

REGISTRATION

FOR CONSTRUCTION

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C	02.03.2015	DETAILED DESIGN
B	13.02.2015	PRELIM. DETAILED DESIGN
A	28.01.2015	PRELIM. DETAILED DESIGN

KEY PLAN

PROJECT NUMBER

60011672

SHEET TITLE

MATERIAL STOCKPILE PLAN

SHEET NUMBER

60011672-SHT-CI-0017

NOTES

1. CONTRACTOR TO INSTALL TEMPORARY WHEEL WASH PRIOR TO CONSTRUCTION LOCATION TO BE CONFIRMED.

LEGEND

- PROPERTY BOUNDARY
- EXISTING CONTOURS
- SEDIMENT FENCE
- CONSTRUCTION AND LANDFILL OPERATIONS EXCLUSION ZONE

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PROJECT

Armidale Landfill - Cell 1 Works

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- [x] NO
- [ ] YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
G	21.10.2015	REISSUED FOR TENDER
F	18.09.2015	ISSUED FOR TENDER
E	29.06.2015	ISSUED FOR TENDER
D	24.03.2015	DETAILED DESIGN
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED

KEY PLAN

PROJECT NUMBER

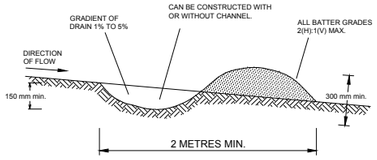
60011672

SHEET TITLE

EROSION AND SEDIMENT CONTROL PLAN

SHEET NUMBER

60011672-SHT-CI-0018

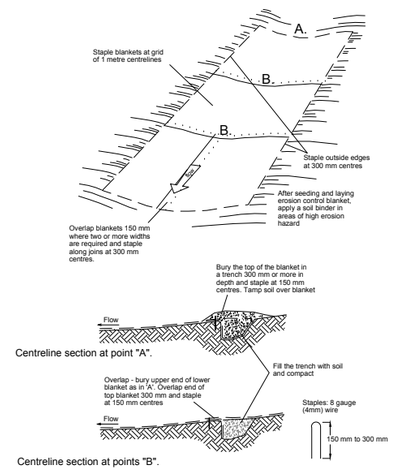


NOTE: ONLY TO BE USED AS TEMPORARY BANK WHERE MAXIMUM UPSLOPE LENGTH IS 80 METRES.

CONSTRUCTION NOTES

1. BUILD WITH GRADIENTS BETWEEN 1 PERCENT AND 5 PERCENT.
2. AVOID REMOVING TREES AND SHRUBS IF POSSIBLE - WORK AROUND THEM.
3. ENSURE THE STRUCTURES ARE FREE OF PROJECTIONS OR OTHER IRREGULARITIES THAT COULD IMPEDE WATER FLOW.
4. BUILD THE DRAINS WITH CIRCULAR, PARABOLIC OR TRAPEZOIDAL CROSS SECTIONS, NOT V SHAPED.
5. ENSURE THE BANKS ARE PROPERLY COMPACTED TO PREVENT FAILURE.
6. COMPLETE PERMANENT OR TEMPORARY STABILISATION WITHIN 10 DAYS OF CONSTRUCTION.

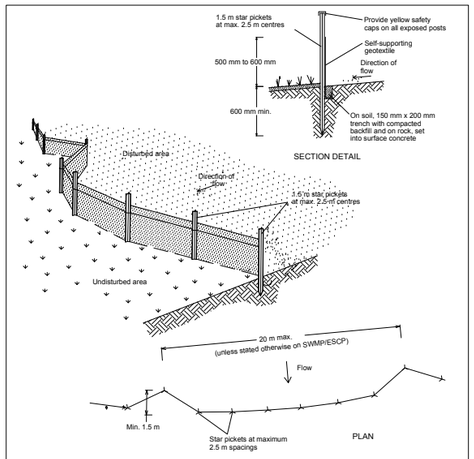
EARTH BANK (LOW FLOW) SD 5-5



Construction Notes

1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end (Standard Drawing 5-7b).
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

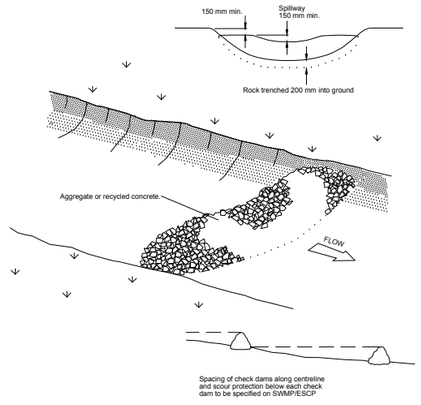
EROSION CONTROL MATTING: CONCENTRATED FLOW SD 5-7



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE SD 6-8



Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.
4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM SD 5-4

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

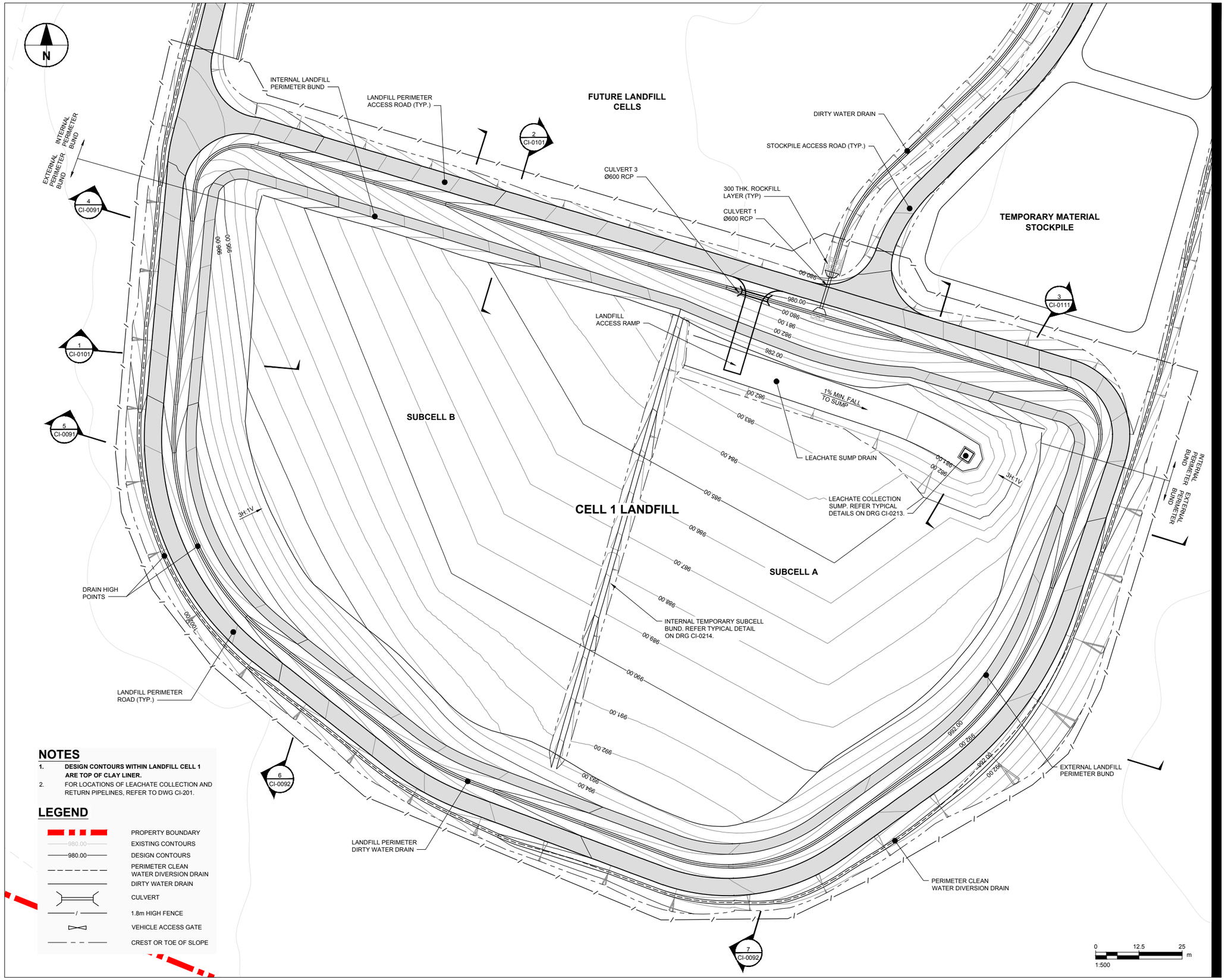
60011672

SHEET TITLE

EROSION AND SEDIMENT CONTROL DETAILS

SHEET NUMBER

60011672-SHT-CI-0019



NOTES

1. **DESIGN CONTOURS WITHIN LANDFILL CELL 1 ARE TOP OF CLAY LINER.**
2. FOR LOCATIONS OF LEACHATE COLLECTION AND RETURN PIPELINES, REFER TO DWG CI-201.

LEGEND

- PROPERTY BOUNDARY
- 980.00 EXISTING CONTOURS
- 980.00 DESIGN CONTOURS
- PERIMETER CLEAN WATER DIVERSION DRAIN
- DIRTY WATER DRAIN
- CULVERT
- 1.8m HIGH FENCE
- VEHICLE ACCESS GATE
- CREST OR TOE OF SLOPE

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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SAFETY IN DESIGN INFORMATION

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- ☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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ISSUE/REVISION

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D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B	13.02.2015	PRELIM. DETAILED DESIGN
A	28.11.2014	PRELIM. DETAILED DESIGN

KEY PLAN

PROJECT NUMBER

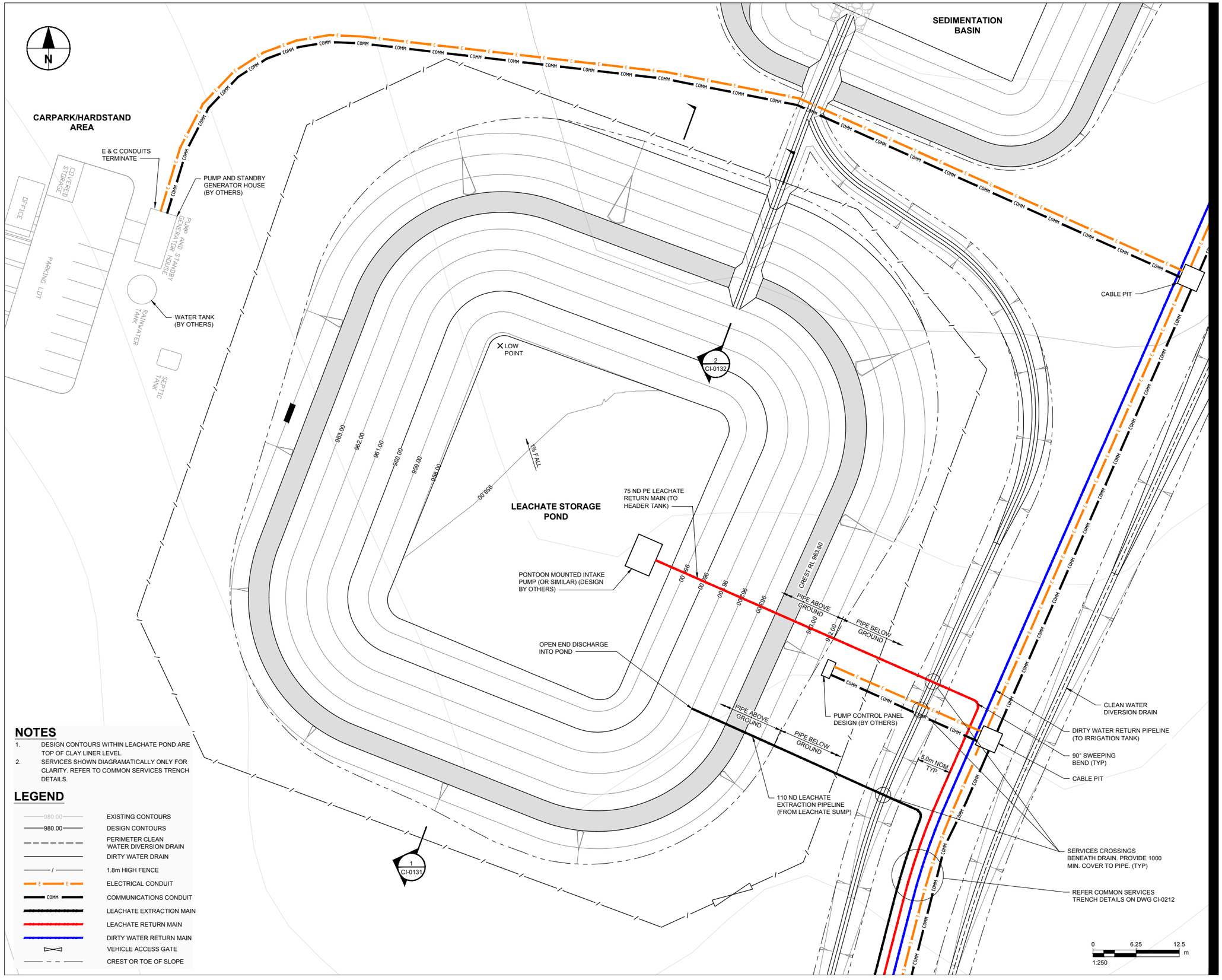
60011672

SHEET TITLE

LANDFILL CELL 1
LAYOUT PLAN

SHEET NUMBER

60011672-SHT-CI-0021



NOTES

1. DESIGN CONTOURS WITHIN LEACHATE POND ARE TOP OF CLAY LINER LEVEL.
2. SERVICES SHOWN DIAGRAMATICALLY ONLY FOR CLARITY. REFER TO COMMON SERVICES TRENCH DETAILS.

LEGEND

- 980.00 — EXISTING CONTOURS
- 980.00 — DESIGN CONTOURS
- PERIMETER CLEAN WATER DIVERSION DRAIN
- DIRTY WATER DRAIN
- 1.8m HIGH FENCE
- E — ELECTRICAL CONDUIT
- COMM — COMMUNICATIONS CONDUIT
- LEACHATE EXTRACTION MAIN
- LEACHATE RETURN MAIN
- DIRTY WATER RETURN MAIN
- VEHICLE ACCESS GATE
- CREST OR TOE OF SLOPE

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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SAFETY IN DESIGN INFORMATION

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- [x] NO
- [ ] YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
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D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A	28.11.2014	PRELIM. DETAILED DESIGN
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

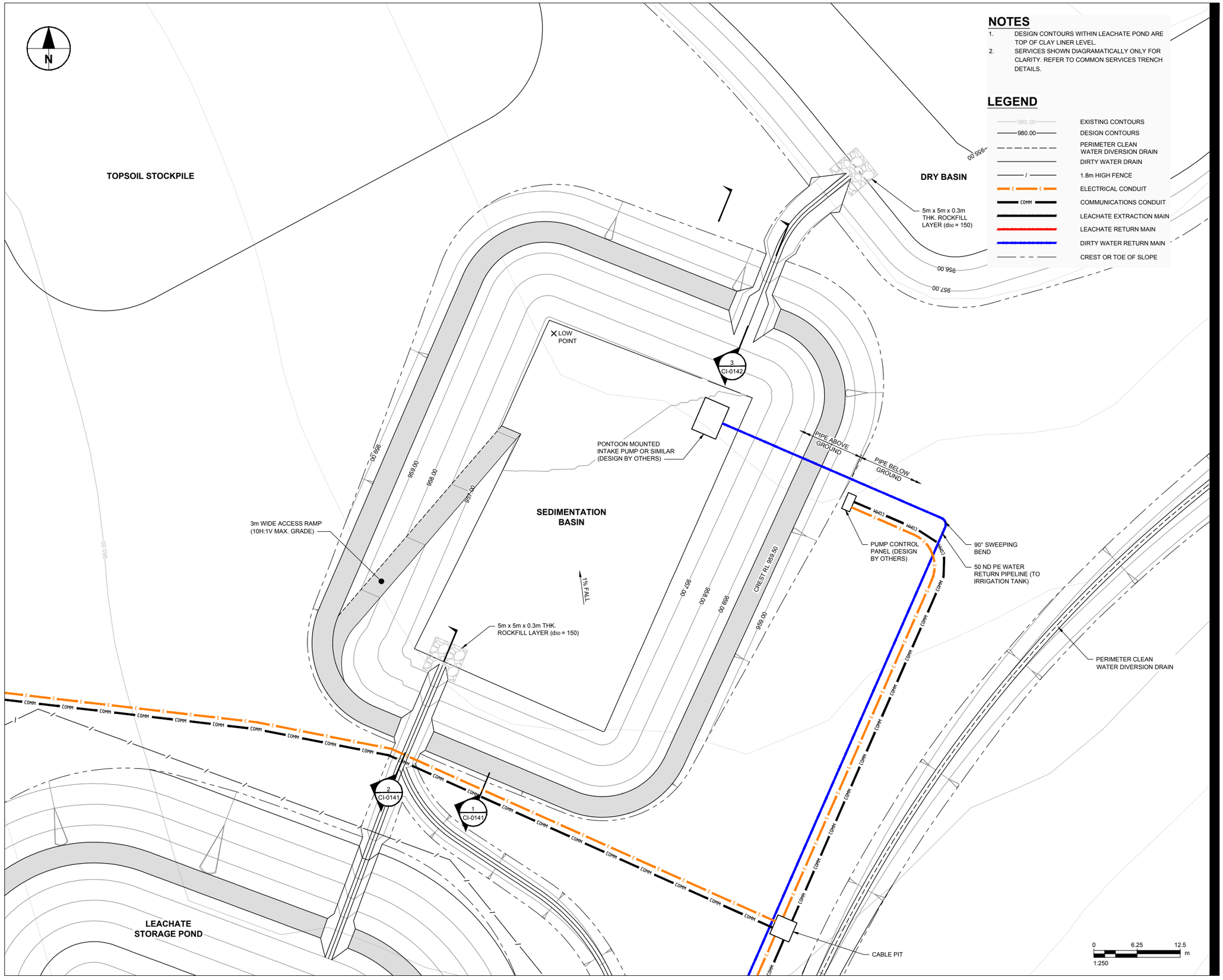
60011672

SHEET TITLE

LEACHATE STORAGE POND LAYOUT PLAN

SHEET NUMBER

60011672-SHT-CI-0022



NOTES

1. DESIGN CONTOURS WITHIN LEACHATE POND ARE TOP OF CLAY LINER LEVEL.
2. SERVICES SHOWN DIAGRAMATICALLY ONLY FOR CLARITY. REFER TO COMMON SERVICES TRENCH DETAILS.

LEGEND

- EXISTING CONTOURS
- DESIGN CONTOURS
- PERIMETER CLEAN WATER DIVERSION DRAIN
- DIRTY WATER DRAIN
- 1.8m HIGH FENCE
- ELECTRICAL CONDUIT
- COMMUNICATIONS CONDUIT
- LEACHATE EXTRACTION MAIN
- LEACHATE RETURN MAIN
- DIRTY WATER RETURN MAIN
- CREST OR TOE OF SLOPE

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

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CONSULTANT

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SAFETY IN DESIGN INFORMATION

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REGISTRATION

FOR CONSTRUCTION

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C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A	28.11.2014	PRELIM. DETAILED DESIGN

KEY PLAN

PROJECT NUMBER

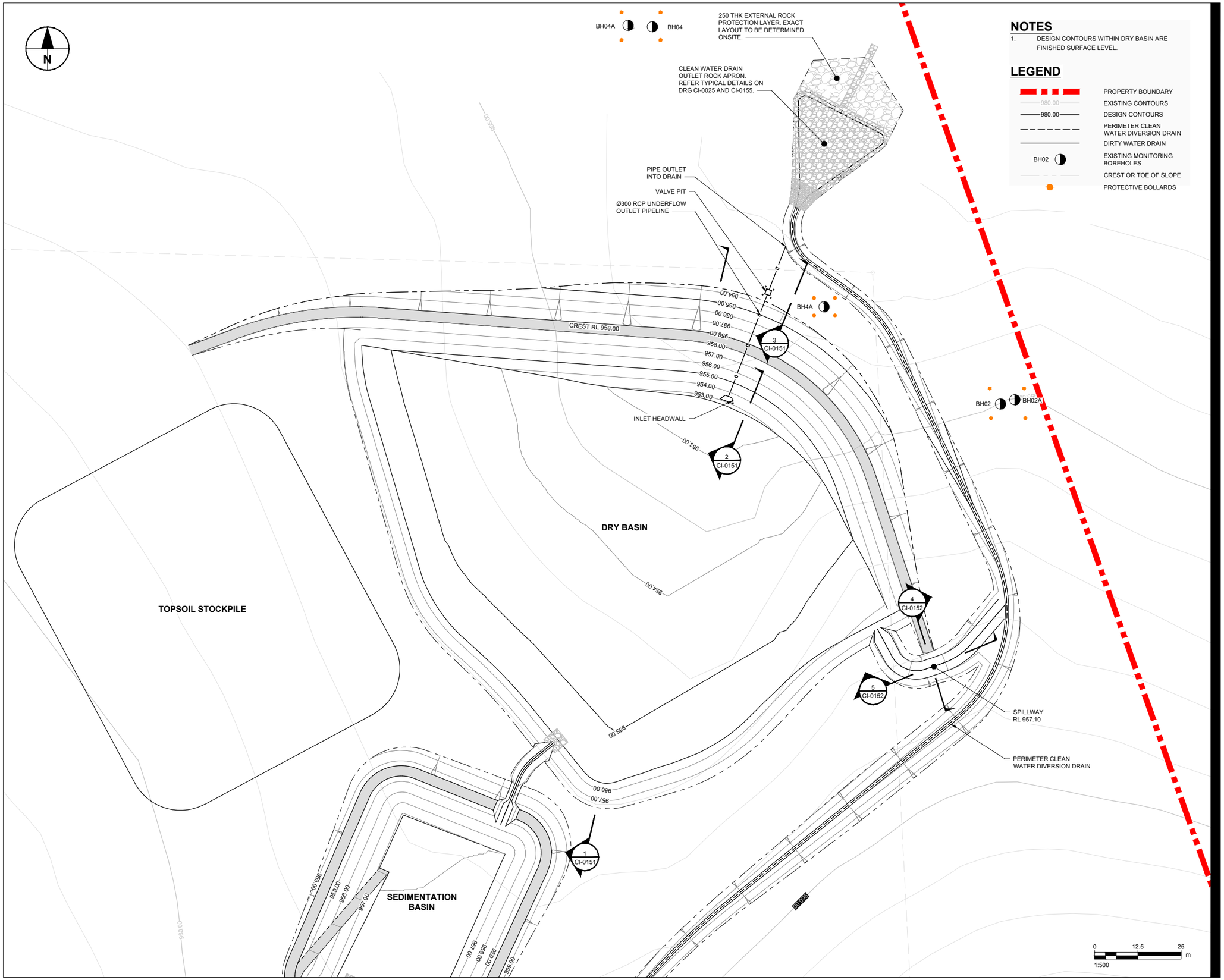
60011672

SHEET TITLE

SEDIMENTATION BASIN LAYOUT PLAN

SHEET NUMBER

60011672-SHT-CI-0023



NOTES

1. DESIGN CONTOURS WITHIN DRY BASIN ARE FINISHED SURFACE LEVEL.

LEGEND

- PROPERTY BOUNDARY
- 980.00 EXISTING CONTOURS
- 980.00 DESIGN CONTOURS
- PERIMETER CLEAN WATER DIVERSION DRAIN
- DIRTY WATER DRAIN
- BH02 EXISTING MONITORING BOREHOLES
- CREST OR TOE OF SLOPE
- PROTECTIVE BOLLARDS

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PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

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- [ ] YES

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KEY PLAN

PROJECT NUMBER

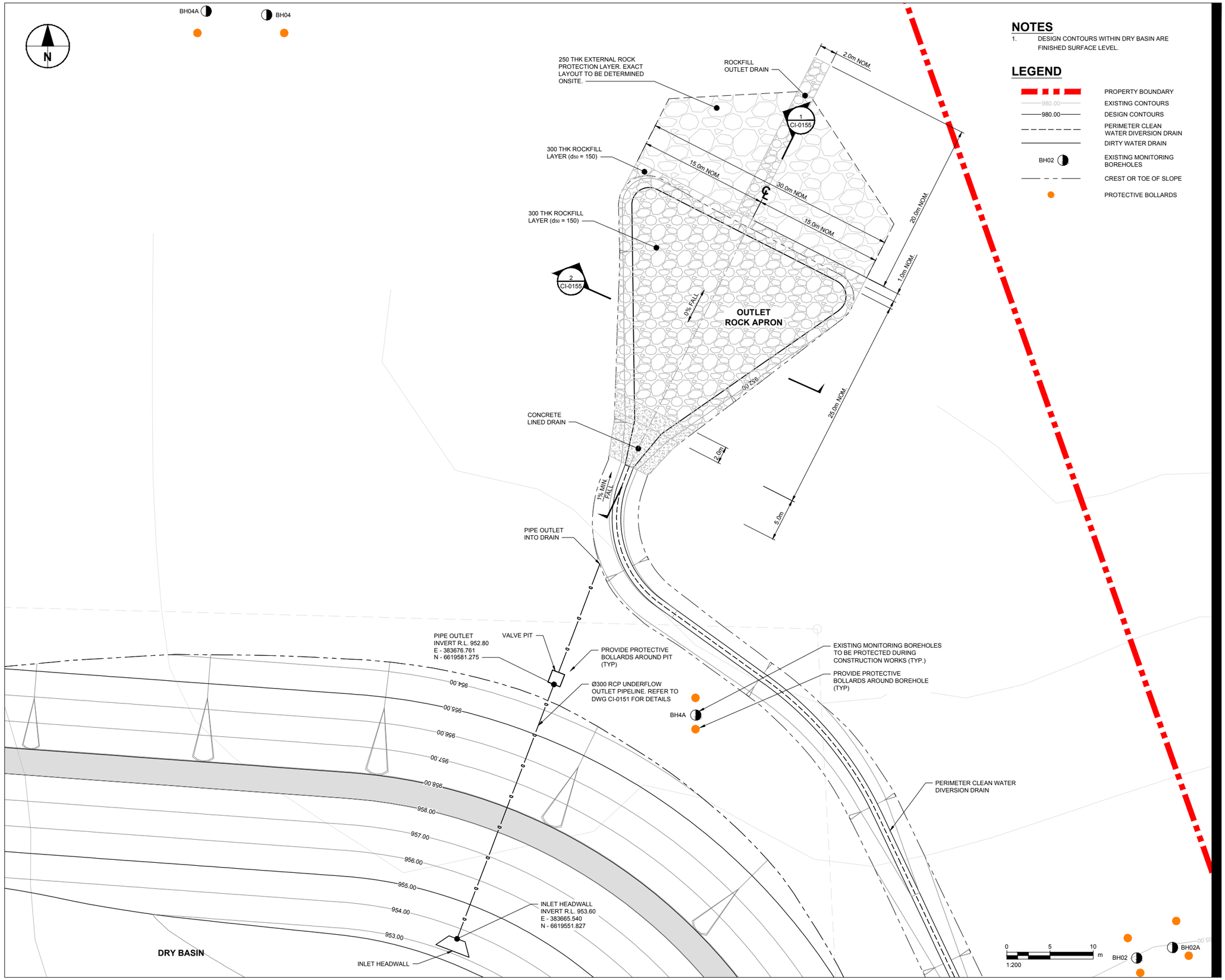
60011672

SHEET TITLE

DRY BASIN
LAYOUT PLAN

SHEET NUMBER

60011672-SHT-CI-0024



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- BH02 EXISTING MONITORING BOREHOLES
- CREST OR TOE OF SLOPE
- PROTECTIVE BOLLARDS

AECOM

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REGISTRATION

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KEY PLAN

PROJECT NUMBER

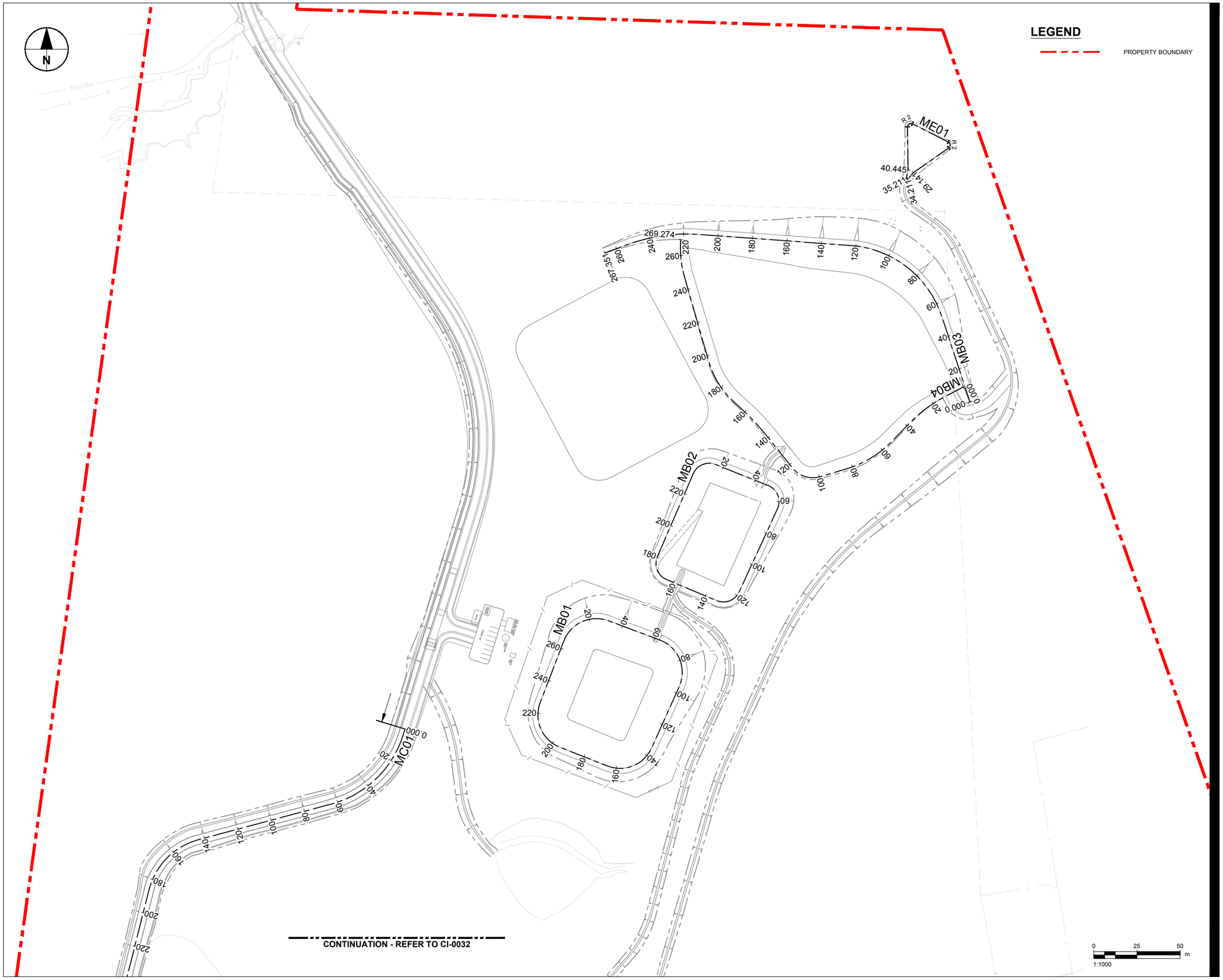
60011672

SHEET TITLE

CLEAN WATER DRAIN OUTLET ROCK APRON LAYOUT PLAN

SHEET NUMBER

60011672-SHT-CI-0025



AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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A		NOT ISSUED
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60011672

SHEET TITLE

CONTROL STRING PLAN
SHEET 1

SHEET NUMBER

60011672-SHT-CI-0031

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

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C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

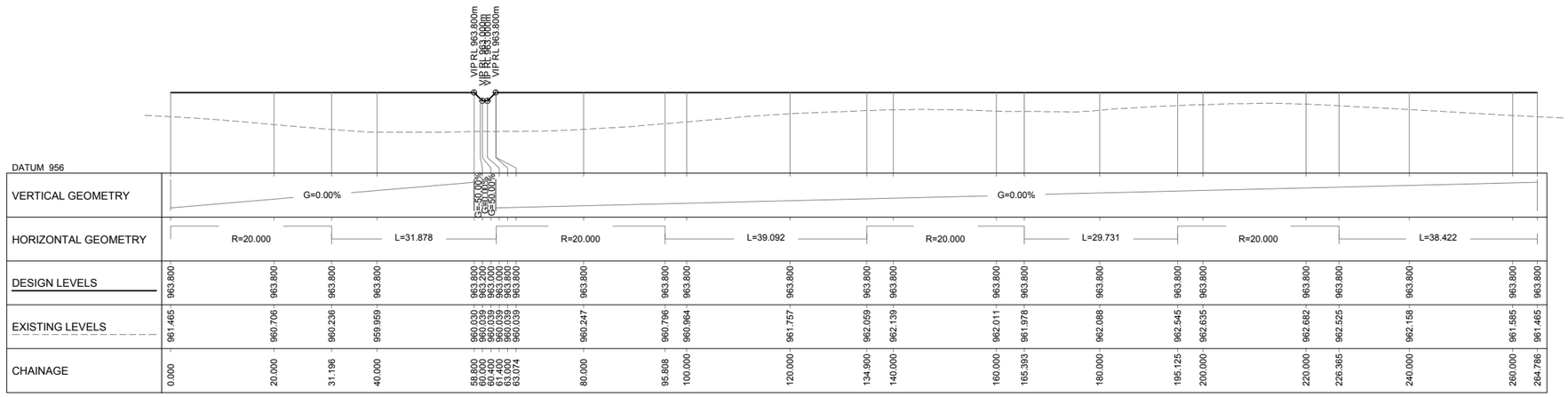
60011672

SHEET TITLE

CONTROL STRING PLAN
SHEET 2

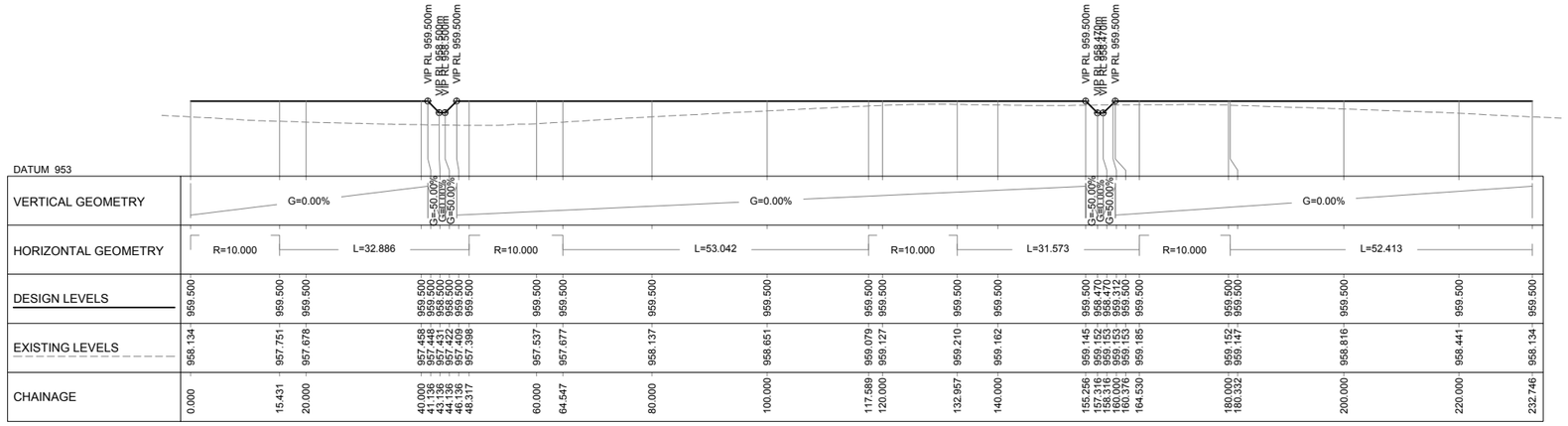
SHEET NUMBER

60011672-SHT-CI-0032



LONGITUDINAL SECTION - MB01 LEACHATE POND BUND

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



LONGITUDINAL SECTION - MB02 SEDIMENTATION BASIN BUND

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

0 12.5 25 m
1:500

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60011672

SHEET TITLE

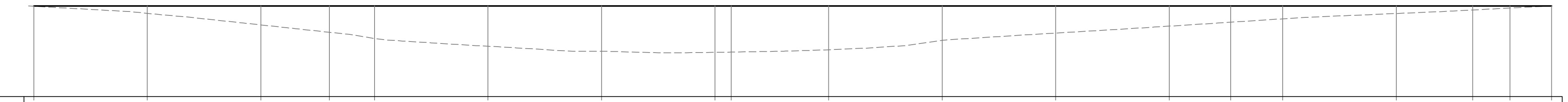
EARTHWORKS
LONGITUDINAL SECTIONS

SHEET NUMBER

60011672-SHT-CI-0041

LONGITUDINAL SECTION - MB03 DRY BASIN D/S BUND

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



DATUM 950

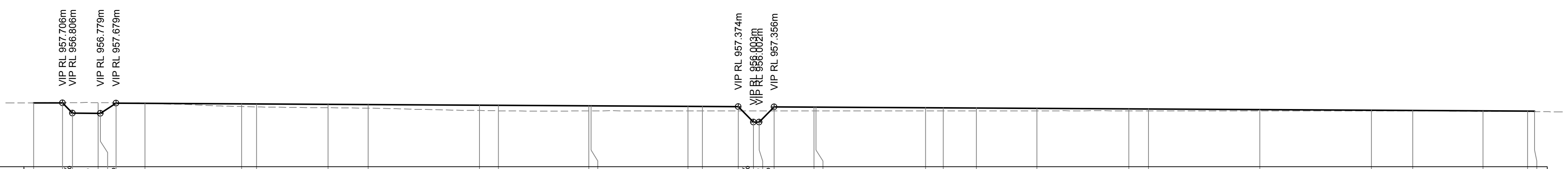
VERTICAL GEOMETRY: G=0.00%

HORIZONTAL GEOMETRY: L=52.048 | R=-60.000 | L=87.979 | R=-100.000 | L=13.892

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	958.000	957.976
20.000	958.000	957.358
40.000	958.000	956.330
52.048	958.000	955.686
60.000	958.000	955.137
80.000	958.000	954.453
100.000	958.000	954.000
120.000	958.000	953.908
122.825	958.000	953.931
140.000	958.000	954.139
160.000	958.000	954.969
180.000	958.000	955.614
200.000	958.000	956.225
210.805	958.000	956.571
220.000	958.000	956.869
240.000	958.000	957.340
253.459	958.000	957.655
260.000	958.000	957.826
267.351	958.000	958.002

LONGITUDINAL SECTION - MB04 DRY BASIN U/S BUND

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



DATUM 952

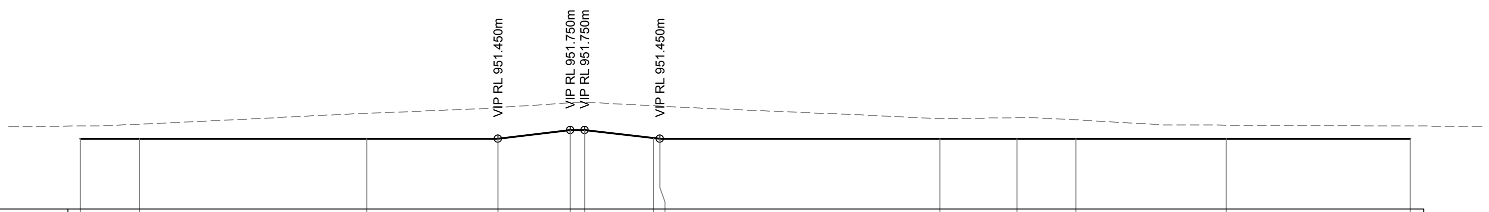
VERTICAL GEOMETRY: G=-50.00% | G=-0.05% | G=32.14% | G=-0.27% | G=-50.00% | G=-0.06% | G=50.00% | G=-0.27%

HORIZONTAL GEOMETRY: L=11.566 | R=-80.000 | L=15.507 | R=60.000 | L=16.199 | R=15.000 | L=22.977 | R=-150.000 | L=5.962 | R=50.000 | L=50.938 | R=60.000 | L=1.246

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	957.720	957.720
5.200	957.706	
7.000	956.806	
11.566	957.688	957.740
12.000	956.779	
14.800	957.679	
20.000	957.665	957.685
37.306	957.618	957.390
40.000	957.610	957.360
52.813	957.575	957.280
60.000	957.555	957.242
80.000	957.501	957.033
83.392	957.491	957.007
99.591	957.447	956.994
100.000	957.446	956.994
117.372	957.398	957.005
120.000	957.391	957.005
126.419	957.374	957.003
129.160	956.003	957.002
130.161	956.002	957.002
132.868	957.356	957.001
140.000	957.336	956.998
140.348	957.335	956.998
160.000	957.282	956.995
163.185	957.273	956.999
169.147	957.256	957.003
180.000	957.227	957.003
196.484	957.182	957.007
200.000	957.172	957.001
220.000	957.117	957.000
240.000	957.062	957.002
247.422	957.042	957.001
260.000	957.008	956.963
268.028	956.986	956.942
269.274	956.982	956.934

LONGITUDINAL SECTION - ME01

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:125



DATUM 949

VERTICAL GEOMETRY: G=0.00% | G=5.92% | G=0.00% | G=-5.73% | G=0.00%

HORIZONTAL GEOMETRY: R=2.000 | L=25.016 | L=5.070 | L=1.000 | L=5.234 | L=24.935 | R=2.000 | L=23.350

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	951.450	951.892
4.124	951.450	951.956
20.000	951.450	952.334
29.141	951.450	952.531
34.211	951.750	952.704
35.211	951.750	952.723
40.000	951.476	952.596
40.445	951.450	952.584
60.000	951.450	952.149
65.380	951.450	952.180
69.490	951.450	952.106
80.000	951.450	951.922
92.840	951.450	951.892

0 6.25 12.5 m 1:250

0 12.5 25 m 1:500

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
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D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
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A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

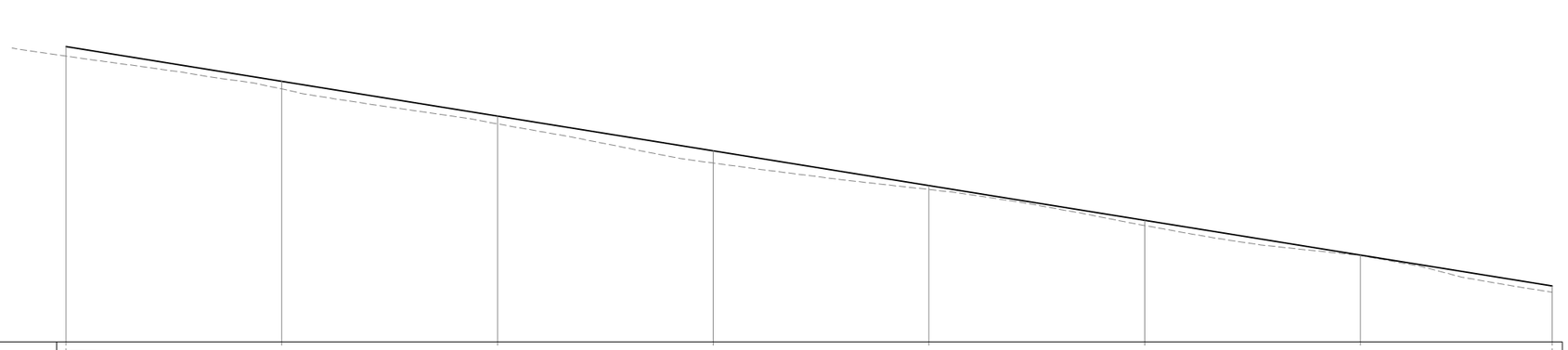
60011672

SHEET TITLE

EARTHWORKS
LONGITUDINAL SECTIONS

SHEET NUMBER

60011672-SHT-CI-0042



DATUM 980

VERTICAL GEOMETRY	G=-8.06%							
HORIZONTAL GEOMETRY	L=137.789							
DESIGN LEVELS	993.692	992.081	990.469	988.858	987.246	985.635	984.023	982.590
EXISTING LEVELS	993.248	991.726	990.106	988.292	987.065	985.399	984.009	982.307
CHAINAGE	0.000	20.000	40.000	60.000	80.000	100.000	120.000	137.789

LONGITUDINAL SECTION - ME09

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:125

0 6.25 12.5 m
1:250

0 3.125 6.25 m
1:125

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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☐ YES

REGISTRATION

FOR CONSTRUCTION

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DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

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A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

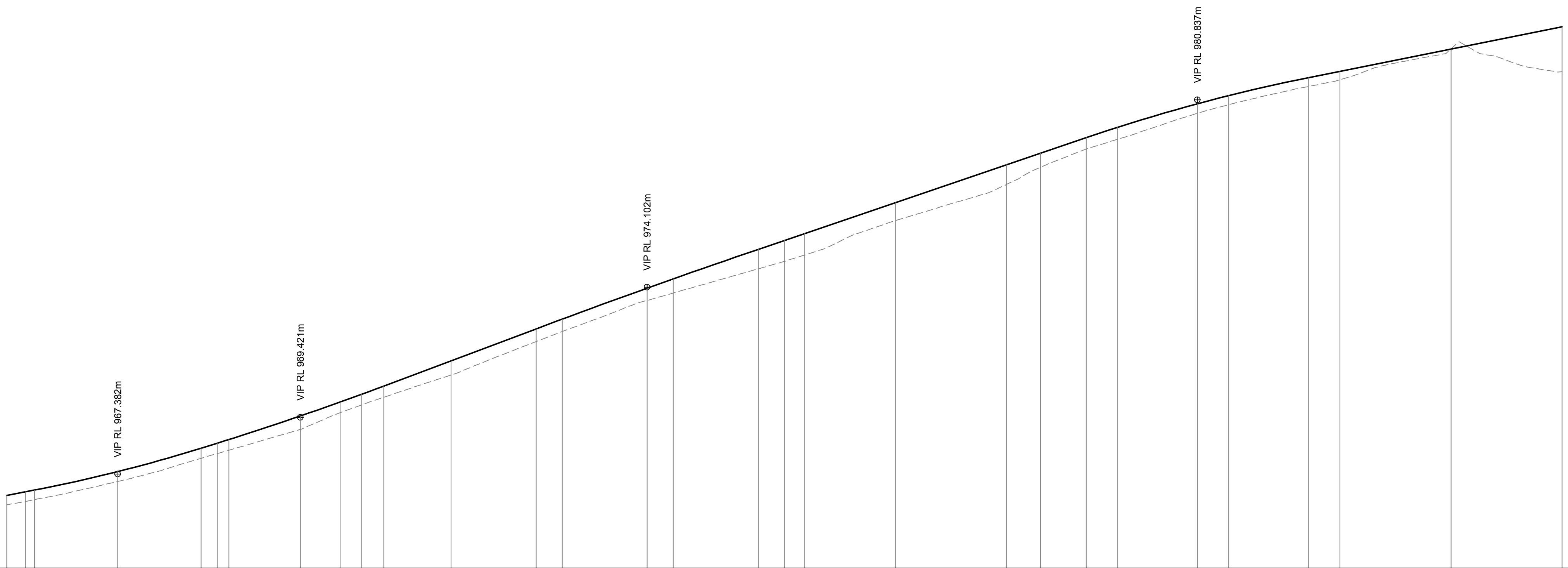
60011672

SHEET TITLE

EARTHWORKS
LONGITUDINAL SECTIONS

SHEET NUMBER

60011672-SHT-CI-0053



DATUM 964

VERTICAL GEOMETRY: G=3.85% | L=30.000 | G=6.20% | L=30.000 | G=7.50% | L=40.000 | G=6.80% | L=40.000 | G=4.00%

HORIZONTAL GEOMETRY: L=3.343 | R=60.000 | L=79.748 | R=-40.000 | L=297.440

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	966.612	966.272
3.343	966.741	966.397
5.000	966.805	966.458
20.000	967.470	967.114
35.000	968.312	967.946
37.893	968.491	968.117
40.000	968.623	968.238
52.893	969.470	968.989
60.000	969.968	969.584
63.926	970.252	969.870
67.893	970.546	970.142
80.000	971.454	970.943
95.304	972.602	972.144
100.000	972.952	972.505
115.304	974.067	973.625
120.000	974.401	973.888
135.304	975.462	974.760
140.000	975.782	975.029
143.674	976.031	975.259
160.000	977.142	976.495
180.000	978.502	977.795
186.116	978.917	978.415
194.347	979.477	979.072
200.000	979.850	979.420
214.347	980.697	980.353
220.000	980.991	980.664
234.347	981.637	981.319
240.000	981.863	981.559
260.000	982.663	982.669
280.000	983.463	981.849

LONGITUDINAL SECTION - MC01 INTERNAL ROAD

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:100

0 2.5 5 m 1:100
0 12.5 25 m 1:500

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Regional Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION
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☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
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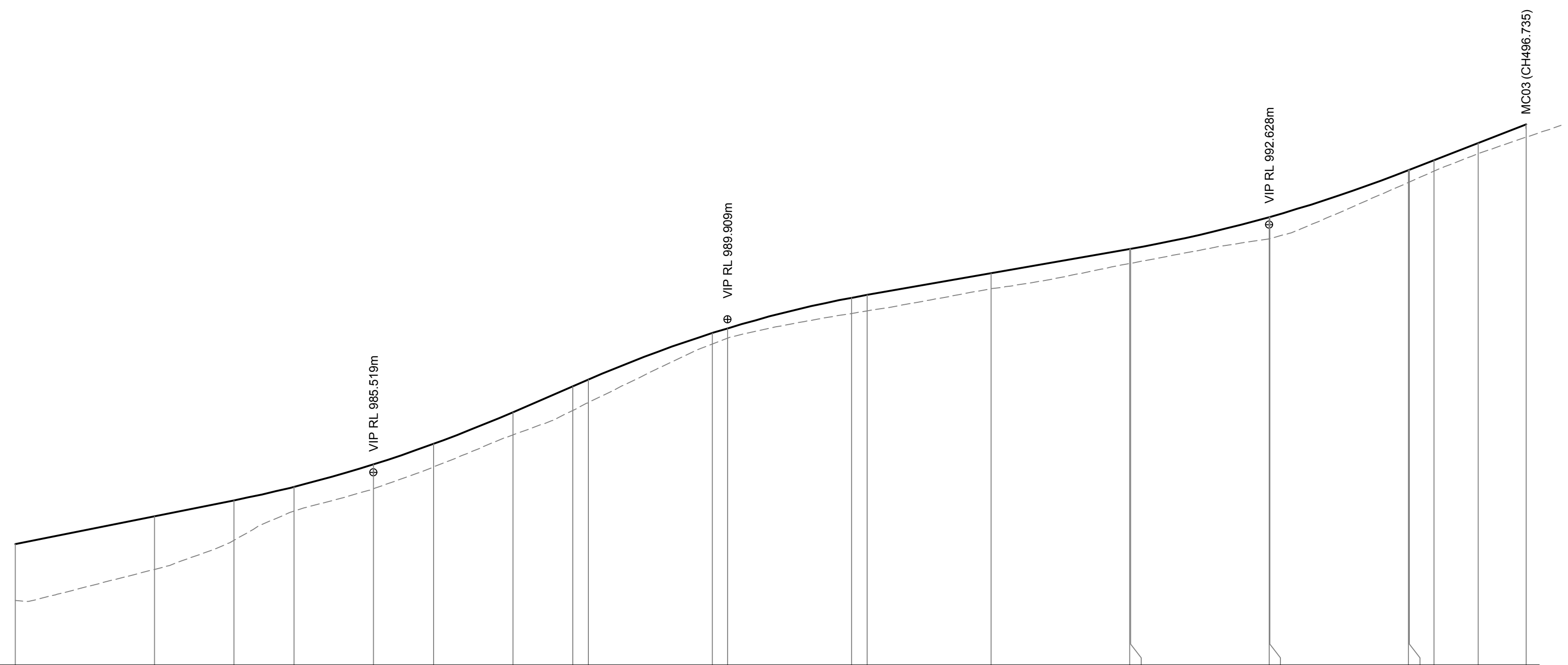
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER
60011672

SHEET TITLE
ROAD
LONGITUDINAL SECTIONS

SHEET NUMBER
60011672-SHT-CI-0061



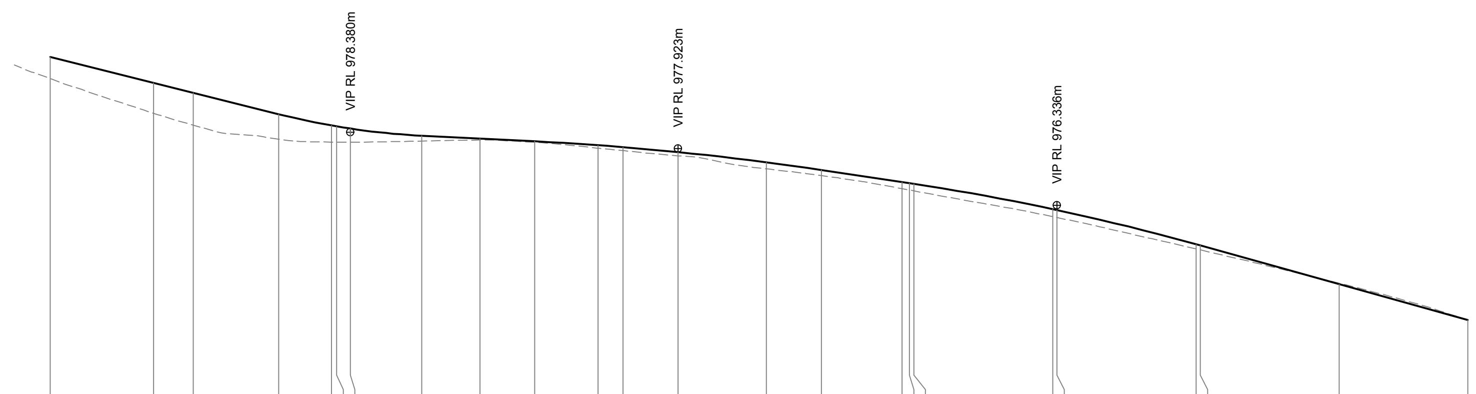
VERTICAL GEOMETRY: G=4.00% | L=40.000 | G=8.64% | L=40.000 | G=3.50% | L=40.000 | G=7.79%

HORIZONTAL GEOMETRY: L=297.440 | R=-40.000 | L=6.893

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
280.000	983.463	981.849
300.000	984.263	982.742
311.401	984.719	983.574
320.000	985.106	984.408
331.401	985.751	985.053
340.000	986.338	985.675
351.401	987.247	986.596
360.000	987.991	987.298
362.207	988.181	987.522
380.000	989.515	989.199
382.207	989.652	989.370
400.000	990.529	990.080
402.207	990.609	990.152
420.000	991.232	990.788
439.892	991.928	991.513
440.000	991.932	991.517
459.892	992.843	992.222
460.000	992.849	992.228
479.892	994.186	993.840
480.000	994.194	993.850
483.556	994.471	994.161
489.881	994.963	994.660
496.775	995.500	995.135

LONGITUDINAL SECTION - MC01 INTERNAL ROAD

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:100



VERTICAL GEOMETRY: G=-5.00% | L=20.000 | G=-1.00% | L=40.000 | G=-3.00% | L=40.000 | G=-5.57%

HORIZONTAL GEOMETRY: L=14.446 | R=50.000 | L=37.199 | R=-100.000 | L=78.988

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	980.476	979.875
14.446	979.754	978.908
20.000	979.476	978.573
31.910	978.880	978.178
39.295	978.566	978.101
40.000	978.541	978.101
41.910	978.480	978.101
51.910	978.280	978.133
60.000	978.200	978.158
67.679	978.123	978.098
76.494	978.015	977.934
80.000	977.962	977.868
87.679	977.823	977.720
100.000	977.538	977.359
107.679	977.323	977.171
118.965	976.984	976.805
120.000	976.953	976.765
120.587	976.936	976.743
140.000	976.232	976.025
140.587	976.207	976.000
160.000	975.254	975.125
160.587	975.221	975.098
180.000	974.139	974.168
197.954	973.139	973.139

LONGITUDINAL SECTION - MC02 STOCKPILE ACCESS ROAD

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:100

0 2.5 5 m 1:100
0 12.5 25 m 1:500

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Regional Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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SAFETY IN DESIGN INFORMATION
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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
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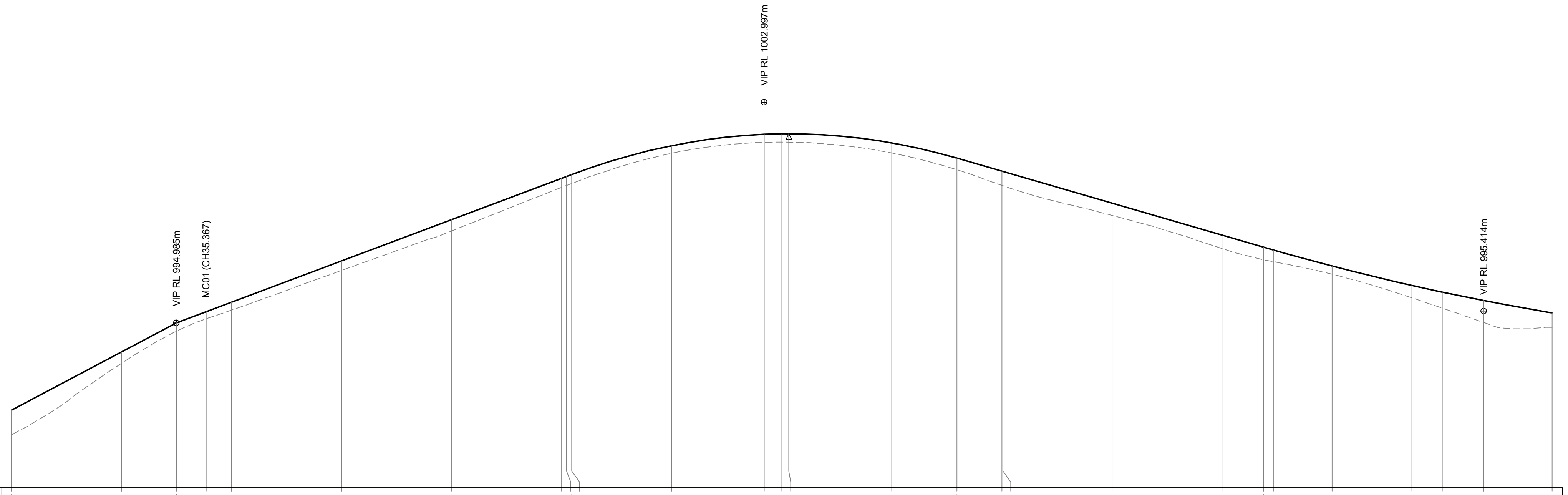
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER
60011672

SHEET TITLE
ROAD
LONGITUDINAL SECTIONS

SHEET NUMBER
60011672-SHT-CI-0062



DATUM 989

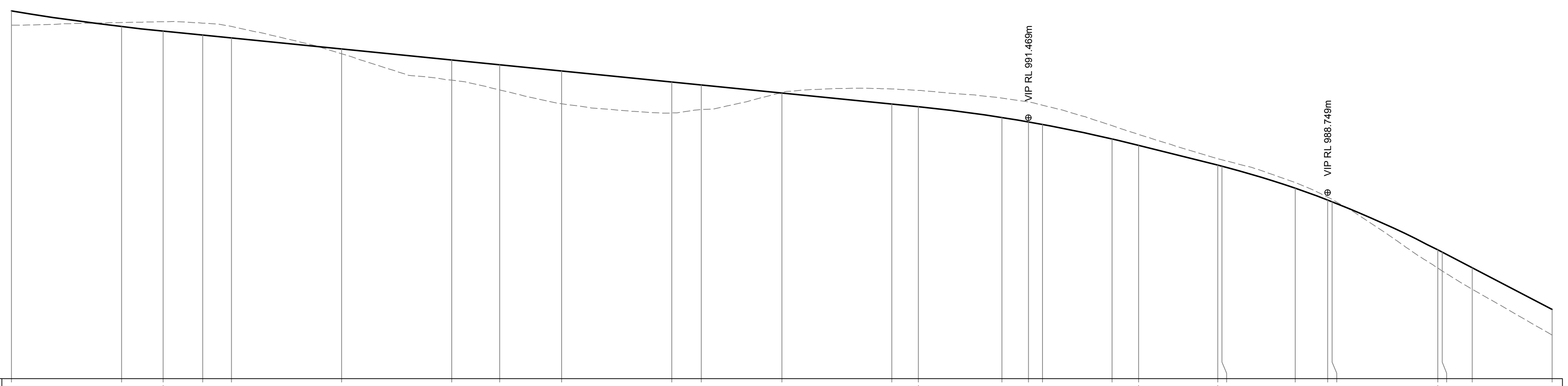
VERTICAL GEOMETRY: G=10.59% · G=7.50% · L=70.000 · G=-5.80% · L=80.000

HORIZONTAL GEOMETRY: R=-20.000 · L=65.461 · R=-80.000 · L=49.143 · R=-80.000 · L=60.415

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	991.809	990.915
20.000	993.926	993.517
30.000	994.985	994.685
35.407	995.391	995.135
40.000	995.735	995.445
60.000	997.235	996.890
80.000	998.735	998.325
100.000	1000.235	999.908
100.868	1000.300	999.977
101.821	1000.372	1000.051
120.000	1001.421	1001.151
136.821	1001.833	1001.545
140.000	1001.851	1001.555
141.294	1001.852	1001.553
160.000	1001.520	1001.157
171.821	1000.967	1000.554
180.000	1000.493	999.982
180.177	1000.482	999.970
200.000	999.333	998.890
220.000	998.173	997.686
227.557	997.734	997.274
229.320	997.633	997.209
240.000	997.049	996.755
254.355	996.350	995.905
260.000	996.102	995.520
267.557	995.794	995.000
280.000	995.346	994.825

LONGITUDINAL SECTION - MC03 CELL PERIMETER ROAD

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:100



DATUM 982

VERTICAL GEOMETRY: L=80.000 · G=-2.00% · L=40.000 · G=-5.00% · L=40.000 · G=-10.37%

HORIZONTAL GEOMETRY: L=60.415 · R=-55.000 · L=36.630 · R=-100.000 · L=45.929 · R=-20.000 · L=244.338

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
280.000	995.346	994.825
300.000	994.779	994.924
307.557	994.614	994.953
314.770	994.470	994.904
320.000	994.365	994.782
340.000	993.965	993.793
360.000	993.565	992.832
368.753	993.390	992.482
380.000	993.165	991.979
400.000	992.765	991.643
405.383	992.658	991.764
420.000	992.365	992.385
440.000	991.965	992.518
444.824	991.869	992.462
460.000	991.479	992.185
464.824	991.319	992.046
467.384	991.227	991.927
480.000	990.701	991.182
484.824	990.469	990.867
499.220	989.749	989.985
500.000	989.710	989.945
513.314	988.911	989.116
519.220	988.480	988.591
520.000	988.420	988.510
539.220	986.674	986.013
540.000	986.593	985.913
545.454	986.027	985.252
560.000	984.518	983.585

LONGITUDINAL SECTION - MC03 CELL PERIMETER ROAD

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:100

0 2.5 5 m — 1:100
0 12.5 25 m — 1:500

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Regional Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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SAFETY IN DESIGN INFORMATION
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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

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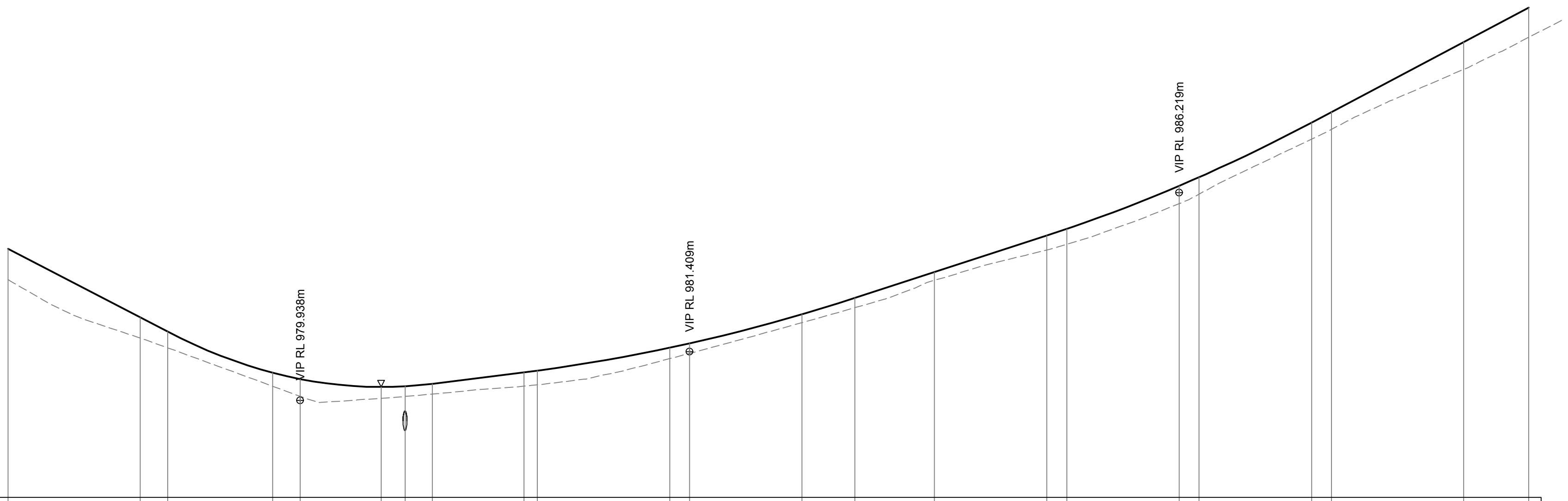
KEY PLAN

PROJECT NUMBER
60011672

SHEET TITLE
ROAD
LONGITUDINAL SECTIONS

SHEET NUMBER
60011672-SHT-CI-0063



DATUM 977

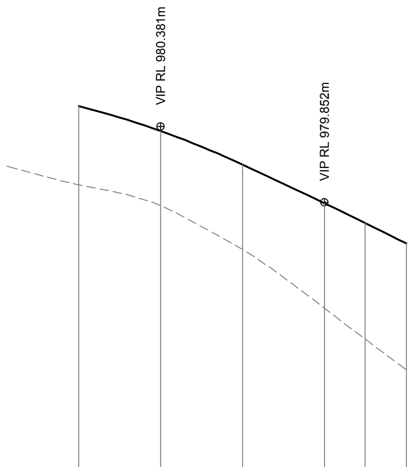
VERTICAL GEOMETRY: G=-10.37% | L=40.000 | G=2.50% | L=50.000 | G=6.50% | L=40.000 | G=10.59%

HORIZONTAL GEOMETRY: L=244.338

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
560.000	984.518	983.585
580.000	982.443	981.819
584.150	982.013	981.524
600.000	980.773	980.363
604.150	980.581	980.057
616.383	980.341	980.000
620.000	980.362	980.053
624.150	980.438	980.126
638.004	980.784	980.366
640.000	980.836	980.406
660.000	981.527	981.197
663.004	981.659	981.358
680.000	982.539	982.286
688.004	983.034	982.739
700.000	983.814	983.565
717.000	984.919	984.482
720.000	985.118	984.657
737.000	986.423	985.886
740.000	986.684	986.171
757.000	988.337	987.834
760.000	988.654	988.130
780.000	990.772	989.945
789.792	991.809	990.915

LONGITUDINAL SECTION - MC03 CELL PERIMETER ROAD

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:100



DATUM 978

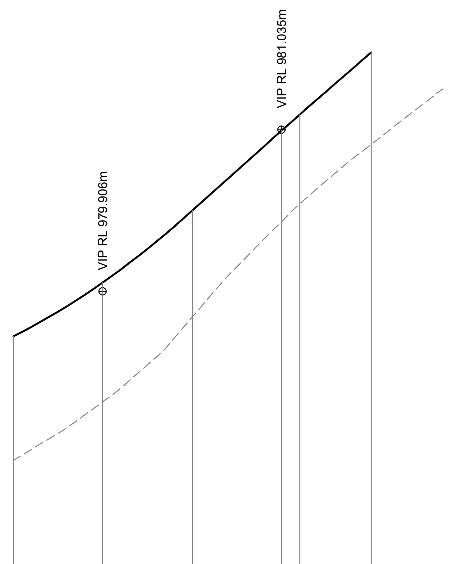
VERTICAL GEOMETRY: G=-2.50% | L=11.442 | G=-4.63% | L=11.442 | G=-5.00%

HORIZONTAL GEOMETRY: R=-15.000

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	980.524	979.975
5.721	980.351	979.833
11.442	980.117	979.529
17.162	979.846	979.115
20.000	979.708	978.898
22.883	979.566	978.683

LONGITUDINAL SECTION - MK01

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:25



DATUM 978

VERTICAL GEOMETRY: G=5.00% | L=12.487 | G=9.05% | L=12.487

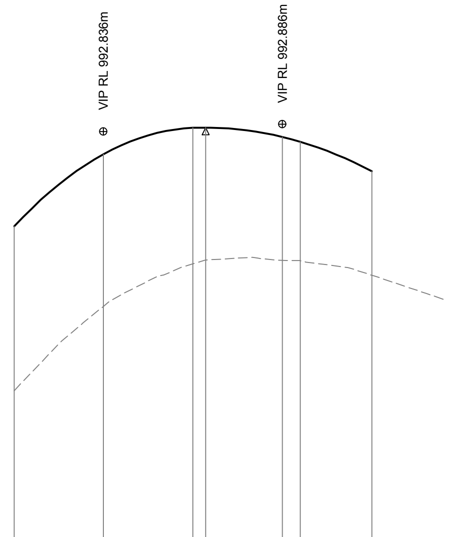
HORIZONTAL GEOMETRY: R=-15.000

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	979.593	978.727
6.243	979.969	979.135
12.487	980.470	979.726
18.730	981.029	980.398
20.000	981.141	980.520
24.974	981.575	980.933

LONGITUDINAL SECTION - MK02

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:25

CELL PERIMETER ROAD/STOCKPILE ROAD INTERSECTION



DATUM 990

VERTICAL GEOMETRY: G=10.59% | L=12.499 | G=0.40% | L=12.499 | G=-5.25%

HORIZONTAL GEOMETRY: R=15.000

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	992.174	991.027
6.250	992.677	991.620
12.499	992.861	991.920
13.391	992.863	991.939
18.749	992.798	991.946
20.000	992.764	991.934
24.998	992.559	991.833

LONGITUDINAL SECTION - MK03
CELL PERIMETER RD/INTERNAL RD INTERSECTION

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:25

Scale bars:
1:500 — 0, 12.5, 25 m
1:100 — 0, 2.5, 5 m
1:250 — 0, 6.25, 12.5 m
1:25 — 0, 0.625, 1.25 m

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Regional Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION
ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?
☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

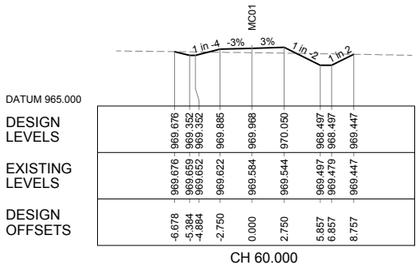
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED
I/R	DATE	DESCRIPTION

KEY PLAN

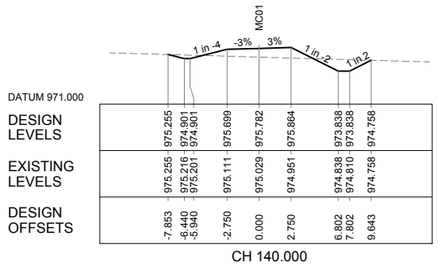
PROJECT NUMBER
60011672

SHEET TITLE
ROAD
LONGITUDINAL SECTIONS

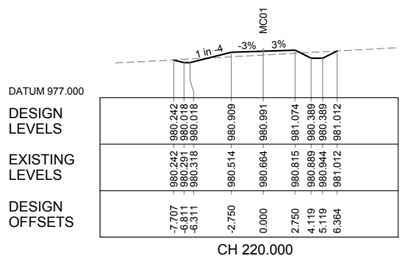
SHEET NUMBER
60011672-SHT-CI-0064



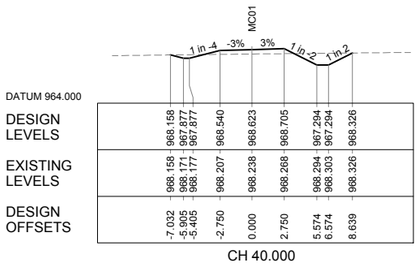
CH 60.000



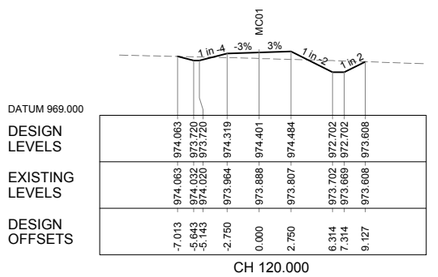
CH 140.000



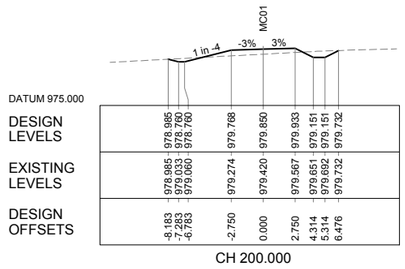
CH 220.000



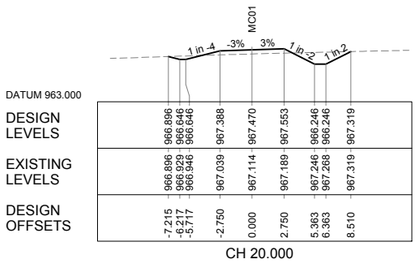
CH 40.000



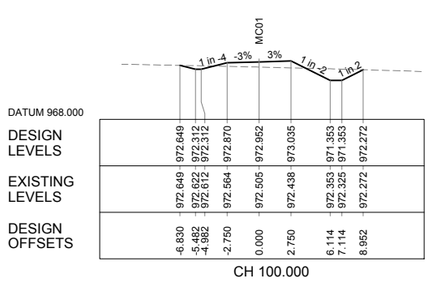
CH 120.000



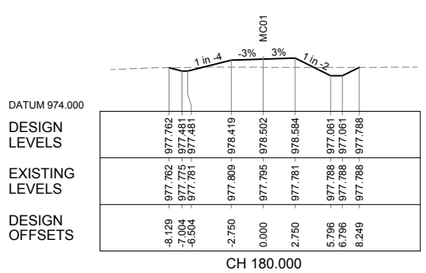
CH 200.000



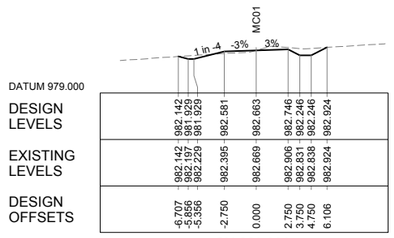
CH 20.000



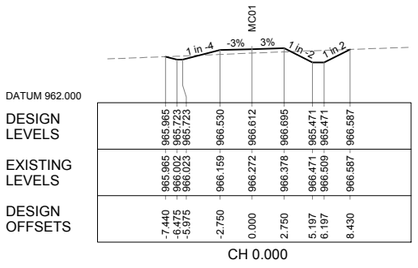
CH 100.000



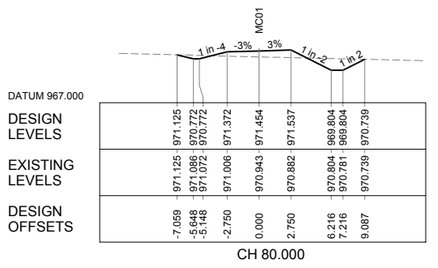
CH 180.000



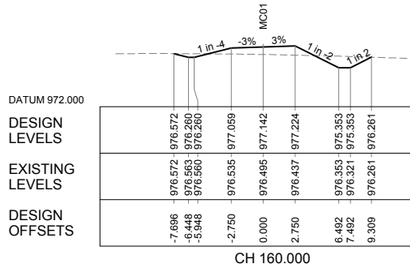
CH 260.000



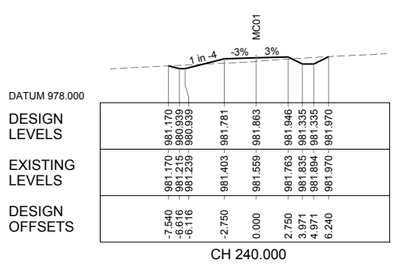
CH 0.000



CH 80.000



CH 160.000



CH 240.000

CROSS SECTIONS - MC01 INTERNAL ROAD

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

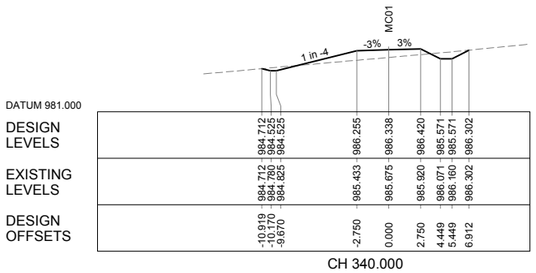
60011672

SHEET TITLE

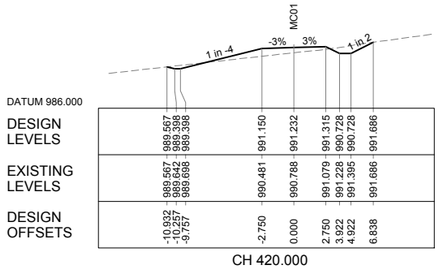
ROAD
CROSS SECTIONS

SHEET NUMBER

60011672-SHT-CI-0071



CH 340.000



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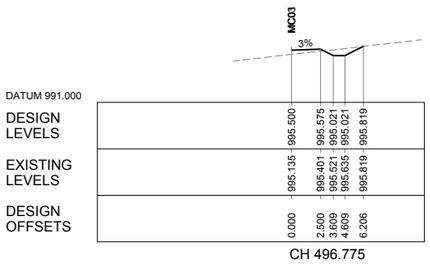
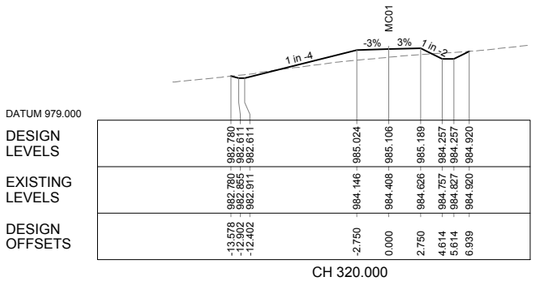
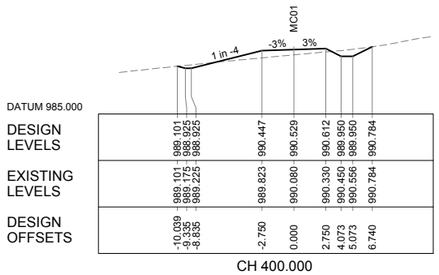


CH 496.775



CH 320.000



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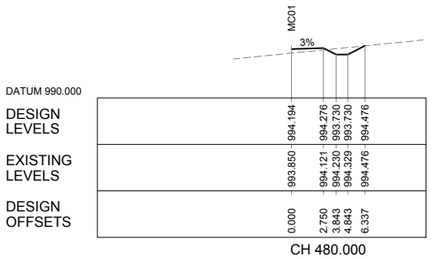
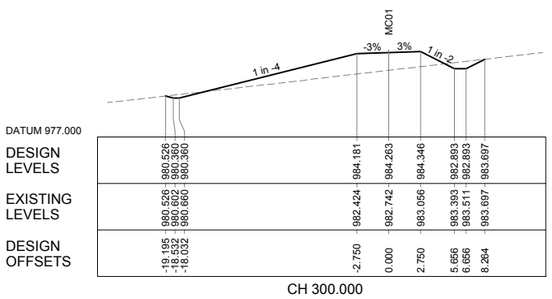
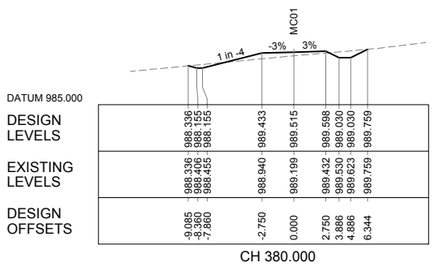


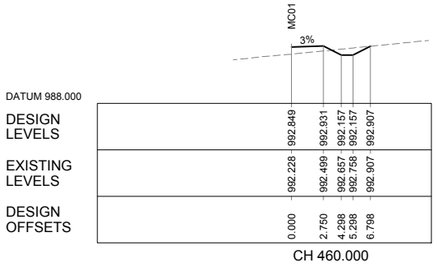
CH 480.000



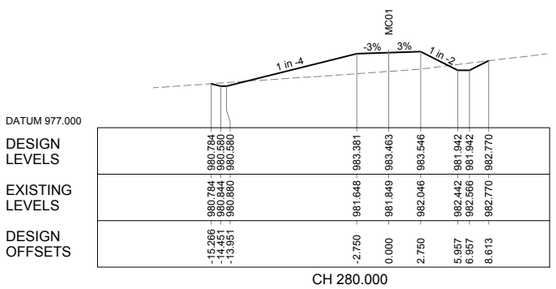
CH 300.000



CH 380.000



CH 460.000



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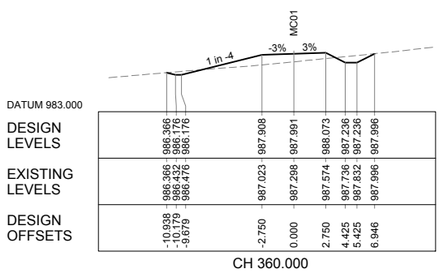
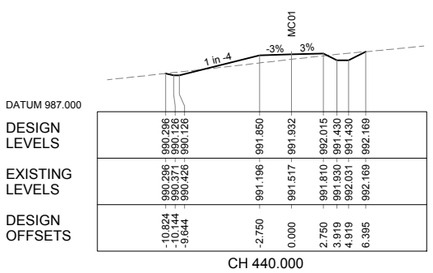


CH 360.000



CH 440.000

CROSS SECTIONS - MC01 INTERNAL ROAD

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

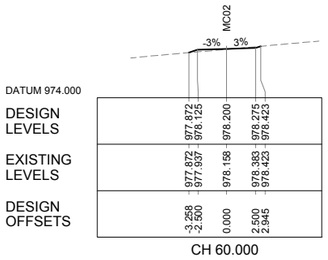
60011672

SHEET TITLE

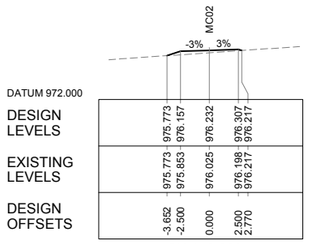
ROAD
CROSS SECTIONS

SHEET NUMBER

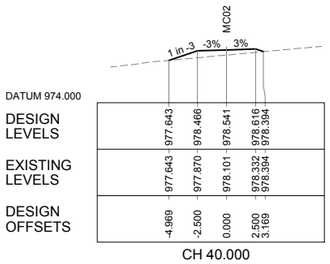
60011672-SHT-CI-0072



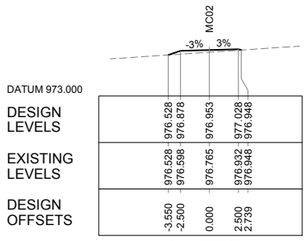
CH 60.000



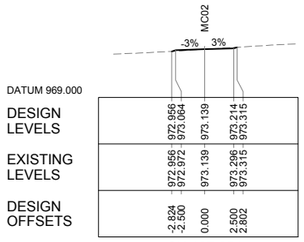
CH 140.000



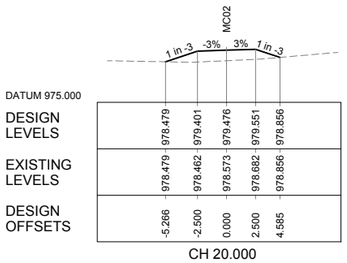
CH 40.000



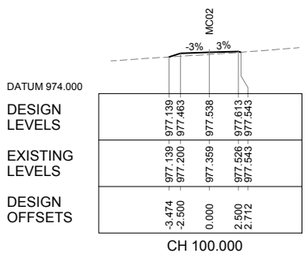
CH 120.000



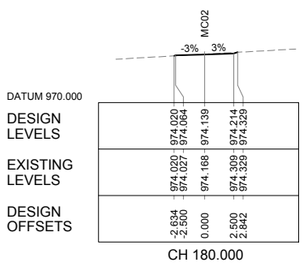
CH 197.954



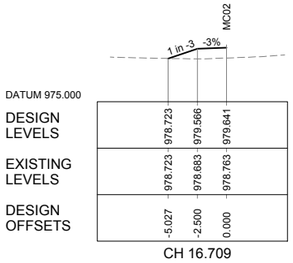
CH 20.000



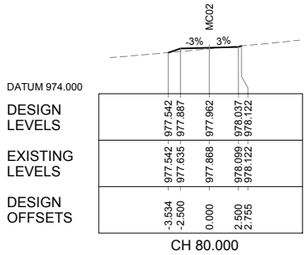
CH 100.000



CH 180.000



CH 16.709



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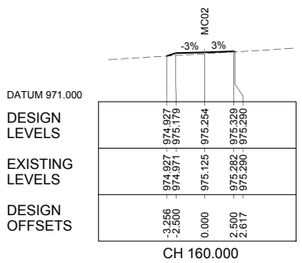


CH 160.000

CROSS SECTIONS - MC02 STOCKPILE ACCESS ROAD

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

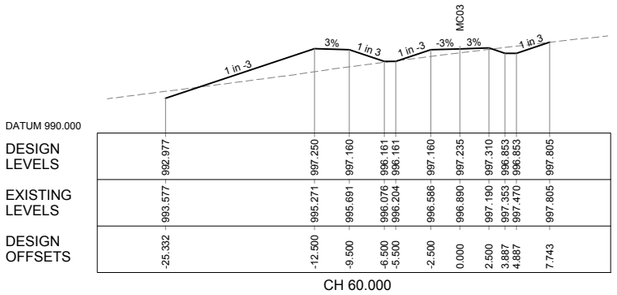
60011672

SHEET TITLE

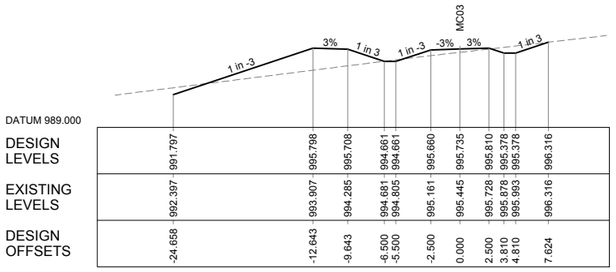
ROAD
CROSS SECTIONS

SHEET NUMBER

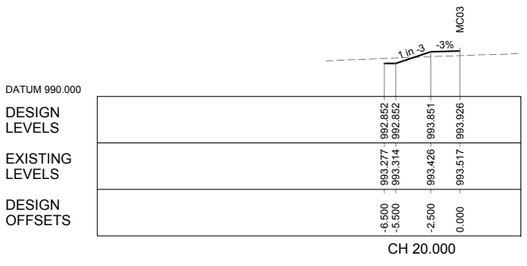
60011672-SHT-CI-0073



CH 60.000



CH 40.000



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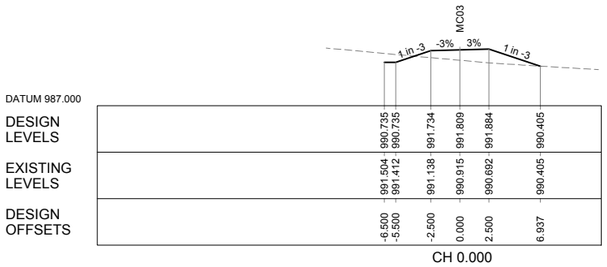

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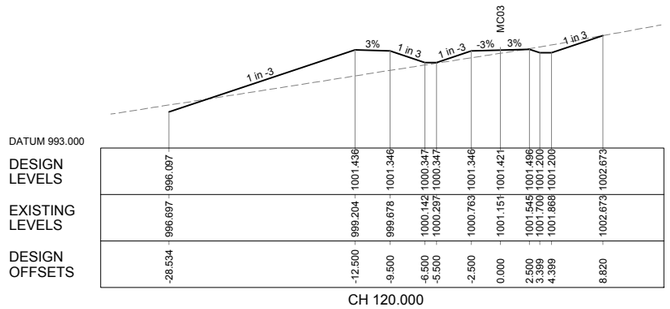

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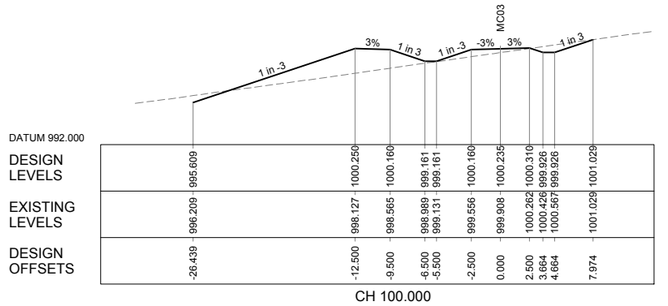

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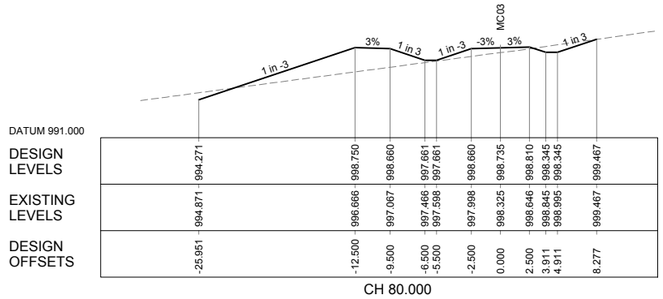


CH 80.000

CROSS SECTIONS - MC03 CELL PERIMETER ROAD

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

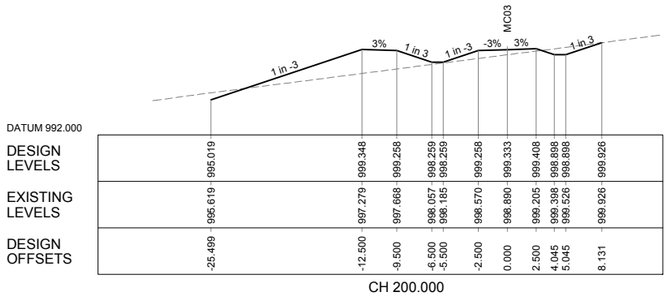
60011672

SHEET TITLE

ROAD
CROSS SECTIONS

SHEET NUMBER

60011672-SHT-CI-0074



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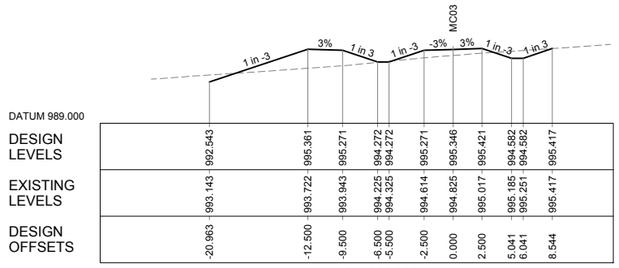

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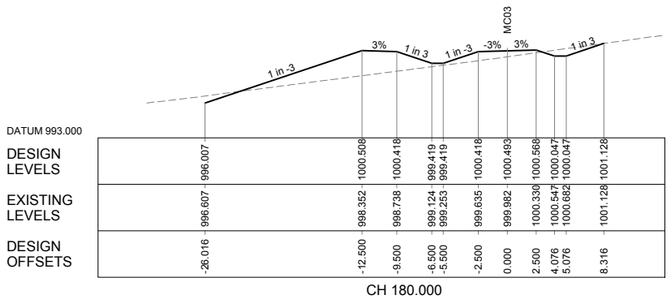

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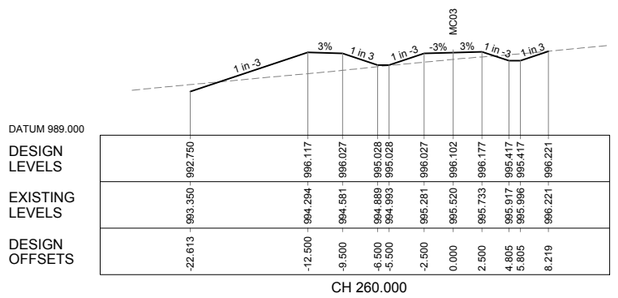

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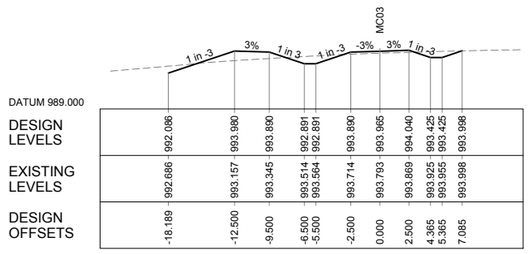

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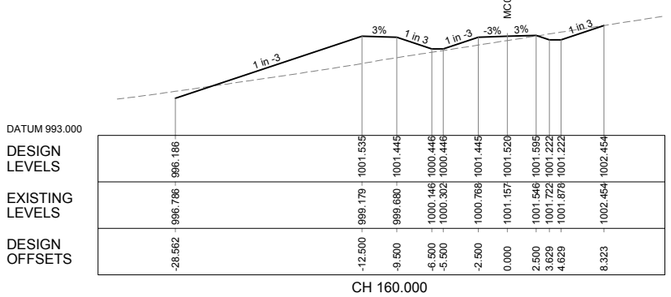

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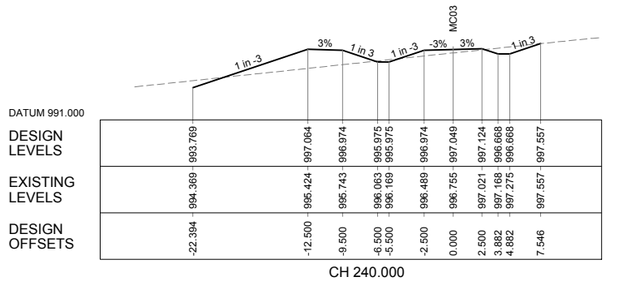

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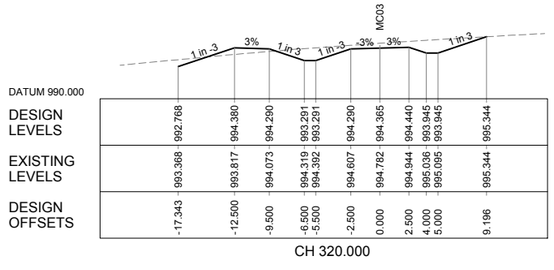

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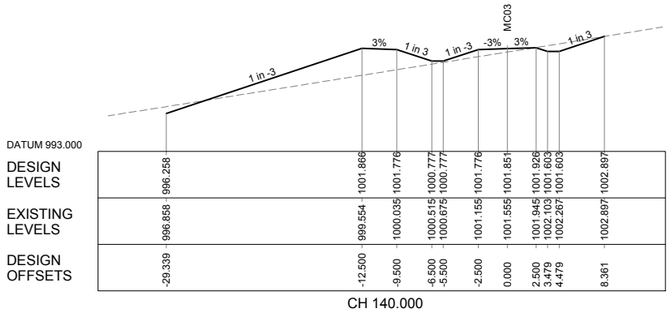

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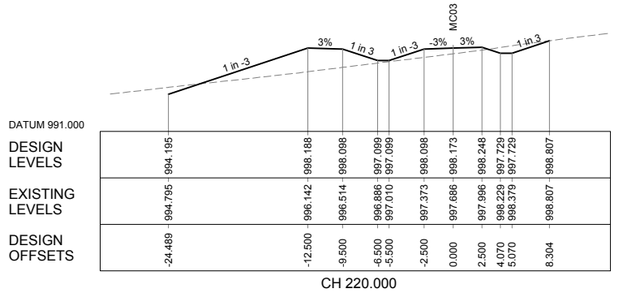

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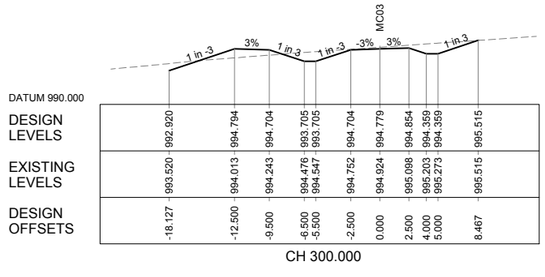

CH 300.000

CROSS SECTIONS - MC03 CELL PERIMETER ROAD

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
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D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

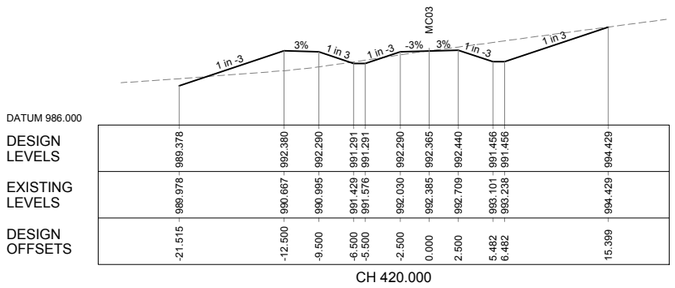
60011672

SHEET TITLE

ROAD
CROSS SECTIONS

SHEET NUMBER

60011672-SHT-CI-0075



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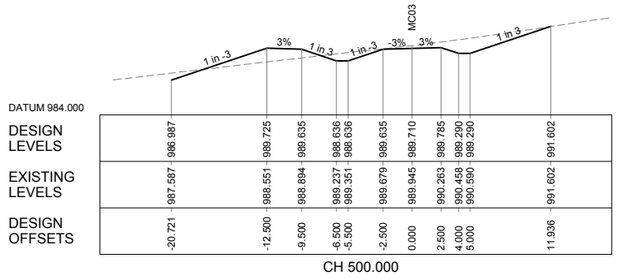

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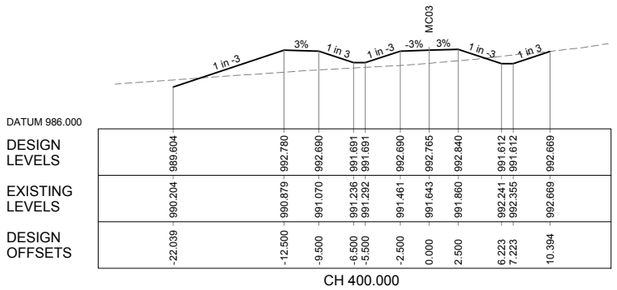

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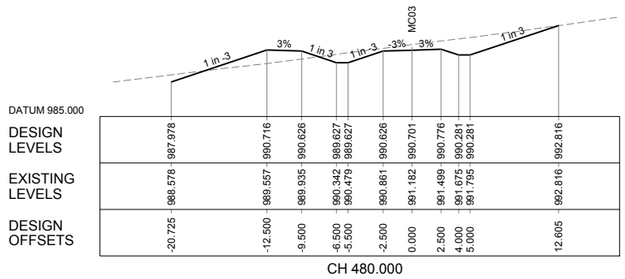
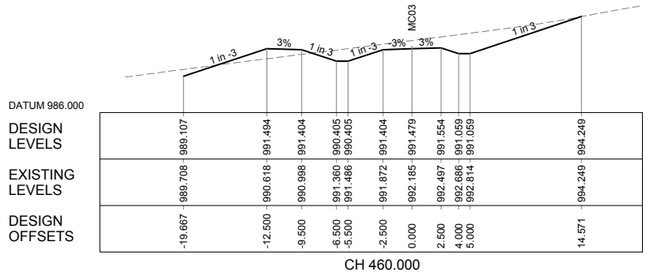


CH 480.000

CH 380.000



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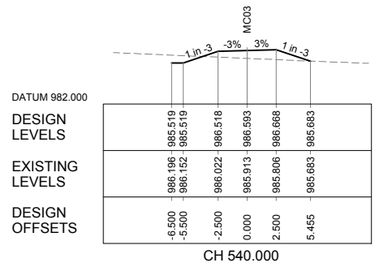

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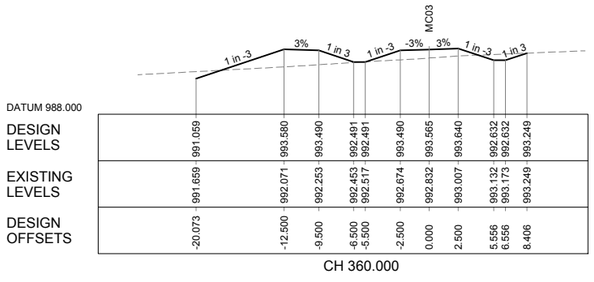

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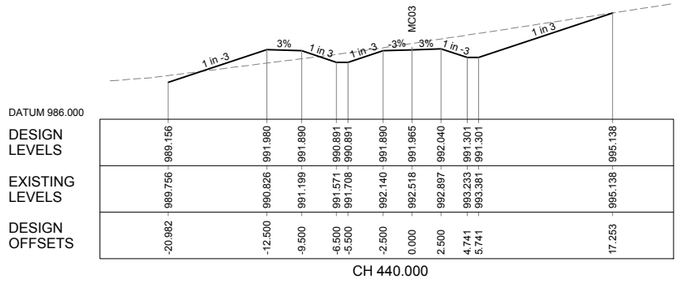

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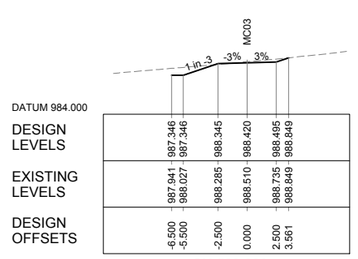


CH 520.000

CROSS SECTIONS - MC03 CELL PERIMETER ROAD

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

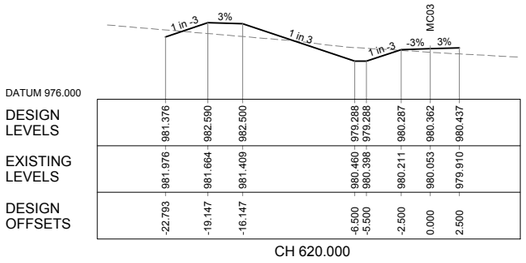
60011672

SHEET TITLE

ROAD
CROSS SECTIONS

SHEET NUMBER

60011672-SHT-CI-0076



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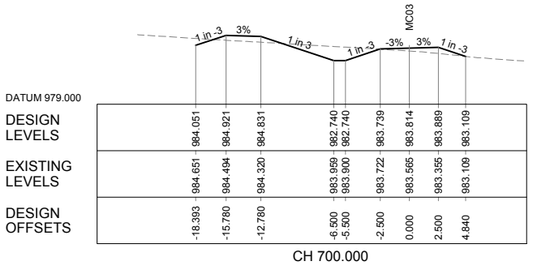

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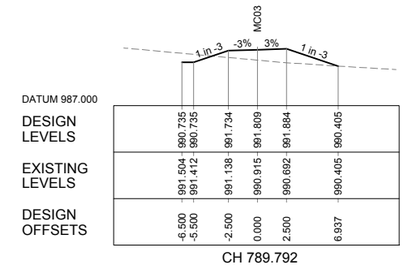
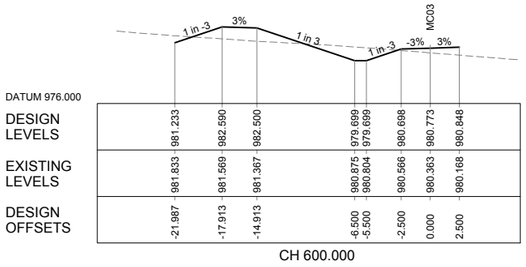
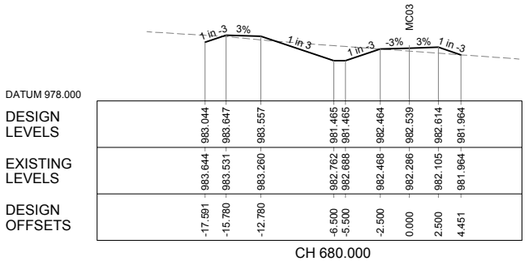


CH 789.792



CH 600.000



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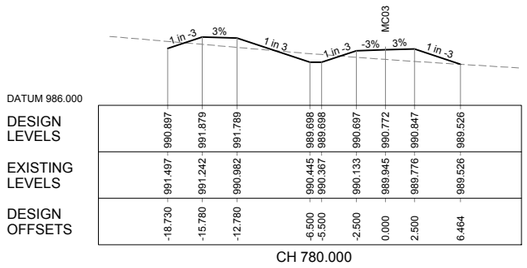

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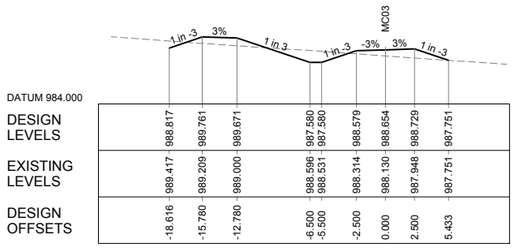

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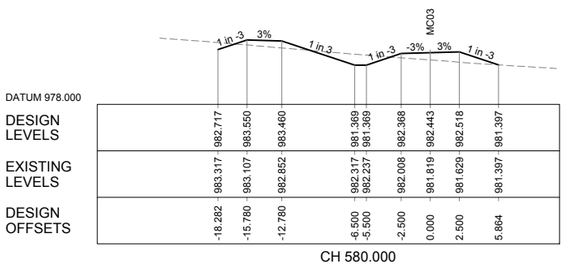

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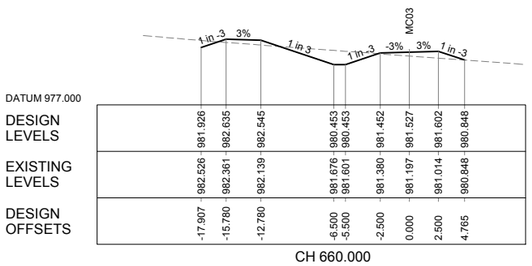
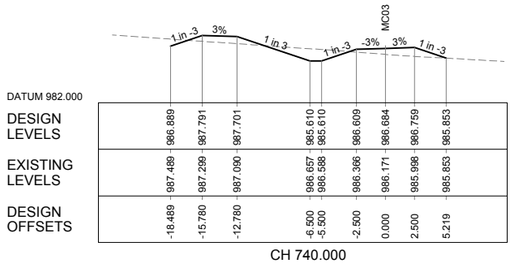


CH 660.000



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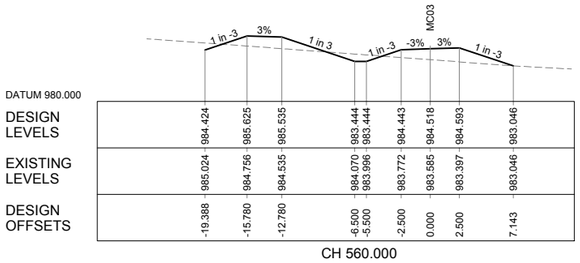

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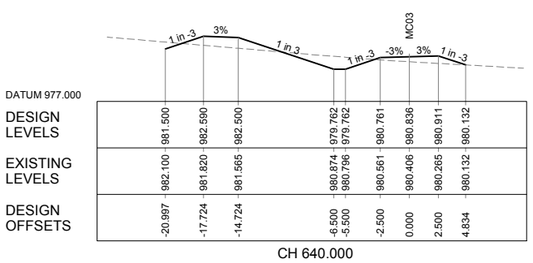

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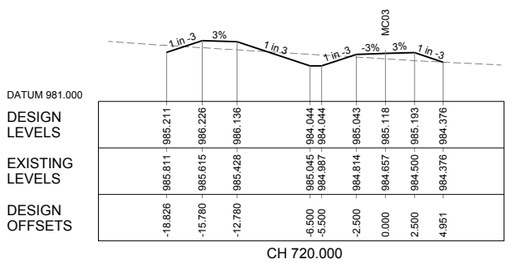


CH 720.000

CROSS SECTIONS - MC03 CELL PERIMETER ROAD

A1 HORIZONTAL SCALE 1:250
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

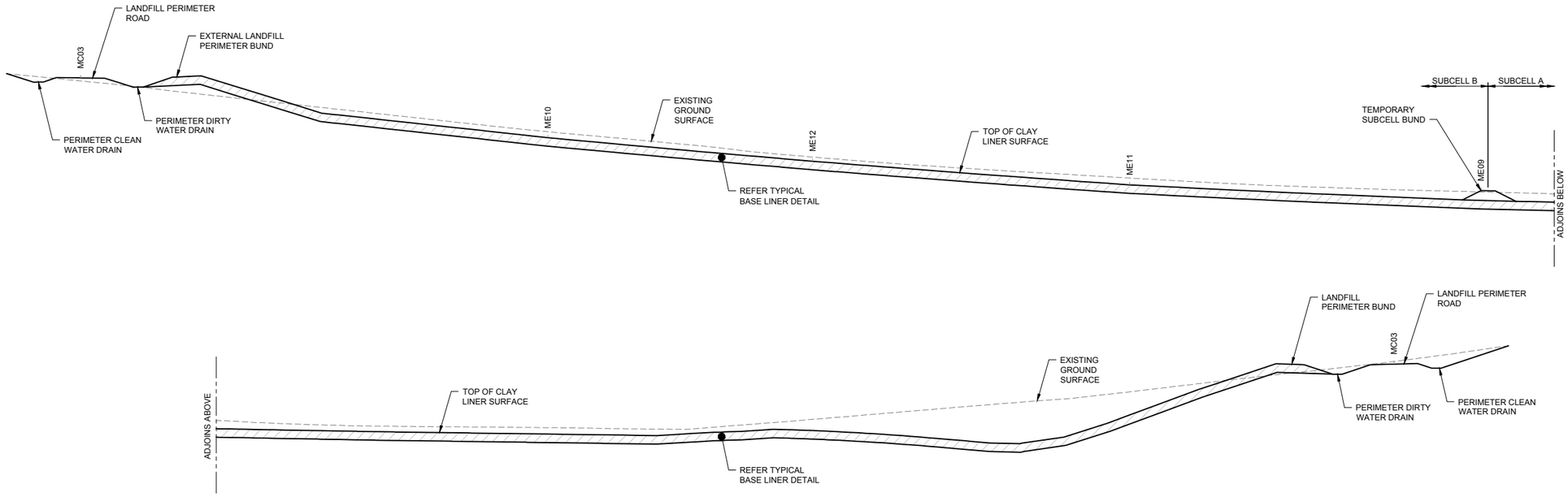
60011672

SHEET TITLE

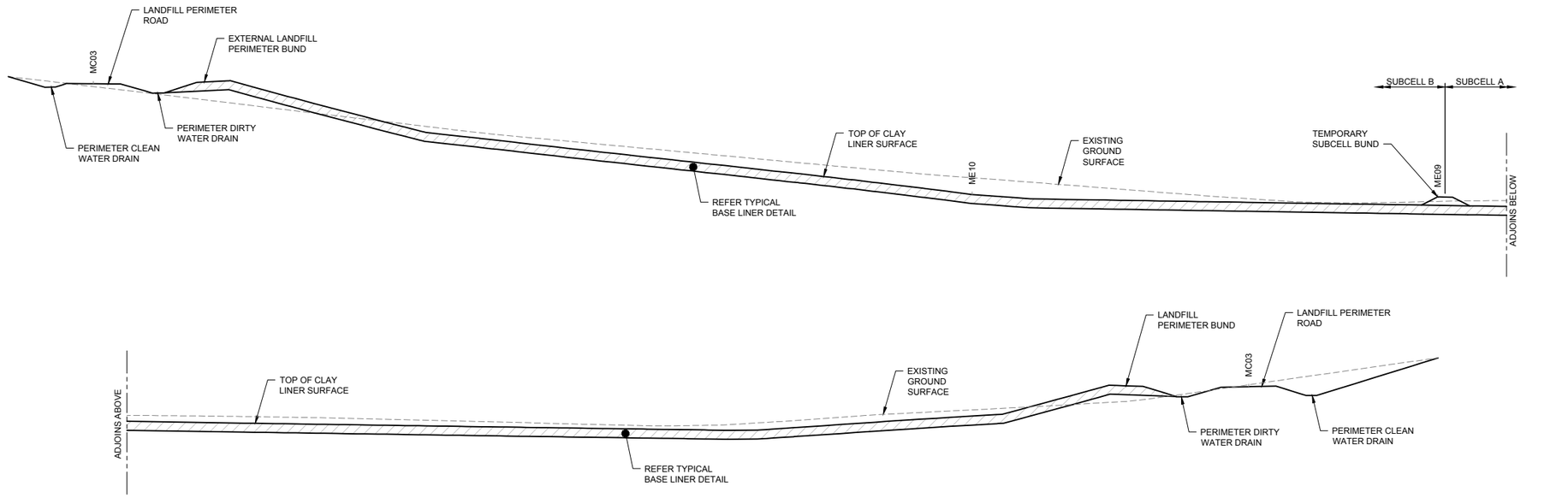
ROAD
CROSS SECTIONS

SHEET NUMBER

60011672-SHT-CI-0077



4 SECTION
CI-0021 SCALE 1:250



5 SECTION
CI-0021 SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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SAFETY IN DESIGN INFORMATION

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☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

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C		NOT ISSUED
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

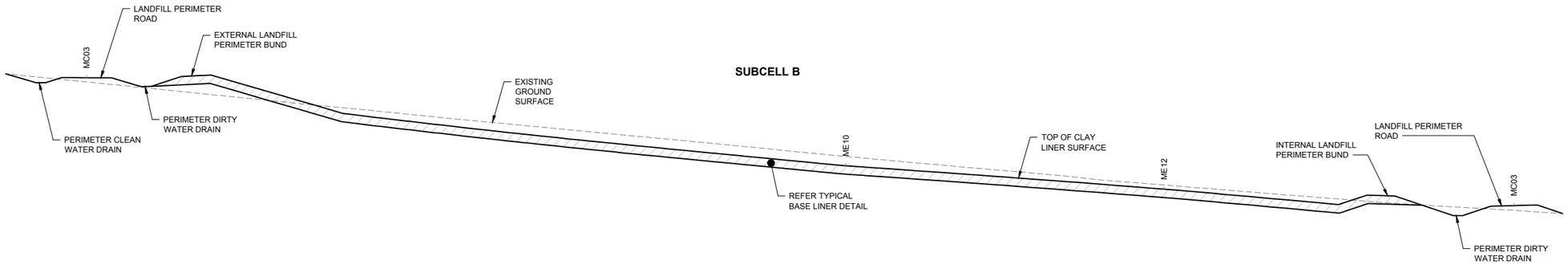
60011672

SHEET TITLE

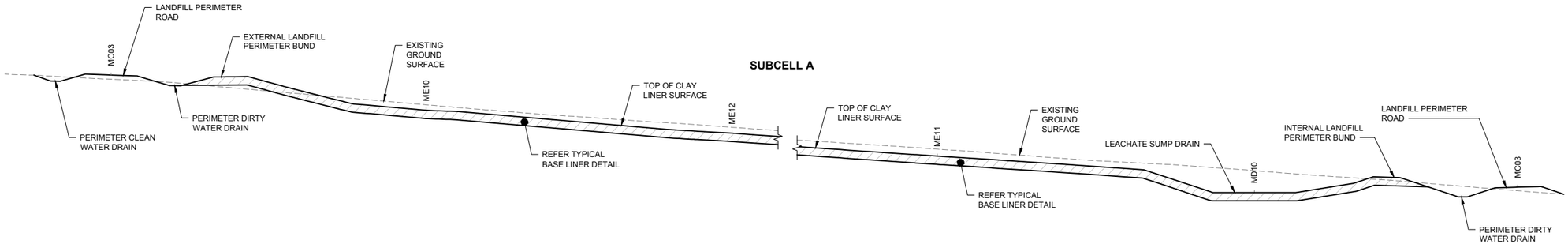
CELL 1 LANDFILL
TYPICAL SECTIONS
SHEET 1

SHEET NUMBER

60011672-SHT-CI-0091



6 | SECTION
CI-0021 | SCALE 1:250



7 | SECTION
CI-0021 | SCALE 1:250

0 6.25 12.5 m
1:250

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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☐ YES

REGISTRATION

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DESIGNER	CHECKED	APPROVED

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KEY PLAN

PROJECT NUMBER

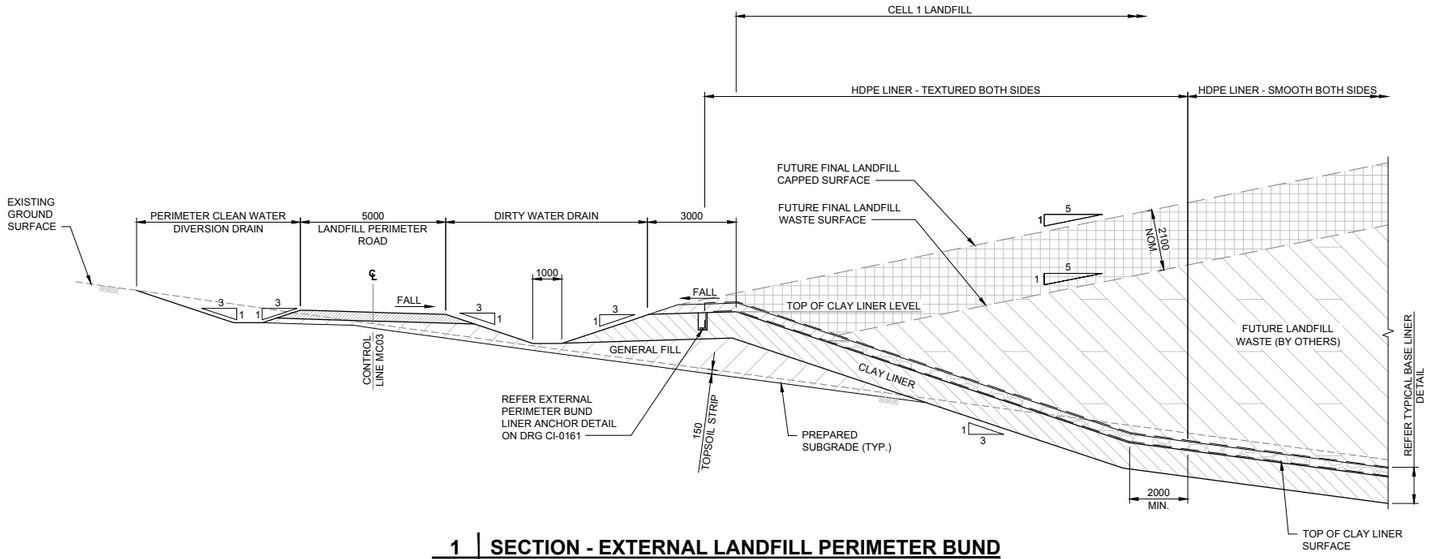
60011672

SHEET TITLE

CELL 1 LANDFILL
TYPICAL SECTIONS
SHEET 2

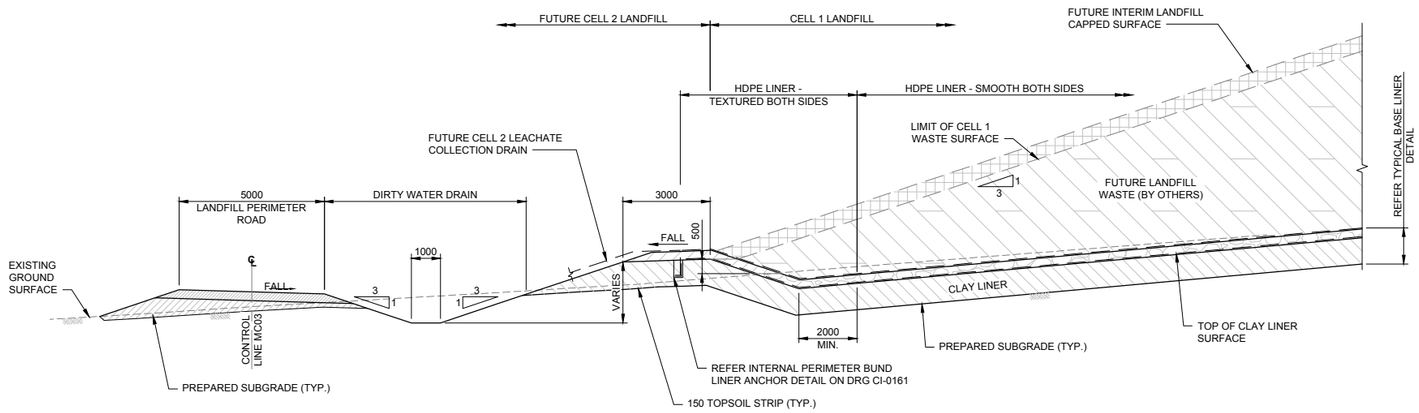
SHEET NUMBER

60011672-SHT-CI-0092



1 | CI-0021 SECTION - EXTERNAL LANDFILL PERIMETER BUND

SCALE 1:100



2 | CI-0021 SECTION - INTERNAL LANDFILL PERIMETER BUND

SCALE 1:100

0 2500 5000 mm

1:100

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A	28.11.2014	PRELIM. DETAILED DESIGN
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

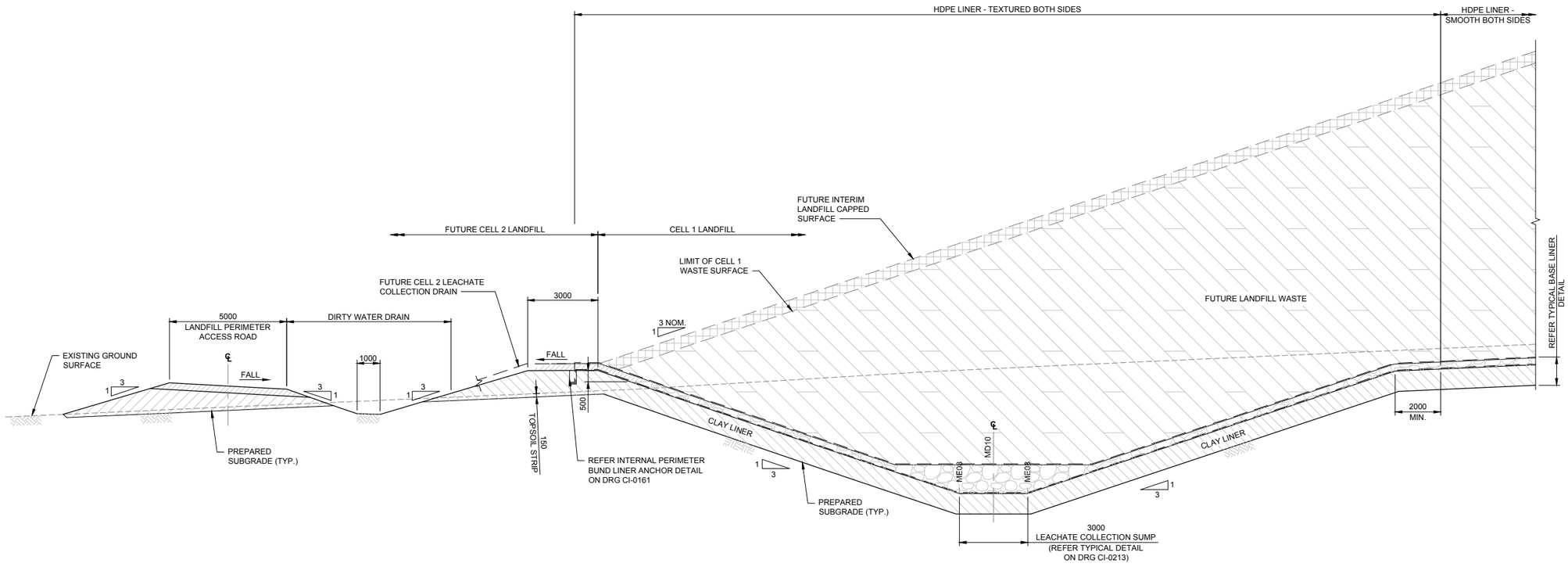
60011672

SHEET TITLE

LANDFILL PERIMETER BUND
TYPICAL DETAILS
SHEET 1

SHEET NUMBER

60011672-SHT-CI-0101



3 | SECTION - INTERNAL LANDFILL PERIMETER BUND (AT LEACHATE SUMP)

CI-0021

SCALE 1:100

0 2500 5000 mm
1:100

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

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B		NOT ISSUED
A	28.11.2014	PRELIM. DETAILED DESIGN

KEY PLAN

PROJECT NUMBER

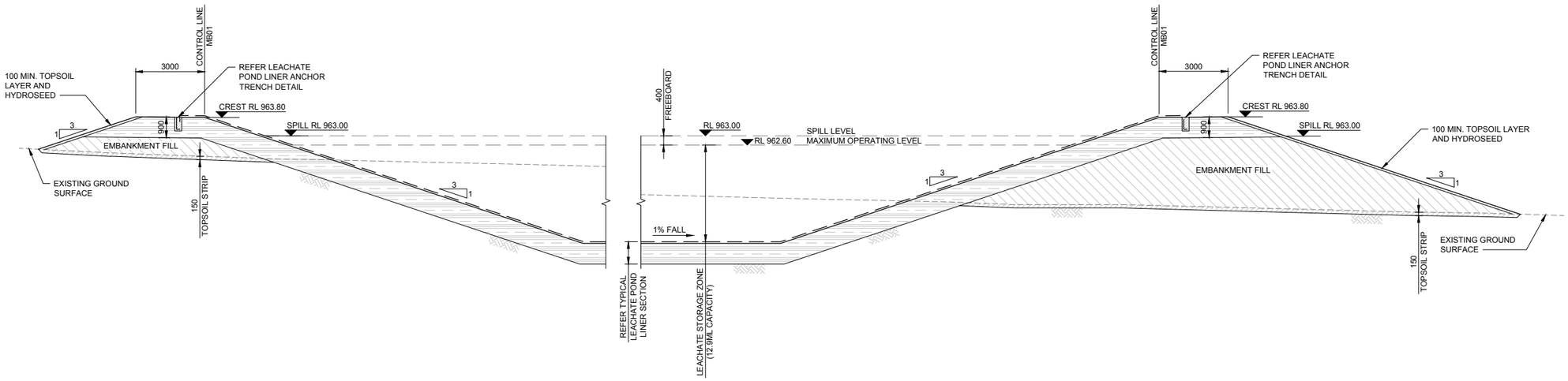
60011672

SHEET TITLE

LANDFILL PERIMETER BUND TYPICAL DETAILS SHEET 2

SHEET NUMBER

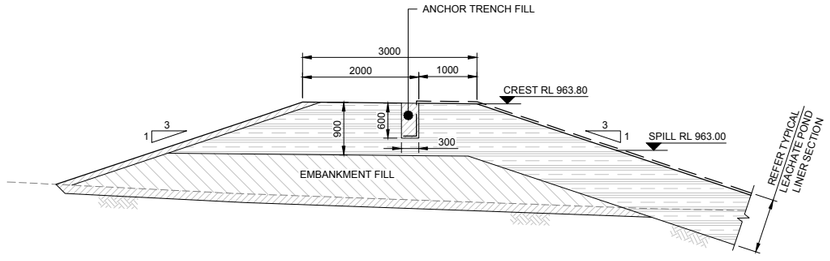
60011672-SHT-CI-0111



1 | SECTION - LEACHATE STORAGE POND

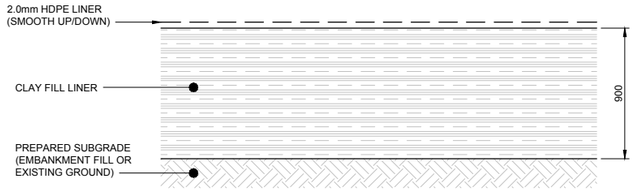
CI-0022

SCALE 1:100



LEACHATE POND LINER ANCHOR TRENCH DETAIL

SCALE 1:50



TYPICAL LEACHATE POND LINER DETAIL

SCALE 1:20

0 500 1000 mm
1:20

0 1250 2500 mm
1:50

0 2500 5000 mm
1:100

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

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DESIGNER	CHECKED	APPROVED

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A	28.11.2014	PRELIM. DETAILED DESIGN
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

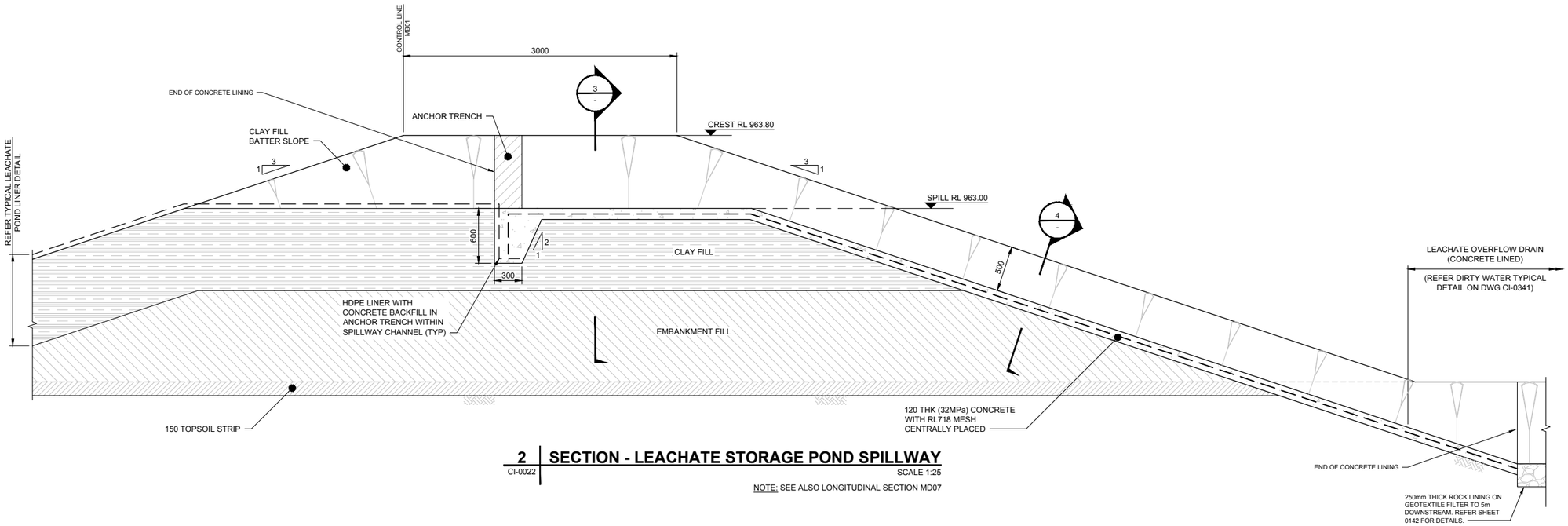
60011672

SHEET TITLE

LEACHATE STORAGE POND
TYPICAL DETAILS
SHEET 1

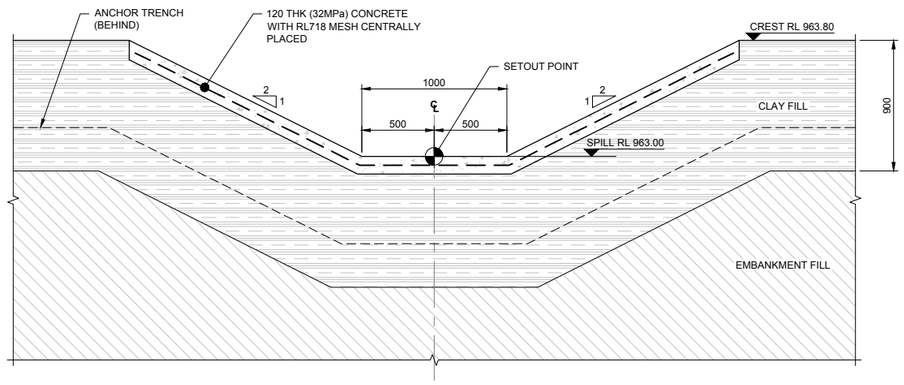
SHEET NUMBER

60011672-SHT-CI-0131

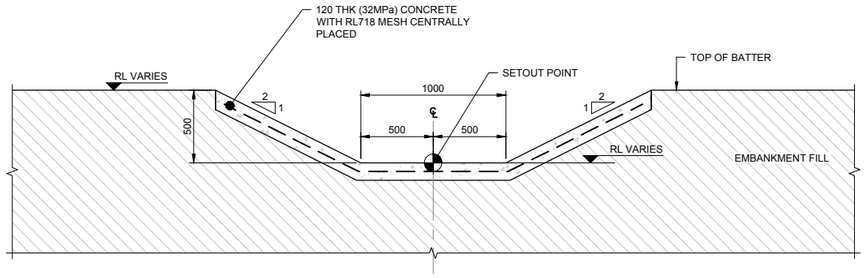


2 | SECTION - LEACHATE STORAGE POND SPILLWAY
CI-0022 | SCALE 1:25

NOTE: SEE ALSO LONGITUDINAL SECTION MD07



3 | SECTION
- | SCALE 1:20



4 | SECTION
- | SCALE 1:20

0 500 1000 mm
1:20

0 625 1250 mm
1:25

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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SAFETY IN DESIGN INFORMATION

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☐ YES

REGISTRATION

FOR CONSTRUCTION

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A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

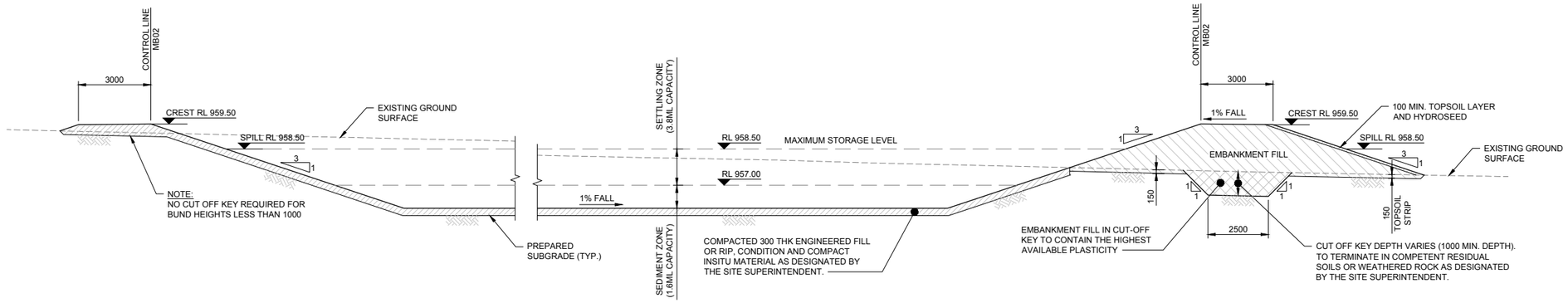
60011672

SHEET TITLE

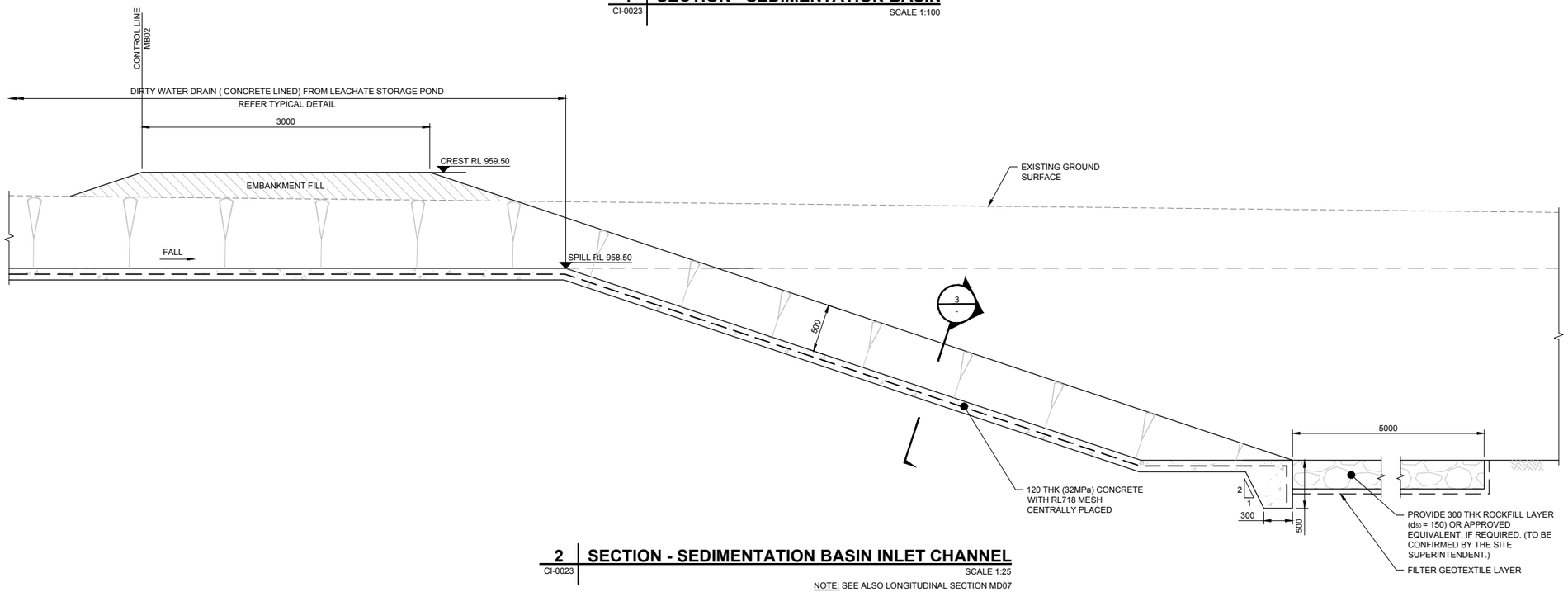
LEACHATE STORAGE POND
TYPICAL DETAILS
SHEET 2

SHEET NUMBER

60011672-SHT-CI-0132

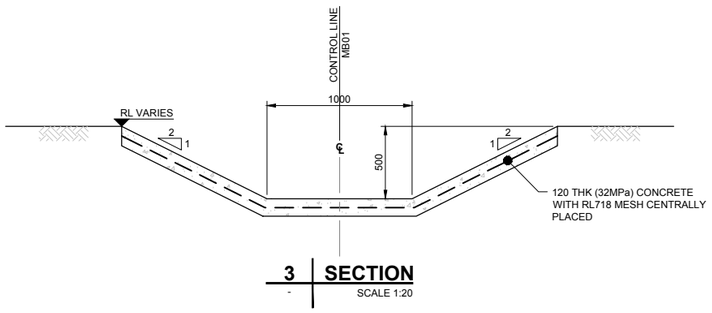


1 | SECTION - SEDIMENTATION BASIN
CI-0023 | SCALE 1:100



2 | SECTION - SEDIMENTATION BASIN INLET CHANNEL
CI-0023 | SCALE 1:25

NOTE: SEE ALSO LONGITUDINAL SECTION MD07



3 | SECTION
- | SCALE 1:20

0 500 1000 mm
1:20

0 625 1250 mm
1:25

0 2500 5000 mm
1:100

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Regional Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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SAFETY IN DESIGN INFORMATION
ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?
☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

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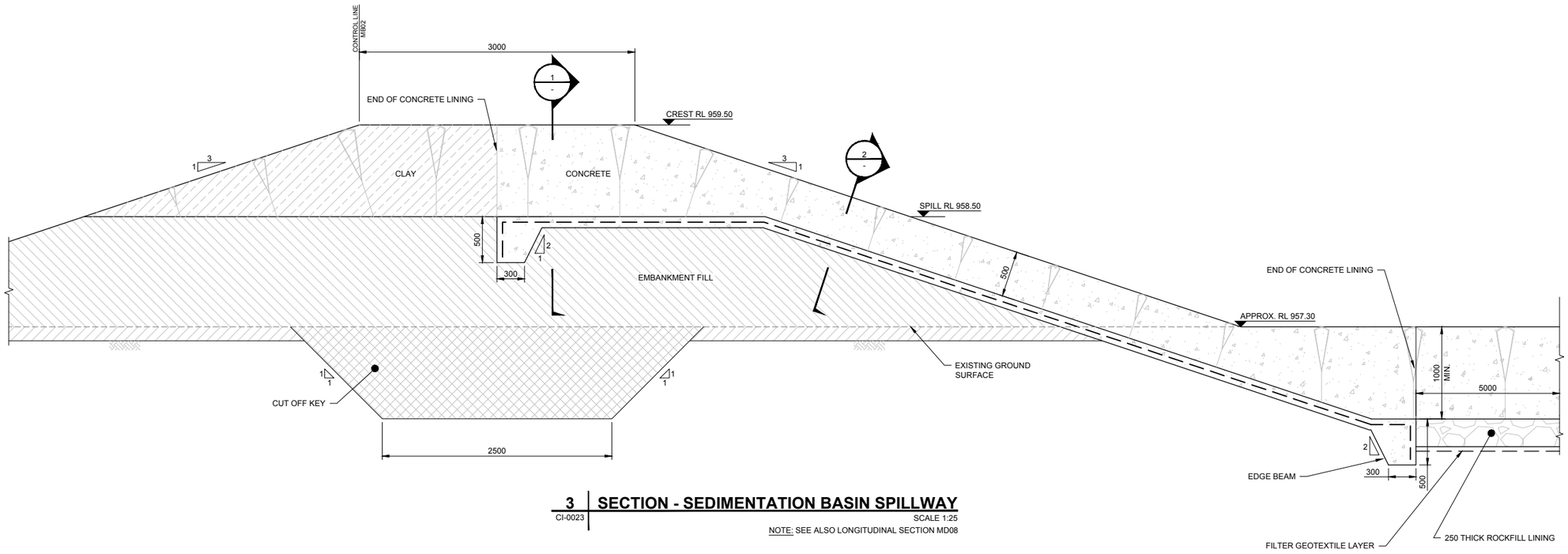
KEY PLAN

PROJECT NUMBER
60011672

SHEET TITLE
SEDIMENTATION BASIN
TYPICAL DETAILS
SHEET 1

SHEET NUMBER
60011672-SHT-CI-0141

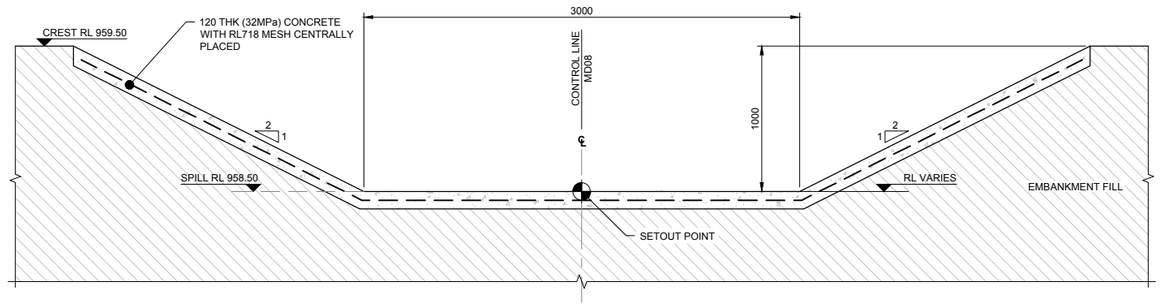


3 | SECTION - SEDIMENTATION BASIN SPILLWAY

CI-0023

SCALE 1:25

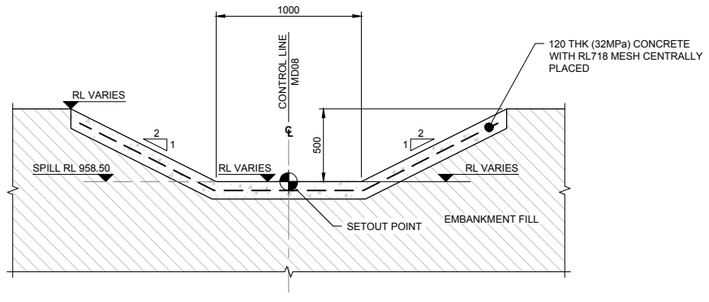
NOTE: SEE ALSO LONGITUDINAL SECTION MD08



1 | SECTION

-

SCALE 1:20



2 | SECTION

-

SCALE 1:20

0 500 1000 mm

1:20

0 625 1250 mm

1:25

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PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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A.B.N 20 093 846 925
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SAFETY IN DESIGN INFORMATION

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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

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C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

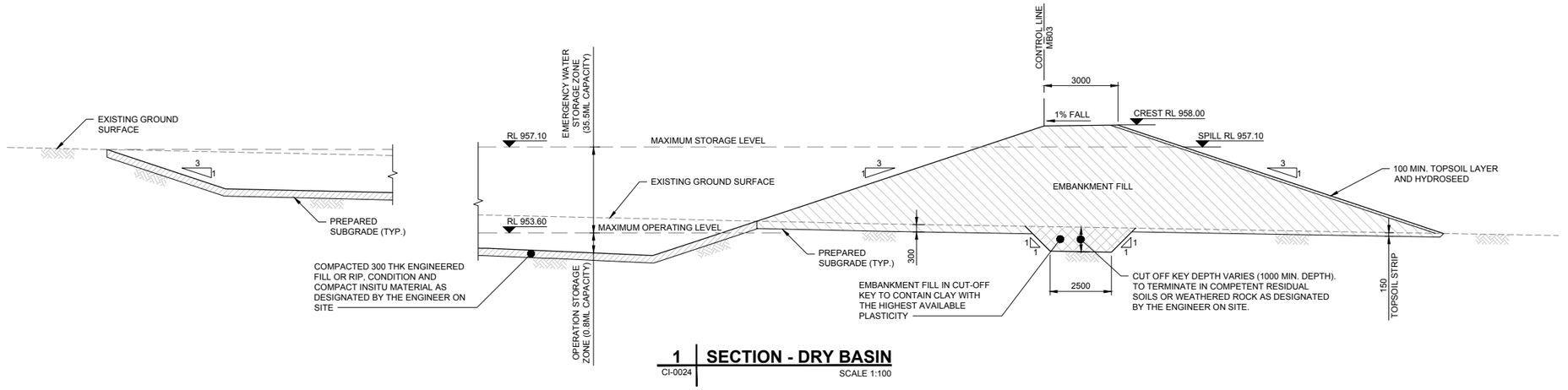
60011672

SHEET TITLE

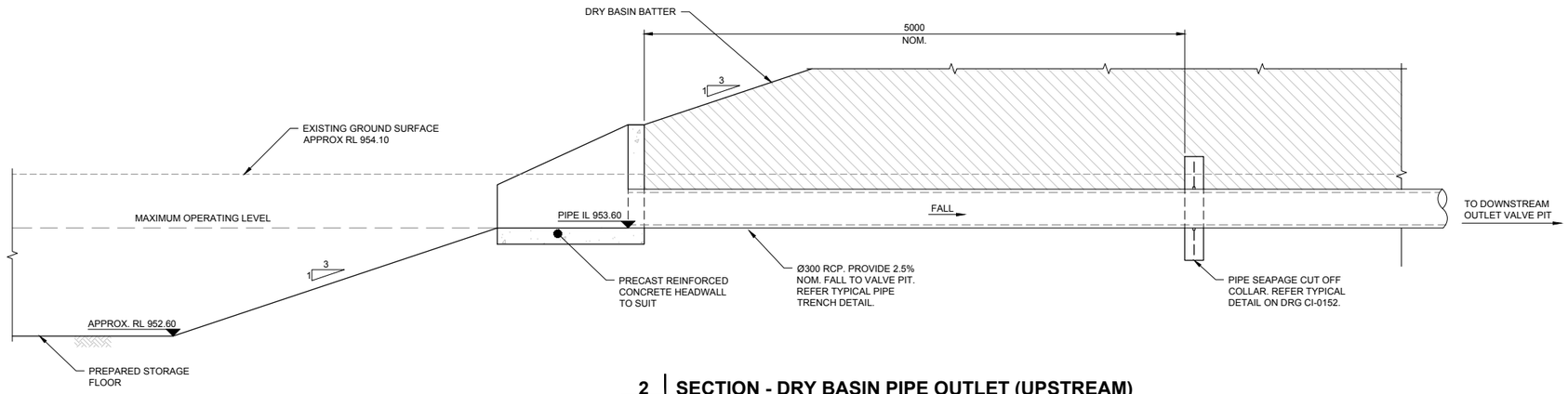
SEDIMENTATION BASIN TYPICAL DETAILS SHEET 2

SHEET NUMBER

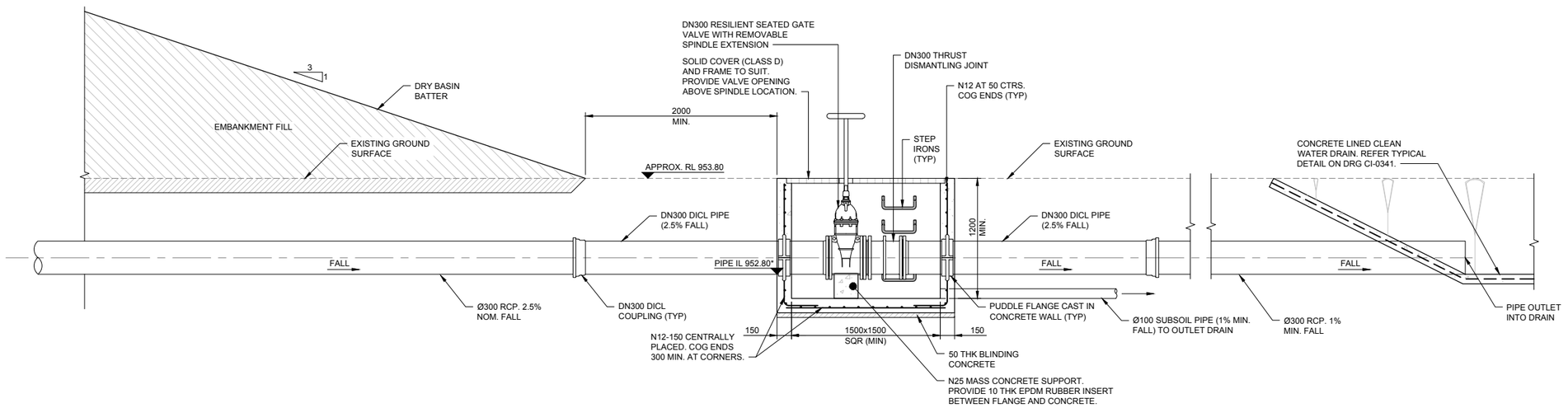
60011672-SHT-CI-0142



1 | SECTION - DRY BASIN
CI-0024 | SCALE 1:100



2 | SECTION - DRY BASIN PIPE OUTLET (UPSTREAM)
CI-0024 | SCALE 1:25



3 | SECTION - DRY BASIN PIPE OUTLET (DOWNSTREAM) AND VALVE PIT
CI-0024 | SCALE 1:25
*TO BE CONFIRMED ON SITE

0 625 1250 mm
1:25
0 2500 5000 mm
1:100

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Regional Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION
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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

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DESIGNER	CHECKED	APPROVED

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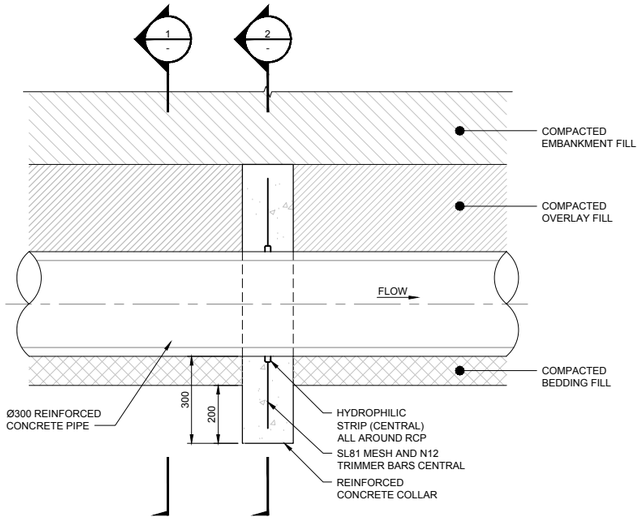
A	28.11.2014	PRELIM. DETAILED DESIGN

KEY PLAN

PROJECT NUMBER
60011672

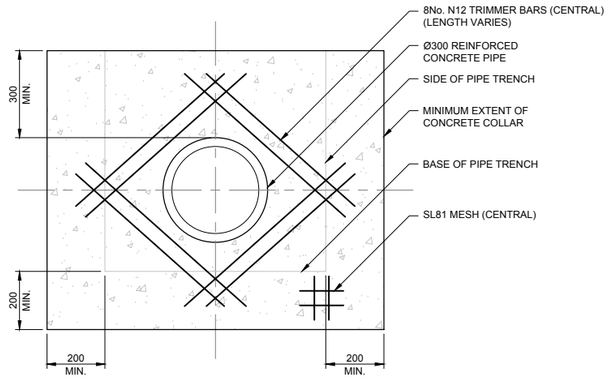
SHEET TITLE
DRY BASIN
TYPICAL DETAILS
SHEET 1

SHEET NUMBER
60011672-SHT-CI-0151



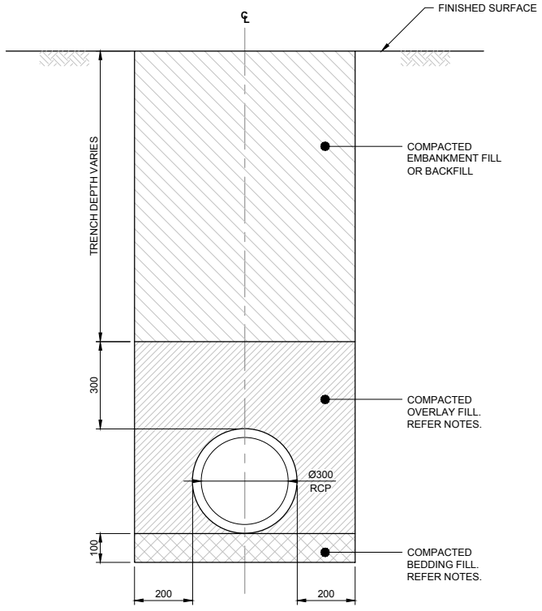
TYPICAL DRY BASIN OUTLET PIPE TRENCH AND CUT OFF COLLAR DETAIL

SCALE 1:10



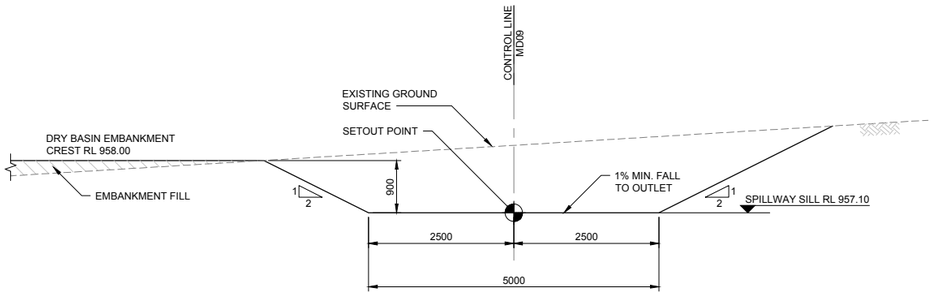
2 | **SECTION - REINFORCED CONCRETE CUT OFF COLLAR**

SCALE 1:10



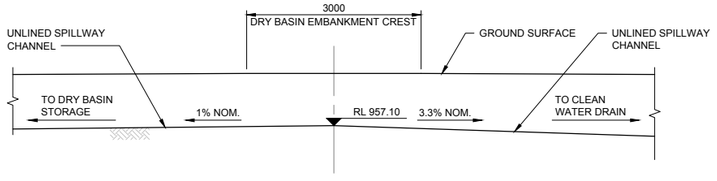
1 | **SECTION - DRY BASIN OUTLET PIPE TRENCH**

SCALE 1:10



4 | CI-0024 | **SECTION - DRY BASIN SPILLWAY CHANNEL**

SCALE 1:50



5 | CI-0024 | **SECTION - DRY BASIN SPILLWAY LONGSECTION**

SCALE 1:50

0 250 500 mm
1:10

0 1250 2500 mm
1:50

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
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SAFETY IN DESIGN INFORMATION

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☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

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DESIGNER	CHECKED	APPROVED

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C	02.03.2015	DETAILED DESIGN
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A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

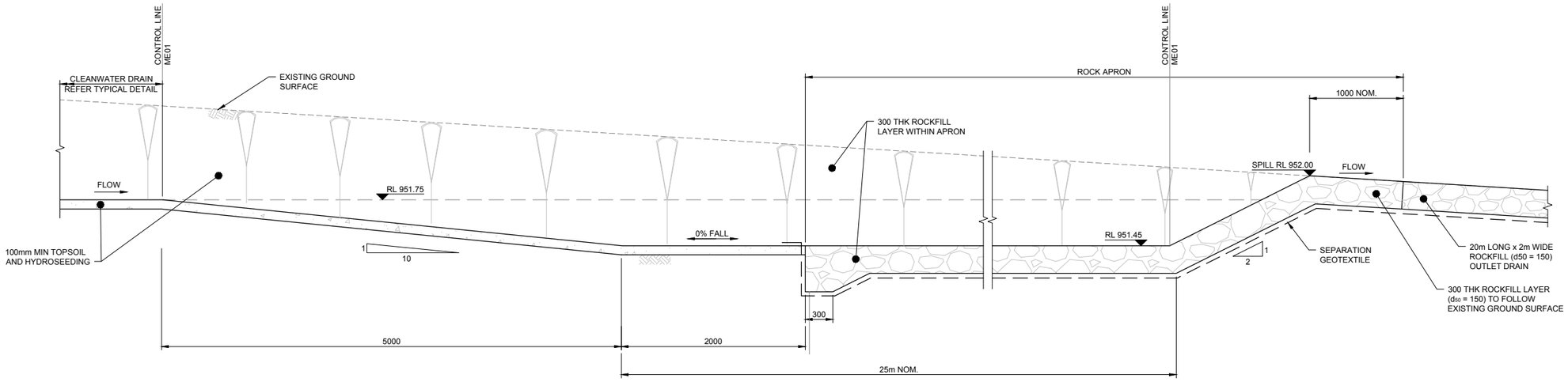
60011672

SHEET TITLE

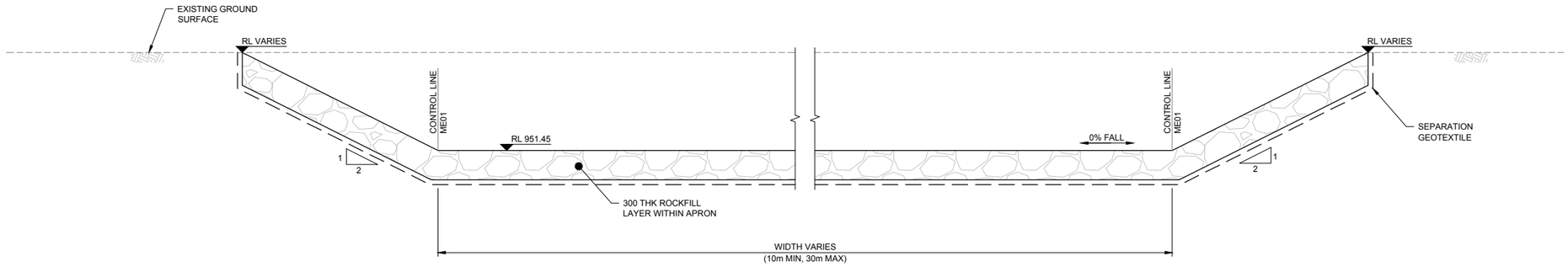
DRY BASIN
TYPICAL DETAILS
SHEET 2

SHEET NUMBER

60011672-SHT-CI-0152



1 SECTION
CI-0025 SCALE 1:25



2 SECTION
CI-0025 SCALE 1:25

0 625 1250 mm
1:25

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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☐ YES

REGISTRATION

FOR CONSTRUCTION

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DESIGNER	CHECKED	APPROVED

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C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

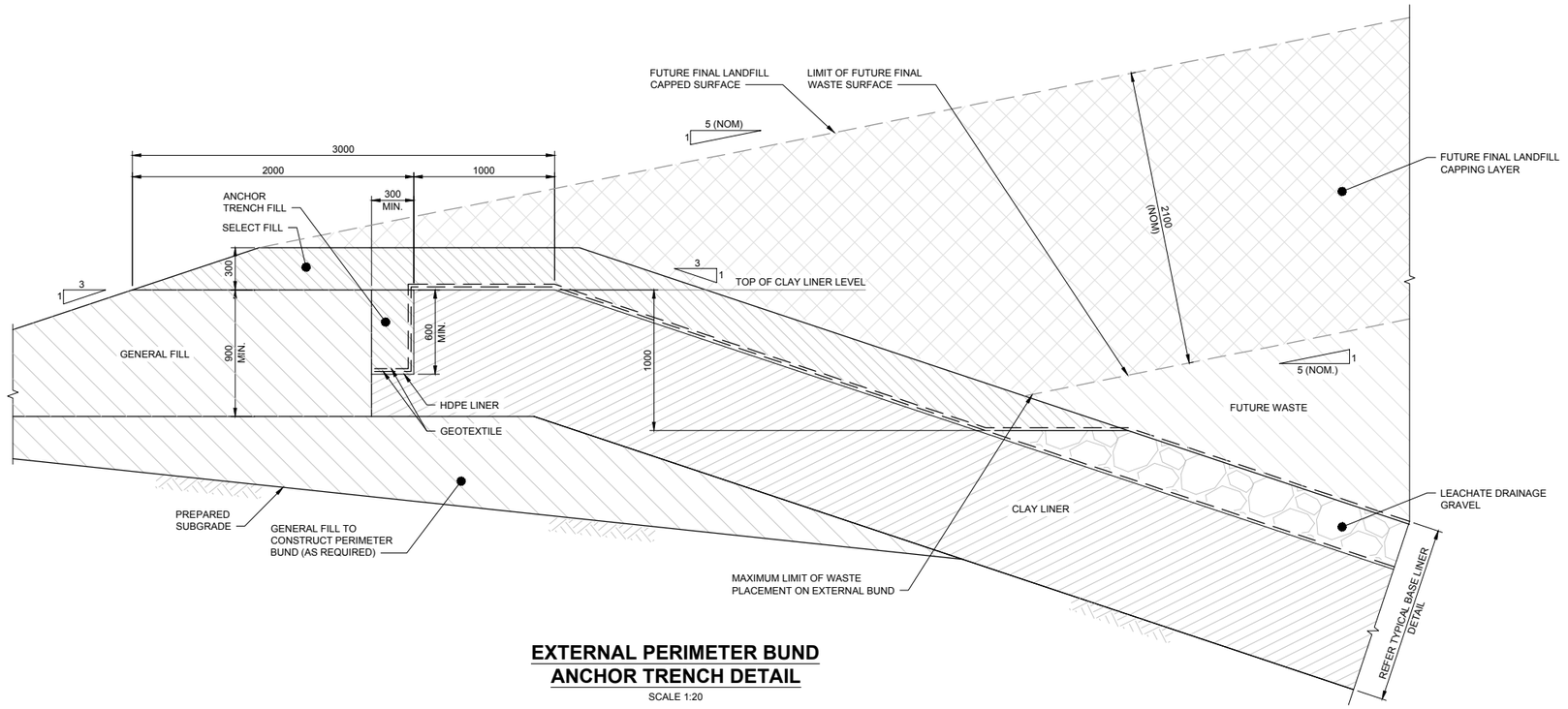
60011672

SHEET TITLE

CLEANWATER DRAIN
OUTLET ROCK APRON
TYPICAL DETAILS

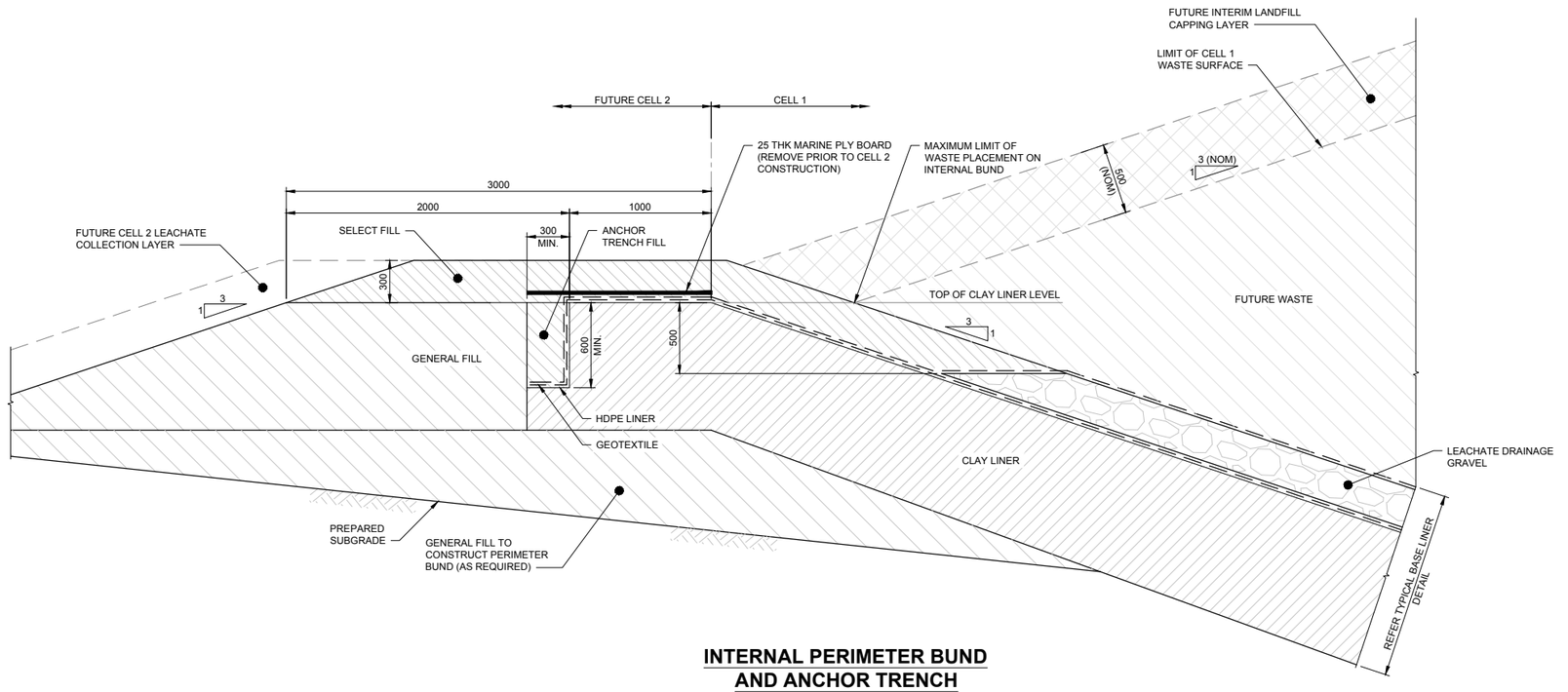
SHEET NUMBER

60011672-SHT-CI-0155



EXTERNAL PERIMETER BUND ANCHOR TRENCH DETAIL

SCALE 1:20



INTERNAL PERIMETER BUND AND ANCHOR TRENCH DETAIL

SCALE 1:20

0 500 1000 mm
1:20

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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SAFETY IN DESIGN INFORMATION

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KEY PLAN

PROJECT NUMBER

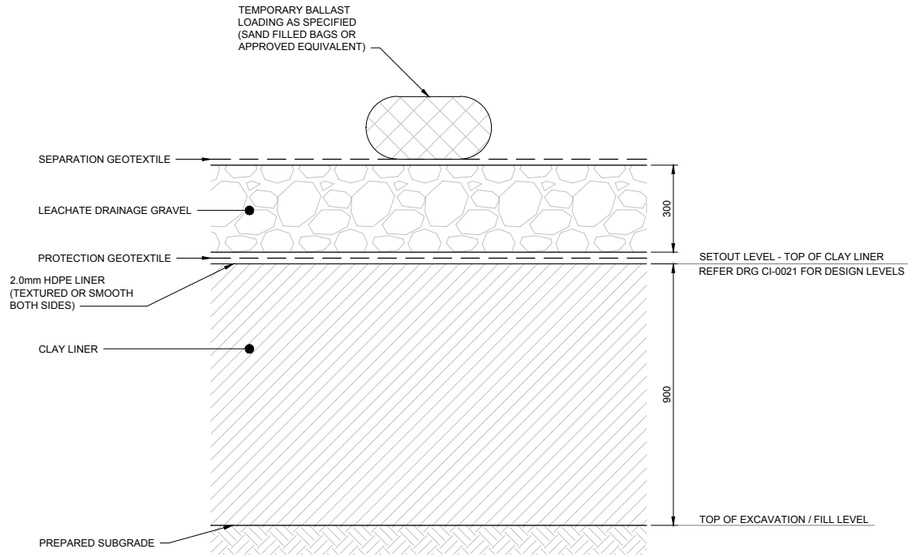
60011672

SHEET TITLE

LANDFILL BASE LINER TYPICAL DETAILS SHEET 1

SHEET NUMBER

60011672-SHT-CI-0161



TYPICAL BASE LINER DETAIL

SCALE 1:10

0 250 500 mm
1:10

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
A		

KEY PLAN

PROJECT NUMBER

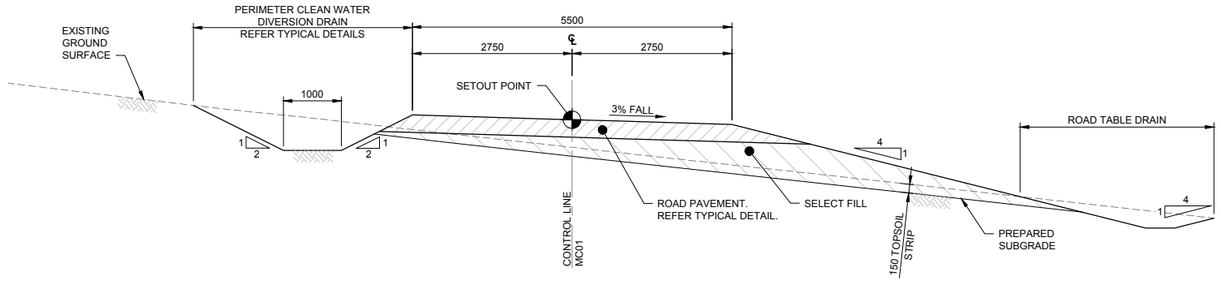
60011672

SHEET TITLE

LANDFILL BASE LINER
TYPICAL DETAILS
SHEET 2

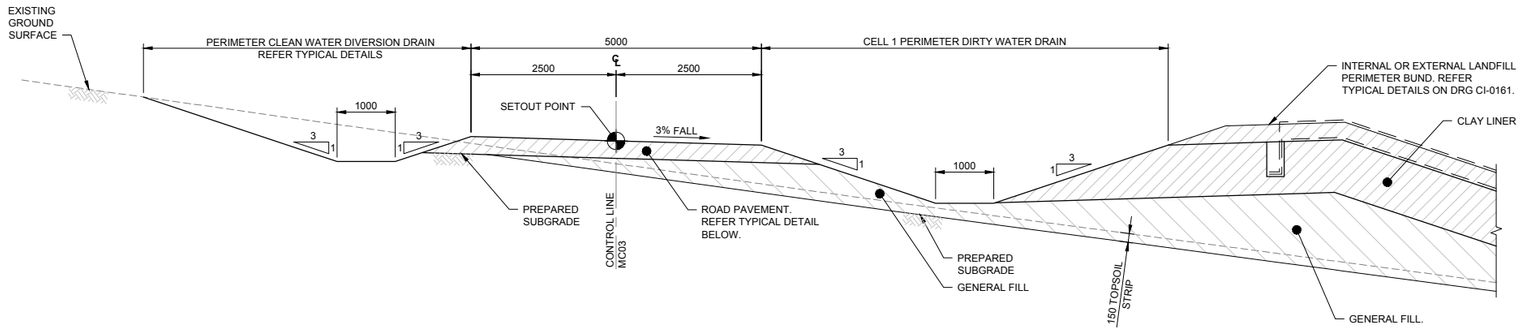
SHEET NUMBER

60011672-SHT-CI-0162



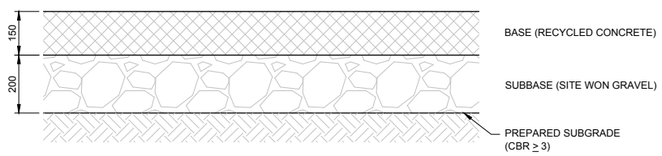
TYPICAL LANDFILL INTERNAL ROAD SECTION

SCALE 1:50



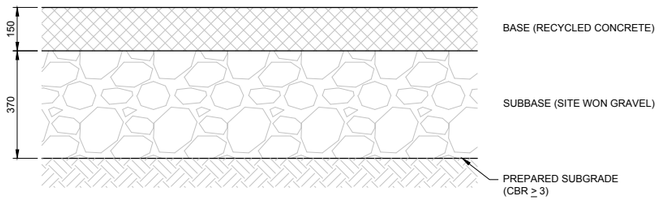
TYPICAL LANDFILL PERIMETER ROAD SECTION

SCALE 1:50



LANDFILL PERIMETER AND STOCKPILE ACCESS ROAD PAVEMENT DETAIL

SCALE 1:10



ACCESS ROAD PAVEMENT DETAIL

SCALE 1:10

0 0.25 0.5 m
1:10

0 1.25 2.5 m
1:50

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PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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REGISTRATION

FOR CONSTRUCTION

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C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

60011672

SHEET TITLE

ACCESS ROAD
TYPICAL DETAILS

SHEET NUMBER

60011672-SHT-CI-0171

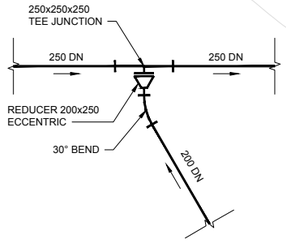
NOTES

1. SERVICES SHOWN DIAGRAMATICALLY ONLY FOR CLARITY. REFER TO COMMON SERVICES TRENCH DETAILS.
2. DESIGN CONTOURS WITHIN LANDFILL CELL 1 ARE TOP OF CLAY LINER.

LEGEND

- PROPERTY BOUNDARY
- 980.00 EXISTING CONTOURS
- 980.00 DESIGN CONTOURS
- 250 DN PERFORATED MAIN LEACHATE COLLECTION PIPES
- 200 DN PERFORATED LATERAL PIPES
- LEACHATE RISER PIPE
- LEACHATE CLEANOUT RISER PIPE
- CLEANOUT POINT
- 1.8m HIGH FENCE
- ELECTRICAL CONDUIT
- COMMUNICATIONS CONDUIT
- LEACHATE EXTRACTION MAIN
- LEACHATE RETURN MAIN
- DIRTY WATER RETURN MAIN
- PIPE FLOW DIRECTION

LANDFILL PERIMETER ACCESS ROAD
LANDFILL PERIMETER BUND
PERIMETER DIRTY WATER DRAIN
DIRTY WATER DRAIN (TO SEDIMENTATION BASIN)
CULVERT 3 Ø600 RCP
CONNECT LEACHATE PIPE THROUGH SUBCELL BUND. REFER TYPICAL DETAIL ON DWG CI-0214.
CULVERT 1 Ø600 RCP
REFER COMMON SERVICES TRENCH DETAIL ON CI-0212
CP1
REFER TYPICAL JUNCTION DETAIL
CLEANOUT RISER PIPE. REFER TYPICAL DETAILS DWG CI-0211.
PIPE END CAP (TYP)
TEE JUNCTION AND REDUCER ECCENTRIC (TYP)
CP2
CP3
1 CI-0211
2 CI-0212
3 CI-0212
4 CI-0213
5 CI-0214
6 CI-0214
LANDFILL ACCESS RAMP
315DN LEACHATE RISER PIPE. REFER TYPICAL DETAIL.
LEACHATE EXTRACTION PUMP WITHIN RISER (BY OTHERS)
LEACHATE COLLECTION SUMP. REFER TYPICAL DETAIL ON DWG CI-0213.
OUTLET PIPE IN SUMP
CABLE PIT
BUND CREST WIDENED AT SPILLAGE PIT REFER DRG CI-0213
SUBCELL B
SUBCELL A
35m NOM.
30m NOM.
60m NOM.
45m NOM.
TEMPORARY LEACHATE IRRIGATION/INJECTION TANK (BY OTHERS)
REFER COMMON SERVICES TRENCH DETAIL ON CI-0212
PERIMETER CLEAN WATER DRAIN
LANDSCAPE IRRIGATION TANK (BY OTHERS)
CABLE PIT



TYPICAL JUNCTION DETAIL
N.T.S

0 12.5 25 m
1:500

CLEANOUT POINT SETOUT TABLE

POINT	EASTING	NORTHING
CP1	383184.287	6618890.151
CP2	383178.062	6618820.383
CP3	383205.112	6618767.209

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PROJECT

Armidale Landfill - Cell 1 Works

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REGISTRATION

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KEY PLAN

PROJECT NUMBER

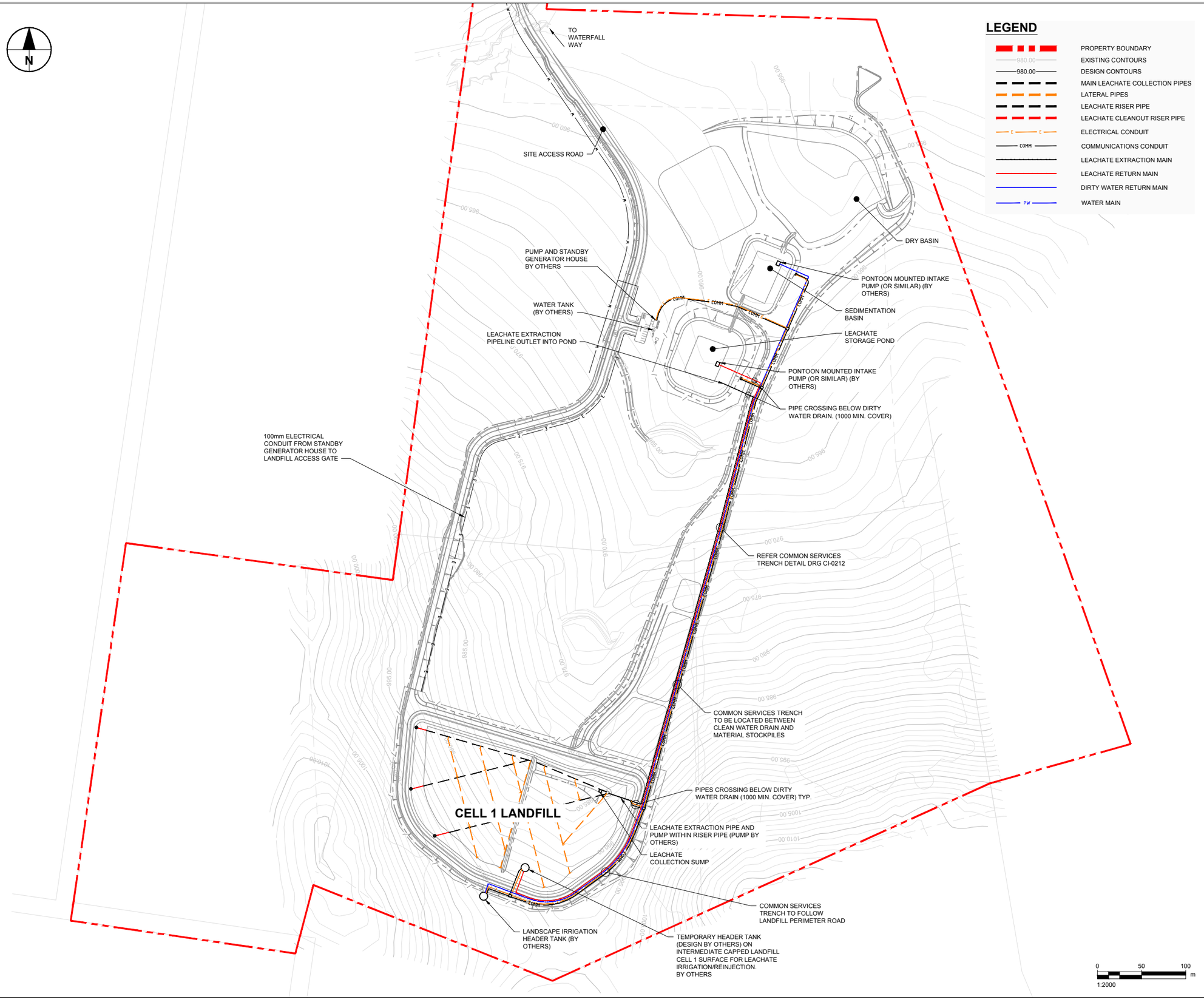
60011672

SHEET TITLE

LEACHATE COLLECTION SYSTEM PLAN

SHEET NUMBER

60011672-SHT-CI-0201



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PROJECT

Armidale Landfill - Cell 1 Works

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A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

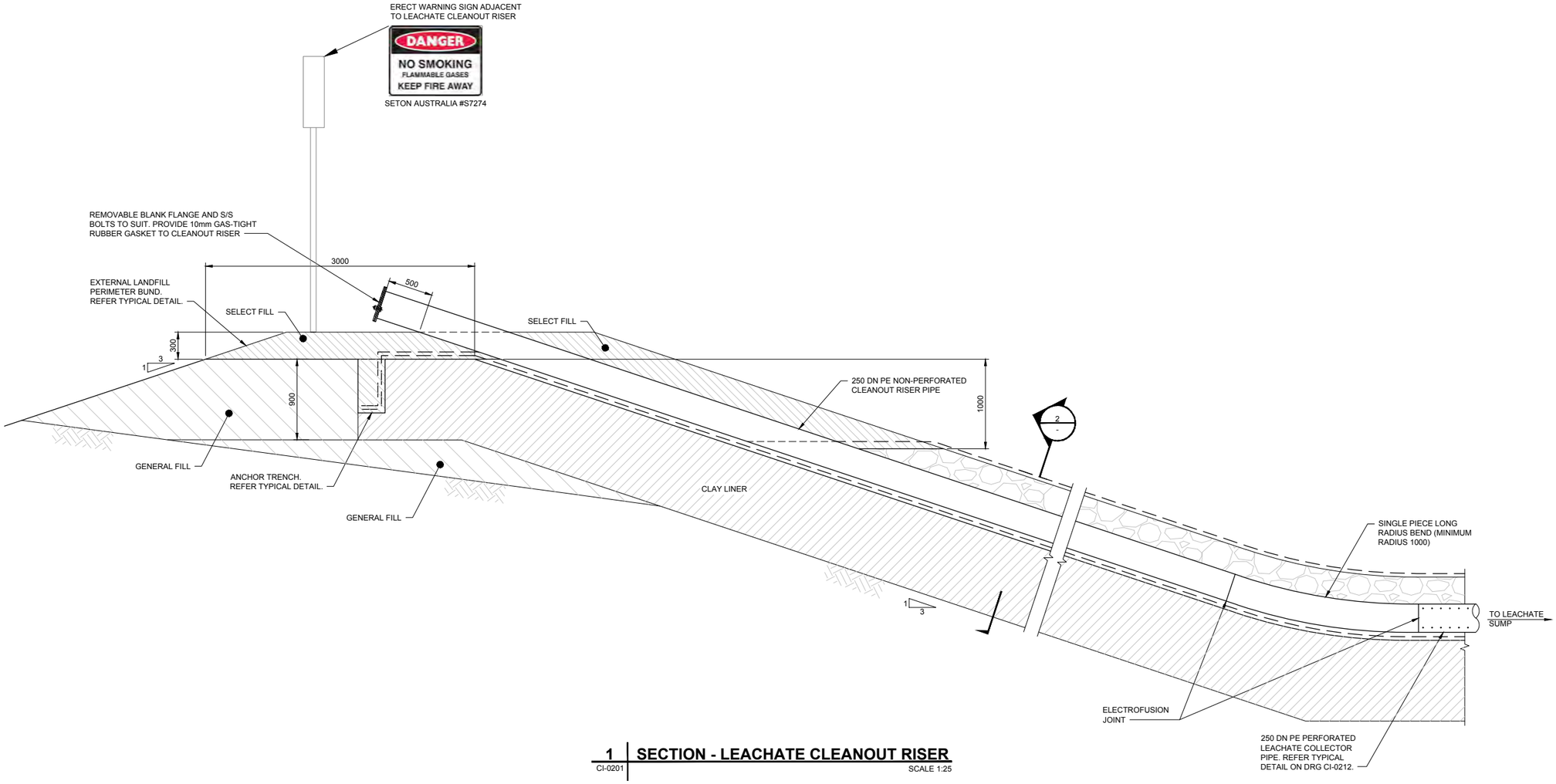
60011672

SHEET TITLE

SITE SERVICES PLAN

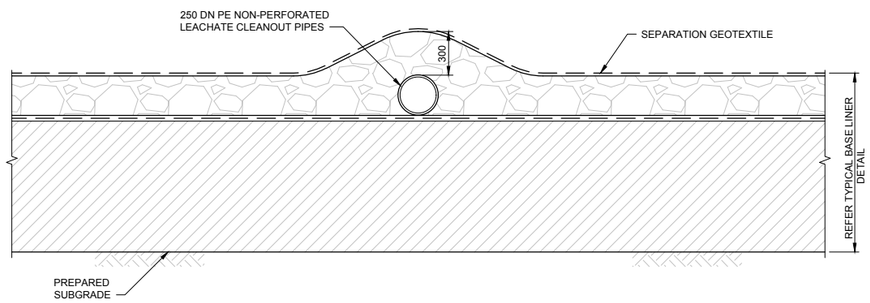
SHEET NUMBER

60011672-SHT-CI-0202



1 | SECTION - LEACHATE CLEANOUT RISER

CI-0201 SCALE 1:25



2 | SECTION - TYPICAL LEACHATE CLEANOUT PIPE

\- SCALE 1:20

0 500 1000 mm
1:20

0 625 1250 mm
1:25

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PROJECT

Armidale Landfill - Cell 1 Works

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KEY PLAN

PROJECT NUMBER

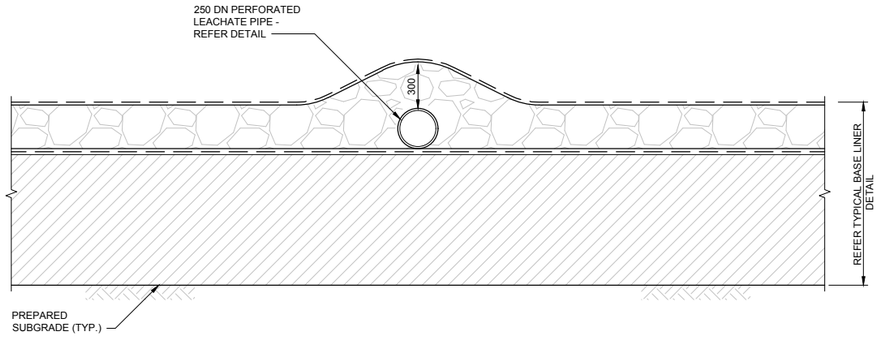
60011672

SHEET TITLE

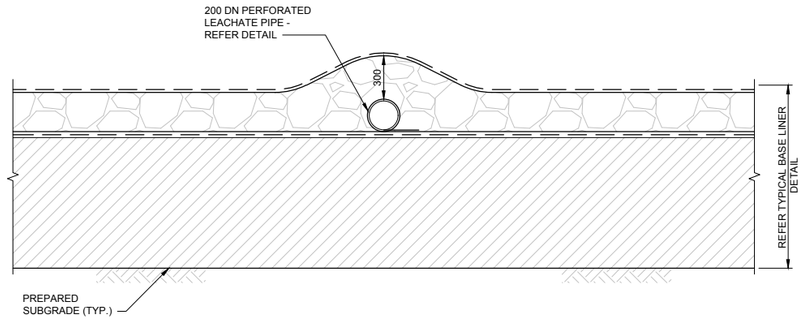
LEACHATE COLLECTION SYSTEM
TYPICAL DETAILS
SHEET 1

SHEET NUMBER

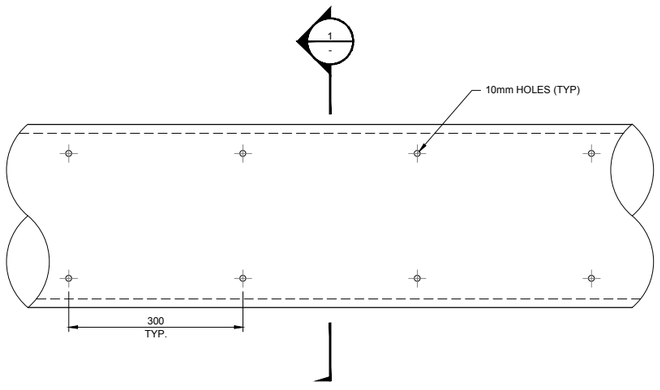
60011672-SHT-CI-0211



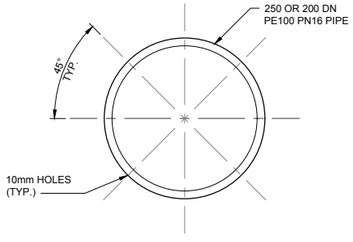
2 | SECTION - MAIN LEACHATE COLLECTION PIPE
CI-0201 | SCALE 1:20



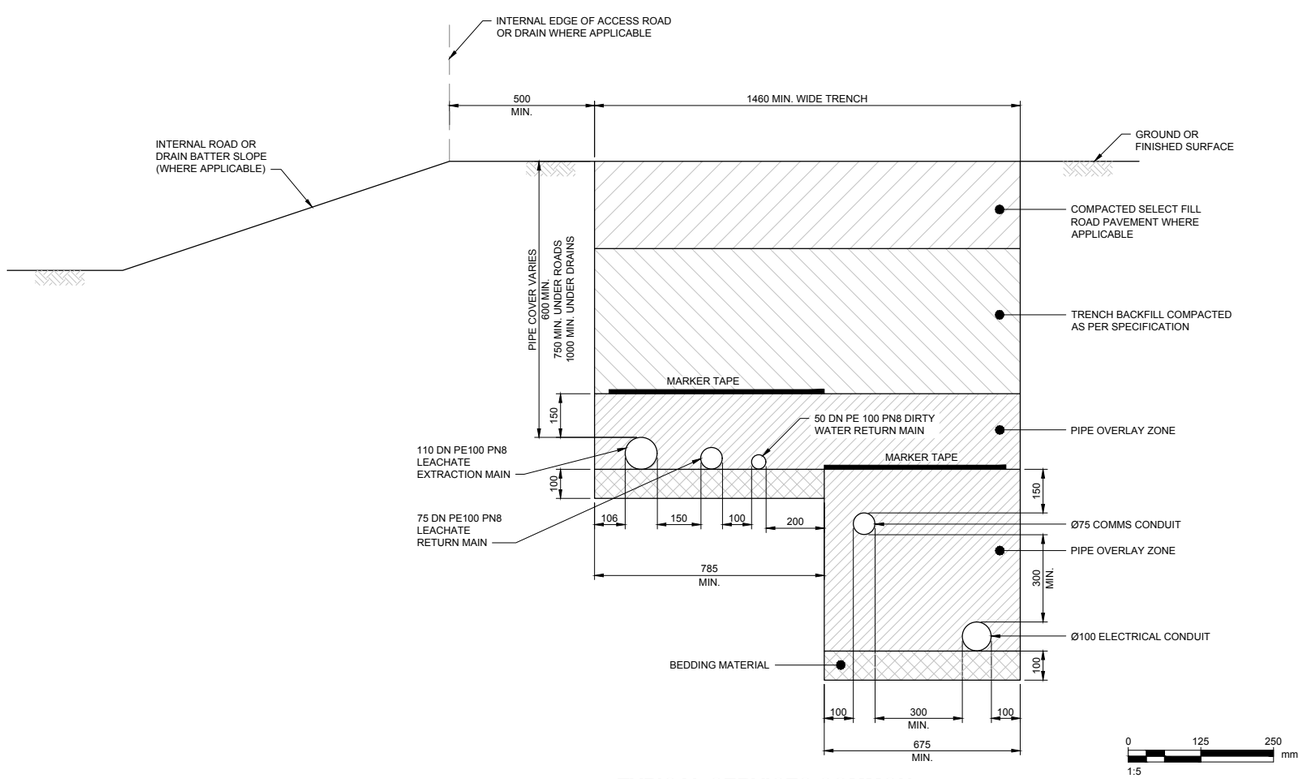
3 | SECTION - LATERAL LEACHATE COLLECTION PIPE
CI-0201 | SCALE 1:20



TYPICAL LEACHATE COLLECTION PIPE PERFORATION DETAIL
SCALE 1:5



1 | SECTION
- | SCALE 1:5



TYPICAL SERVICES COMMON TRENCH DETAIL
SCALE 1:10

0 125 250 mm
1:5
0 250 500 mm
1:10
0 500 1000 mm
1:20

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PROJECT
Armidale Landfill - Cell 1 Works

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REGISTRATION

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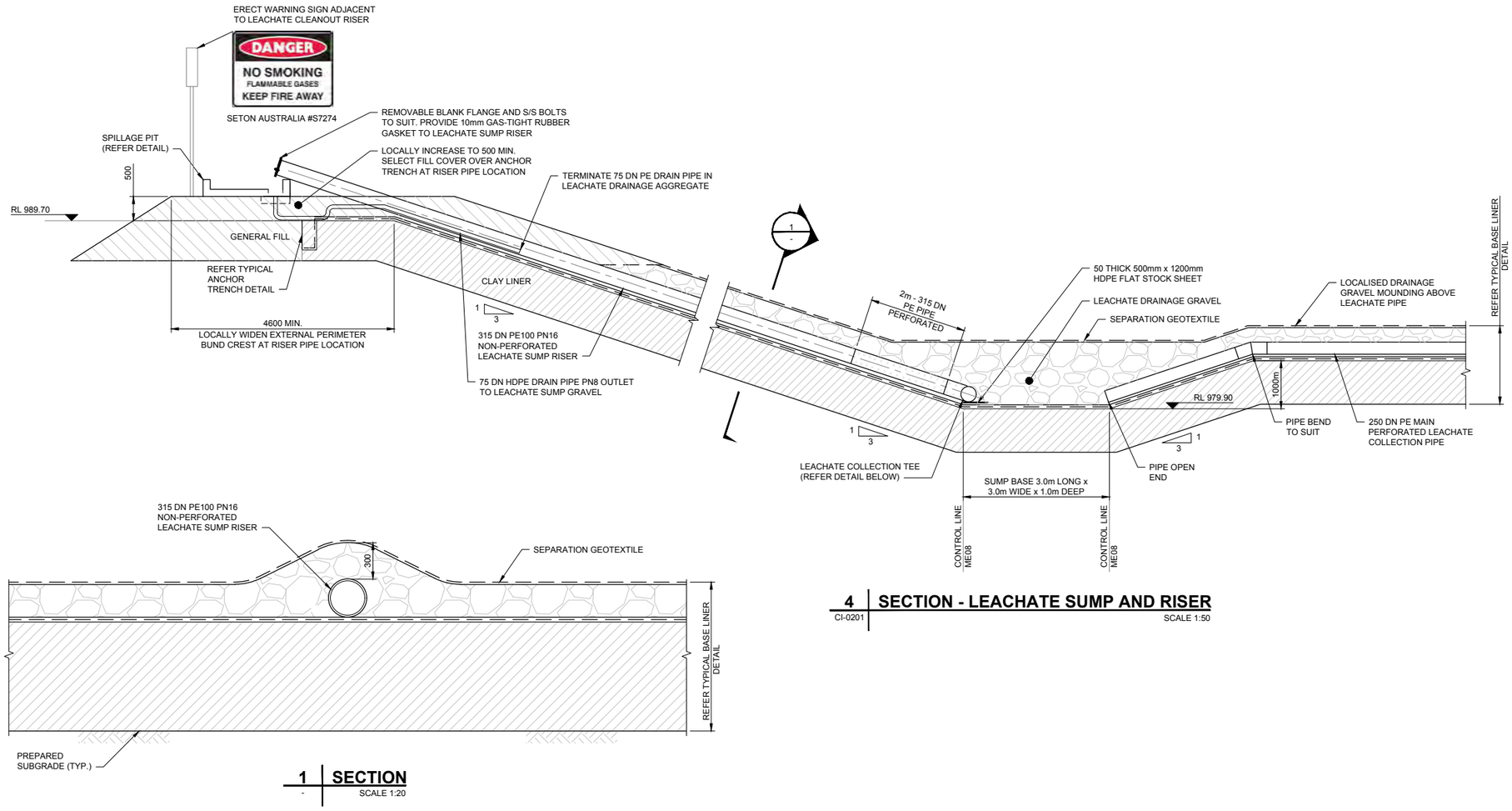
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER
60011672

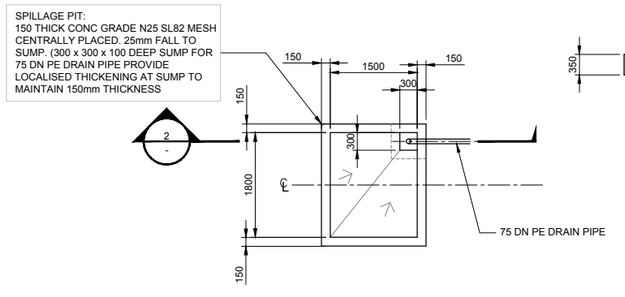
SHEET TITLE
LEACHATE COLLECTION SYSTEM
TYPICAL DETAILS
SHEET 2

SHEET NUMBER
60011672-SHT-CI-0212

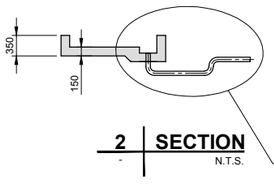


4 | SECTION - LEACHATE SUMP AND RISER
CI-0201 SCALE 1:50

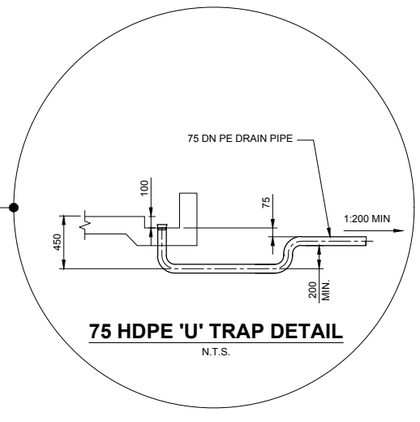
1 | SECTION
- SCALE 1:20



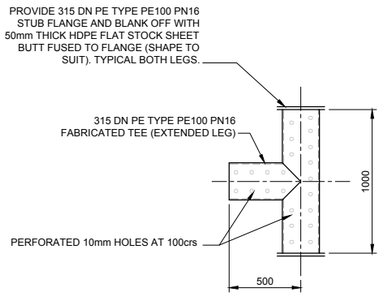
SPILLAGE PIT PLAN
N.T.S.



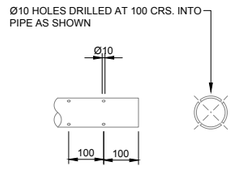
2 | SECTION
- N.T.S.



75 HDPE 'U' TRAP DETAIL
N.T.S.



LEACHATE COLLECTION RISER AND TEE DETAIL
N.T.S.



315 DN PE PIPE PERFORATION DETAIL
N.T.S.

0 500 1000 mm
1:20

0 1250 2500 mm
1:50

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
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CONSULTANT
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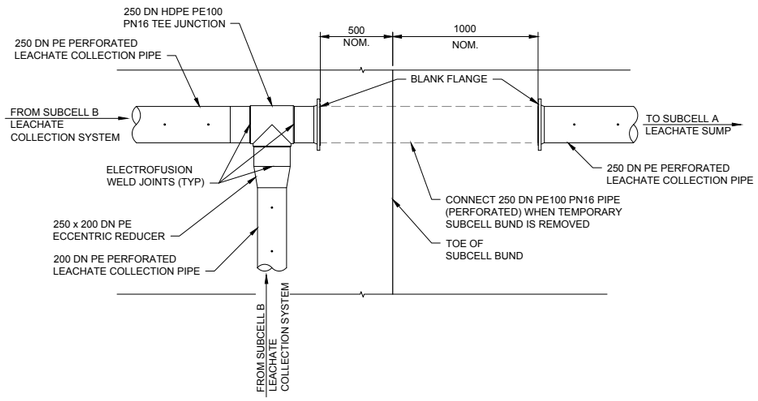
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER
60011672

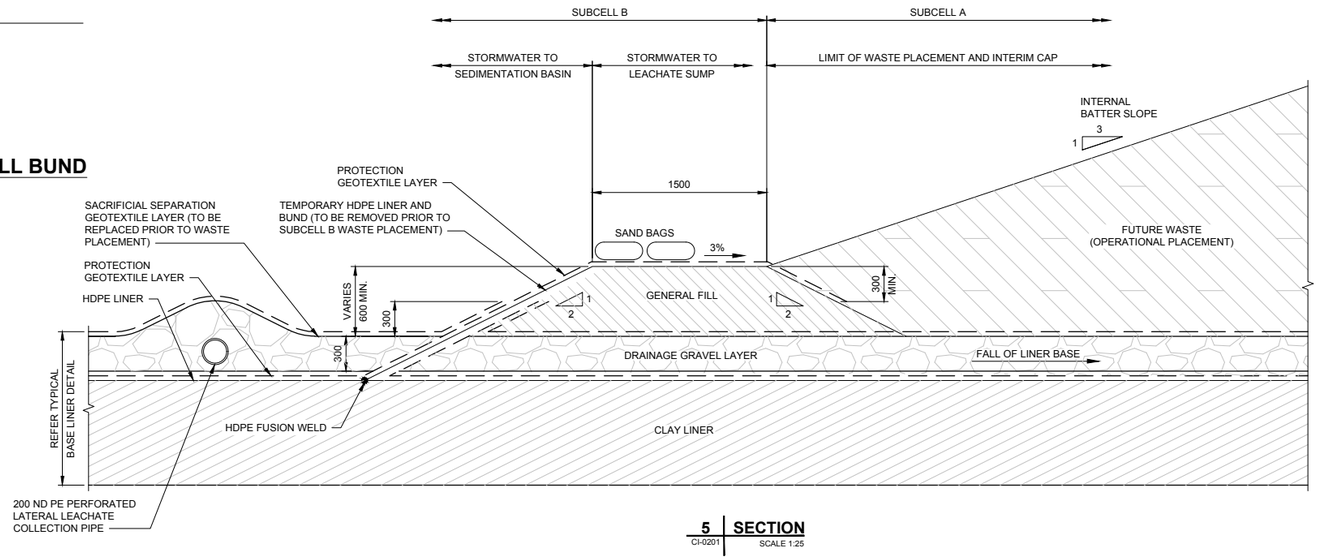
SHEET TITLE
LEACHATE COLLECTION SYSTEM TYPICAL DETAILS SHEET 3

SHEET NUMBER
60011672-SHT-CI-0213



LEACHATE COLLECTION PIPE AT SUBCELL BUND CONNECTION DETAIL

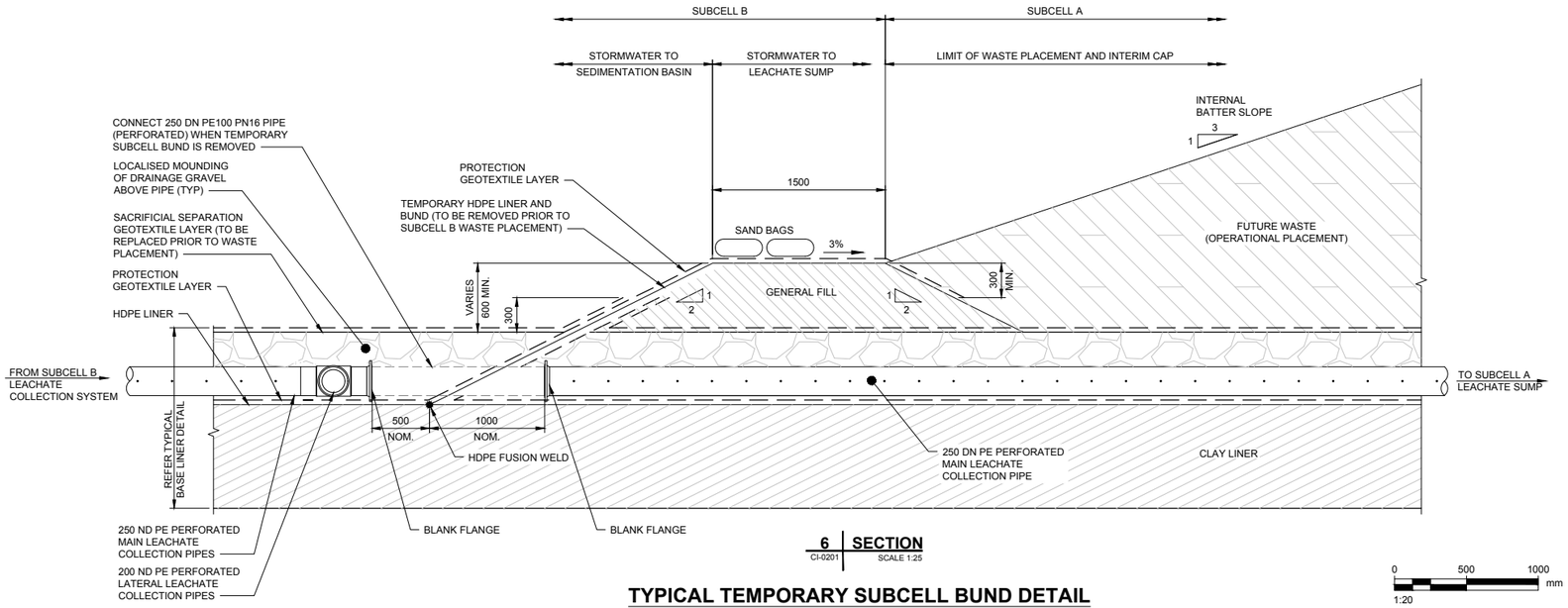
SCALE 1:20



5 CI-0201 **SECTION**

SCALE 1:25

TYPICAL TEMPORARY SUBCELL BUND DETAIL (OUTSIDE LEACHATE COLLECTION PIPE)



6 CI-0201 **SECTION**

SCALE 1:25

TYPICAL TEMPORARY SUBCELL BUND DETAIL (AT LEACHATE COLLECTION PIPE)

0 500 1000 mm
1:20

0 625 1250 mm
1:25

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PROJECT

Armidale Landfill - Cell 1 Works

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KEY PLAN

PROJECT NUMBER

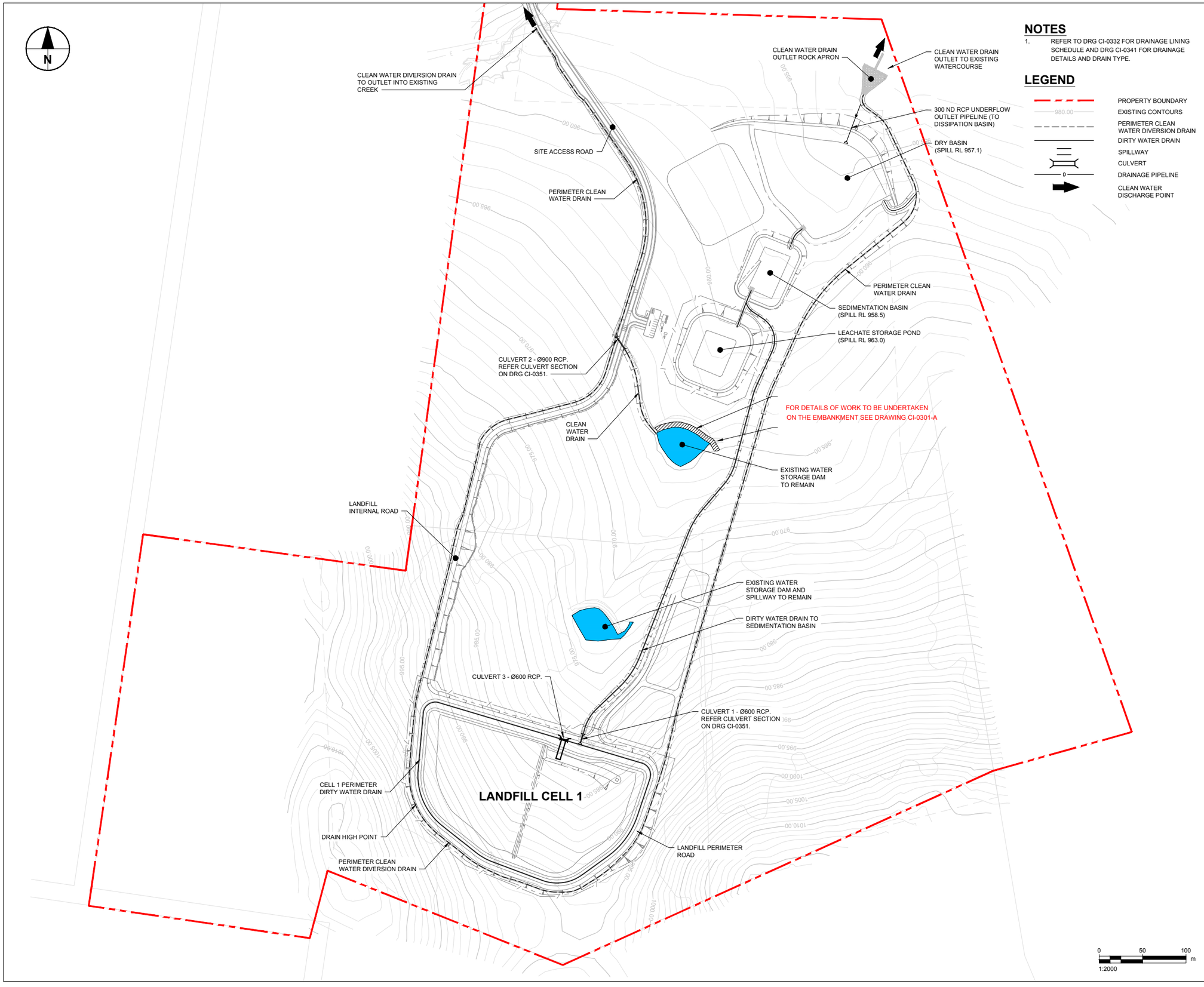
60011672

SHEET TITLE

LEACHATE COLLECTION SYSTEM
TYPICAL DETAILS
SHEET 4

SHEET NUMBER

60011672-SHT-CI-0214



NOTES

1. REFER TO DRG CI-0332 FOR DRAINAGE LINING SCHEDULE AND DRG CI-0341 FOR DRAINAGE DETAILS AND DRAIN TYPE.

LEGEND

- PROPERTY BOUNDARY
- EXISTING CONTOURS
- PERIMETER CLEAN WATER DIVERSION DRAIN
- DIRTY WATER DRAIN
- SPILLWAY
- CULVERT
- DRAINAGE PIPELINE
- CLEAN WATER DISCHARGE POINT

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PROJECT

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KEY PLAN

PROJECT NUMBER

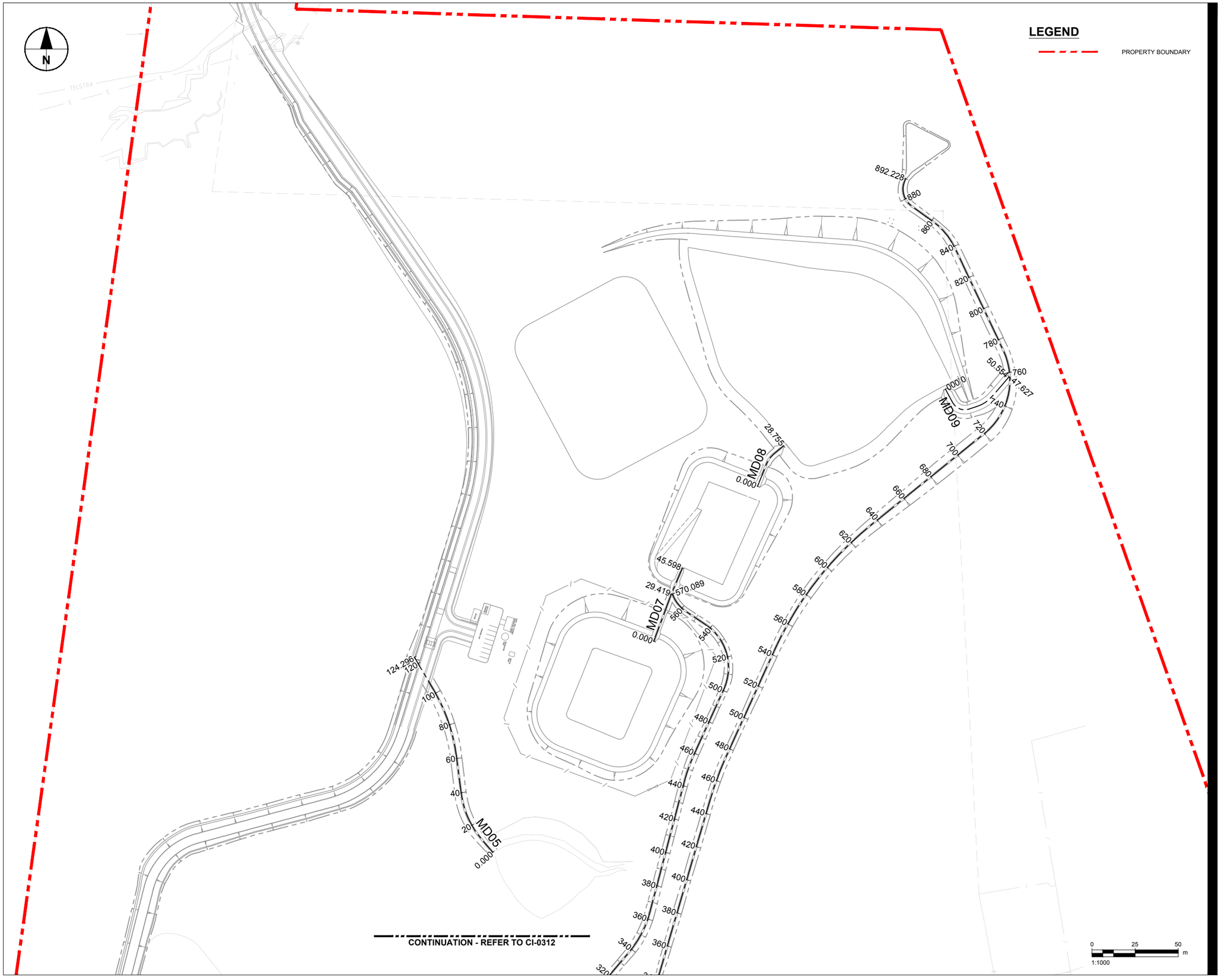
60011672

SHEET TITLE

DRAINAGE PLAN

SHEET NUMBER

60011672-SHT-CI-0301



AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

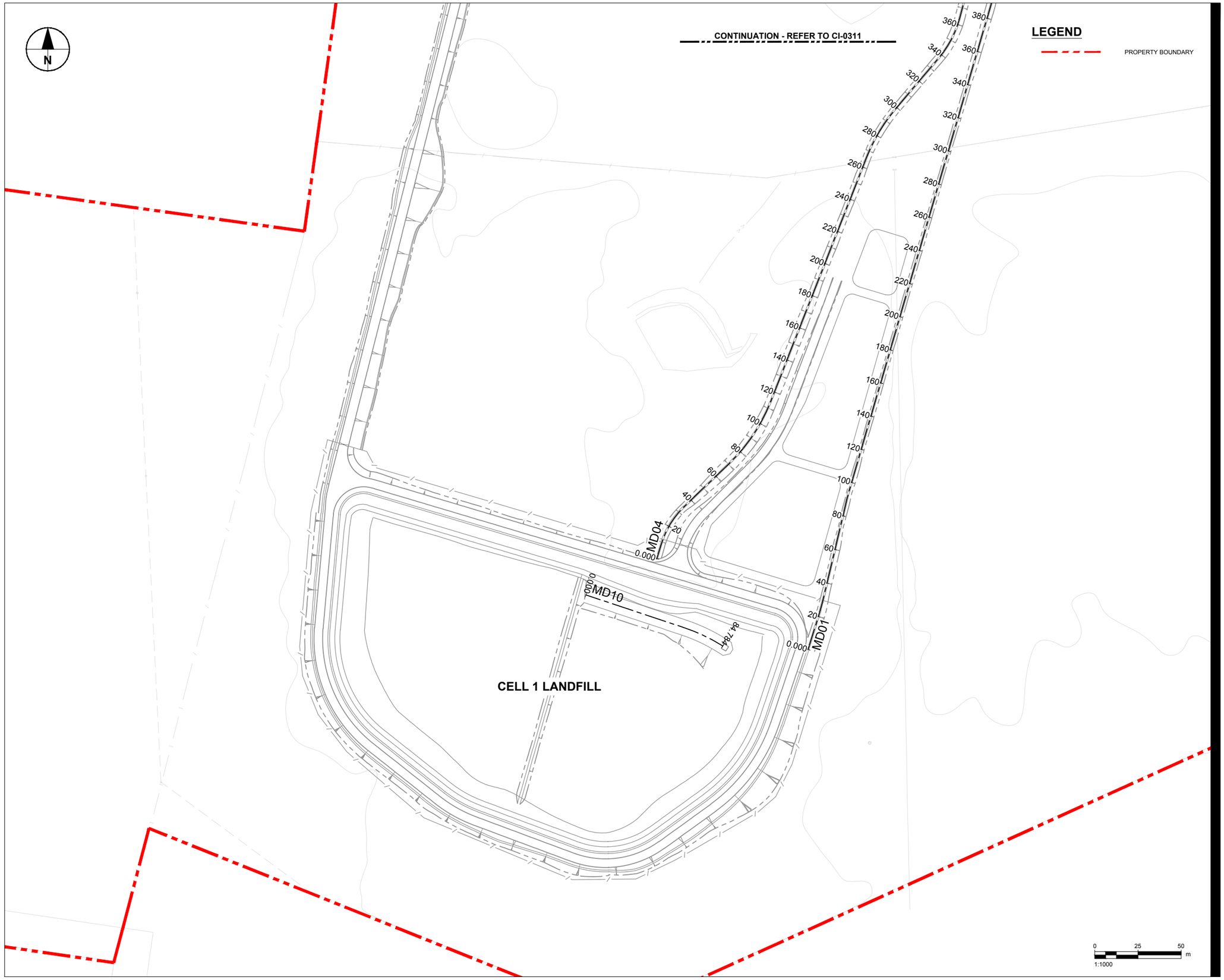
60011672

SHEET TITLE

DRAINAGE CONTROL STRING PLAN
SHEET 1

SHEET NUMBER

60011672-SHT-CI-0311



AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?

☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

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DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

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F	21.10.2015	REISSUED FOR TENDER
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D	29.06.2015	ISSUED FOR TENDER
C	02.03.2015	DETAILED DESIGN
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

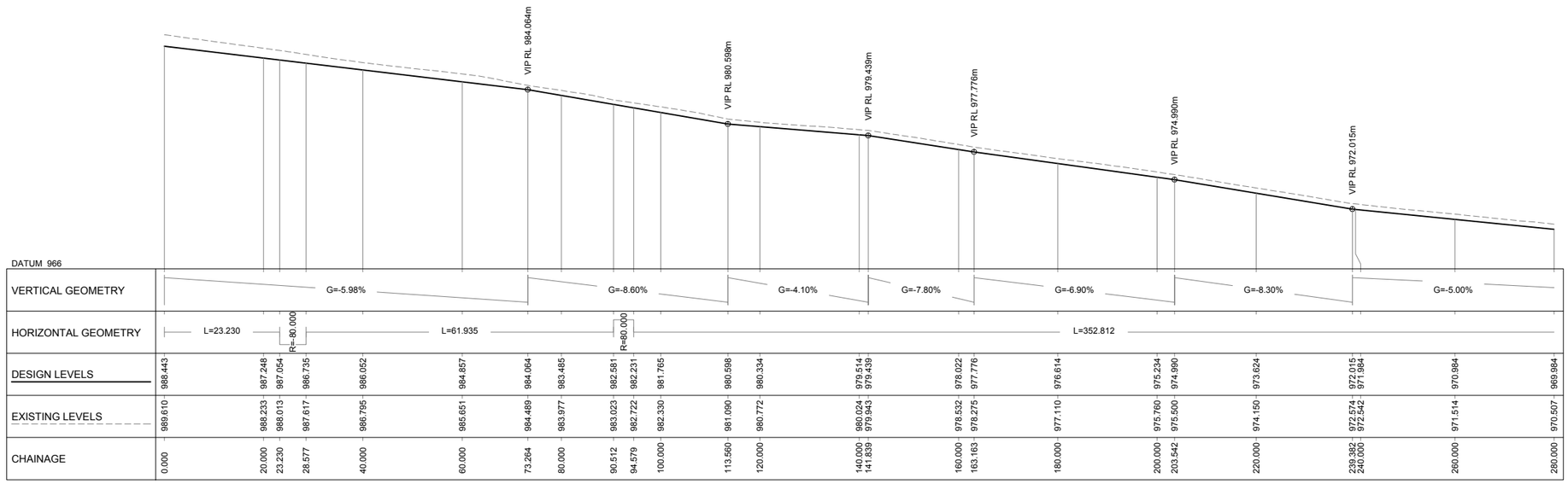
60011672

SHEET TITLE

DRAINAGE CONTROL STRING PLAN
SHEET 2

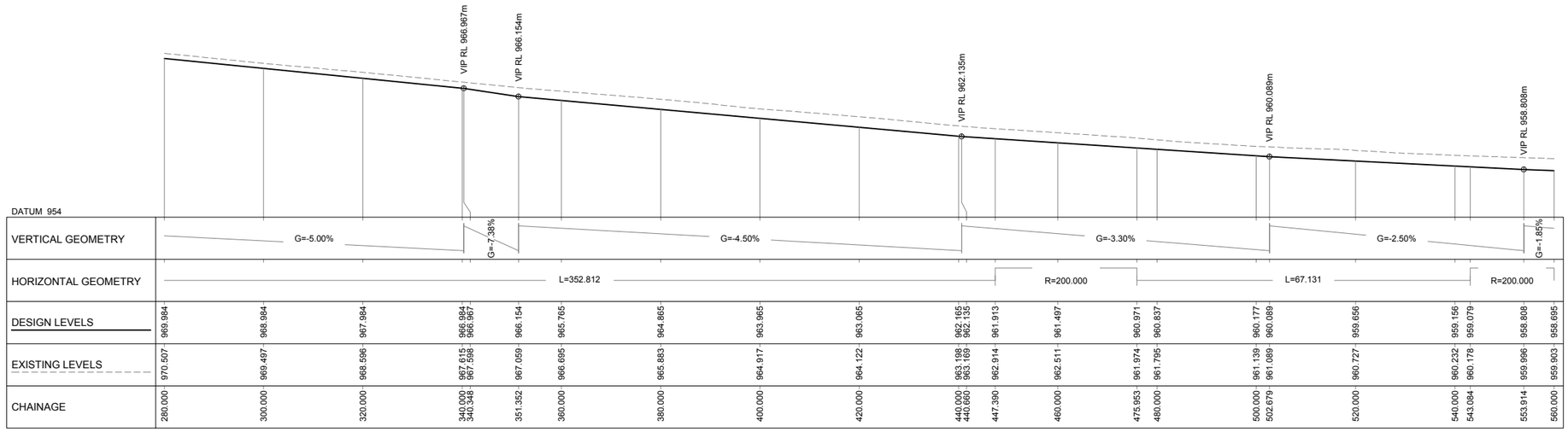
SHEET NUMBER

60011672-SHT-CI-0312



LONGITUDINAL SECTION - MD01

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



LONGITUDINAL SECTION - MD01

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

0 12.5 25 m
1:500

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KEY PLAN

PROJECT NUMBER

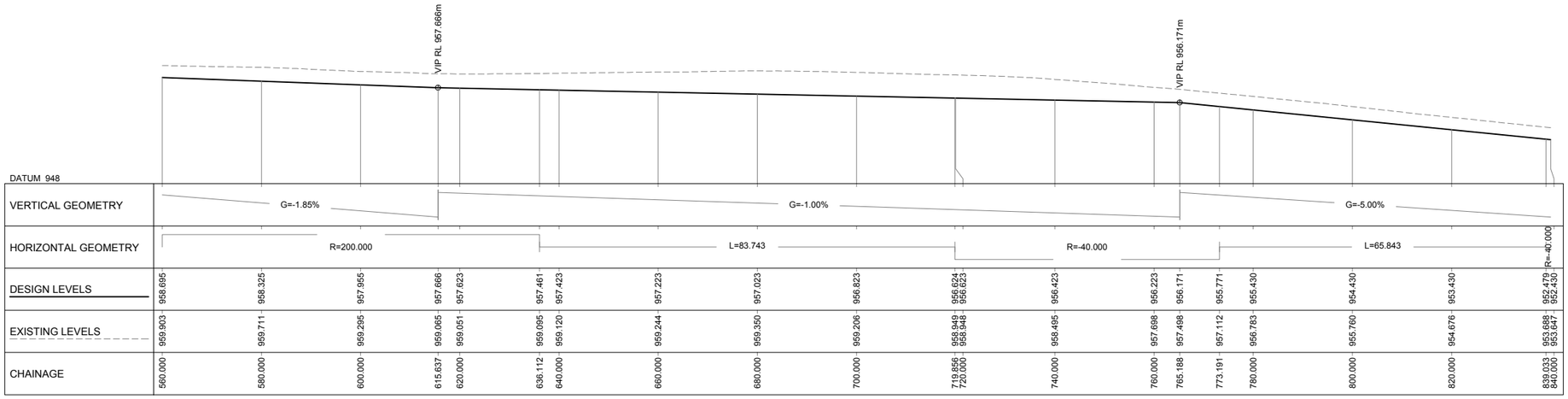
60011672

SHEET TITLE

DRAINAGE
LONGITUDINAL SECTIONS

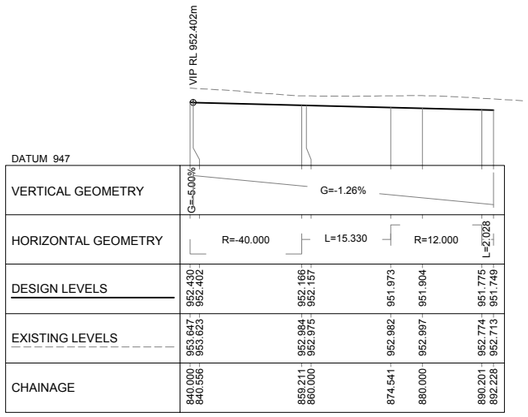
SHEET NUMBER

60011672-SHT-CI-0321



LONGITUDINAL SECTION - MD01

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



LONGITUDINAL SECTION - MD01

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

0 12.5 25 m
1:500

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PROJECT

Armidale Landfill - Cell 1 Works

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KEY PLAN

PROJECT NUMBER

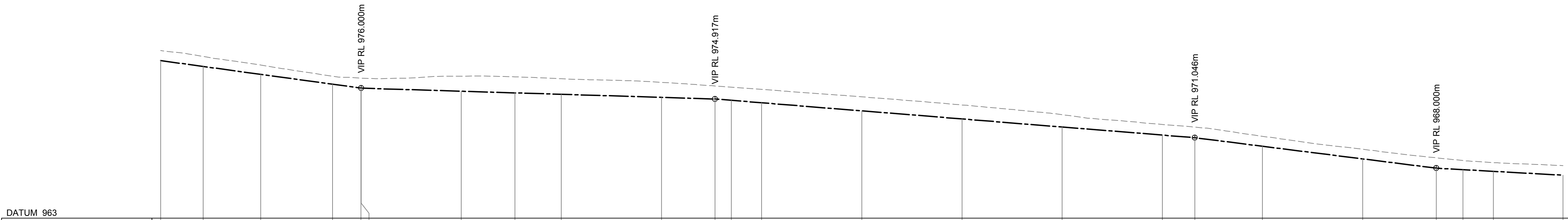
60011672

SHEET TITLE

DRAINAGE
LONGITUDINAL SECTIONS

SHEET NUMBER

60011672-SHT-CI-0322



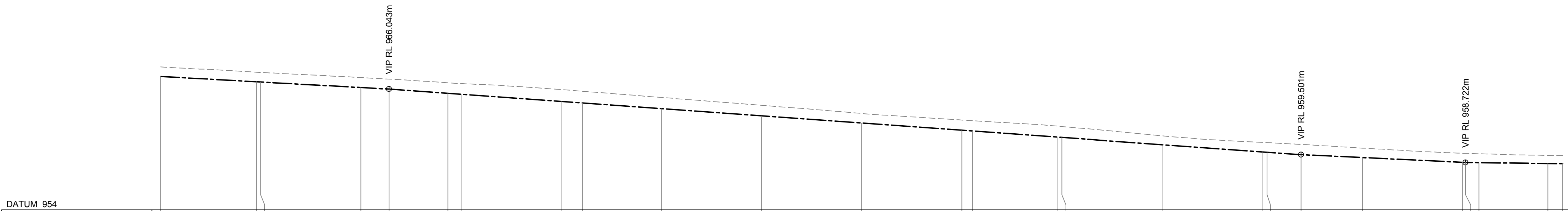
VERTICAL GEOMETRY: G=-6.88% | G=-1.53% | G=-4.04% | G=-6.32% | G=-2.76%

HORIZONTAL GEOMETRY: L=8.495 | R=50.000 | L=36.411 | R=-100.000 | L=152.138 | R=100.000

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
0.000	978.754	979.754
8.495	978.170	979.167
20.000	977.379	978.309
34.345	976.393	977.192
40.000	976.004	977.002
40.060	976.000	977.000
60.000	975.694	977.193
70.755	975.529	977.137
80.000	975.387	976.946
100.000	975.080	976.584
110.680	974.917	976.224
113.942	974.785	976.102
120.000	974.540	975.874
140.000	973.732	975.134
160.000	972.924	974.323
180.000	972.116	973.348
200.000	971.308	972.373
206.490	971.046	972.107
220.000	970.192	971.190
240.000	968.928	969.892
254.682	968.000	969.036
260.000	967.853	968.768
266.080	967.686	968.562
280.000	967.302	968.252

LONGITUDINAL SECTION - MD04

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



VERTICAL GEOMETRY: G=-2.76% | G=-3.59% | G=-2.37% | G=-0.63%

HORIZONTAL GEOMETRY: R=100.000 | L=14.833 | L=23.407 | R=-60.000 | L=77.877 | R=100.000 | L=41.800 | R=-30.000 | L=13.748 | R=20.000

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
280.000	967.302	968.252
299.152	966.774	967.733
300.000	966.750	967.710
320.000	966.199	967.197
325.639	966.043	967.043
337.391	965.621	966.677
340.000	965.527	966.597
360.000	964.809	965.994
364.242	964.656	965.831
380.000	964.090	965.214
400.000	963.372	964.426
420.000	962.654	963.616
440.000	961.935	962.957
442.119	961.859	962.896
459.170	961.247	962.343
460.000	961.217	962.307
480.000	960.499	961.380
500.000	959.780	960.726
500.971	959.746	960.702
507.765	959.501	960.525
520.000	959.211	960.157
540.000	958.736	959.643
540.590	958.722	959.634
543.287	958.705	959.594
557.036	958.619	959.426
560.000	958.600	959.405

LONGITUDINAL SECTION - MD04

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250
0 12.5 25 m
1:500

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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SAFETY IN DESIGN INFORMATION

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KEY PLAN

PROJECT NUMBER

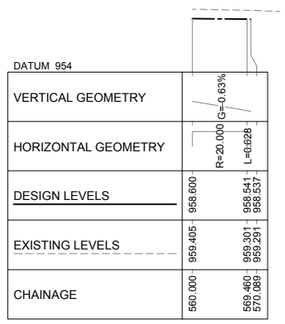
60011672

SHEET TITLE

DRAINAGE
LONGITUDINAL SECTIONS

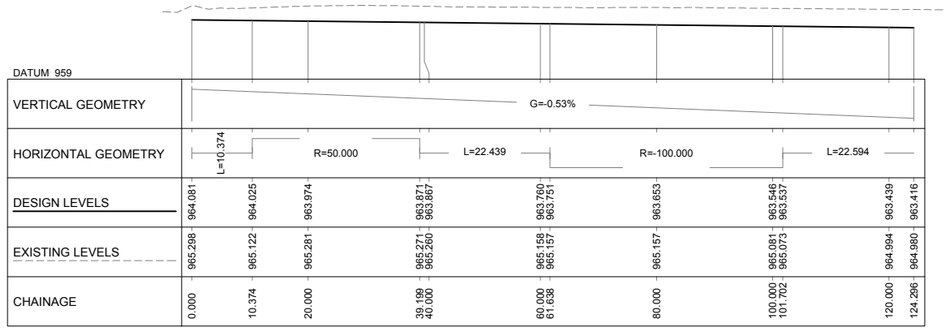
SHEET NUMBER

60011672-SHT-CI-0323



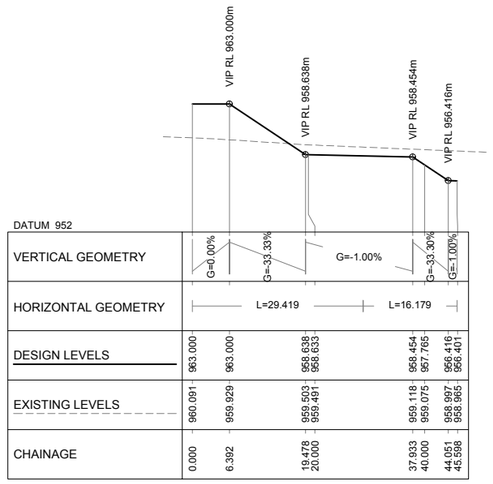
LONGITUDINAL SECTION - MD04

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



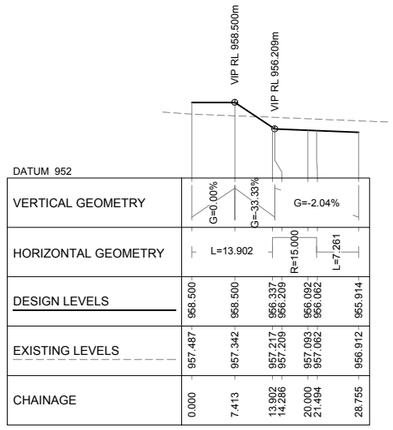
LONGITUDINAL SECTION - MD05

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



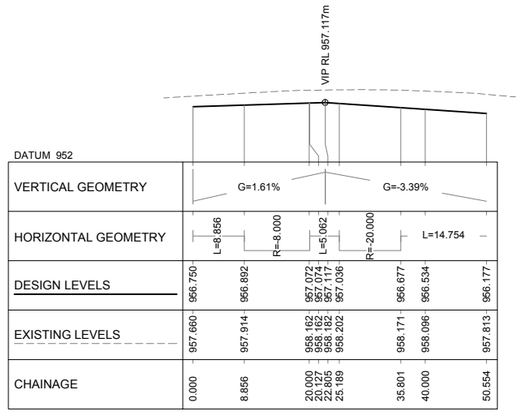
LONGITUDINAL SECTION - MD07

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



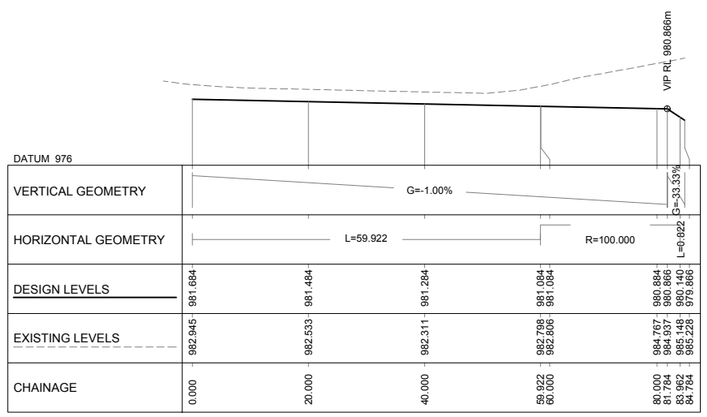
LONGITUDINAL SECTION - MD08

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



LONGITUDINAL SECTION - MD09

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250



LONGITUDINAL SECTION - MD10

A1 HORIZONTAL SCALE 1:500
A1 VERTICAL SCALE 1:250

0 6.25 12.5 m
1:250

0 12.5 25 m
1:500

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

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REGISTRATION

FOR CONSTRUCTION

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KEY PLAN

PROJECT NUMBER

60011672

SHEET TITLE

DRAINAGE
LONGITUDINAL SECTIONS

SHEET NUMBER

60011672-SHT-CI-0324

DRAIN LINING SCHEDULE

CONTROL STRING	DRAIN TYPE	CHAINAGE	LINING TYPE	DETAIL REFERENCE
MD01	CLEAN WATER	CH 0.000 - CH 892.2 EXCEPT 3 SECTIONS SHOWN BELOW	TYPE 2A OR 2B	CI-0341
		CH 100.0 - CH 120.0	TYPE 3 - ROCK FILL	
		CH 230.0 - CH 250.0		
		CH 340.0 - CH 360.0		
MD05	CLEAN WATER	CH 0.0 - CH 124.3	TYPE 2A OR 2B	
MC01	CLEAN WATER	CH 0.0 - CH 496.8 EXCEPT 2 SECTIONS SHOWN BELOW	TYPE 2A OR 2B	
		CH 310.0 - CH 340.08	TYPE 3 - ROCK FILL	
		CH 440.0 - CH 480.0		
MC03A	CLEAN WATER	CH 38.0 - CH 515.0	TYPE 1 - HYDROSEED	
MC03B	DIRTY WATER	CH 0.0 - CH 790.0	TYPE 1 - HYDROSEED	
MD04	DIRTY WATER	CH 0.0 - CH 570.1 EXCEPT 1 SECTION SHOWN BELOW	TYPE 1 - HYDROSEED	
		CH 0.0 - CH 40.0	TYPE 2A OR 2B	
MD07	DIRTY WATER	CH 0.0 - CH 45.6 EXCEPT 2 SECTIONS SHOWN BELOW	TYPE 1 - HYDROSEED	
		CH 6.4 - CH 19.5	TYPE 2A OR 2B	
		CH 37.9 - CH 44.1		
MD08	DIRTY WATER	CH 0.0 - CH 28.8 EXCEPT 1 SECTION SHOWN BELOW	TYPE 1 - HYDROSEED	
		CH 7.4 - CH 13.9	TYPE 2A OR 2B	
MD05	DRY BASIN SPILLWAY	CH 0.0 - CH 50.6	TYPE 1 - HYDROSEED	

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KEY PLAN

PROJECT NUMBER

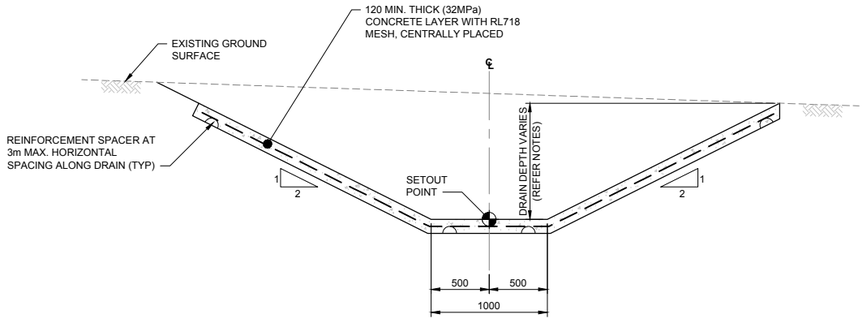
60011672

SHEET TITLE

DRAINAGE LINING SCHEDULE

SHEET NUMBER

60011672-SHT-CI-0332



DRAIN - LINED - TYPE 2B TYPICAL DETAIL

SCALE 1:25

NOTES

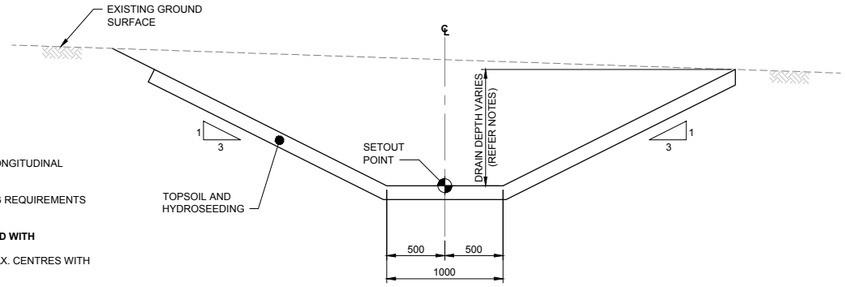
FOR DRAIN DEPTHS REFER TO DRAINAGE LONGITUDINAL SECTIONS OR ROAD CROSS SECTIONS.

FOR DIRTY AND CLEAN WATER DRAIN LINING REQUIREMENTS REFER TO DRAIN LINING SCHEDULE.

CONCRETE CHANNELS TO BE CONSTRUCTED WITH

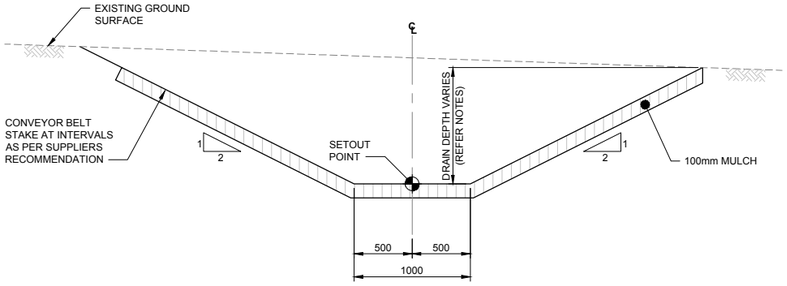
CONSTRUCTION (SAWCUT) JOINTS AT 5m MAX. CENTRES WITH NO FILL.

EXPANSION (DOWELLED) JOINTS AT 10m MAX. SPACINGS INCORPORATING R10 GALVANISED STEEL DOWELS 400mm LONG AT 500mm INTERVALS WITH 10mm ABLEFLEX JOINT FILLER BETWEEN.



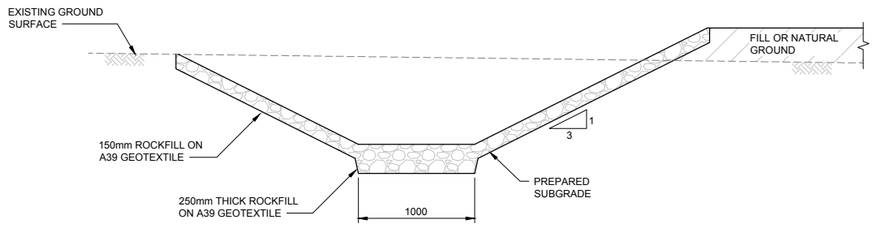
DRAIN - TOPSOIL AND HYDROSEED - TYPE 1 TYPICAL DETAIL

SCALE 1:25



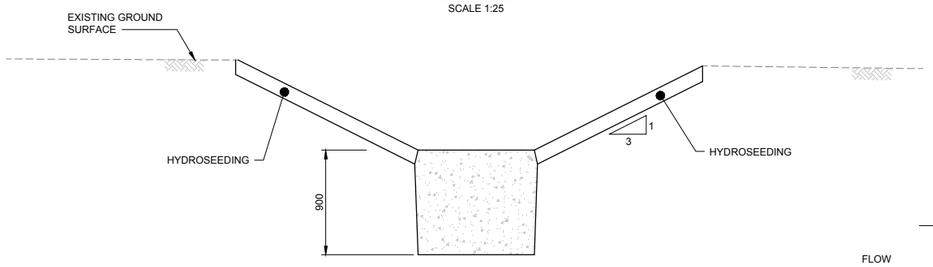
DRAIN - LINED - TYPE 2A TYPICAL DETAIL

SCALE 1:25



DIVERSION DRAIN - TYPE 3 TYPICAL DETAIL

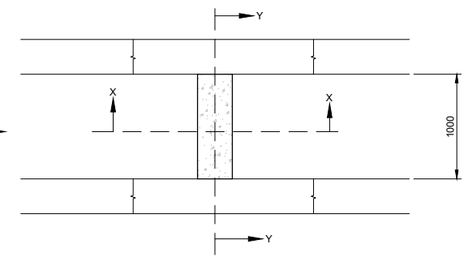
SCALE 1:25



Y-Y

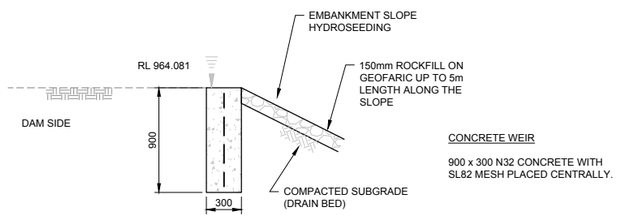
SCALE 1:25

FLOW



PLAN

SCALE 1:25



CONCRETE WEIR

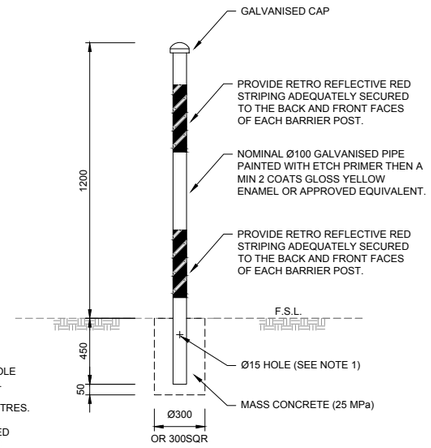
900 x 300 N32 CONCRETE WITH SL82 MESH PLACED CENTRALLY.

SECTION X-X

SCALE 1:25

NOTES

1. PLACE 150mm N12 BAR IN HOLE BEFORE FIXING INTO PLACE.
2. ALL DIMENSIONS IN MILLIMETRES.
3. ALL STEEL TO BE HOT DIPPED GALVANISED OR APPROVED EQUIVALENT.



BOLLARD DETAIL

N.T.S.

CONCRETE OVERFLOW WEIR DETAILS

0 625 1250 mm

1:25

AECOM

PROJECT

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KEY PLAN

PROJECT NUMBER

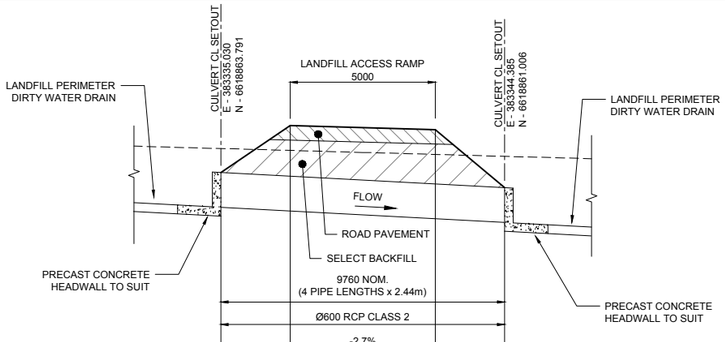
60011672

SHEET TITLE

DRAINAGE
TYPICAL DETAILS

SHEET NUMBER

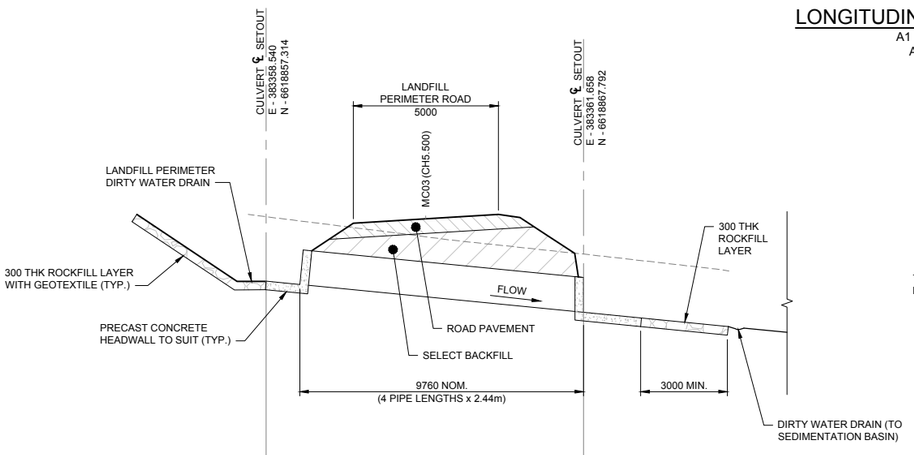
60011672-SHT-CI-0341



DESIGN LEVELS	980.487	981.293	981.224	980.226
DEPTH TO INVERT	1.012			1.139
INVERT LEVELS	979.886			979.625
EXISTING LEVELS	980.898			980.764
CHAINAGE	0.000	2.380	7.380	9.760

LONGITUDINAL SECTION - CULVERT 3

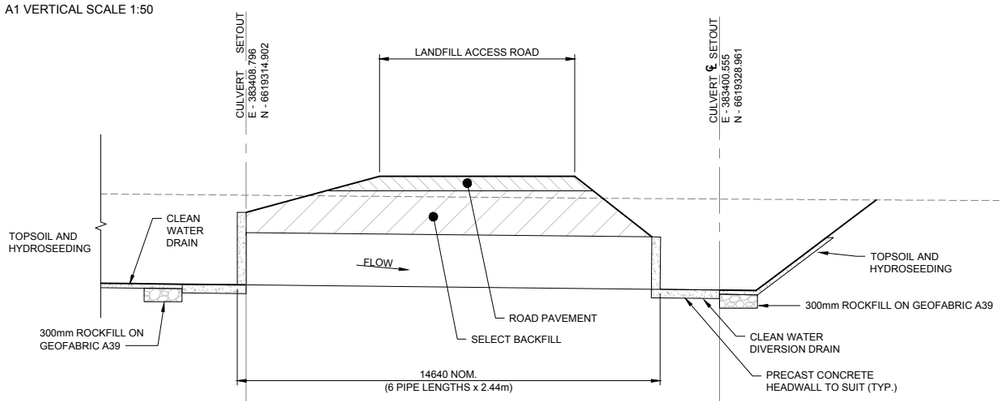
A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:50



PIPE CLASS AND SIZE	600Ø RCP CLASS 2	
GRADE	-5%	
DATUM 972.00		
DESIGN LEVELS	979.288	978.754
DEPTH TO INVERT	1.108	1.000
INVERT LEVELS	979.290	978.754
EXISTING LEVELS	980.398	979.754
CHAINAGE	0.000	10.932

LONGITUDINAL SECTION - CULVERT 1

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:50



PIPE CLASS AND SIZE	900Ø RCP CLASS 2	
GRADE	-0.5%	
DATUM 957.00		
DESIGN LEVELS	963.503	963.424
DEPTH TO INVERT	1.543	1.564
INVERT LEVELS	963.503	963.416
EXISTING LEVELS	965.046	964.980
CHAINAGE	0.000	16.296

LONGITUDINAL SECTION - CULVERT 2

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:50

0 5 10 m
1:200

0 2.5 5 m
1:100

AECOM

PROJECT

Armidale Landfill - Cell 1 Works

CLIENT

Armidale Regional Council

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION

ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?
☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	DP
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
F	21.10.2015	REISSUED FOR TENDER
E	18.09.2015	ISSUED FOR TENDER
D		NOT ISSUED
C		NOT ISSUED
B		NOT ISSUED
A		NOT ISSUED

KEY PLAN

PROJECT NUMBER

60011672

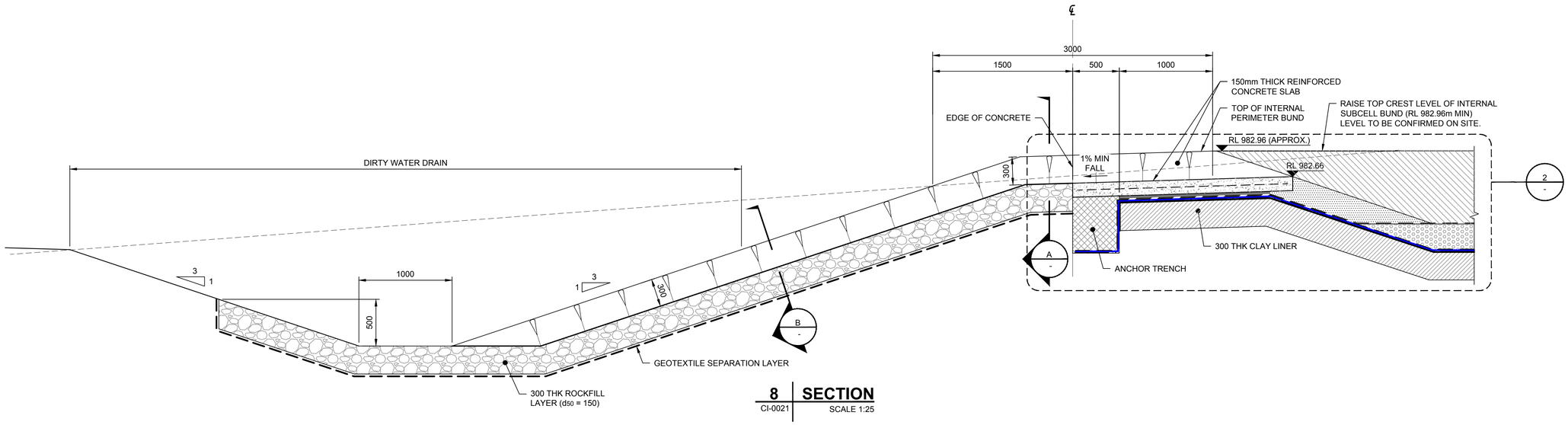
SHEET TITLE

DRAINAGE
CULVERT LONGITUDINAL SECTIONS

SHEET NUMBER

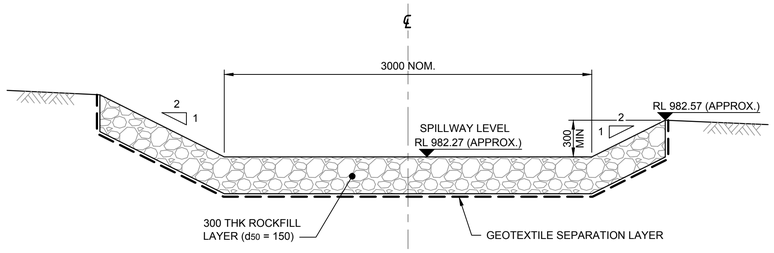
60011672-SHT-CI-0351

ISO A1 594mm x 841mm



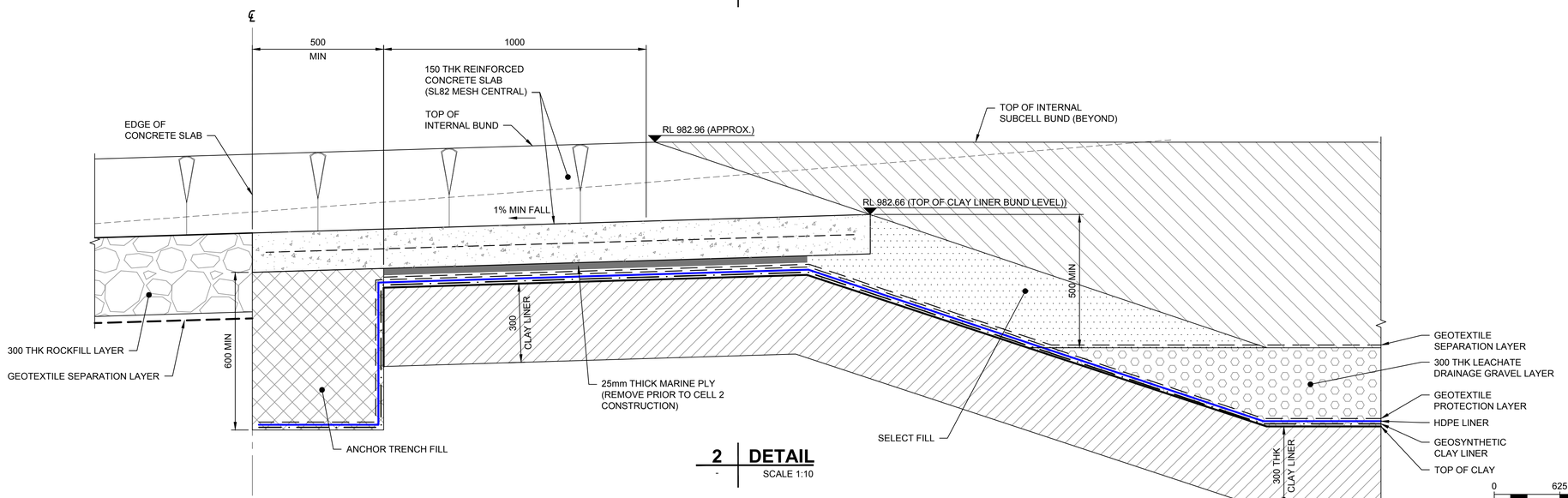
8 | SECTION
CI-0021 | SCALE 1:25

TYPICAL SECTION THROUGH TEMPORARY SUBCELL B SPILLWAY



A | SECTION
- | SCALE 1:25

B | SECTION
- | SIMILAR



2 | DETAIL
- | SCALE 1:10

0 625 1250 mm
1:25

0 250 500 mm
1:10

Last saved by: WONGJ3(2017-01-12) Last Plotted: 2017-01-12
Filename: I:\P\60X\60011672\5. CAD\02-SHEETS\60011672-SHT-CI-0352.DWG

This drawing is confidential and shall only be used for the purpose of this project. The signing of this title block confirms the design and drafting of this project have been prepared and checked in accordance with the AECOM quality assurance system to ISO 9001:2000.

AECOM

PROJECT
Armidale Landfill - Cell 1 Works

CLIENT
Armidale Dumaresq Council

CONSULTANT
AECOM Australia Pty Ltd
A.B.N 20 093 846 925
www.aecom.com

SAFETY IN DESIGN INFORMATION
ARE THERE ANY ADDITIONAL HAZARDS / RISKS NOT NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING?
☒ NO
☐ YES

REGISTRATION

FOR CONSTRUCTION

PROJECT MANAGEMENT INITIALS

AK	SC	#VALUE!
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

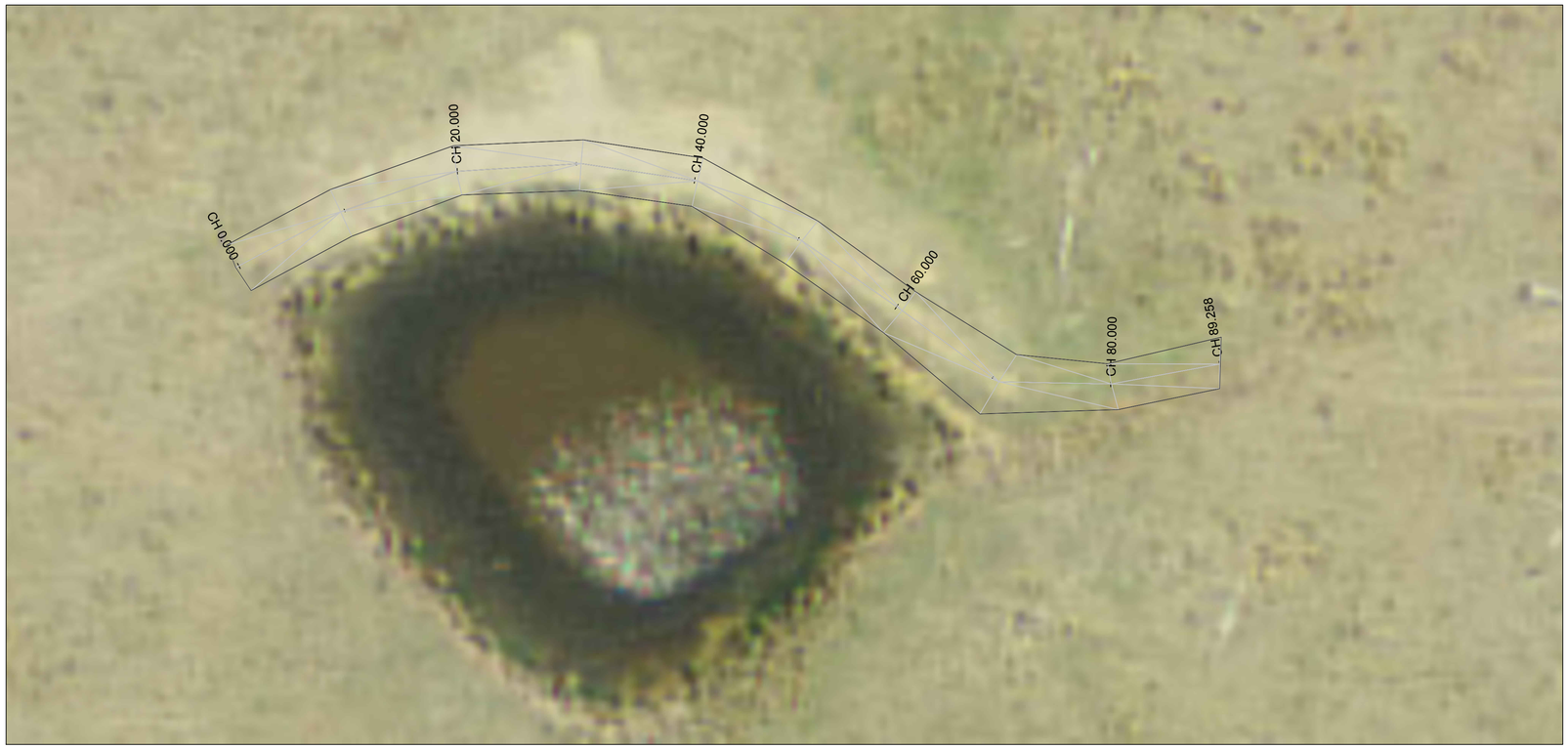
A	12.01.2017	REVISED TENDER ISSUE
I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER
60011672

SHEET TITLE
DRAINAGE
TEMPORARY SUBCELL B SPILLWAY

SHEET NUMBER
60011672-SHT-CI-0352



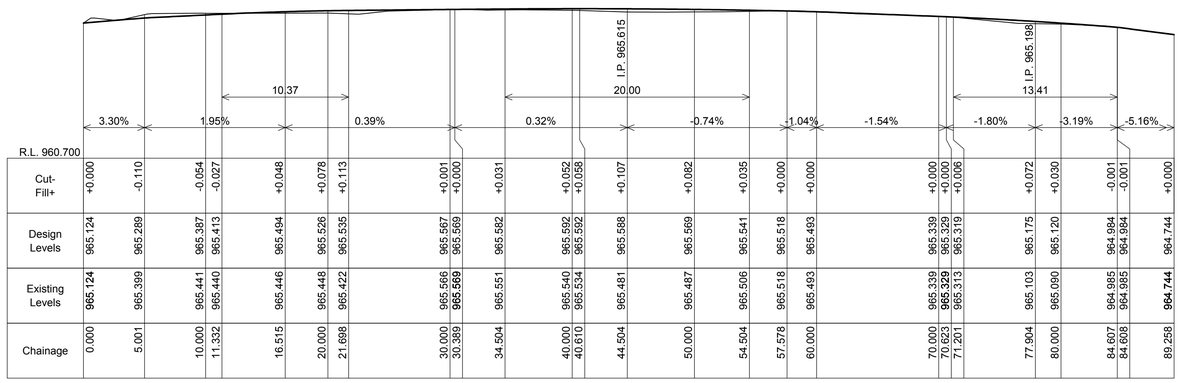
PLAN
SCALE 1:250

EMBANKMENT CENTRELINE SETOUT

POINT #	EASTING	NORTHING	DESCRIPTION
1	383442.9588	6619216.51	CH0.000
2	383451.8066	6619221.162	CH10.000
3	383461.2376	6619224.432	CH20.000
4	383471.2335	6619225.061	CH30.000
5	383481.1289	6619223.676	CH40.000
6	383489.8266	6619218.777	CH50.000
7	383498.0534	6619213.094	CH60.000
8	383506.1157	6619207.178	CH70.000
9	383515.9878	6619206.627	CH80.000
10	383525.101	6619208.28	CH89.258

Work Method

1. Excavate and remove topsoil on existing embankment batters.
2. Scarify the whole surface including batters to a depth of 150mm.
3. Import site won gravel, spread, wet and compact to 98% MDD.
4. Shape, compact and finish to profiles shown.



SCALE 1:250 HORIZONTAL 1:100 VERTICAL

EMBANKMENT CENTRELINE LONGITUDINAL SECTION

NOTES:

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DWG 60011672-SHT-CI-0301.

1. DELETE "RAISE EXISTING DAM EMBANKMENT TO RL 965.0 MIN".
2. DELETE "EXISTING SPILLWAY TO BE FILLED IN TO RL 965.0 MIN".
3. NEW SPILLWAY (CONCRETE OVERFLOW WIER 60011672-SHT-CI-0341

AMDT No	DESCRIPTION	DATE

DATUM .....
BENCHMARK

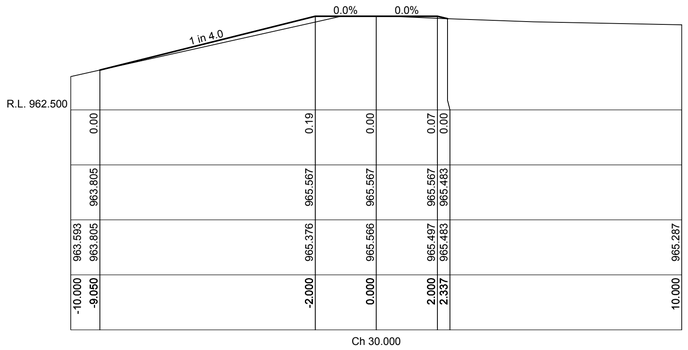
GENERAL NOTES

Armidale Regional Council
Civic Administration Building, Rusden Street, Armidale N.S.W. 2350

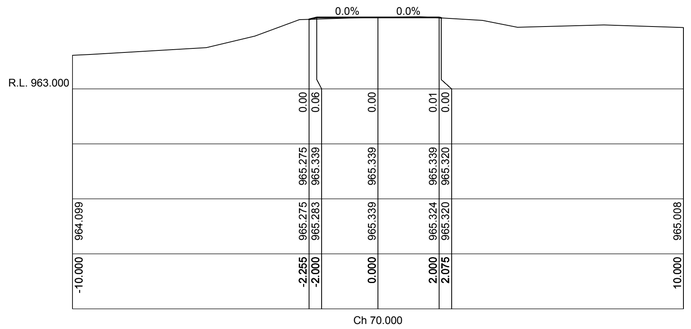
TITLE
NEW LANDFILL DAM EMBANKMENT
PLAN & LONGITUDINAL SECTION

SCALES AS SHOWN | SURVEY PD | AS SHEET SIZE A1 | SHEET 1 OF 2 | AMDT No
APPROVED ..... DIRECTOR OF REGIONAL SERVICES | DRAWN VC | DRAWING No. CI-0301-A
DATE ..... | DESIGNED | CADFILE | AREA No.
CHECKED

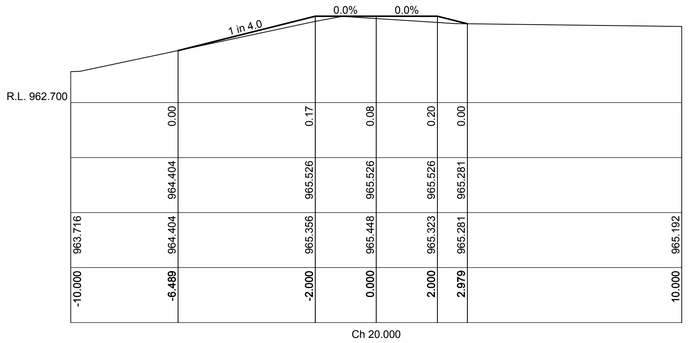
FILE No. .....



Ch 30.000



Ch 70.000



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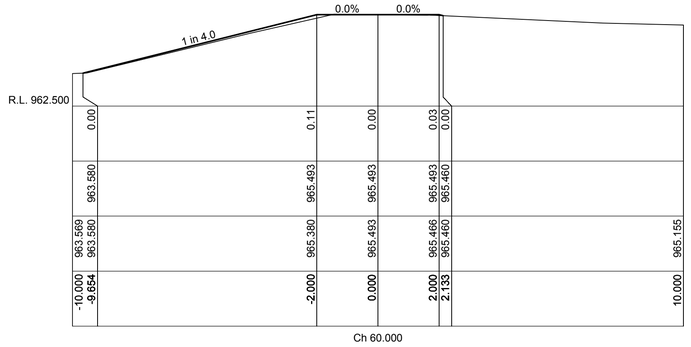
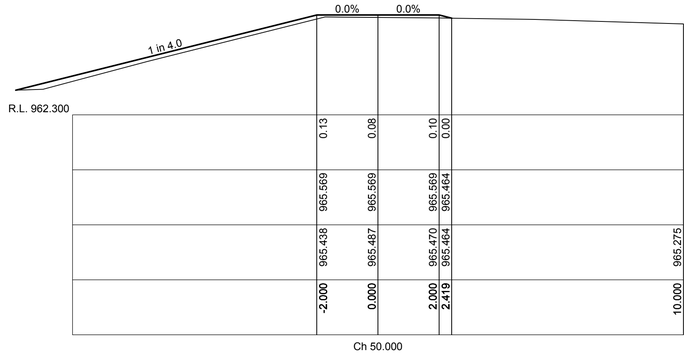
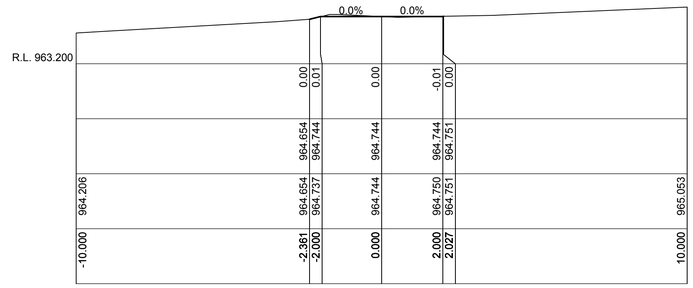


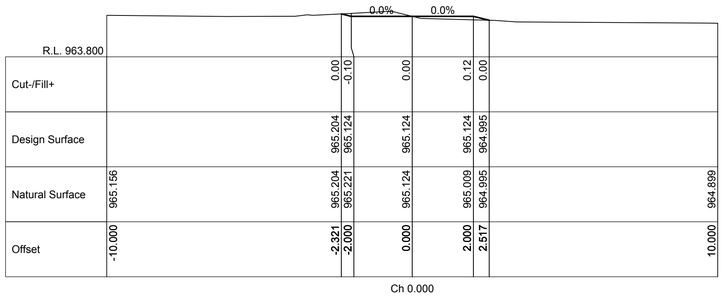
Ch 60.000



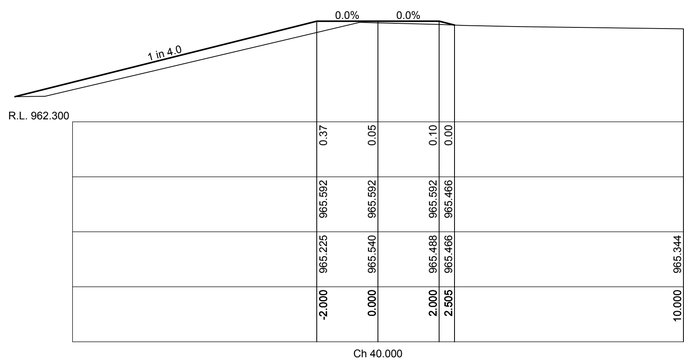
Ch 50.000



Ch 89.258



Ch 0.000



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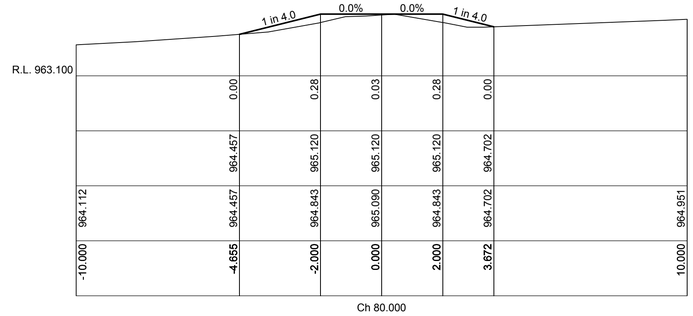

Ch 80.000

AMDT No	DESCRIPTION	DATE

DATUM .....
BENCHMARK

GENERAL NOTES

Armidale Regional Council

Civic Administration Building, Rusden Street, Armidale N.S.W. 2350

TITLE

NEW LANDFILL DAM EMBANKMENT CROSS SECTIONS

SCALES 1:100	SURVEY PD	AS SHEET SIZE A1	SHEET 2 OF 2
APPROVED ..... DIRECTOR OF REGIONAL SERVICES	DRAWN VC		DRAWING No. CI-0301-A
DATE	DESIGNED	CADFILE	AREA No.
	CHECKED		

AMDT No

FILE No. .....