

# Armidale Regional Landfill

## Construction Quality Assurance Plan

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Client: Armidale Dumaresq Council

ABN: 63 781 014 253

### Prepared by

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## Quality Information

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## Table of Contents

1.0	Introduction	1
1.1	Project Background	1
1.2	Purpose	1
1.3	Scope of Work	2
2.0	Roles and Responsibilities	3
2.1	Responsible Parties	3
2.2	Definitions	4
2.3	CQA Responsibilities	4
2.3.1	Principal	4
2.3.2	Design Engineer	4
2.3.3	Superintendent	4
2.3.4	Site Superintendent	4
2.3.5	CQA Engineer	5
2.3.6	CQA Monitor	6
2.3.7	Contractor	6
2.3.8	Geotechnical Testing Authority	6
3.0	General CQAP Requirements	7
3.1	General	7
3.2	Meetings and Communication	7
3.2.1	Project Inception Meeting	7
3.2.2	Environmental Awareness Induction	7
3.2.3	Progress Meetings	8
3.2.4	Special Meetings	8
3.3	Hold and Witness Points	9
3.3.1	General	9
3.4	Design Engineer's Requirements	9
3.5	Regulatory Authority Requirements	9
3.6	Independent CQA Conformance Testing	9
3.6.1	General	9
3.6.2	CQA Conformance Sampling	10
3.6.3	CQA Conformance Results	10
3.6.4	Non-Conformance and Corrective Action Procedures	10
3.7	Contractor's CQC Documentation and Reporting	11
3.7.1	General	11
3.7.2	Construction Verification Report	11
3.8	CQA Documentation and Reporting	12
4.0	Construction Quality Assurance Requirements	13
4.1	General Earthworks	13
4.2	Compacted Clay Layer	14
4.3	Geosynthetic Clay Liner	15
4.3.1	General	15
4.4	Geomembrane Liner	16
4.4.1	General	16
4.4.2	Geomembrane Leak Location Survey	19
4.5	Leachate Gravel Drainage Layer	20
4.6	Geotextile Layers	20
5.0	Construction Quality Assurance Report	22
Appendix A		
	Technical Specification	A
Appendix B		
	Geotechnical Assessment and Maps	B-A

## 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 211,000m<sup>3</sup>. 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.

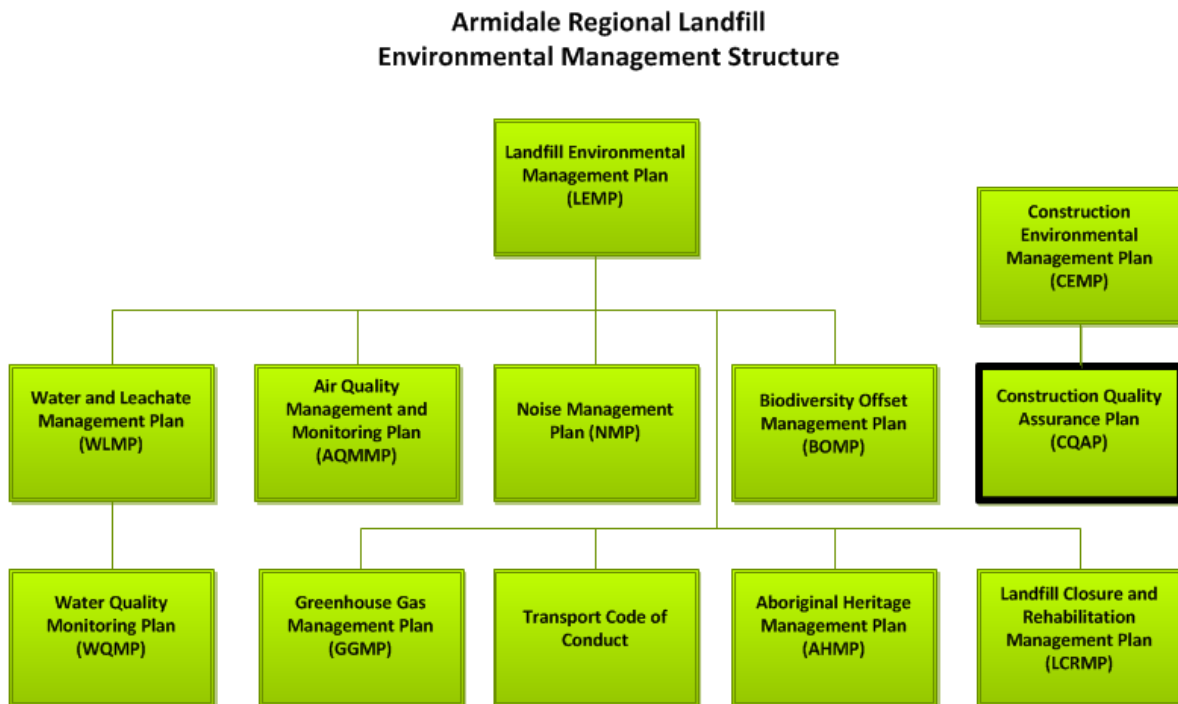


Figure 1 Environmental Management Structure

### 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 Authority (GTA)	Testing 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.
- Advise 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 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 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 be 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 be 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 Contractor's 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 <sup>2</sup>	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 <sup>2</sup> , 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 <sup>2</sup> , or resin type or manufacturing run.  <b>Note</b> – 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 <sup>2</sup>	N/A
CBR Burst Strength	AS 3706.4	1 test per 10,000m <sup>2</sup>	N/A
Grab Tensile Strength	AS 3706.2	1 test per 10,000m <sup>2</sup>	N/A
Flow Rate (separation geotextile)	AS 3706.9	1 test per 10,000m <sup>2</sup>	N/A
Ultraviolet Stability	AS 3706.11	1 test per 10,000m <sup>2</sup>	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 <sup>2</sup>	N/A
Mass per unit area	AS 3706.1, AS 2001-2.13	1 test per 2,500m <sup>2</sup>	N/A
Trapezoidal Tear	AS 3706.3	1 test per 5,000m <sup>2</sup>	N/A
CBR Burst Strength	AS 3706.4	1 test per 5,000m <sup>2</sup>	N/A
Grab Tensile Strength	AS 3706.2	1 test per 5,000m <sup>2</sup>	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