Quality Assurance and Quality Control Plan including ITPs

for

Burnt Hill Storage Limited - Storage Ponds

Rev. 3

ROONEY Group Ltd

ROONEY Earthmoving

Telarc. REGISTERED QUALITY ISO 9001

Telarc. REGISTERED ENVIRONMENT ISO 14001

Telarc. REGISTERED HEALTH + SAFETY AS/NZS 4801

Contents

1.0 Document Control

Project Title:	Burnt Hill Storage Limited - Storage Ponds.				
Business Name:	Rooney Earthmoving Limited				
Document Title:	Burnt Hill Storage Limited QMP - ITP				
Document No.	QMP-01	**Issue**	v1.0	**Date**	02/03/2026
Prepared by:	Cameron Rooney				

Reviewing Person

Signature: 
Name: Steven Woods
Role: Quality Assurance Reviewer
Company: Stantec New Zealand
Date: 30 April 2026

Authorising Person – Design Build Lead Contact

Signature: 
Name: Cameron Rooney
Role: Contract Manager
Company: Rooney Group Limited
Date: 24th February 2026

Revision Table

Document	Prepared by	Authorised by
Revision 1, Date 5 March 2026	Gerard Richardson/Cameron Rooney	Cameron Rooney
Revision 2, Date 24 March 2026	Cameron Rooney	Cameron Rooney
Revision 3, Date 30 March 2026	Cameron Rooney	Cameron Rooney

2.0 Objective of this Document

To be able to meet the requirements for a Code Compliance Certificate under the Building Act (2004) the quality processes must demonstrate compliance against the relevant documentation. The Quality documentation and the Construction Management Plan (CMP) must meet the requirements of the following documents, listed in the order of precedence:

- Various Consent clauses as set out in the consenting process.
- The requirements of the Technical Specification for the Burnt Hill Storage Ponds: –"Wrights Road Storage Ponds Technical Specification" Issue 8, Damwatch, 26 October 2021.
- Detailed design documentation: – "Wrights Road Storage Ponds Design Report" Issue 6, Damwatch, 26 October 2021.
- Drawings for the Burnt Hill Storage Ponds: – "Wrights Road Storage Ponds Drawing Issue" Issue 6, Damwatch, August 2021.

3.0 Applicable standards

Applicable Standards means the standards, codes of practice, guidelines and references to be adopted for design, execution and completion of the Works, as are pertinent, consistent and appropriate to the design and/or construction of a particular element of the Works.

The Works shall be designed, manufactured, constructed, commissioned, tested and completed in compliance with Applicable Standards.

Generally, New Zealand/Australian Standards, International (ISO) IEC Standards are to be used in preference to standards from other countries. In the absence of relevant New Zealand/Australian, ISO or IEC Standards, other relevant International Standards may be used subject to the Design Subconsultant's approval.

Please refer to TS1.6 for the standards selection hierarchy if nothing is stated for any item in the Technical specification. then the Contractor shall apply the following hierarchy:

TS Heading	Standard	Work Area	TS Detail
-	New Zealand Society on Large Dams (NZSOLD) New Zealand Dam Safety Guidelines 2015 (NZSOLD Guidelines);	All aspects of construction documentation and physical works and reporting	All
4.0	Embankment Construction Two NZS standards Listed Also, NDM, Scala, water contents testing	Density, grading, air voids, water contents, CBR value,	TS4.1.1
6.0	Geomembrane Liner 21 ASTM standards listed 2 x GRI-GM standards	Geomembrane Liner, all aspects including welding, ID, leak testing, Tensile properties, density, tear and puncture strength, thickness, carbon black content and distribution, etc.	Ts 6.1
6.9	HDPE Geomembrane Specification Above standards with targets and frequencies		TS 6.9, Table 6, 7 & 9.
8.0	Concrete, Formwork and Reinforcement * A copy of NZS 3109 Concrete Construction must be held on site. 23 x NZS Standards 2 x AS Standards 7 x AS/NZS standards	Concrete, reinforcing, timber framing, structural steel, backfill buried pipes, soils, sampling soil and aggregates, masonry buildings, laminated veneer lumber	TS 8.3.1

8.4	Concrete quality control 2 x NZS Standards 1 x AS Standards 1 x AS/NZS standards 1 x ASTM Standard	Admixtures, concrete, water and aggregate testing, testing fresh concrete, blended cements reinforcing, aggregate soundness	TS 8.4.2
12.0	Control Gates – Steel work NZSOLD (2015) Dam Safety Guidelines 1 x NZS Standards 1 x AS Standards 4 x AS/NZS standards 1 x DIN Standard 1 x EM USACE Standard	Design of hydraulic steel structures, bolts and screws, welding, surface prep and treatment, structural steel, bars and sections, steel structures	TS 12.8
13.0	Pump Stations and Pumps Standards not specified just guidance around selection of relevant/appropriate standards and refer to Section TS 1.6 Applicable standards	Design, manufacture, install, test and commissioning	TS 13.9
18.0	Electrical: Standard references are buried in text for each item.	Power supply Transformers, distribution, switchgear, earthing, cabling, AS/NZS 3000 and AS/NZS 3008.1.2:2010. All MV cable supplies shall comply AS/NZS 1429.1 or IEC 60502.2, AS 2374.1.2-2003, all relevant IEC standards	TS 18.6, 18.8, 18.9, 18.10, 18.12

* TS = Technical Specification (Damwatch Wrights Road Storage Ponds Technical Specification 26 October 2021 Issue 8)

4.0 Resource Consent Compliance

The two most relevant resource consents are CRC 263186 and CRC 263195 and RC255077 which each contain almost identical conditions regarding QA/QC on the project.

To clarify how we are meeting these consent requirements we have provided the following compliance table.

Table of RCC QA/QQC condition compliance

Starting next page

Summary of relevant Resource Consent conditions compliance

RC ID and condition number(s)		Condition Requirements	Compliance Met	Met how	Specification reference
CRC263186 CRC263195	12 10	Prior to construction activities commencing on the site the Consent Holder must prepare a Quality Assurance and Quality Control Plan to be incorporated into the Construction Management Plan.	Yes	This document and CMP	TS 1.7
CRC263186 CRC263195	13 11	The Consent Holder shall appoint a suitably qualified and registered Chartered Professional Engineer who has a minimum of 10 years' experience in dam design, construction, and the preparation and peer review of documentation required for large dams, and who is a recognised Category A Recognised Engineer for the purposes of the NZSOLD Guidelines to act as an independent certifier to ensure the Quality Assurance and Quality Control Plan is being complied with at all times (the Quality Assurance Reviewer.	Yes	Steve Woods Stantec	TS 1.7
CRC263186 CRC263195	14 12	Construction work shall not commence at the site until the Quality Assurance and Quality Control Plan has been accepted by the Manager, RMA Monitoring and Compliance, Canterbury Regional Council and that acceptance advised by notice in writing to the Consent Holder.	Yes	This is the first HOLD point in the ITP	NA
CRC263186 CRC263195	15 13	Should the Manager, RMA Monitoring and Compliance, Canterbury Regional Council refuse to accept the Quality Assurance and Quality Control Plan in accordance with these conditions, the Consent Holder shall provide a revised Quality Assurance and Quality Control Plan to the Canterbury Regional Council for acceptance as soon as is practicable.	TBC if required	TBC if required	NA
CRC263186 CRC263195	16 14	All construction activities authorised under this consent shall be undertaken in accordance with the Quality Assurance and Quality Control Plan.	Yes	Approved documents issued, used by REL Staff to update ITPs, REL Quality Manager appointed Checking and reporting to TS and RC requirements Independent review of our performance	TS 1.12
CRC263186 CRC263195	17 15	a. ensure that the construction activities achieve compliance with the conditions of consent for these activities;	Yes	All activities listed in QA Plan with construction methodology	NA
CRC263186 CRC263195	17 15	b. ensure that the relevant parts of the Technical Specification are complied with at all times during construction;	Yes	All activities have an ITP with reference to the TS for checks, notifications, reporting, hold points	NA
CRC263186 CRC263195	17 15	**provide for ii.: quality assurance** - as to evaluating the construction undertaken on a regular basis to provide confidence that the project will satisfy the relevant quality standards; and	Yes	Full time REL QA Manager on siter	TS 1.12, 1.13, 1.14
CRC263186 CRC263195	17 15	**provide for iii.: quality control** - as to monitoring specific information as necessary to enable determination of compliance with the relevant quality standards as set out in the Technical Specification and the conditions of this consent.	Yes	Full time QA Manager on siter Review by REL Contract/Project Manager or Engineer Independent Review of all Quality results	TS 1.12, 1.13, 1.14
CRC263186 CRC263195	18 16	The Quality Assurance and Quality Control Plan shall include, but not be limited to: a. ensuring the embankment construction meets the requirements of section	Yes	TS4.1.3 requirements included in descriptive construction methodology	TS 4.0

		4.1.3 of the Technical Specification (including all associated piping and control structures) and the conditions of this consent;		TS4.1.3 requirements referred to in ITP required checks	
CRC263186 CRC263195	18 16	b. detail on how the HDPE geomembrane liner complies with the Technical Specification, the conditions of this consent and all management plans, including:	Yes	DamWatch have confirmed approval of the geomembrane for use on this project	TS 6.9
CRC263186 CRC263195	18 16	the QA/QC Manual and summary inspection test and test plan required by section 6.6.2 of the Technical Specification;			
CRC263186 CRC263195	18 16	i. the results of manufacturer and external laboratory testing of the geomembrane liner and the adequacy of testing to ensure the properties set out in section 6.5 of the Technical Specifications;	Yes	DamWatch to review and approved Manufacturers QA testing prior to use on this project	TS 6.10
CRC263186 CRC263195	18 16	ii. the accurate identification of enhanced geomembrane liner rolls for pond corner areas set out in section 6.9.5 of the Technical Specifications;	Yes	DamWatch to select liner rolls for use on corners based on Manufacturers QA results	TS 6.10
CRC263186 CRC263195	18 16	iii. the installation of the geomembrane liner and test coupons as required by the Technical Specification and the conditions of this consent; and	Yes	Completed at Project Completion	TS 6.22
CRC263186 CRC263195	18 16	iv. methods for ensuring the on-going monitoring complies with the Technical Specification and the conditions of this consent;		Determined post construction	
CRC263186 CRC263195	18 16	v. c. procedures that ensure the Review by the Quality Assurance Reviewer of all information relating to construction that is to be received under the conditions of this consent.	Yes	Steven Woods to oversee all construction activities and QA records	

5.0 Contract Details

Contract Name:	Burnt Hill Storage Limited (BHSL) – Storage Ponds
Location:	Wrights Road, Waimakariri
Client Name:	Waimakariri Irrigation Limited
Start Date:	23/03/2026
Completion Date:	30/06/2029

2.1 Scope of Works:

1. Preparation and approval of contract documentation and plans including the Construction Programme, Health and Safety, Quality and Environmental Plans and any Traffic Management Plans.
2. Establish Erosion & Sediment Control measures prior to commencing any earthworks.
3. Site clearance including removal of vegetation, trees and structures.
4. Enabling Works
5. Excavations for Embankment Foundations and Reservoir Area
6. Embankment Construction
7. Ecotech 500 GSM Geotextile
8. Geomembrane Liner
9. Construction of Pipelines Culverts and Ancillary Works
10. Concrete, Formwork and Reinforcement
11. Embankment and Foundation Instrumentation
12. Log Boom
13. Seismic Loading for Supplier Designed Components
14. Control Gates
15. Pump Stations and Pumps
16. General
17. Pump Station and Pump Specification Precedence
18. Control System
19. Review and comply with all resource and building consent conditions
20. Operation, Maintenance and Surveillance Manual
21. Commissioning

6.0 Contract Management & Delivery

The following personnel with the following responsibilities have been assigned to this contract:

REL Management Staff

Overall Contract & Company Governance	**Gary Rooney**
Company:	Rooney Group/Rooney Earthmoving Limited
Telephone and email:	03 689 6200 | g.rooney@xtra.co.nz

Appointed to oversee and provide leadership to the management team and ensure supply of the resources necessary to complete works. Gary is responsible for the development of company policy and the action of the management systems controlling safety and quality on work sites.

Contract Manager	**Cameron Rooney**
Company:	Rooney Group/Rooney Earthmoving Limited
Telephone and email:	027 335 7530| Cameron.rooney@rooneygroup.co.nz

The Contract Manager is the first point of contact for all enquiries, issues or reporting for the contract. Authorised to address and resolve issues of dispute relating to compliance with the quality requirements of the Contract and this plan, as well as rectification of any non-conforming work.

Project Manager	**Brett Middleton**
Company:	Rooney Earthmoving Limited
Telephone and email:	027 839 9768 | brett.middleton@rooneygroup.co.nz

Responsible for the day to day on site resourcing, direction, supervision, control and inspection of the works and communicating on such matters with the Principal's or Engineer's site representative. Authorised to resolve contractual issues or refer to the Contract Manager where required.

REL Compliance Staff

Quality and Environmental Technian	**Kennedy Fernandes**
Company:	Rooney Earthmoving Limited
Telephone and email:	021 0880 4874 | kennedy.fernandes@rooneygroup.co.nz

Responsible for the overall review of environmental plans and documentation including inspection sheets completed by the Site Supervisor. Authorised to resolve compliance issues should it be required. Responsible for our compliance with the requirements of the Health and Safety at Work Act and Resource Management Act.

Health & Safety Officer	**Jason Wells**
Company:	Rooney Earthmoving Limited
Telephone and email:	027 444 5804 | Jason.wells@rooneygroup.co.nz

Responsible for the on-site implementation of REL's Safety Systems to ensure the safety of all personnel

and compliance with the Health and Safety at Work Act. Audit and review of health and safety documentation including Health and Safety Plan, Tailgates and Weekly Inspection Sheets carried out by the on-Site Supervisor or Site Supervisor. Authorised to resolve on-site Health and Safety issues.

Ecotech Lining Supervisor

Site Supervisor	**Boris Leroy**
Company:	Rooney Earthmoving/Ecotech
Telephone:	027 522 9812

20 years' experience in the industry. 12 years with Rooney Group. Boris has supervised or been second in command of all the Rooney jobs listed below (except McSkimming Dam) as well as numerous projects in New Caledonia.

HDPE Welding Specialist	**Vince Melgies**
Company:	Rooney Earthmoving/Ecotech
Telephone and email:	021 1809 068

20 years' experience in the industry. 13 years with Rooney Group. Vince worked on all the Rooney jobs listed above as well as numerous projects in New Caledonia.

REL's team HDPE geomembrane lining experience is extensive and includes

Rangitata South Irrigation Dams	1,000,000 m^2
Mayfield Hinds – Carew Storage Dams	1,500,000 m^2
Klondyke Dairy – Irrigation Storage Pond	87,000 m^2
Dairy Farm Partnership – McSkimming Dam	200,000 m^2
Ron Smith – Ashwick Flat Dams (x2)	50,000 m^2
Infinity Farming – Foveran Dams	190,000 m^2
Killermont Station Storage Pond	80,000 m^2

Staff and Sub-Contractors

All staff and subcontractors employed to complete works within the site must do so in accordance with this Quality Plan as well as the Health and Safety at Work Act. They are tasked with completing Tailgate Forms and identifying the daily hazards which they encounter in accordance with company policy.

They have the responsibility to ensure that works is completed safely, and plant and equipment are not operated unsafely. Any incidents that staff or subcontractors witness must be notified by the REL Site Supervisor and the REL Health and Safety Officer.

Staff Site Commitment

The following table sets out the approximate time commitment of key staff to contract operations on-site in Christchurch.

Name	Role	During Contract Start-up	During Remainder of Contract
Cameron Rooney	Contract Manager	50%	50%
Brett Middleton	Project Manager	75%	100%
Kennedy Fernandes	Quality and Environmental	20%	100%

	Technian		
Jason Wells	Health & Safety Officer	20%	25%
Brian Lowe	Mobile Mechanic/Servicing	As required	As required

Key Client Representatives

Contract Name:	Burnt Hill Storage Limited (BHSL) – Storage Ponds
Location:	Wrights Road, Waimakariri
Client Name:	Burnt Hill Storage Limited

Client Contact	**John Wright**
Company:	Burnt Hill Storage Ltd
Telephone and email:	0274 362 358 | john@wrightfarms.co.nz

Independent QA Reviewer:	**Steve Woods**
Company:	Stantec New Zealand
Telephone and email:	027 220 2241 | steven.woods@stantec.com

NZS3109 Engineer to the Contract	**Lawrie Saegers**
Company:	Rawlinsons
Telephone and email:	021 610 302 | l.saegars@rawlinsons.co.nz

7.0 Site Layout Plan

Site Office, Container(s), and toilets will form the basis for site office area within the contract area. The site office & laydown area will have a fixed location, double skinned, self-bunded fuel tank and will be managed by REL's Project Manager who will form the focus point for this contact on site.

Signage and fencing will be erected where required, ensuring compliance with health and safety and public awareness. All site information signage will contain contact details of the Contract Manager and Project Manager in case of concerns.

Construction access will be via Wrights Road, at the eastern end of the site. Contract plant and equipment establishment/disestablishment to the site will be via this entrance. Clear signage will delineate the start of the contract works and direct construction traffic and visitors to the site and site office.

All access routes will be kept clear of any construction debris and dust suppressed, if necessary, please refer to the Environmental, Dust and Sediment Control Plan.

7.1 Site Office and Lay-down Area

The site office will contain tailgate forms, SSSP and sign-on forms for staff and visitors to site. The Site office will also have external signage with REL contact numbers and explaining the site entry restrictions that are in place.The site office is 35 to 40m from the fuel tank and refueling area. The fuel tank and refueling area is over 100m from the nearest downstream waterway.

Site Access point(s)

Site office, secure laydown, park-up, refueling area

8.0. Communication

The line of communication will be through Cameron Rooney and Brett Middleton for day-to-day communications. Day-to-day interaction with the Engineer or their representative on site will be with the Project Manager, Brett Middleton.

An initial compliance audit will be undertaken at the start of the contract as well as a Health & Safety audit. Health and Safety audits will be completed weekly by the REL Health & Safety Officer. Please refer to Section 9 of the REL Health & Safety Plan for the contract.

Any non-conformances identified by internal site audits will be communicated immediately to the Site Supervisor and Contract Manager for resolution or immediate action via the Quality Improvement System in Mango. The Compliance Manager will be notified within 24 hours.

Safety and environmental information will be briefed to all staff and sub-contractors during a site induction to this Health, Safety, Quality and Environment plan. Where additional information becomes issued or hazards known, this information will be briefed to staff via Tailgate Meetings run by the Site Supervisor.

Associated Documents:

- QIF Notification Form (Appendix A)
- QIF Reporting Flow Chart (Appendix B)

The majority of communications will be verbal for this project, either via cell phone, face to face or at operational meetings. Contract instructions and communications between REL and any compliance authorities will be followed up with paper documentation.

A copy of this plan, including relevant documentation and appendices, will be maintained on site with the Site Supervisor and staff.

Communications Matrix

Item	Author	Recipient/Responder	Recipient	Method	Timing & Frequency
Notice to Engineer	Contract Manager: Cameron Rooney	Engineer's Representative: TBC	Engineer: Lawrie Saegers	Email	As required
Notice to Contractor	Engineer: Lawrie Saegers	Engineer's Representative: TDC	Contract Manager: Cameron Rooney	Email	As required
Claim and Summary	Contract Manager: Cameron Rooney	Engineer's Representative: TBC	Client: John Wright	Email and/or phone.	Monthly
Instructions from Contract Manager	Contract Manager: Cameron Rooney	Project Manager: Brett Middleton	REL Staff	Email and/or phone. Or site meeting	As required
Instructions from Inovo	Site Engineer: TBC	Engineer's Representative/Engineer: TBC/Lawrie Saegers	Contract Manager: Cameron Rooney	Email and/or phone. Or site meeting if required.	As required

Item	Author	Recipient	Method	Timing & Frequency
External Laboratory QA Testing & Results	FH Laboratory	Contract Manager : Cameron Rooney Engineers Rep. : TBC	Email.	As required to meet specification
Site QA Results	Brett Middleton	Contract Manager: Cameron Rooney Engineers Rep.: Kevin Peters	Email.	Weekly.
Health & Safety and Quality Audits	Jason Wells	Project Manager: Brett Middleton Contract Manager: Cameron Rooney Engineers Rep. TBC	Email.	Weekly.
Compliance Audits, QIF, Corrective Action	Jason Wells	Project Manager: Brett Middleton Contract Manager: Cameron Rooney Engineers Rep.: TBC	Email.	At start-up, then weekly.
Non-Conformance	Cameron Rooney	Engineers Rep.: TBC	Email.	As required
Tailgate Forms, Hazard ID	Brett Middleton	Contract Manager: Cameron Rooney	Email and/or phone. Or site meeting	Updated weekly at formal meeting, can be updated at any time
Request to work outside Standard hours.	Cameron Rooney	Engineers Rep.: TBC	Email and/or phone. Or site meeting	As required
Complaints	Cameron Rooney	Engineers Rep.: TBC	Email	As required

9.0 Quality Assurance Procedures to achieve the required Standard

REL uses a Quality oriented business model and our internal ISO systems of defect identification and continuous improvement to design and constructing high quality assets for our clients. We hold AS/NZS 9001:2008 Quality, AS/NZS4801:2001 Health & Safety and 14001:2004 Environmental certification

The project QA will cover and identify all standards, procedures; checks, verifications and confirmation steps required by the Contract Documents and shall include but not be limited to:

• Detailed Quality Plans	This plan specifically includes Section 10.
• Standard/Safe Operating Procedures.	Attached in Appendix C.
• Work Instructions and Method Statements	IN this document in Sections 10 - 14
• Hold Points.	Refer to Project Quality Plan Section 6.
	• QA Checks & testing, reporting and sign-off.Refer to this document, Section 30 ITPS and Appendix D – O for test and reporting forms etc.
Applicable Standards	Refer to this document, Section 3.0 Applicable standards and referenced Technical Specification Sections

9.1. Safe Operating Procedures

Safe Operating Procedures (SOP's) will be used to control the work and verify compliance with the quality requirements identified on this contract. The following SOP's have been adopted for this contract.

3.0	SOP	Compaction NDM	2016.
4.0	SOP	Drainage Culvert	2016.
6.0	SOP	Earthworks	2016.
10.0	SOP	Environmental Storage	2016.
11.0	SOP	Traffic Control	2016.
14.0	SOP	Setout (Survey)	2016.

These documents are attached in Appendix C.

Other specific methodologies may be required to be developed for unforeseen tasks or extra work, should the need be identified by the Engineer, Site Supervisor or contract management team.

9.2. Quality Assurance Staff

Quality assurance checking will be carried out by personnel experienced in site QA and they will report to the Site Supervisor and the Contract manager, and any technical testing, methods or materials issues are to be referred to the REL Technical Manager.

Site QA staff will liaise with REL site supervisory staff, and any Client appointed staff to ensure that all aspects of the contract are checked.

This will include:

1. Foundation Strength Checking.
2. Sampling & testing of Bedding/Zone material –gradings & compaction.
3. NDM testing of Zone 4 materials and overlay layers.
4. Geomembrane foundations
5. Geomembrane placement, lapping and welding
6. All pipe and structure installation including penetrations through embankments
7. Sediment Control Measures

All quality assurance testing will be undertaken by suitably experienced and trained staff with proven ability in this field and all results will be checked and approved by the Project Manager in the first instance, Results will be forwarded to the Contract Manager for review and to address any technical

compaction, testing method or material suitability issues, if needed.

Non-complying results that indicate product or materials that are not of the required standard will be addressed at the time of identification and the specific items, redesigned, reworked, repaired or replaced.

9.3. Quality Assurance Testing

Contract Quality Assurance is carried out by personnel experienced in site QA, trained in the use of NDM and other test equipment and who will be dedicated to this role for the duration of the job. On this contract this task will be completed by Kennedy Fernandes.

Kennedy will liaise with the Contract Manager and the Site Engineer to ensure that all aspects of the contract are fully QA checked.

- Any identified areas of sub-standard or weak fill will be reworked or replaced until the required standards are met and approved by the Engineer.
- We use calibrated, Nuclear Density Gauges along with scala penetrometers or shear vanes.
- QA results will then be checked by the REL Contract Manager then forwarded to the Engineer's representative as required.
- Inspection Hold Points will also be adhered to as set out in the Quality Plan and the Engineer will be notified ahead of time of upcoming inspections or approvals required to keep the contract running smoothly.

Contract test Forms are listed in Appendix D and are the standard form to be used on site.

9.4. Quality Assurance of Materials

The REL procurement process has requirements for suppliers to be able to demonstrate compliance with various levels of production testing and certification. Test certificates for the HDPE geomembrane and other materials will be provided from the manufacturer where applicable or where requested.

These certificates will prove compliance with production standards and with minimum test values required by industry specific test standards for the relevant products.

External testing of materials will be carried out by Fulton Hogan Laboratories on Miners Road, Christchurch.

External testing results and certificates will be forwarded to the Contract Manager for compliance checking and approval for use. This is then relayed directly to the Project Manager.

9.5. Non-Conformance

A Noncompliance will signal a hold point, and the following actions will be considered by the Designer:

1. Review of construction methodology.
2. Review material type; and
3. Agree upon a solution.

Solutions shall be implemented by the Contractor with suitable engineering guidance as required.

Purpose and Scope

The purpose of this procedure is to identify and control any improvements, suggestions or non-conformances, to agree upon suitable corrective and preventative actions and to ensure improvements or suggestions are actioned and reported.

REL construction methodology and SOP's strive to minimize non-conformance completely by providing rework of substandard materials until they meet specification and are no longer a non-conformance.

In the case of a noncompliant test result: results shall be furnished to the Designer and Contractor within 24 hours of the test being carried out. In addition, the Contractor shall produce a weekly quality report incorporating, among others, the following details of numbers and types of tests carried out, a summary of results, staff employed in testing and the forthcoming programme of testing.

Responsibility

It is the responsibility of all employees but the Project Managers in particular to use QIF forms for the

reporting of Non-Conformances and Improvements.

It is then the responsibility of the Contract Manager in consultation with the Engineers Representative and to agree upon Corrective Actions, then for the Site Supervisor and Contract Manager to enforce the recommendations and any retesting/checking.

It is then the responsibility of the Compliance Manager to check the documentation and process and sign off actions as complete.

It is the responsibility of the Contract Manager to collate QIF's and report findings in the Report to be discussed at Management Review Meetings.

It is the responsibility of the Senior Management to attend the Management Review Meeting to identify any trends and agree upon individual or trend Preventative Actions.

Notifications

The Client or Engineer to the contract shall be notified immediately of any non-conformance that cannot be rectified, or that can be rectified but with subsequent negative effects on productivity, quality, budget or programme.

Using a collaborative approach, we will then seek to determine an acceptable outcome without any negative impacts upon the contract.

Please note: On a day to day basis the Engineer may become aware of failing or temporarily non-conforming work e.g. Fill not meeting compaction requirements. If this fill is reworked, recompacted and retested with passing results this will not raise a non-conformance – this is part of the day to day contract earthworks quality control process.

Procedure

1. Non-conformances are notified and enter the QIF System.
2. Corrective Action = Action to eliminate the cause of detected non-conformity.
3. Preventive Action = Action to eliminate the cause of a potential non-conformity.
4. Improvement Reports can originate from the following but not limited to.

Associated Documents

- Appendix B - QIF Notification Form.
- Appendix B - QIF Reporting Flow Chart.

9.6 QA/QC Reporting

As per TS 1.18, The Contractor shall produce the following reports:

- Weekly Quality Reports;
- Weekly Progress Reports;
- Specific reporting against defined Critical Areas;
- Final Construction Report;
- As-built drawings;
- Operation and maintenance manual; and
- Commissioning Report.

Embankment Construction

As per TS 4.4.4 Reporting

The Contractor shall prepare and issue weekly reports confirming test results for the period including compliances and non-compliances. In the case of non-complying test results the Contractor shall inform the Designer without delay so that they can agree the extent of any remedial action required.

The Contractor shall produce the following reports:

- Results of all non-compliant tests shall be furnished to the Designer within 24 hours of the test being carried out;
- Factual test data reports on a weekly basis: quality report incorporating, the following details of numbers and types of tests carried out, a summary of results, staff employed in testing and the

forthcoming programme of testing;
- Interim reports as required for example compaction field trials or particular testing requirements; and
- As built completion report at the end of the construction period.

REL will establish a weekly Microsoft Teams meeting with the Independent Certifier and Designer. This meeting will follow the distribution of the previous week's quality reporting. Exact timings will be determined between parties during the initial project start up, however, once established, the meeting will be held at the same time each week. Weekly reports will be issued at least 1x working day prior to the weekly QA reporting Teams Meeting.

Geomembrane Lining

As per TS 6.8 Daily Reports

The Contractor shall provide the Designer with daily reports detailing:

- the amount and location of HDPE placed.
- the length and location of seams completed and the operator and equipment used.
- changes in layout drawings (if applicable).
- location and results of repairs.
- location of destructive test samples.
- destructive test results (if applicable).

As per TS 6.20 Certificates and Records

The Contractor shall provide all Quality System certificates and records as required, including the following:

- An ITP outline which shows the tests and frequencies
- Raw Material Testing Reports.
- Geomembrane Production Test Reports.
- Register of Key Personnel.
- Geomembrane Roll Reports (Sheet Defect).
- Acceptance of Subgrade Certificates.
- Panel and Welding Layout Drawings.
- Welding Equipment and Methods.
- Daily Operating Control Report (for each welding unit).
- Trial Weld Reports.
- Pre-Weld Test Certificates.
- 'As Constructed' Drawings.
- Daily Weld Vacuum Box Test Reports.
- Daily Weld Specimen Destructive Test Report.

As per TS 6.21.3 Reporting

The Contractor shall produce the following quality control reports:

- Factual test data reports on a weekly basis: quality report incorporating the following details of numbers and types of tests carried out, a summary of results, staff employed in testing and the forthcoming programme of testing; and
- As-built completion report, including layout plan (locating with identification code all panels, seams, tests, repairs and patches), at the end of the construction period.

Concrete

As per TS 8.4.6 Quality control and assurance

- Reports & Records: Maintain daily records of concrete placement, including but not limited to, delivery records, concrete volumes, lengths of pours, time of pours, slump, and cylinder sample preparation.
- Submit reports and records to the Designer's Representative within 24 hours.
- Quality reports on concrete testing shall be made available to the Designer at regular monthly intervals.

The format and the level of minimum detail required for all reports shall be in accordance with the High

PIC classification for all components of this project, as recommended in the NZSOLD Dam Safety Guidelines.

The various report timeframes, minimum detail and format and distribution will be agreed with the Engineer or Designer before we submit the first report with agreed amendments from then on.

9.7 Independent Quality Assurance Reviewer and required submittals.

The Consent Holder shall appoint a suitably qualified and registered Chartered Professional Engineer who has a minimum of 10 years in dam design, construction, and the preparation and peer review of documentation required for large dams, and who is a Category A Recognised Engineer for the purposes of the NZSOLD Guidelines to act as an independent certifier to ensure the Quality Assurance and Quality Control Plan is being compiled with at all times (the Quality Assurance Reviewer).

BHSL have appointed Steve Woods of Stantec as the independent Quality Assurance Reviewer (IQAR) to provide independent review and reporting of RELs compliance with design requirements and the RC conditions.

The Contractor shall ensure documentation of Quality Control systems is implemented in accordance with the consents. Regular audits shall be carried out by the Designer and the Independent Certifier, as discussed in Section TS1.3.

Using a collaborative team approach to QA/QC compliance on this contract, before we commence construction, REL will provide the IQAR with our team's names, roles and contact details and work through the appropriate communication formats and methods with REL and Damwatch.

The submittals for review to the IQAR will include:

1. Any proposed design changes during construction (for comment on behave of BHSL only).
2. Certification of all items requiring this review in the Resource Consents as outlined in the table below.

Clause	*Items requiring certification from Independent Certifier*	Minimum Timeframe
CRC263186		
6(b)	*Construction Management Plan (CMP) meets objectives and performance standards (CMP to include QA and QC Plan, Dust Management Plan, Erosion Sediment Control Plan).*	3 months prior to construction
13	*QA and QC Plan is being complied with at all times*	Throughout construction (QA/QC Plan needs to be approved in writing prior to construction)
21	*Control system is capable and installed to enable the provision of set warnings*	3 months prior to the installation of the system
23	*Water Storage Commissioning Plan meets objective and performance standards*	3 months prior to first filling
26	*Confirming that the structure has performed in accordance with the commissioning plan*	On completion of commissioning
32, 33	*DSMP and EAP is appropriate and robust and meets NZSOLD guidelines*	3 months prior to first filling
44, 45	*As-built construction of the dam is in accordance with good engineering practice i.e. NZSOLD, Building Act 2004, CMP, QA/QC Plan.* *No filling until as-built certification is complete.*	2 months before first filling
46	*All certificates to be submitted to RMA along with copies of the* *DSMP, EAP and Water Storage Commissioning Plan.*	2 months before first filling

50	*QA reviewer to provide a report to Consent holder, Designer, Contractor and RMA summarizing the results of the QA/QC information received, the supervision of the QA on site, the QA/QC plan and the EAP with an opinion on compliance with the tech spec and RC.*	3 months intervals during commissioning
51(b)	*Review EAP*	Bi-annually or within 3-months following an event
57	*As-built plans, producer statements and completion report*	Within 12 months of construction activities ceasing
63	*Water Quality Management Plan*	30 working days before first filling
CRC263201 - dust		
10	*Instrument to measure TSP concentrations and a meteorological monitoring station to be installed.*	1 month prior to construction
CRC263199 – Stormwater Discharge		
12	*Appropriate erosion and sediment control measures have been constructed in accordance with the plan*	1 month prior to commencement of bulk earthworks for the site.

9.8 Personnel, qualifications and training.

Please refer to Section 6.0 Contract Management & Delivery of this document, for a list of key staff and their experience. CVs can be provided on request

9.9 Approved laboratories.

All external laboratory independent verification testing of project materials will be completed by a reputable materials testing laboratory with IANZ accreditation in the required testing.

The same standard applies to site visits by an external laboratory to provide onsite testing checks or verification of our test methods or equipment.

Our preferred laboratory is Fulton Hogan on Miners Road, but we have other local backup laboratories available if needed.

IANZ Laboratory	Location	Services Summary
Fulton Hogan Limited	24 Miners Road, Templeton, Christchurch, 7676	Aggregates, Bituminous Materials, Concrete, Soils, Pavement Testing
Isaac Construction Limited	552 McLeans Island Road, Harewood, Christchurch, 8051	Soils and Aggregates
Geotechnics Ltd	45A Parkhouse Road, Wigram, Christchurch, 8042	Aggregates, Concrete, Soils, Geotechnical Field Tests
WSP New Zealand Limited	52C Hayton Rd, Wigram, Christchurch, 8042	Aggregates, Concrete, Soils

Independent verification testing will include:

- In-situ density test of Zone 4 initially when the first 100 m3 of Zone 4 material is placed, and at 6 monthly intervals thereafter.
- Nuclear Density Meter (NDM) calibration at regular intervals (not greater than 6 months) or as

recommended by the manufacturer whichever is the lesser.

9.10 Hold Points

As noted in TS Section 1.3, the full-time on-site Designer's representative shall inspect critical construction stages, such as the foundation preparation, earthworks construction and placement of the geomembrane liner (see also Section 1.13). We have a list of Hold Points compiled below, with these included within the Quality Control Plan.

Item	Works Item – Hold Point	Inspection/Reviewed By
1	Construction Management Plans (ESCPs, etc)	Independent Certifier
2	Preconstruction ESC Measures and Site Facilities in place	Independent Certifier
3	First stripping/topsoil removal of embankment foundations	Independent Certifier/Designers Rep
4	Stripping/topsoil removal of all remaining embankment foundations	Designers Rep
5	Zone 4 embankment fill trail	Independent Certifier/Designers Rep
6	Geotextile Manufacturing QA Documents	Designers Rep
7	HDPE Geomembrane Manufacturers QA Documents	Designers Rep
8	HDPE Geomembrane Panel Layout and Programme	Designers Rep
9	First placement of liner underlay	Independent Certifier/Designers Rep
10	Prestart HDPE Liner welding trial	Independent Certifier/Designers Rep
11	First placement of liner on slopes	Independent Certifier/Designers Rep
12	First placement of RRJ Pipe	Independent Certifier/Designers Rep
13	Backfilling of first RRJ Pipe	Independent Certifier/Designers Rep
14	Placement and backfilling of all RRJ Pipe	Designers Rep
15	Pre-pour inspection of reinforcing (first pour)	Independent Certifier/Designers Rep
16	Pre-pour inspection of reinforcing for all structures	Designers Rep
17	Post-pour inspection of a wall (first wall pour)	Independent Certifier
18	First HDPE connection to structure	Independent Certifier/Designers Rep
19	First test of actuated gate	Independent Certifier

10.0 Embankment and Floor Construction Testing Plan

REL will have a full time QA/QC technician on site during the embankment formation. This technician will be responsible for completing and recording all NDM testing results on the embankment fill (zone 4). REL's Project Manager and Contract's Manager will oversee/review all QA testing onsite and will ensure all requirements of the BHSL – Technical Specification are met.

10.1 Structural Embankment Fill (Zone 4) Testing Procedure

The following Quality Assurance tests will be completed on the Structural Embankment Fill (Zone 4) as per the Akarana Pond – Technical Specification.

Test	Recording	Testing Completed By
NDM's – Back Scatter	Field recording – REL's field NDM record sheet. GPS survey of each test location.	REL's QA/QC Technician
NDM's – Direct Transmission	Field recording – REL's field NDM record sheet. GPS survey of each test location.	REL's QA/QC Technician
Maximum Dry Density (MDD) – Vibrating Hammer Test	Sample collected and sample sheets completed by REL - supplied to FH Laboratories. REL to complete GPS survey of each test location. FH will supply test record certificates.	Sampled by REL. Tested by FH Laboratories.
Particle Size Distribution (PSD)	NZS 4407:2015 Test 3.8	Sampled by REL. Tested by FH Laboratories.
Outlet Structure – Backfill Testing; NDM's PSD's	NZS 4407:2015 Test 4.3 NZS 4407:2015 Test 3.8	REL's QA/QC Technician Sampled by REL. Tested by FH Laboratories.

QA/QC testing will be completed daily. All test results will be transferred onto the projects Smartsheet to be shared with the whole project team (DamWatch, Inovo, BHSL and the Independent Certifier). All test results will be uploaded weekly; hence all results will be made available to the Design Engineer and Independent Certifier on a weekly basis for review and approval.

REL will complete NDM testing on the embankment fill within 'sub-lots' (1 test per layer for every 1000m^2). The embankment will be split into 200m sections which will be referred to as 'sub-lots'. Hence chainage CH0000 – CH0200 will be classed as sub-lot #1, CH0200 – CH0400 will be classed as sub-lot #2 and so on. REL will provide a site plan showing all of the 'sub-lots'. The area of each sub-lot will vary a lot along the pond embankment chainage due to the difference in existing ground height across the site (lower existing ground heights will result in a higher embankment to construct, hence a larger embankment foundation). Due to the differing sub-lot areas REL will complete one NDM test for every 1000m^2. Hence if a sub-lot is 5,000m2; REL will complete 5 tests per vertical lift, if a sub-lot is 8,000m^2; REL will complete 8 NDM tests per vertical lift, etc.) The area of each sub-lot will be shown on the 'sub-lot' plan completed by REL's surveyor/QA Technician. All QA/QC test (NDM's, MDD & PSD samples, etc.) locations will be referenced to a sub-lot and chainage along the pond embankment. Successive vertical lifts within each sub-lot will be identified using a letter to record successive vertical lifts (e.g. sub-lot #1; CH0000 – CH0200_Lift-A will be the first lift, sub-lot #1; CH0000 – CH0200_Lift-B will be the second lift, etc.). REL's QA/QC technician will reference each NDM test location (sub-lot and chainage) on the NDM field test record sheet while in the field. All locations will be confirmed using GSP survey. The GSP survey shots will also be used to confirm layer thicknesses (RL's of success layers can easily be compared in the field and

in the office using the GSP). An as-built drawing and excel file will be provided with all NDM test results and sampling locations (for Laboratory testing). The as-built drawing will label all tests with a test number. The excel spreadsheet will provide all test/sample location information including coordinate's, RL's, date and time for each test/sample taken.

10.2 Compaction Trial, Compaction Targets and Compaction Methodology

10.2.1 Fill Compaction Trial

We have extensive experience in fill trials/plateau testing for embankment and floor fill materials. Rather than duplicate a process already documented in detail, please refer to the Technical Specification 4.3 Fill Placing Trials. This section of the TS contains a comprehensive fill-compaction trail process which we will work through with the ETC, Designers Representative and provide results to the IQAR if required.

10.2.2 Target Compaction Factors

Prior to constructing the trial embankments, representative samples of Zone 4 material will be taken for laboratory for compaction and particle size distribution testing to the specified standards

Averaging the laboratory results has resulted in the following target compaction factors for each material type;

Material Type	Maximum Dry Density (MDD) t/m3	Average Density (per set of 5 consecutive NDM tests)	Minimum Density (per set of 5 consecutive NDM tests)
Structural Embankment Fill, Zone 4	TBC	TBC	TBC

Hence the target dry density for Zone 4 Fill for 5 consecutive NDM tests within a sub-lot is to yield a compaction with a target density of at least 95% of MDD.

Cl. 4.1.1 of the Wrights Road Storage Ponds - Technical Specification states the 'in-situ moisture content shall be 2% below and 2% above OWC'.

10.2.3 Compaction Methodology

Each un-compacted fill layer (400mm zone 4) will be leveled prior to compaction using the scrapers and/or 14G grader. Once leveled each layer will be compacted using the 20ton Hamm 3520 flat drum roller. The following compaction methods will be used.

- Zone 4 material (400mm depth un-compacted layer) – 4-6 passes with the 20ton roller on vibrate.

Additional compaction will be applied by the scrapers running on top of the fill. This additional compaction has not been accounted for as part of our compaction methodology.

If a material type does not reach the required compaction standard, moisture conditioning may be required. If moisture conditioning is required, the layer surface will be scarified using the 14G graders rippers prior to adding water to the sacrificed surface using the A35C water cart. This process will be repeated until the optimum moisture content is reached.

10.3.4 Geomembrane Panel Layout Plan and programme (10 days prior to commencement).

Prior to commencing any HDPE liner installation, REL's Contract Manager will provide a Panel Layout plan and programme of works to the engineer for review and approval. The Panel Layout will be governed by;

1. The embankment and floor areas completed and ready for lining (embankments will be completed in stages)
2. Prevailing wind direction
3. Time of year

Lining works are expected to commence during early 2027, hence REL staff will have experienced a full 12 months of weather prior to commencing any lining works. This experience will allow REL's management to determine the best starting locations and panel placement layouts based on the previous year's wind direction and intensity.

The geomembrane panel layout plan will be provided to the engineer and designer for review and approval at least 10 days prior to commencing any liner deployment.

11.0 Earthworks Method Statements

11.1 Site Stripping and Clearance

The initial work to be undertaken onsite includes the removal of all trees and fences within the construction area. The trees will be removed using a combination of felling, burning, firewood recovery and mulching/grinding. The combination of tree disposal activities will be chosen based on time of year, access and machinery availability. REL's preferred option is to recover all suitable logs for firewood and burn the remaining slash and debris. All stumps will be disposed of through burning and/or grinding into wood chips.

All fences will be removed, with all fence posts salvaged and fencing wire collected for reuse or disposal at a suitable waste facility. All fence removal will be completed using REL's site excavator and labour resource.

REL will utilize the 627H scrapers to strip (uplift) all topsoil to a depth of 100mm, cart and place the topsoil in a stockpile located on the southeastern corner of site. The A35C watercart, grader and roller will work alongside the scraper group to mitigate dust, provide a smooth haul road surface and compact the stockpile (seal off the stockpile from the elements).

11.2 Foundation Preparation

Following the site stripping of topsoil, REL will utilize the 627H scrapers to cut all remaining silt, cart and place the silt in a stockpile located on the southeastern corner of site. This silt will consist of all fine materials located between the topsoil (top 100mm) and the underlying gravels. This silt will be stockpiled for reuse as liner bedding later. The A35C watercart, grader and roller will work alongside the scraper group to mitigate dust, provide a smooth haul road surface and compact the stockpile (seal off the stockpile from the elements).

REL's scraper group will strip all fine silts and sands, leaving a clean gravel surface under all embankment footprints. Once all fine materials are removed, REL's Project Manager will arrange a subgrade inspection with the Design Engineer. During this inspection, REL may be required to complete scala penetrometer testing and/or proof rolling of the gravel surface in the presence of the Engineer.

11.3 Structural Embankment Fill (Zone 4)

Structural embankment fill (zone 4) placement will commence once the embankment foundation excavation/strip (removal of all silts and organic materials) has been inspected and signed off by the design Engineer, DamWatch. REL will utilize the 631 scrapers to uplift (excavate) the in-situ zone 4 material, cart and spread in 400mm loose layers (+/- 100mm). The 631 scrapers will be loaded with help from REL's 375 Komatsu bulldozer push loading each scraper. The A35C watercart, grader and roller will work alongside the scraper group to mitigate dust, provide a smooth haul road surface, level each 400mm layer deposited by the scrapers and compact each layer to at least 95% of MDD. If moisture conditioning is required, the layer surface will be scarified using the 14G graders rippers prior to adding water to the scarified surface using the A35C water cart. This process will be repeated until the optimum moisture content is achieved.

11.4 Embankment and Silt Liner Construction and Sequencing

REL's proposed construction sequencing plan can be seen in Appendix E – Earthworks Sequencing Plan.

REL intends to follow the earthworks construction sequence listed below for the BHSL Pond construction.

1. Strip Area P1 (of Pond #1) including topsoil and underlying silts from approx. 6ha area to stockpile.
2. Commence cut to fill of embankments using in-situ gravels.
3. Strip Topsoil from Stage P2 (of Pond #1) area to stockpile (approx. 6ha).
4. As sections of Area P1 Floor are cut to subgrade level, begin stripping of silts from Area P2 and place as silt fill.

5. Embankment filling is to be undertaken continuously.
6. Technical work and preparation for Liner System in this area.
7. Commence cut to fill of embankments using in-situ gravels.
8. Strip Topsoil from Stage Area P3 to stockpile (approx. 6ha).
9. As sections of P2 Floor are cut to subgrade level, begin striping of silts from Area P3 and place as silt fill.
10. Embankment filling is to be undertaken continuously.
11. Area P1 is lined.
12. Technical work and prepping for Liner System in P2 area.
13. Commence cut to fill of embankments using in-situ gravels from Area P3
14. Strip Topsoil from Stage Area P4 to stockpile (approx. 6ha)
15. As sections of P3 Floor are cut to subgrade level, begin stripping of silts from Area P4 and place as silt fill.
16. Embankment filling is undertaken continuously.
17. Area P2 is Lined
18. Technical work and prepping for Liner System in P3 area.
19. Cut to Fill is completed in P4 and any excess gravels are used in Pond 2
20. Silts from P1 are used to fill P4 floor where needed.
21. Topsoil to be placed as ballast on liner.
22. Pond #2 will be completed using similar sequencing as Pond #1

REL will provide the following machines for this project;

- 2x 627H Scrapers
- 6x 631 Scrapers
- 1x 375 Komatsu Bulldozer
- 1x 20 Ton Hamm 3520 Hamm Roller
- 1x PC200 LC Excavator
- 1x 14G Cat Grader
- 1x A35C Volvo Watercart

11.5 Concrete and Steel Pipe Installation

All pipes will be installed in accordance with the Wrights Road Storage Pond Technical Specification. This will include;

- All material QA documentation is to be supplied to the Designers Representative for review and approval before use on this project (concrete pipe, steel pipe, bedding and backfill materials).
- Installation and testing method statements provided and approved.

Works will commence with the initial setout of each pipe/conduit location. This will be aided by the design alignment with invert levels uploaded to the site GPS equipped excavator. This excavator will excavate each pipeline to depth and grade, allowing for the 300mm of CLSM bedding.

Whilst completing the pipeline excavation to subgrade, REL's excavator operator will ensure all trenches comply with WorkSafe regulations, including benching any excavations that exceed 1.5m in depth. Once the trench has been cut to design subgrade, REL and the Designers Representative will inspect the trench subgrade and complete scala testing (if required). Following acceptance of the trench subgrade, REL will place approved CLSM over the trench subgrade and compact in 2x layers (2x 150mm layers).

Once prepped, all heights will be checked using a combination of total station survey and laser level checks off survey reference points. REL's Project Manager will confirm all heights are correct or instruct any adjustments needed. When REL's Project Manager, QA technician and site surveyor are happy with the bedding heights, REL's team will install the concrete or steel pipe.

Concrete pipes will be installed by lifting into placed by a 20 or 30-tonne excavator. Pipes will be lifted in 1 by 1, using certified lifting chains and lifting eyes. The first pipe will be lifted into position, checked for heights, grade, etc. then fixed in placed by several compacted layers of AP20 cover material. This

material will be dropped into place by an excavator, leveled by hand and compacted using a combination of foot whackers and plate compactors. If needed, each layer will be moisture conditioned to aid compaction. All compacted layers will be NDM tested to ensure compliance with the Technical Specification.

Once firmly fixed in place, the second pipe will be lifted into position. This rubber ring will be checked to confirm condition and position on the pipe. All pipes must be completely dry before installation. Following the rubber ring checks, REL's excavator will lift the concrete pipe off the bedding layer, allowing REL's ground team to push the pipe into position using crowbars. The pipe will be checked internally and externally to confirm connection compliance. Backfilling of this pipe will commence following acceptance of all checks. The pipe installation process will continue using the same process until all pipes have been installed.

The remaining cover material backfill will continue to 300mm above the top of each concrete pipe. Zone 4 engineered fill will continue to be placed over each pipeline, placed in continual layers with the embankment construction.

The steel penstock conduit will be installed in a similar manner; however, the joining will be completed above ground (where possible) and within the trench (to join large pipe lengths). This jointing will be welding and epoxy coating each exposed pipe/weld. No backfilling will be undertaken until the steel pipe is fully joined.

Each concrete pipe installation will follow the above methodology, with daily inspections by the Designers Representative.

11.6 Concrete work

All concrete works will be completed in accordance with the Wrights Road Storage Pond Technical Specification. Prior to undertaking any concrete work onsite, REL's builder will provide detailed method statements for each structure confirming materials, sequencing and time.

All QA records for all materials will be provided by the reinforcing steel manufacturer and the concrete supplier. These records will be reviewed and approved by the Designers Representative prior to use on site.

Each structure will be prepped by REL's team, with the site handed over to REL's builder. REL will ensure each site is excavated/prepped using approved materials, compacted to 98% of MDD and ample workspace provided to the builder.

Reinforcing steel will be assembled onsite, in position and inspected by the Designers Representative to ensure full compliance with the Technical Specification. This will include measuring all overlaps, clearances, etc. A full photo record will be kept for verification purposes.

All form work will be assembled onsite around the reinforcing steel. Again, the Designers Representative will complete full inspections of each structure/pour. This will include full measurements and photograph records of all structures before each concrete pour.

Concrete will be slump tested in delivery, with core samples collected at the plant for strength testing at 7 & 28 days.

All QA records will be provided to the Designers Representative for review and approval, including all photographs and manufacturers QA records.

12. HDPE Geomembrane Subgrade Preparation Method Statements

12.1 Embankment Slope HDPE Subgrade Preparation

REL will be responsible for the pond embankment construction and HDPE subgrade preparation on this Wrights Road Storage Pond project. Once the pond embankments have been constructed and tested to meet the requirements of the Wrights Road Storage Pond Technical Specification. REL will cut the inner pond embankment slope to grade using a CAT14M or Komatsu 655 with GPS guidance technology. This inner slope will be cut on a 3H:1V slope. A 20-tonne excavator may be needed to complete a final trim on areas of the inner embankment slope, if areas are left untidy or the grader is having difficulty cutting the slope on grade. The 20-tonne excavator's cleaning bucket will be fitted with a smooth steel bar/rod which will be used to trim and brush over the embankment slope to create a smooth surface. Once the slopes' surface has been cut/trimmed to grade, REL will compact the finished surface using a 14-tonne CAT roller. The roller will be used to compact the top layer, hence creating a firm and smooth surface.

Before commencing with the placement of a 500gsm geotextile on the embankment slopes, REL's Lining Supervisor will inspect the final embankment subgrade surface. The subgrade surface inspection will be carried out by walking grids through the prepped area. If any minor adjustments are required (the odd sharp stone present, a stony pocket with little fines, etc.) REL's staff will complete the final preparation by hand (picking up the sharp stones, covering the stony patches with silty material, etc.). If REL's Lining Supervisor has an issue with a large portion of the prepped subgrade, REL will be asked to re-prep this area, adding silty material (fines) if required.

Once REL's Lining Supervisor is satisfied with the subgrade, REL staff will deploy a 500gsm geotextile on the embankment slopes. This geotextile will be pulled off a spreader bar, held up by a 20-tonne excavator. REL staff will pull the geotextile by hand and lay it in position (1 metre beyond the embankment toe and into the HDPE anchor trench) before cutting the geotextile off the roll. Each geotextile sheet overlap (approximately 100mm wide) will be flame welded together (a flame torch will be run between the geotextile overlap, melting the two geotextile layers together) to ensure the geotextile subgrade remains fixed in position during and after the HDPE liner placement.

12.2 Protection of Exposed Surfaces

Subgrade material (silts) is very sensitive to water. Hence, subgrade HDPE bedding preparation will occur only one day ahead of the HDPE geomembrane placement crew. From experience, REL knows how long it takes for a compacted silt subgrade to dry in winter. Hence all silt liner bedding placements will be directed by the HDPE lining superior and subject to a fine (no rain) weather forecast.

The pond embankment slopes will be protected and safe from scouring, etc. as soon as the Zone 4 surface has been trimmed and compacted. The placement of geotextile on the embankment slopes will add additional security from rain and will allow REL to continue deploying HDPE geomembrane straight after rain events.

12.3 Pond Floor HDPE Subgrade Preparation

REL will cut the pond floor to grade using a CAT14M with GPS guidance technology. The pond floor will be cut and finished to the final design surface. A 20 tonne excavator may be needed to tidy up areas on the pond, if areas are left untidy by the grader. Once the pond floors' surface has been cut/trimmed to grade, REL will compact the finished surface using a 14 tonne CAT roller. The roller will be used to compact the top layer, hence creating a firm and smooth surface.

Before commencing the placement of silty liner bedding on the pond floor, REL's lining supervisor will complete an inspection of the compacted Zone 4 surface. He will remove any large broken stones, etc. within the prepped area if he believes these items will cause issues after the silt liner bedding has be placed.

Silty liner bedding will be placed using CAT 627 scrapers, a CAT 14M grader and a CAT 14 tonne roller. The CAT 627 scrapers will uplift in-situ silt material (free of stones/cobbles), cart and spread this material across the pond floor. The CAT 14M grader will trim the silty material across the pond floor. The silt material will be trimmed to a loose depth of approximately 75mm. The liner bedding will be compacted using a 14 tonne roller. REL staff will ensure the compacted depth of silt material is at least 50mm. The trimming

depth of loose silt material will be altered as required to meet the 50mm compacted depth.

Once compacted, REL's Lining Supervisor will inspect the final floor liner prepped subgrade surface. The subgrade surface inspection will be carried out by walking grids through the prepped area. As mentioned above, if any minor adjustments are required (any stones in the prep, etc.) REL's staff will complete the final preparation by hand (picking up the stones). If REL's Lining Supervisor has an issue with a large portion of the prepped subgrade, REL will be asked to re-prep this area, excavating and adding new silty material if required.

12.4 Soil Subgrade Lot Authorization Sign Off

REL's Lining Supervisor will sign off the soil and zone 4 subgrade daily before deploying any geotextile and/or HDPE geomembrane. The daily subgrade signoff will be recorded on a 'Certificate of Acceptance of Soil Subgrade Surface' record sheet. This certificate will outline the subgrade surface which has been accepted – this will be recorded using the HDPE geomembrane panel numbers placed on top of the soil subgrade surface. These HDPE geomembrane panel numbers will be recorded and labeled on the final HDPE panel as-built, hence each days' approved subgrade lot will be labelled Panel No. – Panel No. A new Certificate of Acceptance of Soil Subgrade Surface will be signed off by REL's Lining Supervisor and the Site Engineer (DamWatch) each day, before HDPE geomembrane is deployed.

A template of the 'Certificate of Acceptance of Soil Subgrade Surface' is attached in Appendix 2.

The proposed EcoTech 500gsm geotextile datasheet is attached in Appendix 9 – 'Ecotech 500gsm Geotextile Underlay Data Sheet' of the document.

12.5 Field Trial Methodology

Prior to commencing with the HDPE geomembrane deployment, REL will arrange with DamWatch to witness the subgrade preparation of both embankment slopes (geotextile placement) and the pond floor (silt liner bedding placement). The HDPE geomembrane subgrade preparation will be completed as described in 12.1 and 12.3 above.

13.0 HDPE Geomembrane Installation Method Statements

The following methodology outlines the installation methods which REL staff will follow to complete the HDPE geomembrane installation on Burnt Hill's Wright Road Storage Ponds.

REL will be using GSE HX 1.5mm White Reflective smooth HDPE geomembrane manufactured by Solmax. Solmax's GSE HX 1.5mm White Reflective Smooth HDPE Geomembrane Technical Data Sheet is attached in Appendix 1.

13.1 HDPE Cartage, Storage and Protection

HDPE geomembrane and 500gsm geotextile rolls will be carted to site on REL's flat deck truck and trailer units and/or B Train units from their customs clearance site, King Street, Timaru (EcoTech). Each roll will be unloaded by a 20 tonne excavator from the truck and trailer units using the attached lifting strops and stockpiled on a flat nominated location along the inside embankment toe. The HDPE will be stockpiled on timber, off the ground to minimize any potential damage during storage.

Geotextile is very soft and flexible; hence this material will be stockpiled directly on the flat Zone 4 surface.

The HDPE geomembrane and geotextile roll stockpile location will be positioned within Pond 2, close to the site compound. This stockpile location will change as the HDPE geomembrane placement progresses. Each stockpile location will provide security from the weather, heavy machinery and small vehicles.

13.2 Anchor Trench Excavation and Backfilling

The HDPE geomembrane anchor trench will be excavated using a 20 tonne excavator and narrow trenching bucket (500-600mm). The anchor trench will be excavated 1000mm off the inside embankment crest edge. The anchor trench will be excavated to a depth of 750mm. All excavated spoil will be placed along the outside embankment crest edge. This material will be reused for backfilling the anchor

trench once the HDPE geomembrane and geotextile have been placed, welded and are ready for securing within the anchor trench.

Backfilling of the anchor trench will only be completed during the cool temperatures of the morning hours. Hence, the anchor trench will remain open overnight. REL staff will backfill the anchor trench slightly each night by hand, to ensure the HDPE geomembrane is safe and secure for the night. The remaining anchor trench will be backfilled using a 20 tonne excavator. The excavator will place the excavated material from the outside embankment crest in the anchor trench in 150mm layers. Each layer will be compacted using a small plate compactor to meet the requirements of the Wrights Road Storage Pond Technical Specification.

13.3 HDPE Geomembrane Deployment and Placement

HDPE geomembrane deployment will be completed using a 20 tonne excavator and man power. A steel spreader bar will be attached to the 20 tonne excavator using certified lifting chains. Each HDPE geomembrane roll will be attached securely to the spreader bar and lifted into position by the 20 tonne excavator. Each HDPE geomembrane panel will be pulled off the roll (attached to the spreader bar) and laid into position by hand. All minor placement adjustments/movements will be completed by hand (several labourers pulling at once). Once each panel has been pulled into position and adjusted, ready for welding, the HDPE lining supervisor will cut the HDPE geomembrane off the roll at an appropriate length to ensure the HDPE geomembrane will be fixed securely in the anchor trench, once backfilled.

After each panel has been cut off the HDPE geomembrane roll, the 20 tonne excavator will move into position for the next panels' deployment. Each HDPE geomembrane roll is 140 metres long; hence 3-4 full panels will be pulled from each roll. Any short off cuts will be pulled off the roll and placed on the pond floor. REL staff will ensure no horizontal panel welds are completed on the embankment slopes.

13.4 Water Control and Management

Water control on both the HDPE geomembrane and the subgrade preparation is crucial on this project. Heavy dews and precipitation can create major hold ups and additional work for REL staff if the site is not managed appropriately.

As mentioned in 12.3 above, REL will only prep the silt liner bedding one working day ahead of the HDPE geomembrane placement. The silt liner bedding will only be placed if the weather forecast promises fine weather; therefore, no prepped silt liner bedding will be exposed to any foreseen precipitation events.

After HDPE geomembrane has been placed each day, silt/soil ballast will be placed along the border of the last HDPE geomembrane panel at a height of approximately 500mm. This ballast will be continuous along this HDPE geomembrane border, hence creating an impervious barrier for any water which falls onto the HDPE geomembrane. The floor prep will be flat, hence the perimeter of the liner placed each day will be bunded using the soil ballast to prevent any potential runoff onto the exposed/cut zone 4 floor surface beyond the extent of the HDPE geomembrane.

13.5 Fixing HDPE Geomembrane to Concrete Structures

Before welding the HDPE geomembrane onto the inlet and outlet structures, REL staff will remove all sharp objects and defects from the polylock profile attached to the concrete structure, including concrete edges, screws and nails. All holes and/or defects in the polylock profile will be repaired using an extrusion weld prior to the attaching the HDPE geomembrane. The polylock profile and HDPE geomembrane will be scarified using handheld grinders prior to completing the extrusion weld. The extrusion weld will attach the two PE items permanently together. Each extrusion weld will be completed and tested as described in the jointing methodologies (in section 14).

The HDPE geomembrane will be laid flat along the prepped subgrade and hard up against the concrete structure to the polylock profile. REL's Lining Supervisor will ensure the HDPE geomembrane is lying flat and there is no risk of air pockets under the HDPE geomembrane prior to attaching the geomembrane to the polylock profile.

HDPE Geomembrane Panel Layout

As requested in Cl 6.4 of the Technical Specification, REL will provide a Panel Layout Plan 10x days prior to commencing and HDPE deployment on site.

14.0 HDPE Panel Welding/Jointing

REL recognizes that careful and specific documentation of the installation is required to substantiate this Quality Control Programme. This section addresses the HDPE geomembrane installation procedures for the BHSL Pond, to assure the quality of welding/jointing workmanship and the installation integrity of the HDPE geomembrane.

REL will join all HDPE geomembrane seams using fusion wedge welders and extrusion welders.

14.6.1 Welding Procedures

Fusion (Wedge) Welding:

Fusion (wedge) welding utilizes a metallic wedge heated to the required temperature and guided between the lapped edges of adjacent panels. The welding machine is aligned and set to the required temperature (typically 325 to 400C depending on the material thickness and site conditions), and the machine travel speed is set to the required setting for the applicable material thickness. The wedge heats the area of the two panels to be joined to the required temperature. Rollers immediately following the wedge exert the required pressure on the heated area to obtain fusion between the adjoining panels.

Welding apparatus shall be automated, vehicular-mounted, and equipped with devices giving applicable temperatures and pressures.

As the welding progresses, the welding operator takes care to assure correct machine speed and alignment.

REL staff will ensure all HDPE geomembrane panel overlap widths are at least 80mm. The fusion welded surface and non-welded air pressure zone widths will vary, depending on the external air temperature and wedge welder speed.

Extrusion Welding:

Adjacent panels shall be tack bonded together using procedures that do not damage the geomembrane, allow required tests to be performed, and are not detrimental to final seaming. Welding apparatus shall be free of heat-degraded extrudate before welding. The geomembrane surface shall be abraded to a maximum ¼ inch, 5mm beyond the weld bead area, using a disc grinder, or equivalent, not more than ½ hour before welding. The top edges of geomembrane 1.5mm or greater shall be beveled 45□ using a hand-held grinder. The ends of all seams, which are more than five minutes old, shall be ground when restarting the weld. Grinding depth shall not exceed ten percent of the liner thickness.

Extrusion welding entails placing a hot extrudate on top of the preheated lap of two adjoining panels while simultaneously applying pressure and utilizes a welding rod made from the same type of resin as the membrane. The welding rod is melted inside the extrusion welding machine to form the hot extrudate. Preheating of the sheet in the weld area is performed by the extrusion welding machine.

The Teflon shoe (that determines the profile of the molten extrudate) is checked for correct dimensions. The temperature controllers are then set to appropriate temperatures and the machines are allowed to heat to the temperature set point.

When the seam area is prepared, the welding machine is positioned so the nozzle and the shoe are flat on the seam. As the machine is moved forward, care is taken to assure that the point of the preheat nozzle is centered on the edge of the top sheet and is as close to the sheet as possible.

As the welding progresses, the welding operator takes care to assure correct machine speed and alignment.

14.6.2 Seaming Documentation

All seaming operations will be documented by the CQC coordinator or a designated Assistant. Welding Technicians will mark on the liner with Mean Streak permanent markers at the start of all seams information regarding, date, time, Welding Technician ID, machine number, and set temperature. CQC Co-Ordinator or Assistant will record date, time, seam number, Technician ID, machine ID, set temperature, speed, and weather conditions on the Panel Seaming Record Sheet (See Appendix 3).

Welding Technicians will periodically check operating temperature and speed and mark the information along the seam.

CQC Coordinator will make periodic checks on welding operations to verify overlap, cleanliness, etc.

14.6.3 Seam Inspection and Repair

After welding, a close visual inspection of the seam is made. This is done as soon as possible after the weld has been completed. The inspection is to include weld alignment. For extrusion welding, the weld thickness and profile are inspected. Defective areas are marked and repaired then the repairs are inspected and approved. This inspection/repair process is carried out in a systematic manner as soon as possible to ensure that no defective area goes unrepaired.

Trial Welding/Seaming and Engineer Sign Off

REL staff will demonstrate the total wedging operation to the engineer prior to commencing any welding on the pond embankments. This demonstration will be used to confirm REL's welding techniques with the Engineer and ensure approvals of these techniques by the engineer. REL will demonstrate both primary and secondary welding techniques.

14.6.4 Preparing – Test Weld Specimens

As requested in Cl 6.15.1 of the Technical Specification, REL staff will initially complete test weld specimens at the following frequency;

- Prior to the commencement of each shift for each operator
- Prior to the recommencement (after equipment has been shut down)
- Each time the extrusion or thermal controls are altered
- After every 5 hours of operation.

Test weld specimens will measure at least 3m in length by 300mm wide. All specimens will be clearly marked to identify the time of the test and ambient temperatures, prevailing environmental conditions, etc. Each test weld will be suitably labeled and identified against the panel seam number.

Test weld frequencies may be reduced as the project progresses if the engineer is satisfied with REL's welding techniques and test results.

14.6.5 HDPE Geomembrane and Extrusion Rod Quality Assurance Documentation

REL will supply a full QA/QC document to the engineer upon the completion of the HDPE geomembrane installation. This document will contain the following records;

- HDPE Geomembrane Roll Numbers – this document will identify the following roll properties;

1. Manufacturer/Supplier
2. Product Identification/Type
3. Roller number
4. Container number (shipping reference)
5. Roll Width
6. Roll Length
7. Roll surface area
8. Packing Slip/QA Documentation Reference
9. Roll weight
10. Delivery – Shipping and Devanning Dates

- EcoTechs Certificate of Acceptance of Soil Subgrade
- EcoTechs Panel Placement Record Sheets
- EcoTechs Trial Weld Information Record Sheets
- EcoTechs Panel Seaming Record Sheets
- EcoTechs Geomembrane Delivery QA Records Sheets
- EcoTechs Repair Report Record Sheets
- EcoTechs Non-Destructive Test Record Sheets
- EcoTechs Destructive Test Record Sheets
- Manufacturer's QA/QC Certification Results – this document will outline the laboratory QA testing

completed by Solmax. Hence, REL will provide geomembrane test results completed by Solmax for geomembrane properties listed in Cl 6.10.2 of the Technical Specification or to the satisfaction of the design engineer.

Quality assurance documentation for the HDPE extrusion rod (used on secondary welds) will be provided with the HDPE geomembrane QA documentation.

14.6.6 Non-Destructive Testing

We will non-destructively test all field seams over their full length using vacuum box testing, air pressure testing for fusion (wedge) welded seams only, or spark testing. Generally non-destructive testing is carried out as the seaming progresses.

Air pressure testing

Fusion (wedge) welded seam with an enclosed space will be tested in accordance with ASTM 5820, and shall conform to the following requirements:

The equipment shall consist of the following: an air pump (manual or motor driven) equipped with pressure gauge capable of achieving pressure over 190kPa, a rubber hose with fittings and connections, a sharp hollow needle and a pressure gauge. Sufficient cushioning (i.e. rubsheet, wheels, padding, etc.) should be provided under the air pump equipment to protect the geomembrane.

Testing shall conform to the following procedure:

Seal both ends of the seam to be tested. Insert needle into the channel created by the double-wedge weld. Energize the air pump to a pressure of 240kPa, close the valve, and sustain the pressure for at least five minutes. If pressure loss exceeds the allowable drop (20 kPa) or does not stabilize, locate faulty area and repair as described in this section.

After test completion, the air channel at the opposite end of the seam from the air insertion point should be punctured to release the air. This will assure there is no channel blockage and that the seam has been tested along its entire length. If blockage is present, locate and test seam on both sides of blockage. Remove needle and repair penetration holes by extrusion welding as necessary.

All information regarding air-pressure testing, (date, initial time and pressure, final time and pressure, pass/fail designation, and Technicians initials) will be written at both ends of the seam, or portion of seam tested. All the above information will also be logged by the CQC Coordinator on the Non-Destructive Testing Record Sheet as exhibited in Appendix 4.

Non-destructive air pressure testing values, including the maximum pressure differences for the test to pass are shown in Section E. EcoTech intends to pressurize the primary welds to 240 kPa, as mentioned above.

In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

- Check seam end seals and retest seams.
- If a seam does not maintain the specified pressure, the seam should be visually inspected to localise the flaw. If this method is unsuccessful, cut one 25 mm sample from each end of the seam.
- Perform destructive peel tests on the samples using the field tensionmeter.
- If all samples pass destructive testing, remove the overlap left by the wedge welder and vacuum test the entire length of seam.
    - If a leak is located by the vacuum test, repair by extrusion fillet welding. Test the repair by vacuum testing.
    - If no leak is discovered by vacuum testing, the seam will be considered as passing non-destructive testing.
- If one or more specimens fail the peel tests, additional samples will be taken.

Vacuum box testing

This shall conform to the following requirements:

- The equipment shall include two vacuum box assemblies consisting of the following: a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a vacuum gauge, a vacuum device equipped with pressure control, a rubber pressure/vacuum hose with fittings and connections, a soapy solution and an applicator.

- Testing shall conform to the following procedure: Brush soapy solution on seam. Place vacuum box over the wetted area. Ensure that a leak-tight seal is created. Apply a vacuum of approximately 35kPa. Examine the geomembrane through the viewing window for the presence of soap bubbles for not less than ten seconds. All areas where soap bubbles appear shall be marked and repaired as described in this section.
- Vacuum box testing will be performed by qualified construction personnel with frequent supervision by the CQC Coordinator.
- Overlap must be trimmed prior to vacuum boxing all seams.
- Special attention shall be exercised when vacuum testing "T" seams or patch intersections with seams.
- Vacuum testing crew will use Mean Streak permanent markers to write on liner indicating tester's initials, date, and pass/fail designation on all areas tested.
- Records of vacuum testing will be maintained by the CQC Coordinator or testing crew on QC Non-Destructive Testing Form or Repair Report Form as exhibited in Appendix J.

Spark testing

This shall be used for those extrusion seams at penetrations and extrusion welding around structures.

The spark test method consists of placing 24-gauge copper wire at the edge or just under the top sheet overlap of the two sheets, prior to extrusion welding. After welding, a spark detector operating between 10 and 30 kVA is run along the weld. If any pinholes are present, a circuit will be completed through the copper wire and the spark detector. Sparks will be observed jumping from the probe to the seam this will indicate a failure. The spark test is typically used for extrusion welded seams where there is no hazard anticipated from a spark and where there is no chance of creating a vacuum seal.

There is no immediate danger to human or animal life if a circuit is made through the spark detector. However, the spark detector should not be used in the presence of water or excessive moisture.

The spark testing crew will use mean streak permanent markers to write on liner indicating testers initials, date and pass/fail designation on all areas tested.

Records of spark testing will be maintained by the CQC Coordinator or tester crew on Repair Report Record Sheet or Non-Destructive Testing Record Sheet as exhibited in Appendix I and Appendix J.

14.6.7 Destructive Testing

As the welding of the geomembrane progresses, test samples shall be cut from the geomembrane every 200m of welded seam. These destructive test specimens shall measure 900mm long by 300mm wide as specified in Cl 6.15.3 of the Technical Specification. REL's Lining Supervisor shall determine the location of the destructive samples (every 200m). When reasonable, destructive samples should be taken at the beginning or end of a seam, preferably from areas that will be buried in the trench. Based upon successful test results and Engineer's approval the frequency of testing may be reduced. It is in the interest of all parties to minimize the number of destructive holes in the liner.

Both destructive and trial weld samples shall be labelled with the following information:

- destructive or trial weld sample
- job name and number
- date sample was welded
- membrane thickness
- sample or seam number, if applicable
- welder's name
- welding machine number
- ambient temperature at time of welding

Destructive Testing: Samples shall be tested in peel and shear. Minimum acceptable strength to be obtained for these tests shall follow the minimum seam testing values listed in table 11 Cl 6.15.8) of the Technical Specification (see Section E).

At least five specimens shall be tested by each test method. Specimens from each sample shall be selected alternately for testing (i.e., peel, shear, peel, and shear). For double wedge seam samples, both

welds shall be tested in peel. Test results shall be provided verbally within 24 hours after receiving samples, and in written form within seven days.

Prior to the geomembrane being covered by the next layer of geosynthetics or soil, seams shall exhibit passing results from onsite destructive testing.

Immediately repair all holes in the geomembrane resulting from destructive samples. The continuity of the repair shall be vacuum tested in accordance with this section.

All destructive seams shall be numbered and recorded on QC Destructive Test Form as exhibited in Appendix N.

14.6.8 Defects and Repairs

The geomembrane shall be examined for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The geomembrane surface shall be clean at the time of examination. Each suspect location shall be repaired and non-destructively tested. Geomembrane shall not be covered at locations that have not been repaired.

Damaged geomembrane shall be removed and replaced with acceptable geomembrane if damage cannot be satisfactorily repaired.

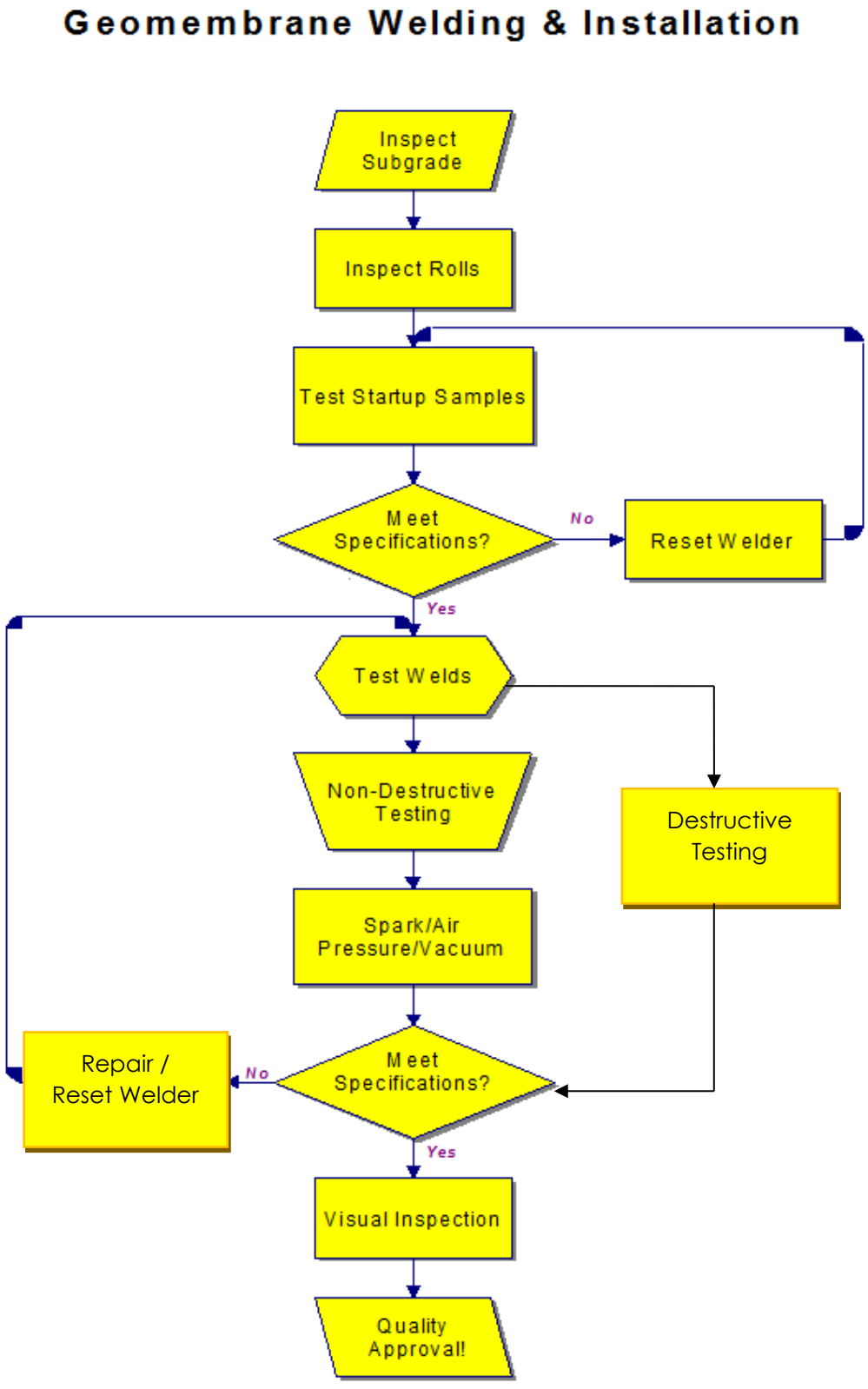
Any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test shall be repaired. Procedures available include:

- Patching used to repair large holes (over 1cm diameter) and tears (over 30cm long), and contamination by foreign matter.
- Abrading and re-welding: used to repair small extrusion seam sections (less than 30cm long).
- Spot welding: used to repair small tears (less than 5cm long), pinholes, or other minor, localized flaws.
- Capping used to repair large lengths of failed seams.
- Extrude overlap along the lengths of failed fusion welded seams
- Removing the unsatisfactory material or seam and replacing with new material.
- Patches or caps shall extend at least 15cm beyond the edge of the defect, and all corners of material to be patched and these shall be rounded to a radius of at least 15cm. The geomembrane below caps shall be cut to avoid water or gas collection between the two sheets.
- Repairs shall be non-destructively tested using methods specified in this section.

14.6.9 Geomembrane Acceptance

REL shall retain all ownership and responsibility for the geomembrane until final acceptance by the owner. Owner will accept the geomembrane installation when the installation is complete and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

FLOW CHART-Geomembrane Welding and Installation



15.0 Dewatering and Control of Perched Groundwater

Initial investigations of the site indicate groundwater should not be an issue during the pond construction. However, if groundwater is intercepted while excavating REL will control the groundwater using one of the following methods;

1. Sykes pump – if the groundwater is discovered in an isolated location and has a low flow rate REL will manage the groundwater using Sykes pumps. A 'cut-off' trench will be excavated along the upstream perimeter of the excavation to intercept the groundwater prior entering the excavation. This water will be pumped out of the 'cut-off' trench using a Sykes pump into a suitable discharge location (deep nearby excavation, nearby paddock or swale). The discharge location will be agreed on by all parties involved prior to commencing any dewatering.
2. Internal drains – if groundwater is discovered throughout the pond floor and has a significant flow rate REL will manage the groundwater using internal drains and or soakage trenches. A series of 'cut-off' trenches will be excavated along the upstream perimeter of the pond to intercept the groundwater prior entering the pond excavation. These trenches will be excavated below the underside of the silt liner layer to drop the groundwater level below the proposed excavation level. These drains will be excavated on a flat grade to the southeast corner. REL expects the groundwater to infiltrate back into the sandy in-situ gravels within the trench over a short distance (the fall across the pond is significant, hence groundwater should only be a potential issue along the northern perimeters. REL will consult with DamWatch to determine a more permanent groundwater control design, if required.

16.0 Establishing Grassed Topsoil

Topsoiling the exterior embankments will not occur until late August/Early September to prevent potential scouring/topsoil runoff prior to grass establishing on the slope. The bulk of the construction period is over the winter; hence grass will not strike/grow until the warmth of spring. To eliminate the potential of sediment runoff REL intends to leave the exterior batters as a solid graveled surface until late in the project. REL will spread grass seed by hand on the slopes and drill on flat topsoiled surfaces immediately after placement of the topsoil.

17.0 Contract Quality Control Plan

17.1 Project delivery

17.1.1 Scope changes

Any changes to the scope of the work shall be address via RELs change management process. It is the responsibility of all team members to notify the project leader of any potential or actual changes to the scope of work.

17.2 Project controls

17.2.1 Inspection and test plan (ITP)

Inspection and Test Plans will be used for:

- Confirming that pre-construction sign offs are in place to enable work to commence on site,
- Construction verification,
- Recording that all inspections and testing requirements are met,
- Scope and location of work,
- Inspection and test method and frequency,
- Timing and/or location of inspections and tests,
- Witness and Hold points notification and release requirements,
- Witness and Hold points.

An Inspection and Test Plan is required to be created and approved by Project Manager before work commences. The ITP identifies each step of a specific task, including hold points, inspections and testing requirements.

All Inspection and Test Plans will be uploaded to REL System and only the current revisions of these will be visible. This ensures that they are up-to-date and that superseded copies will not be used. The Client Representative can request the ITPs, which can be transmitted via M-Files.

Site Engineer will be responsible for ensuring all hold points and inspections are signed off before work progresses. Once work is completed the ITP will be submitted to Senior Management to be closed out.

Following the steps in the ITPs will ensure that we meet the requirements of our designers and client. Successful completion of quality documents will demonstrate a high standard of physical works.

An Inspection and Testing Plan should be used in conjunction with a Method Statement so that the task is clearly explained.

17.3 Method statements

A Method Statement is to be developed and approved by Contract Manager before work commences. It will have clear, concise instructions of the job at hand. The Method Statement will also describe safe work methods and detail significant hazards and environmental risks.

Method Statements are considered 'live' documents and will be updated if methodologies change on site due to unforeseen circumstances.

The crew will read and discuss the work method before work begins and sign the work method to show that they have been shown clearly and understand the work at hand.

New Method Statements may be created for a new task or can be utilised from the library where applicable. However, they must be specific to the task and location of a particular activity. As such, Method Statements must be reviewed by Project Manager before they are used.

Our method statements are provided above in Sections 11 to 15.

17.4 Engineer hold points and inspections

The contractor will plan to provide the Engineer/Designers Representative receives timely notifications to arrange for witness and hold inspections as detailed on the ITP. Correspondence is retained that can evidence timely notification of witness and hold point inspections.

The contractor acknowledges that the Engineer/Designer Representative has the right to access any

location where work under the contract is being carried out, including free and safe access to all parts of the work for the Engineer's Representative to carry out inspections.

Engineer'/Designers Hold points and Inspections are generally set out in the Technical Specifications and may be varied by the Engineer's Representative at any time via Notice to Contractor. Where they have already been defined, they are included in the Method Statements and Inspection and Test Plans.

17.4.1 Designer Hold Points

All construction control stages will have hold points to ensure the intent of the design has been met. It is proposed that the Designer and Contractor shall sign off critical construction phases.

It is specified that the Designer shall be represented full time on site by a suitably qualified engineer with experience in specific preconstruction and construction control stages. The following are the key stages of the construction that require the Designer's attention and approval and are therefore HOLD points during the project planning, documentation and execution phases. :

From TS 1.13 Quality Control: Designer Inspections, we have ethe following item, requiring the Designer's attention and approval, therefore these are naturally HOLD points in the QA/QC process:

1. Preparation of quality assurance and method statements;
2. Preparation of the surface supporting the geomembrane both on the embankment slopes and the pond bottom;
3. Preparation of QA/QC plans for the manufacture of Ecotech 500gsm filter cloth;
4. Preparation of QA/QC plans for the installation of Ecotech 500gsm filter cloth;
5. Preparation of QA/QC plans for the manufacture of the Geomembrane;
6. Preparation of QA/QC plans for the installation of the Geomembrane;
7. All stages of fill placing trials of Zone 4 material;
8. Foundation preparation and inspection for all earthworks and concrete works,
9. Embankment construction;
10. Construction of low-level embankment conduits (foundation preparation and inspection, conduit backfilling, reinforcement, concrete placement and backfilling, filter cloth and geomembrane placement and geomembrane attachment to concrete penetrations);
11. All stages of trial placement and jointing of the geomembrane liner;
12. All stages of installation placement, jointing, and anchoring of the geomembrane liner;
13. Construction of intake and outlet structures;
14. Construction of the service and emergency spillways;
15. Construction of flow measuring weirs;
16. Installation of gates;
17. Installation of automation control systems and water level recording wells; and
18. Commissioning of the scheme.

17.4.2 Other notifications or provision of information items from the TS include:

1. ANY Noncompliance will signal a hold point and notification to the Designer:
2. in accordance with TS 6.2 Standards, following Contract award, the Contractor shall submit to the Designer for approval notification of the intent to adopt the standards provided in the Technical Specification along with the respective standards for material compliance in Tables 6 and 7.
3. Critical to the design of the embankment culvert penetrations is to ensure the backfill material for pipe penetrations is compatible with Zone 4 embankment material and underlying foundations. The Contractor shall ensure a hold point for inspection and carry out sieve analysis of foundation and backfill materials placed around pipe penetrations and concrete transitions at locations determined by the Designer. The Designer shall check that materials conform to the grading curves specified in Section 17 and are not susceptible to suffusion.

4. Levels and Reference Points: All co-ordinates are to NZGD2000 Mount Pleasant Circuit 2000 and levels to mean sea level, from control Survey Mark B485, Lyttelton Vertical Datum 1937.
5. Construction activities shall not commence at the site until the Quality Assurance and Quality Control Plan has been accepted by the Manager, RMA Monitoring and Compliance, Canterbury Regional Council and that acceptance advised by notice in writing to the Consent Holder.
6. At least one month prior to commencing any lining works, the Contractor shall provide the Engineer with a proposed Geomembrane installation schedule, cross referenced to the Panel Layout Plan. (TS6.4)
7. At least one month prior to commencing any lining works, the Contractor shall provide the Designer with the information listed in TS 6.3 on the resin used in the HDPE manufacture:
8. At least one month prior to commencing any lining works, the Contractor shall notify the Designer of the area required for Geomembrane storage facilities, and the minimum roll out area for working.
9. At least one month prior to commencing any lining works, the Contractor shall provide Certification to the Designer that the HDPE extrudate to be used in any field extrusion welding is comprised of compatible resins and additives as the parent HDPE and is directly comparable to the information provided in above.
10. The Contractor shall provide the Designer with the manufacturer's test certificates for Ecotech 500 GSM geotextile prior to commencement of geotextile placement.
11. TS 6.14.5 Site Procedure for Primary Welding. The nipping pressure, welding speed range and wedge head temperature parameters of the proposed welding equipment, shall be submitted to the Designer prior to acceptance of the welding unit for any work.
12. The Contractor shall demonstrate the total welding operation to the Designer's Representative prior to the commencement of any welding on site. Specimens of welds shall be destructively tested by the Contractor and approved in writing prior to commencing welding on site.
13. One month prior to commencement of construction, the Contractor shall develop a detailed construction sequence for the execution of the works in accordance with this Specification, Drawings, consent conditions, and the constraints of the site to demonstrate design compliance. The programme shall identify duration of planned works and completion dates. The construction sequence shall be reviewed for compliance with design objectives by the Designer. (TS1.15)
14. As per TS 8.4.3, not later than eight weeks before commencing concreting operations, submit a concrete mix design certified by a Registered Engineer for each type of concrete specified herein.
15. In regard to testing of concrete quality and rejection for low strength, within one week of the rejection order and before taking any action the Contractor shall notify the Designer's Representative in writing of his intention to cut cores.
16. Re TS 8.7.2: Inspections by building consent authority: Notify for inspection sufficiently in advance before placing concrete and any necessary rectification of formwork, reinforcement and construction joint stops. Pour concrete only between properly positioned stops.
17. Re TS 8.7.2: Inspections by construction reviewer: Submit the Concrete pour schedule to the Designer and re-submit amendments as necessary. Notify for inspection sufficiently in advance before adjustment of formwork, reinforcement and construction joint stops, and placing concrete. Pour concrete only between properly positioned, inspected and approved stops.
18. The Contractor shall submit the operation and maintenance section of the manual to the Designer at least two weeks prior to commencement of commissioning for review.
19. As per TS16, prior to impoundment of the ponds the commissioning plan prepared by Damwatch will be updated jointly by the Contractor and the Designer in accordance with the requirements of the Building Act and the NZDSG Commissioning of the scheme.
20. Prior to commissioning the Contractor shall survey and locate the final pond layout, location of all appurtenant structures including alignment of penetrating conduits, electrical supply and

instrument cables for preparation of as-built drawings.

17.5 Access, Check, review, verify and approve

The Contractor will advise the Engineer/Designers Representative with as much notice as possible, when the inspections, testing and Hold Point activities are to be carried out to enable inspection:

Appropriate Site Managers will ensure the necessary inspections and testing to fulfil the requirements of the specifications are undertaken and recorded. Testing frequencies shall be in accordance with requirements and contract specifications and will be noted on the Inspection and Test Plan for sign off.

Engineers are responsible for reviewing and approving quality assurance verification records, as identified on the Inspection and Test Plan.

18 Inspection and Test Plans for the BHSL Burnt Hill Storage Pond

This plan must be read and understood in conjunction with the referenced standards, tables and documents.

18.1. CONTRACTURAL & GENERAL

Item	Work Operation Description	Control Document or specification ref.	Inspection/ Test Type and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
1.1	**Verify requirements of contract documents and plans.**	Contract documents. Schedule of Quantities. Project plans and consents.	Review by the Project Manager and Contract Manager.	Construction documentation received from Engineer.		✓			✓	
1.2	**Prepare Earthworks and HDPE Geomembrane Placement quality plan(s).** **Method Statements**	Contract documents	Preparation and review by the Contract Manager and Engineer.	**HOLD POINT**: Engineer to review and approve.		✓	✓		✓	✓
1.3	**Tailgate Meeting.**	Contract health, safety, quality and environmental plan. REL Mango policy.	First site meeting to include all staff. New Tailgate at each new task. Weekly site safety meeting. All new staff to go through tailgate process-sign in.	All Safety tailgate documentation is held at site office. Generic Hazard Register in site office.	✓	✓			✓	
1.4	**Drawings**	Tech. Specification 1.5	Survey and locate the final pond layout, location of all appurtenant structures including alignment of penetrating conduits, electrical supply and instrument cables for preparation of as-builts drawings	Final as-builts reviewed and approved by Engineer	✓	✓			✓	
1.5	**Traffic Management Implementation.**	NZTA CoPTTM & REL Procedure	Site office documentation.	RCA approval and STMS setup.	✓	✓		✓		
1.6	**Erosion and Sediment Control.**	In accordance with Technical Specification & contractors approved HSE & Q Plans.	Developed by Enviroco (assisted by REL)	To be approved by the Engineer and ECan	✓	✓		✓	✓	
1.7	**Dust Control.**	Burnt Hill Storage Pond Site Specific Environmental Management Plan/ESCP	Developed by Enviroco (assisted by REL)	To be approved by the Engineer and ECan	✓	✓		✓	✓	
1.8	**Noise Control.**	Burnt Hill Storage Pond Site Specific Environmental Management Plan/ESCP	Develop plan and implement.	To be approved by the Engineer.	✓	✓		✓	✓	
1.9	**Environmental Control.**	Burnt Hill Storage Pond Site Specific Environmental Management Plan/ESCP	Develop plan and implement.	To be approved by the Engineer.	✓	✓		✓	✓	
1.10	**Site Clearance – Items.**	In accordance with Tech. Specification Section 2.0.	Items to be cleared and trees to be burnt.	To be marked up by Engineer.	✓	✓		✓	✓	
1.11	**Site Clearance – test pits/waste pits**	To be backfilled in accordance with Technical Specification 2.0.	Holes resulting from removal of waste/unsatisfactory backfill etc.	To be approved by the Engineer.	✓	✓		✓	✓	
1.12	**Existing Services.**	REL SOP's and suitably trained staff.	Locate and mark-up in any.	Supervisor and Engineer agreement.	✓	✓		✓	✓	
1.13	**Quantity Measurement.**	REL SOP's and suitably trained staff.	Project Manager to ensure that tallies and as-builts are recorded.	Provide results to Contract Manager and Engineer for claims and approval.	✓	✓		✓	✓	
1.14	**As Built Drawings.**	REL SOP's and suitably trained staff.	Project Manager to ensure as-builts are recorded.	Provide to the Contract manager and engineer.	✓	✓		✓	✓	
1.15	**Quality Plan**	Tech. Specification 1.7	QP will identify all areas of critical importance to meet design intent and achieve embankment safety.	**HOLD POINT**: Engineer/IC to review and approve ensuring all hold points and inspections are identified within the QP.	✓				✓	✓
1.16	**Quality Control and Management**	Tech. Specification 1.12	REL shall establish and maintain project quality management procedures throughout the duration of the construction. Specific items are; 1. The Designer must be notified of any noncompliant test results. 2. Confirm competency of REL's QA Technicians to take soil samples and NDM testing of the embankment material 3. Log construction photographs at least once weekly of all critical construction phases 4. Sieve analysis to be completed by a competent person (REL staff or subcontractor)	Regular review and acceptance of projects management procedures by Engineers Rep. Including review of competencies and weekly reports.	✓	✓			✓	

Item	Work Operation Description	Control Document or specification ref.	Inspection/ Test Type and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
1.17	**Quality Control – Designer Inspections**	Tech. Specification 1.13	All construction control stages will have hold points to ensure the intent of the design has been met. It is proposed that the Designer and Contractor shall sign off critical construction phases. REL shall ensure a Hold Point for inspection and carry out sieve analysis of foundation and backfill materials placed around pipe penetrations and concrete transitions at locations determined by the Designer. Designer to confirm materials conform to the grading curves specified in Section 17 and are not susceptible to suffusion.	Designer to review QP and confirm acceptance, noting all project Hold Points have been identified. Designer to review all sieve analysis results for all backfill materials prior to use and confirm acceptance.	✓		✓		✓	✓
1.18	**Quality Control – Material Testing and Sampling**	Tech. Specification 1.14	Establish and document a quality control and assurance programme which shall include regular inspection and testing of materials and the work to ensure compliance with the requirements of the project. In the case of a non-compliant test result, results shall be furnished to the Designer and Contractor within 24 hours of the testing being carried out. REL shall produce a weekly quality report incorporating, among others, the following details of numbers and types of tests carried out, a summary of results, staff employed in testing and the forthcoming programme of testing.	Designer to review weekly quality reports. Weekly quality meetings will be established to discuss the previous weeks' quality results, tests completed, etc. Designer to confirm acceptance of each week's report and results.	✓	✓			✓	
1.19	**Construction Sequence and Programming**	Tech. Specification 1.15	REL shall develop a detailed construction sequence for the execution of the works in accordance with the Specification. Drawings, consent conditions, and the constraints of the site to demonstrate design compliance. The baseline programme shall be updated quarterly during construction.	Designer to review and confirm acceptance of construction sequencing.		✓	✓		✓	✓
1.20	**Setting Out.**	REL SOP's and suitably trained staff.	Project start and as required by site staff.	Supervisor and Engineer agreement.	✓	✓		✓	✓	
1.21	**Construction Management Plan**	Tech. Specification 1.16	REL shall provide compliance reporting to BHSL who shall manage the relationship with the environmental authorities and shall inform Environment Canterbury within the required response timeframes if any potential or actual noncompliance condition occurs.	All compliance reporting to be provided the Burnt Hill Storage Ltd for reporting to EA's.		✓			✓	
1.22	**Project Reporting**	Tech. Specification 1.18	REL shall produce the following reports; 1. Weekly quality reports 2. Weekly progress reports 3. Specific reporting against defined critical areas 4. Final construction report 5. As-built drawings 6. Operation and maintenance manual, and 7. Commissioning report	Weekly reports reviewed and accepted by the Designer and Independent Certifier weekly. All other documents reviewed and accepted following completion of the works.	✓	✓			✓	

KEY	W = Witness Activity	R = Review/Verify Document	H = Hold Point for Acceptance

Continued next page.

18.2 ENABLING WORKS

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
2.1	**Existing Structures**	Tech. Specification 2.2	Buildings and foundations shall be demolished to a minimum of 1 m below the final excavation level.	**HOLD POINT** Survey check to show compliance with minimum 1m rule	✓		✓	✓		✓
2.2	**Existing Services**	Tech. Specification 2.5	Utilise existing electrical service and associated facilities as permanent power source to the ponds automated gates and control system. Coordinate in advance with the electricity service authorities. Relocated services that hinder works.	Power connections or relocations will be coordinated through BHSL as the principal (principal is the only party who can arrange connections, etc).	✓			✓		
2.3	**Irrigation and Stock Water through MR4**	Tech. Specification 2.6.1	The Contractor shall ensure uninterrupted irrigation water supply during irrigation times and stock water supply at all times through the MR4.	Any planned outages are to be agreed with WIL at a minimum of 6 weeks in advance.	✓			✓		
2.4	**Irrigation and Stock Water through R2 and R3**	Tech. Specification 2.6.2	The Contractor shall ensure uninterrupted irrigation water supply during irrigation times and stock water supply at all times through the MR4.	Any planned outages are to be agreed with WIL at a minimum of 6 weeks in advance.	✓			✓		
2.5	**Contractor Stockpiles**	Tech. Specification 2.7	Stockpile heights shall be limited to no more than 10 metres; Stockpiles of organic matter including topsoil shall be shaped in order to shed surface water Stockpiles shall not be located within 20 m of any bore, surface water body or artificial watercourse Stockpile material that will not be disturbed for more than three months shall be vegetated as soon as possible Revegetate bare areas that will be undisturbed for more than three months as soon as practical Using water or dust suppressants on all disturbed areas; and Stockpiles shall not occur within 50m of property boundaries. REL shall allow for all costs related to managing compliance requirements in the Schedule of Prices for the project.	Measure, check, submit to Engineer	✓			✓		
2.6	**Haul Roads and Maintenance Access**	Tech. Specification 2.8	Locations and construction details for any permanent haul roads required for maintenance access (i.e. to clean out ponds etc.) during the ponds operational life will need to be agreed with the Designer during the works	Submit plans to Engineer/Designers Representative/Designer for approval	✓			✓		
2.7	**Foundation and Surface Drainage**	Tech. Specification 2.9	Prepare a drainage plan for the construction period, which shall minimize erosion of excavated surfaces and materials	Submit plans to Engineer/Designers Representative/Designer for approval (Part of ESCP)	✓				✓	

18.3 EXCAVATIONS FOR EMBANKMENT FOUNDATIONS AND RESERVOIR AREA

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
3.0	**Excavations for Embankment Foundations and Reservoir Area**	Tech. Specification 3.0	Construction of the culverts under the embankments will require trench excavations in the natural ground. These shall be carried out in accordance with the Good Practice Guideline for Excavation Safety (Workplace New Zealand, 2016) as well as WIL/BHSL contract documents, drawings, specifications and consents.	Relevant documents used to draft and implement construction methodologies Relevant documents on site at all times for reference.	✓		✓	✓		✓
3.1	**Strip Topsoil and Silts**	Tech. Specification 3.1	Topsoil and underlying silts (where they exist) shall be stripped down to the underlying sandy gravels below the footprint of the pond embankments.	Joint Contractor and Engineer inspection and agreement on level of strip is appropriate	✓			✓		
3.2	**Pond Embankment Foundations**	Tech. Specification 3.2	Excavation for the pond foundations shall be carried out to grade and level as shown on the drawings. The Designer Representative shall inspect the embankment foundation suitability and may require additional excavation Following excavation, the Designer Representative shall complete mapping of the foundation and approve the subgrade for fill placement. The Contractor is to provide notice and allow sufficient time for the mapping. The Contractor shall keep foundation mapping records (including sketches and photographs), as part of the Quality Control record for the embankment construction Where unsuitable material is removed locally, the excavation shall be backfilled with compacted Zone 4 material (refer to Section 17.0 for grading envelope). Geotextile shall be placed under the liner instead of sandy silt in areas where the foundation material is too boney and permeable for screened sandy silt to be effective over the liner life, which is approximately 50 years. The Contractor may place 500GSM geotextile as an alternative to the sandy silt throughout the invert, where required.	Inspection by the Design Engineers representative following completion of the excavation. The Design Engineers representative must inspect and approve the subgrade prior to any fill placement. If action is required, the Design Engineers Representative will instruct REL's Project Manager to complete remedial works prior to approving the subgrade surface.	✓		✓	✓		✓
3.3	**Cut Slopes**	Tech. Specification 3.3	Significant excavations are required to form the pond embankments. The pond embankments will generally be founded on alluvial sandy gravels. The available site investigation information is presented in the test pit logs, photos and laboratory test results which are included in the Design Report Appendices A & B. Damwatch shall be responsible for interpretation of the inspection findings referred to in Section 3.2 above. The Contractor and Designer Representative shall review the ground conditions as excavation progresses and may instruct modifications to the cut slope geometry or may propose additional drainage, as necessary.	Inspection by the Design Engineers representative following completion of the excavation. The Design Engineers representative must inspect and approve the subgrade prior to any fill placement. If action is required, the Design Engineers Representative will instruct REL's Project Manager to complete remedial works prior to approving the subgrade surface.	✓		✓	✓		✓
3.4	**Slips**	Tech. Specification 3.4	Material from slips in natural ground shall be removed and used in fills or dumped, as directed by the Design Representative in consultation with the Contractor. Inspection as required and action agreed between Designer Representative and contractor The area affected by the slip shall be shaped, trimmed and repaired to a safe, stable and neat condition or to the lines, dimensions and elevations required by the Designer Representative.	Inspection by the Design Engineers representative following discovery of the slip. The Design Engineers representative must inspect and approve the areas subgrade following excavation/removal of the slip and prior to any fill placement.	✓		✓	✓		✓
3.5	**Reinstatement of Excavated Surfaces**	Tech. Specification 3.5	After removal of vegetation and topsoil and excavation of available material for pond construction, the excavated surface shall be trimmed level Excavated surfaces shall then be proof rolled using a suitable self-propelled vibrating roller to detect unsuitable material and soft spots prior to fill placement or final surface treatment. Any unsuitable material or soft spots shall be removed prior to filling with suitable material	Inspection by the Design Engineers representative following excavation. The Design Engineers representative must inspect and approve the areas subgrade following excavation/removal of the slip and prior to any fill placement.	✓		✓	✓		✓

18.4 EMBANKMENT CONSTRUCTION

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
4.0	**Embankment Construction**	Tech. Specification 4.0	No fill shall be placed in the embankments until their foundations have been dewatered, excavated and suitably prepared. The foundation preparation shall be inspected and mapped by the Designer Representative, in consultation with the Contractor, as discussed in Section 3.2. The embankment crests shall be surfaced with 300 mm of selected well graded Zone 4 material placed over a layer of Ecotech 500 gsm geotextile, for permanent access road use and durability.	Fill placement will commence following the subgrade inspection and approval by the Designers Representative.	✓			✓		
4.1	**Embankment Fill Placing Operations – Zone 4 materials**	Tech. Specification 4.1	No transverse bonding surfaces (i.e. surfaces perpendicular to the pond embankment centrelines) shall be allowed in the embankment. Steps and joints in any fill shall not exceed one-layer thickness, as specified, in any direction. The embankment fill shall be placed and compacted as shown on the drawings with tolerance of +100 / -0 mm. Material placed in Zone 4 shall be placed selectively in order that finer material is placed adjacent to and supports the geomembrane lining layer. The reservoir side of Zone 4 shall be constructed 250 mm oversize and trimmed. This face shall then be graded to the correct shape to remove segregated Zone 4 material by grading at least 0.25 m from the inside surface. Subsequently, this face shall be further shaped and compacted prior to laying the 500 GSM geofabric and geomembrane. All placing of fill shall cease if the air temperature falls below minus 1°C.	The Designers Representative shall regularly witness embankment fill activities to determine fill/placement methodologies are being undertaking as per REL's Method Statements and in accordance with the Technical Specification.	✓			✓		
4.2	**Compaction of Embankment Fill Material – Zone 4 materials**	Tech. Specification 4.1.1 The compaction standard for use in the works shall be determined from field trials described subsequently in Section 4.2.	The in-situ moisture content shall be within 2% below and 4% above the optimum water content (OWC) as determined by NZ Standard Compaction test 4.1.1 of NZS 4402:1986 "Methods of Testing Soils for Civil Engineering Purposes" for each separate field measurement. The in-situ density shall not be less than the dry density determined during the fill placing trials and is anticipated to be a target density of 95% of maximum dry density (MDD) as determined from NZ Standard Compaction Test 4.1.1 of NZS 4402:1986, adjusted for the field particle size distribution (inclusion of large cobble size component) for each set of tests being the average of five separate field measurements. The grading envelope for Zone 4 materials (refer to Section 17.0) shall be confirmed during fill placing trials and kept under review during construction. The frequency and location of the compaction tests for the earthworks of Zone 4 material to be carried out by the Contractor shall be undertaken progressively with at least one set of tests for every 1,000 m^2, refer to Section 4.4.2.	The Designer shall review test results and reserves the right to adjust the testing frequencies. The results of the tests shall be included in the Contractor's weekly report.	✓	✓		✓	✓	
4.3	**Preparation of Embankment Layer Surfaces**	Tech. Specification 4.1.2	Any material too dry or too smooth to bond properly with the next layer, shall be moistened and disked or scarified in an approved manner to a sufficient depth to provide a satisfactory bonding surface before the next layer is placed; This includes old haul roads. Any material that is too wet for proper compaction of the layer, it shall be removed, allowed to dry, or be worked with a disk to reduce the water content to the required amount, and then it shall be re-compacted before the next succeeding layer of earth fill material is placed	The Designers Representative shall regularly witness embankment fill activities to determine fill/placement methodologies are being undertaking as per REL's Method Statements and in accordance with the Technical Specification.	✓			✓		
4.4	**Tolerance Design Layer Thickness**	Tech. Specification 4.2, Text and Table 1.	Granular embankment Zone 4 - Nominal Compacted Layer Thickness (mm): 400 , +/- 100mm tolerance Level surveyed of one surveyed check per 1000 m^3 of placed embankment material. This compacted layer thickness check shall be conducted in conjunction with nuclear density testing in order that the layer is to the specified density.	All compacted layers are to be surveyed. All surveyed surfaces are to be provided to the Designer Representative for review.	✓	✓		✓	✓	
4.5	**Fill Placing Trials**	Tech. Specification 4.3	Before commencing construction in any section of the works, the Designer shall confirm the compaction standard required for the placement and compaction of Zone 4 bulk embankment fill. Organize test area, plant, staff and test equipment: minimum trial area of 25 m long and 10 m wide Placement trials will be carried out as deemed by the Designer to; 1. Establish the agreed methodology for placing embankment materials 2. Determine appropriate range of placement moisture content limits for compacted materials 3. Determine acceptable placement layer thickness 4. Determine the target density; and 5. Establish the optimum compactive effort required for the fill materials used in embankment construction Designer to assign upper and lower limits of in-situ moisture content. Compactive effort shall be verified at a number of agreed locations (minimum 5 tests per layer) on each trial layer using nuclear densometer testing by REL and other methods as agreed with REL.	Notify Engineer/Client to be present. Use different configurations to achieve targets or set new targets, Record all plant used, passes, vibration/speed settings, watering, tabulate results and report	✓		✓	✓		✓

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
4.6	**Quality Control - Laboratory Testing and Sampling**	Tech. Specification 4.4, 4.4.1	Refer to Section 1.14 for Laboratory Testing and Sampling requirements on site.	All Lab testing and sampling results are to be provided to the Designers Representative regularly for review and compliance with current fill placement QA results.	✓	✓		✓	✓	
4.7	**Location and Frequency of Routine Testing**	Tech. Specification 4.4.2	Frequency of testing shall be related to the stage of work and to the conditions existing at any particular time. It shall be initially sufficient to establish proper control criteria and assure consistency of construction conforming to these criteria. Refer to TS4.4.2 including Table 2.	Complete testing to the agreed frequencies and report results to the Designer Representative as they come to hand/at weekly meetings/reporting		✓			✓	
4.8	**Method Statement**	Tech. Specification 4.4.3	The Contractor shall agree in advance of construction his methodology for embankment construction with the Designer. The Method Statement shall include the construction method based on conclusions from fill placing trials, and also testing, sampling frequency and reporting. Refer to TS4.4.3 for details	Submit construction methodology Before construction commences		✓	✓		✓	✓
4.9	**Reporting**	Tech. Specification 4.4.4	The Contractor shall prepare and issue weekly reports confirming test results for the period including compliances and non-compliances. Refer to TS4.4.4 for details	REL will provide a weekly report to the Designer Representative each Monday.		✓			✓	
4.10	**Independent Verification Testing**	Tech. Specification 4.5	Independent verification testing shall be undertaken by a suitably accredited soils laboratory as follows: Refer to TS4.5 for details	In-situ testing of Zone 4 (first 100m^3) is to be tested, with NDMs calibrated to results. Independent testing to be carried out every 6 months thereafter. Designers Representative to witness and confirm results.	✓	✓		✓	✓	
4.11	**Embankment Preparation for Placement of Pond Liner**	Tech. Specification 4.6	The surface of the Zone 4 embankment and pond base materials shall be prepared for placement of the geomembrane liner by proof rolling with a 10 to 12 tonne vibratory steel roller. This and all other requirements are listed in TS4.6 including Table 3.	Visual inspection by Designer Representative prior to lining.	✓			✓		
4.12	**Vegetative Erosion Protection**	Tech. Specification 4.7	Topsoil shall be generally free of stones and foreign matter however some stones are tolerable up to a single maximum aggregate size of 75 mm diameter. The grass seed mix appropriate to the local conditions shall be formulated and shall be suitable for establishing vegetation on the pond embankments.	Final inspection be Designer Representative following completion.	✓			✓		

18.5 ECOTECH 500 GSM GEOTEXTILE

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
5.1	**Ecotech 500 GSM Geotextile**	Tech. Specification 5.0	The Ecotech 500 GSM geotextile, which is a non-woven needle punched polyester (PET) fibre geotextile, shall be placed to support the geomembrane on the inner embankment slopes. The geotextile shall meet the criteria specified in Table 4 in TS5.0. The Ecotech 500 GSM "geotextile" is also referred to as a "filter cloth" in the Drawings. The Contractor shall provide the Designer with the manufacturer's test certificates prior to commencement of geotextile placement.	Test certificates are to be provided for review and approval prior to use.	✓		✓	✓		✓
5.2	**Installation and Joining**	Tech. Specification 5.1	The geotextile shall be placed on prepared embankment slopes (see Section 4.4) and shall extend from the base of the embankment up into the crest anchor trench. Joining of the geotextile shall be provided by sufficient overlap width between adjacent geotextile rolls. The minimum required overlap width is in Table 5. In TS5.1	Visual inspection by the Designers Representative prior to HDPE geomembrane placement.	✓			✓		

18.6 GEOMEMBRANE LINER

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
6.1	**Geomembrane Liner**	Tech. Specification 6.0	All surface areas to be lined must be inspected immediately prior to placement of all geomembranes or Ecotech 500gsm geotextile on embankment slopes and agree the surface is properly prepared for the purpose. All placed geomembrane panels shall be inspected by REL and the Designer prior to joint sealing for any defects or penetrations. All nonconforming areas shall be replaced or repaired prior to joint sealing.	Test certificates are to be provided for review and approval prior to use. Visual inspection prior and d	✓		✓	✓		✓
6.2	**Installation and Joining**	Tech. Specification 6.1	The geotextile shall be placed on prepared embankment slopes (see Section 4.4) and shall extend from the base of the embankment up into the crest anchor trench. Joining of the geotextile shall be provided by sufficient overlap width between adjacent geotextile rolls. The minimum required overlap width is in Table 5. In TS5.1	Visual inspection by the Designers Representative prior to HDPE geomembrane placement.	✓			✓		
6.3	**Standards**	Tech. Specification 6.2	Within one week of being awarded the Contract, the Contractor shall submit to the Designer for approval notification of the intent to adopt the standards provided in this Specification along with the respective standards for material compliance in Tables 6 and 7. Of TS6.9 6.9 HDPE Geomembrane Specification	Notification to be sent for review and acceptance by the Designer.		✓			✓	
6.4	**Raw materials manufacture and delivery**	Tech. Specification 6.3	REL shall notify the Designer of the area required for storage facilities and the minimum roll out area for working. REL shall provide the Designer with raw materials manufacture and delivery formation and, after manufacturing and prior to shipment, the Contractor shall provide a manufacturing Quality Control Certificate for each roll of HDPE. REL shall provide certification to the Designer that the extrudate to be used in any field extrusion welding is comprised of compatible resins and additives as the parent HDPE and is directly comparable to the information provide above.	All Solmax documentation to be provided to the Designers Representative for review and acceptance.		✓			✓	
6.5	**Panel Layout Plan and Programme**	Tech. Specification 6.4	A Panel Layout Plan showing location and type of all seams shall be submitted by the Contractor to the Designer 10 days before commencement of installation. Once the Designer has approved the Panel Layout Plan (including any Engineers amendments), REL shall supply two copies to the Engineer for use during the installation process. Additionally, REL shall provide the Engineer with a proposed installation schedule, cross referenced to the Panel Layout Plan.	No installation is to be undertaken until the Designer has given approval in writing to the Contractor that the panel layout submitted is satisfactory.		✓	✓		✓	✓
6.6	**Method Statement**	Tech. Specification 6.7	The Contractor shall prepare and agree in advance of construction his methodology for lining installation with the Designer. The Method Statement shall be revised following liner trials and shall confirm the inspection and testing methodology, sampling frequency, progressive placement of ballasting and reporting in accordance with this specification and shall be agreed upon by the Designer and Contractor.	Method statements prepared by REL are to be reviewed and approved by the Designers Representative.		✓			✓	
6.7	**Daily Reports**	Tech. Specification 6.8	The Contractor shall provide the Designer with daily reports with the detail provided in TS 6.8	Daily progress reports will be provided by REL's Project Manager to the Designers Representative.		✓			✓	
6.8	**HDPE Geomembrane Specification**	Tech. Specification 6.9	All materials supplied shall be manufactured and supplied in accordance with an appropriate quality system., refer TS6.8 and tables 6 and 7	All manufacturing QA documentation will be supplied to the Designers Representative for review and approval prior to installation		✓	✓		✓	✓
6.9	**Factory Acceptance, Inspection and Testing**	Tech. Specification 6.10	This section sets out requirements for testing and test certificates for the geomembrane. Actual test certificates with results are required – a 'certificate of compliance' is not adequate. Refer to TS6.10.1 and TS6.10.2, with Tables 8 and 9.	All manufacturing QA documentation will be supplied to the Designers Representative for review and approval prior to installation		✓	✓		✓	✓
6.10	**Geomembrane Supply**	Tech. Specification 6.11	Each geomembrane rolls ID and storage requirements, transportation in accordance with ASTM D4873 and requirements for test data of HDPE secondary welding material (extruded rods) Refer to See TS6.11, TS6.11.1 and TS6.11.2	Membrane rolls and welding rod are to be stored in accordance with the manufacturer's specifications.	✓			✓		
6.11	**Site Storage**	Tech. Specification 6.11	REL shall provide an area to storage the geomembrane liner on site after delivery. REL shall provide a waste area for and disposal of the liner packaging once unpackaged. REL shall inspect the liner upon delivery to ensure there is no visual damage to the packaged liner	Visual inspections by REL's Liner Foreman	✓	✓			✓	
6.12	**Placement of Geomembrane Liner**	Tech. Specification 6.13	All requirements for geomembrane placement, as detailed in the Tech. Specification sub clauses listed below, including Table 10. 6.13.1 Excavation of Anchor Trench 6.13.2 Backfilling the Anchor Trench 6.13.3 Site Water Control and Dewatering 6.13.4 Sheet Layout 6.13.5 Liner Properties and Layout at Pond Corners 6.13.6 Geomembrane Lining As Constructed Drawings 6.13.7 Geomembrane Joint Details 6.13.8 Sheet Deployment 6.13.9 Geomembrane Ballasting	All geomembrane placement will be completed in accordance with REL's approved Method Statements and the TS. The Designers Representative will inspect all works, QA and As-built Documentation on a daily basis.	✓	✓		✓	✓	

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
6.13	**Jointing of Geomembrane Liner**	Tech. Specification 6.14.	A complete description of the welding procedure (or procedures) to be employed shall be provided, in the Contractor's Method Statement, including the type of equipment proposed for the welding operations. Only welding procedures and equipment that are approved shall be used. Refer to TS6.14 and sub clauses listed below for all criteria. 6.14.1 Primary Welding 6.14.2 Secondary Welding 6.14.3 Extruded Rod for use in Secondary Welding 6.14.4 Geomembrane Weld Preparation 6.14.5 Site Procedure for Primary Welding 6.14.6 Site Procedure for Secondary Welding 6.14.7 Weld Crossovers	All geomembrane welding will be completed in accordance with REL's approved Method Statements and the TS. The Designers Representative will inspect all work, QA and As-built Documentation on a daily basis.	✓	✓		✓	✓	
6.14	**Geomembrane Field Weld Testing**	Tech. Specification 6.15	All welding of test specimens and field weld testing shall be carried out in the presence of the Designer's Representative. Acceptance of welds or test reports by the Designer's Representative shall in no way relieve the Contractor of responsibility for the integrity, quality and performance of the welded liner. See tech Specification sub clauses Including Table 11, 12 and 13: 6.15.1 Preparing Test Weld Specimens 6.15.2 Test Welds - Specimen from Completed Work 6.15.3 Destructive Testing 6.15.4 Tensiometers 6.15.5 Test Procedures - Welds 6.15.6 Weld Shear Test 6.15.7 Weld Peel Test 6.15.8 Seam Test Criteria 46 6.15.9 Procedure Following Destructive Test Failure 6.15.10 Primary Welds - Pressure Test 6.15.11 Primary Welds - Failure of a Pressure Test 6.15.12 Secondary Weld 6.15.13 Non-Destructive Weld Testing	All geomembrane field testing will be completed in accordance with REL's approved Method Statements and the TS. The Designers Representative will inspect all work, QA and As-built Documentation on a daily basis.	✓	✓		✓	✓	
6.15	**Repairs to Liner**	Tech. Specification 6.16	Any portion of the geomembrane lining system failing a destructive or non-destructive weld test, or showing some other defect, shall be repaired to the satisfaction of the Designer. Refer to TS6.16 and subclauses TS6.16.1, Repair of Secondary Welds, 6.16.2 Repair of Primary Welds, 6.16.3 Repairs to Failed Pressure Tested Primary Welds, 6.16.4 Patching 50 for test and acceptance criteria	All repairs will be completed in the presence of the Designers Representative. All retesting of the repairs will be completed in the presence of the Designers Representative.	✓				✓	
6.16	**Penetrations**	Tech. Specification 6.17.	All penetrations of pipes through the HDPE liner are to be tested using spark testing or other method approved by the Designer to demonstrate an effective seal.	All repairs will be completed in the presence of the Designers Representative. All retesting of the repairs will be completed in the presence of the Designers Representative.	✓				✓	
6.17	**Liner Placement and Jointing Trial**	Tech. Specification 6.18	The placing trials shall be located at agreed locations on a section of constructed pond embankment to determine appropriate procedure for construction installation of the geomembrane lining. Refer TS18 for requirements for trial	Placing trials will be completed on the first section of pond embankment ready for lining. All lining processes will be witnessed by the Designers Representative, including all welding and QA testing. 1x placing trial will be completed on the first corner.	✓		✓	✓		✓
6.18	**Certificates and Records**	Tech. Specification 6.20	The Contractor shall provide all Quality System certificates and records as required, as listed in TS6.20. Representatives from both the Designer and Contractor shall be present throughout the geomembrane installation process, including placement trial, installation and routine inspection and testing. Quality System Documentation shall be reviewed weekly by the Designer's Representative and Contractor jointly, in order to manage any defects and other issues. Weekly and as built reporting will be completed Refer to Table 14 and Section 6.21.2, for Laboratory Testing and Sampling on site requirements, particular to the HDPE liner. For process and acceptance criteria, refer to TS6.21.1 Laboratory Testing and Sampling, 6.21.2 Location and Frequency of Routine Inspection and Testing which includes Table 14 and TS6.21.3 Reporting for test and acceptance criteria.	All QA documentation and records will be provided to the Designers Representative daily, with processed/completed QA records provided weekly.		✓			✓	
6.19	**Provision for Future Liner Performance Testing**	Tech. Specification 6.22	Ten A2 size coupons of the liner geomembrane material shall be welded to the geomembrane surface at the full supply level of the lining in Pond 1, allowing for 60 years of monitoring with testing of a coupon sample every 5 years, commencing at end of year 10. Further, two A2 size coupons shall be welded to the geomembrane surface at the bottom of Pond 1 allowing for testing over 5 years at the time samples from full supply level indicate the need for liner replacement. Location of all twelve coupons shall be recorded on the as-built drawings.	Coupons included as directed.	✓			✓		
6.20	**Pond Safety Ladders**	Tech. Specification 6.23	This item is for supply and installation of access ladders to support safe access and egress in the pond. Ladder number, size and materials are listed in TS6.23	Ladders installed as per Table 15 of TS6.23. The Designers Representative to confirm installation.	✓			✓		

ITP For HDPE Geomembrane Installation

1. HDPE SUBGRADE PREPARATION AND GEOMEMBRANE PLACEMENT

Construction of the HDPE geomembrane lining shall be carried out in accordance with Wrights Road Storage Pond Technical Specification.

Check No.	Work Operation Description	Inspection/ Test Type and Frequencies	Applicable Control Documents	Acceptance Criteria and How Recorded	REL			ENG		
					W	R	H	W	R	H
7.1	**Zone 4 Subgrade Preparation and Sign Off – Before Geotextile Placement**	Visual inspection by REL's Lining Supervisor and the Designers Representative.	Technical Specification 4.6	REL's Liner Supervisor and Designers Representative to designate and approve areas prior to Geotextile Placement.	✓	✓		✓	✓	
7.2	**Silt Subgrade Preparation and Sign Off**	Visual inspection by REL's Lining Supervisor and the Designers Representative.	Technical Specification 4.8.2	REL's Liner Supervisor and Designers Representative to designate and approve areas prior to HDPE Placement.	✓	✓		✓	✓	
7.3	**Geotextile Placement on Embankment Slopes**	Visual inspection by REL's Lining Supervisor and the Designers Representative.	Technical Specification	REL's Liner Supervisor and Designers Representative to designate and approve areas prior to HDPE Placement.	✓	✓		✓	✓	
7.4	**HDPE Geomembrane Delivery and Stockpiling onsite.**	Visual Inspection and Roll Number recording by QA tech and PM.	General QA Check	Project manager and Contracts Manager to review	✓	✓				
7.5	**HDPE Geomembrane – Start of liner installation. Demonstration to engineer on welding and testing techniques – including lining corners.**	Visual Inspection by Designers Representative during liner installation. Witness test results.	Technical Specification 6.18	**HOLD POINT:** Designer inspection and approval.	✓		✓	✓		✓
7.6	**HDPE Geomembrane Installation**	Visual Inspection by Designers Representative, review of HDPE QA results.	Technical Specification 6.0	Regular inspection of liner installation and QA records.	✓	✓		✓	✓	
7.8	**Completion of Works – Final inspection before filling**	Visual Inspection by Designers Representative, review of all QA testing for project.	Technical Specification 6.0	**HOLD POINT:** Engineer Inspection.	✓		✓	✓		✓
7.9	**Test Welds – produce Test Welds for Destructive Testing before Commencing Welding Operations**	Visual Inspection by Designers Representative. Witness and review daily test results. REL's QA technician to complete all testing and recording as per the Technical Specification.	Technical Specification 5.15.1, 5.15.2	Designers Representative and REL's Lining Supervisor to review test weld test results – must meet Technical Specification requirements	✓	✓		✓	✓	
7.10	**Non-destructive Testing – Air pressure testing, vacuum box testing & spark testing**	Visual Inspection by Designers Representative. Witness and review daily test results. REL's QA technician to complete all testing and recording in accordance with the Technical Specification.	Technical Specification 6.15.10, 6.15.12	Designers Representative and REL's Lining Supervisor to review test results – must meet Technical Specification requirements	✓	✓		✓	✓	
7.11	**Destructive Testing**	Visual Inspection by Designers Representative. Witness and review daily test results. REL's QA technician to complete all testing and recording as per the Technical Specification.	Technical Specification 6.15.3	Designers Representative and REL's Lining Supervisor to review destructive test weld test results – must meet Technical Specification requirements	✓	✓		✓	✓	
7.12	**Repair Reporting**	Visual Inspection by Designers Representative. Witness and review daily repairs – repairs to be as-built surveyed.	Technical Specification 6.16	Designers Representative and REL's Lining Supervisor to review repairs and repair testing – must meet Technical Specification requirements	✓	✓		✓	✓	
7.13	**Surveyed As-built of HDPE Panel Placement**	REL's surveyor to complete panel placement survey daily – Designers Representative to review	Technical Specification 6.13.6	Designers Representative to review upon completion of project	✓	✓			✓	
7.14	**QA/QC Documentation including Manufacturers QA Test Results**	Different frequencies before and after compaction.	Technical Specification 6.0	Designers Representative to review upon completion of project	✓	✓		✓	✓	

KEY			
	W = Witness Activity	R = Review/Verify Document	H = Hold Point for Acceptance

18.7 CONSTRUCTION OF PIPELINES CULVERTS AND ANCILLARY WORKS

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
8.1	**Embankment Concrete Pipe Penetrations 54**	Tech. Specification 7.1	The placement of conduits or outlet pipes through earth embankments is a common cause of piping failure and accidents particularly in small embankments without filters. The methodology for construction of culverts in embankments shall align with the pipe performance requirements, be agreed with the Designer prior to commencement of construction and meet acceptance testing. Refer to TS7.1 for details	Designers Representative (DR) to witness all bedding and cover material placement and testing. Hydrostatic testing of installed culverts to be witnessed and approved by DR.	✓		✓	✓		✓
8.2	**Steel Pipe Installation 55**	Tech. Specification 7.2	There is potential to construct a hydro-power station near the intersection of Wrights and Coffey Roads. All specifications and checks are outlined under the Tech. Specification headings below. 7.2.1 Steel Pipe Penetration to Proposed Power Station 7.2.2 Steel Pipe to Pump Stations 7.2.3 Corrosion Protection of Steel Pipes to Pump Stations 7.2.4 Handling of Coated Steel Pipes 7.2.5 Welded Joints and Repairs 7.2.6 Quality Assurance of Site Welded Joints 7.2.7 General Requirements of Joint Welding 7.2.8 Non-Destructive Test Requirements for Site Joint Welding 7.2.9 Protection of Welded Joints 7.2.10 Bedding and Backfilling for Steel Pipes 7.2.11 Field Pressure Test of Steel Penstock Pipe	Designers Representative (DR) to witness all bedding and cover material placement and testing. Hydrostatic testing of installed culverts to be witnessed and approved by DR.	✓		✓	✓		✓
8.3	**Fill against Structures and Around Buried Pipes**	Tech. Specification 7.3	Please refer to TS7.1 and this section, TS7.3	Designers Representative to witness all compaction layers during construction and review all compaction results daily for approval.	✓	✓		✓	✓	
8.4	**Inlet and Outlet Transitions and Energy Dissipater**	Tech. Specification 7.6	Backfill behind wing walls and headwall as detailed on the Drawings and Tech. specification 7.3	Designers Representative to witness all compaction layers during construction and review all compaction results daily for approval.	✓	✓		✓	✓	
8.5	**Energy Dissipater**	Tech. Specification 7.7	To be constructed with an inverted L-beam of high strength concrete (50 MPa). The Contractor shall pay special attention to ensure this beam is completed as per Drawing WIL1125/30/106. At the completion of construction, the Contractor shall backfill behind the dissipater with compacted material as detailed on drawing WIL1125/30/104 and Section 7.3	Designers Representative to witness all compaction layers during construction and review all compaction results daily for approval.	✓	✓		✓	✓	
8.6	**Crump Weirs**	Tech. Specification 7.8	The Contractor shall construct the Crump weirs as shown in Drawings WIL1125/30/110 and 127. The Contractor shall pay special attention to the accuracy of the level and alignment of the crest	Designer Representative to complete all prepour inspections on all concrete pours to confirm dimensions, reinforcing, etc are all constructed as per DamWatch's construction plans.	✓	✓		✓	✓	
8.7	**Quality Control**	Tech. Specification 7.9	The Designer shall inspect all culvert excavations and pipe installations including backfill around pipes. Representatives from both the Designer and Contractor shall be present during the culvert installation, including excavation inspection prior to, pipe placement, back filling next to structures and buried pipes. Refer to TS7.9.1 Inspection, TS7.9.2 Pipe Inspection and TS7.9.3 Compaction Testing for details.	Designers Representative to witness all compaction layers during construction and review all compaction results daily for approval.	✓	✓		✓	✓	

18.8 CONCRETE, FORMWORK AND REINFORCEMENT

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
9.1	**General Performance**	Tech. Specification 8.1 Tech. Specification 8.1 to 8.4.13	The extent of concrete works is detailed on the construction drawings. The requirements of NZS 3109: 1997 Concrete Construction shall apply unless modified in the Tech. Specification 8.0. All NZS3109 Concrete acceptance testing for strength, slump, air, yield, inspections, grade, finished, surface deviations, records, test frequency, certificates, non-conformance process, admixtures allowed, grouts, mix design and approvals, Please refer to the TS subclauses below for above information and all testing acceptance criteria 8.3 Concrete - common requirements 8.3.1 Reference Standards 8.3.2 Requirements 8.3.3 Performance 8.3.4 Inspections 8.4 Concrete quality control 8.4.1 Abbreviations and definitions 8.4.2 Reference Standards 8.4.3 Requirements 8.4.4 Compliance information 8.4.5 Concrete Classes 8.4.6 Quality control and assurance 8.4.7 Materials 8.4.8 Components 8.4.9 Accessories 8.4.10 Equipment 8.4.11 Execution 8.4.12 Quality Control - Execution 8.4.13 Selections	Designers Representative must witness and review QA records for all supplied reinforcing steel and concrete delivered to site. Delivery records and slump testing must be witnessed by the DR before any concrete pour onsite. All QA documentation for reinforcing steel must be provided prior to use onsite. All accreditations must be provided by all suppliers before any materials are delivered to site. The Designers Representative must review and approve all materials/suppliers before any concrete works are undertaken onsite.	✓		✓	✓		✓
9.2	**Formwork for concrete**	Tech. Specification 8.5 to 8.5.9	This section relates to the design and construction of formwork necessary to support and confine the concrete and shape it to the required dimensions. Refer to TS Sub-clauses below and Table 17 for process or acceptance criteria. 8.5.1 Abbreviations and definitions 8.5.2 Requirements - Design by Contractor 8.5.3 Conditions 8.5.4 Products 8.5.5 Finishes 8.5.6 Execution 8.5.7 Application 8.5.8 Finishing 8.5.9 Completion	Designer Representative to inspect all formwork prior to use. DR to complete full inspection and sign off of all formwork prior to all concrete pours.	✓		✓	✓		✓
9.3	**Reinforcement for concrete**	Tech. Specification 8.6 to 8.6.6	This section relates to the supply, cutting, bending and fixing of steel bar and steel welded reinforcement for concrete. Refer to TS Sub-clauses below and Table 17 for process or acceptance criteria. 8.6.1 Requirements 8.6.2 Products 8.6.3 Execution 8.6.4 Assembly 8.6.5 Application 8.6.6 Completion	Designer Representative to inspect all reinforcing steel prior to use. DR to complete full inspection and sign off of all tied reinforcing steel prior to all concrete pours.	✓		✓	✓		✓
9.4	**Concrete placement**	Tech. Specification 8.7 to 8.7.8	This section relates to the handling, placing, finishing and curing of concrete. The Contractor shall prepare a method statement for the placement of concrete above and it shall be reviewed by the Designer prior to commencement of work on site. Refer to TS Sub-clauses below and Table 17 for process or acceptance criteria. 8.7.1 Products 8.7.2 Execution 8.7.3 Application 8.7.4 Finishing 8.7.5 Curing 8.7.6 Protection 8.7.7 Defects 8.7.8 Completion	Designer Representative to complete a full inspection of all formwork and reinforcing steel prior to all pours. Placement method statements to be submitted and approved by DR. Slump testing on all concrete deliveries will be witnessed by the DR.	✓		✓	✓		✓

18.9 EMBANKMENT AND FOUNDATION INSTRUMENTATION

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
10.1	**Standpipe Piezometers**	Tech. Specification 9.1 to 9.1.5	This section describes the installation and monitoring requirements for standpipe piezometers including locations depth and all the requirements of the sub clauses listed below, which should be referenced for install and acceptance criteria. . 9.1.1 Piezometer 9.1.2 Drilling Methodology 9.1.3 Piezometer Installation Methodology 9.1.4 Standpipes 9.1.5 Reporting	REL to submit the drilling method statement to the Designers Representative for approval. DR to witness and approve construction asbuilts.	✓		✓	✓		✓
10.2	**Surface Survey Monuments**	Tech. Specification 9.2	The Contractor shall record the horizontal and vertical location of each reference mark with respect to established bench marks at the time of installation, and every 60 calendar days thereafter until completion of the works. Frequency may change during impoundment and will be agreed as part of the commissioning plan. Survey tolerance shall be vertical +/- 2 mm and horizontal +/- 10 mm.	Designers Representative to witness and approve construction asbuilts.	✓			✓	✓	
10.3	**TDR System**	Tech. Specification 9.3	Supply and install Time Domain Reflectometry (TDR) system manufactured by Campbell Scientific Limited (or approved alternative supplier) for automatic detection of an embankment breach. The general arrangement of the TDR system is shown on Drawing WIL1125/30/25. And all layout, unstill and backfill process and acceptance criteria are provided in TS 9.3.1 System Layout, TS 9.3.2 Installation and TS 9.3.3 Type 3 Backfill.	REL to submit the TDR installation method statement to the Designers Representative for approval. DR to witness and approve installation, asbuilts and commissioning.	✓			✓	✓	✓

18.10 CONTROL GATES

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
11.1	**General**	Tech. Specification 12.1 to 12.12	This section covers the performance, functional and serviceability requirements for seven (7) flow control gates for the Burnt Hill Storage Pond Scheme. 12.2 Control Gates Specification Precedence advises that if any clauses of the main body of this Technical Specification do not agree with, or contradict, the information provided in this Section 12.0 (Control Gates) of the Technical Specifications, then Section 12.0 of the Technical Specification shall take precedence. All process; construction, installation compliance and acceptance testing, inspection and reporting criteria is included in the sub clauses below. 12.3 General Operational Description 12.4 Contractual Arrangements and Responsibilities 12.5 Scope and Interfaces 12.6 Contractor's Reference Design and Specifications 12.7 Gate Supplier's Design. 12.8 Applicable Standards – Gate Supplier 12.9 Quality Assurance, Planning and Control 12.10 Dam Safety Function 12.11 Future Hydropower Duty 12.12 Design Life	REL to provide design plans to the Designer for review and approval.	✓		✓	✓		✓
11.2	**Design and Performance Criteria**	Tech. Specification 12.13 to 12.13.6	All position monitoring, gate leakage rates, lift FOS, travel rates and design submittal requirement acceptance criteria are provided in the sub clauses listed below. 12.13.1 Gate Flow Capacity 12.13.2 Gate Flow Control and Position 12.13.3 Gate Sealing 12.13.4 Lifting/Lowering Forces 12.13.5 Hydraulic Hoist System 12.13.6 Document Submittals	REL to provide design plans to the Designer for review and approval.	✓		✓	✓		✓
11.3	**Fabrication**	Tech. Specification 12.14.12 to 12.14.3	All fabrication, treatment/coasting, welding, paint systems requirements are provided in the subclauses TS 12.14.1 General, TS 12.14.2 Fittings and Fastenings and TS 2.14.3 Corrosion Protection of Steel Surfaces.	Designers Representative to inspect gates during fabrication and prior to corrosion coating.	✓			✓		
11.4	**Gate Installation Methodology**	Tech. Specification 12.15	The gate installation methodology will be prepared by the Gate Supplier and reviewed by the Designer. All documentation shall be submitted in form to the Designer with sufficient time available for review and approval by the Contractor, Designer and/or Principal. Time shall also be allowed for document updating and one resubmittal for further review, and subsequent finalization by the Gate Supplier	REL to provide installation method statements and fabrication QA records for approval prior to installation on site.			✓		✓	✓
11.5	**Operation and Maintenance of Scheme**	Tech. Specification 12.16	The Gate Supplier shall provide a complete and comprehensive O&M Schedule for the control gates, identifying all plant and machinery which must be maintained by the scheme Operator, and a full description of the frequency and methodology of planned or emergency maintenance activities.	O&M is to be provided for review and approval by the Designer.		✓			✓	
11.6	**Testing, Commissioning and Handover**	Tech. Specification 12.17	Each gate shall be operated as necessary over its opening and closing range in order to determine and set the travel limits in conjunction with the electrical control system commissioning. All check requirements are provided in TS 12.17 Testing, Commissioning and Handover.	Commissioning to be completed in the presence of the Designers Representative.	✓			✓		

18.11 PUMP STATIONS AND PUMPS

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
12.1	**General**	Tech. Specification 13.1 to 13.16	This section covers the performance, functionality and serviceability requirements for the two pump stations of the Wright's Road Pond Storage Scheme. There are two pump stations. They are: • the Buffer Pond Pump Station to fill Pond 1; and • the Pond 2 Pump Station to lift water from Pond 2 into the main race MR4 (via the Tub and G6) and indirectly even-out distribution of water in all three directions. All process; construction, installation compliance and acceptance testing, inspection and reporting criteria is included in the sub clauses below. 13.2 Pump Station & Pump Specification Precedence 13.3 Scope and Interfaces 13.4 Contractor's Reference Design Drawings 13.5 Buffer Pond Pump Station 13.6 Pond 2 Pump Station 13.7 Contractual Arrangements and Responsibilities 13.8 Pump Supplier's Design 13.9 Applicable Standards 13.10 Design Service Life 13.11 Design and Performance Criteria 13.12 Document Submittals 13.13 Pump Installation 13.14 Operation and Maintenance 13.15 Testing, Commissioning and Handover 13.16 Warranty and Defects Liability	REL to provide all pump specifications, QA information and installation method statements to the Designer for review and acceptance before delivery and installation.			✓		✓	✓		✓

18.12 CONTROL SYSTEMS

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
13.1	Control Systems	Tech. Specification 14	Refer to Design Report Appendix G for the design requirements and specification of the Control System. Note the detailed design of the Control System is not yet completed	REL to provide design plans to the Designer for review and approval.	✓		✓	✓		✓

18.13 OPERATION, MAINTENANCE AND SURVEILLANCE MANUAL

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
14.1	Operation and Maintenance Manual	Tech. Specification 15.1	An Operations, Maintenance and Surveillance Manual shall be prepared by the Contractor during the construction period and prior to the commissioning phases. This shall comprehensively cover all operation and maintenance aspects of the scheme.	REL to provide an O&M manual to the Designer for review and approval.	✓		✓	✓		✓
14.2	Dam Safety Management Plan	Tech. Specification 15.2	A Dam Safety Management Plan (DSMP) will be prepared by Damwatch Engineering Ltd during construction and prior to commissioning. The objective of which shall be to minimize the risks from the ongoing operation of the ponds.	DamWatch to provide a DSMP for review and approval by the principal's representative.	✓		✓	✓		✓

18.14 COMMISSIONING

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
15.1	Commissioning	Tech. Specification 16.1	Prior to impoundment of the ponds the commissioning plan prepared by Damwatch will be updated jointly by the Contractor and the Designer in accordance with the requirements of the Building Act and the NZDSG	DamWatch to provide a commissioning plan for review and approval by the principal's representative.	✓		✓	✓		✓

18.15 GRADING ENVELOPES FOR POND MATERIALS

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
16.1	17.1 Zone 1 Rip Rap	Tech. Specification 17.1	This Section provides grading envelopes for the pond embankment materials. 17.1 Zone 1 Rip Rap (Table) — 17.4 Type 2 Backfill (Table) 17.2 Zone 4 Embankment Fill (Table) — 17.5 Type 3 Backfill. (Table) 17.3 Type 1 Backfill (Table) — 17.6 Fuse plug Sand (Graphs)	REL to provide the Laboratory test certificates where applicable. Riprap grades to be measured by REL and the DR onsite.	✓		✓	✓		✓

18.16 ELECTRICAL

Item	Work Activity	Reference or control document	Inspection/ Test Type, Test Targets and Frequencies	Acceptance Criteria, Action to obtain approval	REL			ENG		
					W	R	H	W	R	H
17.1	General	Tech. Specification 18.1 to 18.15	This section covers the performance, functionality and serviceability requirements for electrical installation at the Burnt Hill Storage Pond. The Electrical Subcontractor shall be responsible for the design, supply, installation, testing and commissioning of the electrical systems required to support the operation and control of the pump stations, control gates, and any other facilities requiring a permanent power supply at the BHSP. Please refer to the Tech. Specification sub clause below for all compliance checks, tests and acceptance and reporting criteria: 18.2 Electrical Specification Precedence — 18.9 LV Switchgear 18.3 Scope and Interfaces — 18.10 Harmonics 18.4 Power Supplies — 18.11 Earthing 18.5 Power Supply Reliability — 18.12 Cabling Systems 18.6 Local Service Transformer — 18.13 Local Service Lighting and Power 18.7 Electrical Distribution Arrangement — 18.14 Electrical System Testing and Commissioning 18.8 MV Switchgear, — 18.15 Drawings for Power Systems.	REL to provide all installation, testing and commissioning QA to the Designers Representative.	✓		✓	✓		✓

Sign-off Identification and Certification Table

Position	Name	Signature and Date
Contract Manager	Cameron Rooney	
Project Manager	Brett Middleton	
QA Testing & Reporting Staff	Kennedy	

Signed as having read and understood work operation/description and performed activity.

Appendices

Appendix A - QIF Notification Form.
Appendix B - QIF Reporting Flow Chart.
Appendix C - Safe Operating Procedures.
Appendix D Testing Forms
Appendix E Earthworks Sequencing Plan
Appendix E Installation Quality Control And Quality Assurance Requirements
Appendix F Solmax 1.5mm Geomembrane Technical Data Sheet
Appendix G Certificate of Acceptance of Soil Subgrade Surface Example
Appendix H Repair Report Record Sheet Example
Appendix I Non-Destructive Testing Record Sheet Example
Appendix J Panel Seaming Record Sheet Example
Appendix K Panel Placement Record Sheet Example
Appendix L Trial Weld Information Record Sheet Example
Appendix M Destructive Test Record Sheet Example
Appendix O Ecotech 500gsm Geotextile Underlay Data Sheet

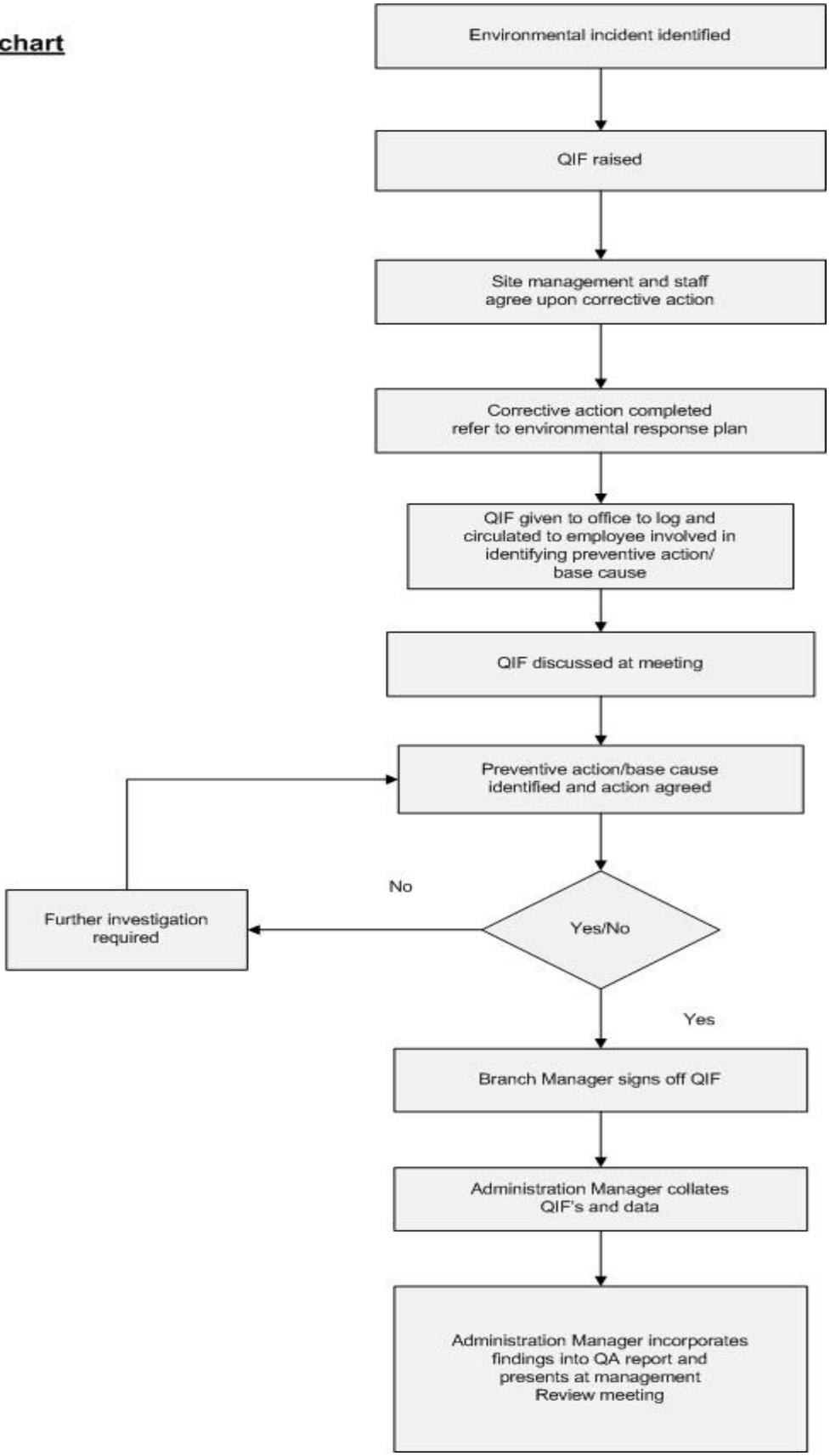
Appendix A - QIF Notification Form

ROONEY Earthmoving	Quality Improvement Form (QIF)	QIF No:
Originator		Date
Audit/Review	Non Conformance	Improvement
Result/Details Investigated by		
Corrective Action Sign		Date
Preventative Action/Result (Responsibility to ensure preventive action is done is) Changes to Hazard Register Y / N and or to Procedures Y / N Sign		Date

QIF Form – To be completed for all non-conformance issued noted in audits. Must be sent to the nearest Depot for loading into Mango

Appendix B - QIF Reporting Flow chart

QIF Flowchart



Appendix C – Safe Operating Procedures

3.0 Safe Operating Procedure – COMPACTION NDM

Purpose and Scope

To describe the use of the Nuclear Densometer (NDM) for the field measure of moisture content and density.

This procedure assumes that operators have training in the safe use of the NDM and familiarisation with Section 4.2 of NZS 4407:1991.

Refer to the QA Engineer for the electronic file, Nuclear Densometer Test Sheet, for editing, unless the attached form is sufficient.

Responsibility

- Site Supervisor
- Suitably trained and experienced QA staff.

Associated Documents

NDM Test Sheets.

Contract Specific Specification and compaction Targets.

Procedure

Important Step	Key Point
Identify testing requirements	1. Establish test pass requirements and the maximum area per 1 test. 2. List on the Nuclear Densometer Test Sheet.
Safety	1. Testing must be performed under the supervision or instruction of a licensed operator. 2. Notify nearby operators where you will be working and ensure they can see you. Wear a safety vest. 3. Beware of the NDM rod as this is the source of radiation.
Standard Count	Perform a Standard Count in accordance with the manufacturer's instructions and record it in the log book.
Setout	1. Setout to ensure 1 test per area requirements are met. 2. Mark on the ground with dazzle position of tests. 3. Record the location of the test site. If necessary, the surveyor should survey the locations.
Testing	1. Prepare ground surface with foot plate to form a flat surface, preferably using the same material. Use fines to fill any surface voids. 2. For Backscatter Mode, place the NDM on the prepared surface. 3. For a Direct Transmission Mode, drive the spike through the foot plate 50mm further into the soil than the required depth of testing. 4. Remove spike from foot plate, then remove plate from test site. 5. Expose test rod from NDM and gently insert the rod into the hole prepared by the spike, until the rod is fully enclosed by soil and the NDM is flat on the ground. 6. Pull the machine so that the rod is against the side of the hole nearest the centre of the machine. 7. Press the start button. 8. Record results as below. 9. Repeat reading with machine turned 90^0. 10. Record results as below.
Results	1. On the Nuclear Densometer Test Sheet, record off the display screen the wet density, moisture content, dry density and moisture %. Also record the date, site

Important Step	Key Point
	reference / code and rod depth. 2. Log all results on the NDM Compaction Register. If the result fails, retest and note the retest No. beside the original.

22/03/2016.

4.0 Safe Operating Procedure – DRAINAGE CULVERTS

Purpose and Scope

To ensure culverts are constructed within the terms of the contract, and a Quality Record is completed on the 'Culvert Checklist'.

This procedure assumes that personnel have training in the various work skills required for the task. In accordance with the Contract Management Plan, specific people will have authority for directing the operations. The objective is to do the job right first time and create a Quality Record.

Responsibility

- Site Supervisor.
- Contract Manager.
- Certified Drainlayer.

Associated Documents

Test Sheets for pressure Testing, CCTV testing.

Contract specific specifications and targets.

Procedure

Important Step	Key Point
Check the Plans & Specification for particular requirements.	1. It is likely that the specification review will have identified any special requirements. The Checklist should be filled in with required details. 2. A check should be made that fill batters are within the headwall or end of pipe positions.
Set out	1. Offset pegs should be set out in positions close to the culvert ends but in positions that should survive. Check with the excavator operator and pipe layer. 2. Print out the SDR Job details for attachment to the Culvert Checklist.
Testing Requirements	1. The trench invert may require specific testing; list as necessary and attach test result sheet to Culvert Checklist. Backfill testing should also be checked and listed under Backfill. 2. If specific testing is not required, check that the invert is firm and uniform. Check the Contract Management Plan or specification before undercutting if soft.
Materials	1. List the required materials and check stock or order in.
Safety	1. Everyone working in the trench and within the swing of the excavator must wear a Hard Hat. 2. Dayglow jackets must be worn if there is traffic near the work site. 3. Before starting work, the crew should briefly talk through the job and identify any hazards. Any hazards and preventive action shall be listed. 4. Special attention shall be given to trench support. Trenches over 1.5m deep must have some protection provided, such as battering back, timbering or a shield.
Undercut	1. Should the trench base be soft, the Contract Management Plan or Specification will define the procedure before undercutting and backfill requirements.
Backfill	1. Check the requirements for backfill type and compaction standard. 2. List on the Culvert Checklist any specific requirements. Attach any test results to the Checklist.

Created by: Kylie Smith on 13/01/2017.

Approved by: Kylie Smith on 13/01/2017.

Published by: Kylie Smith on 13/01/2017.

6.0 Safe Operating Procedure – EARTHWORKS

Purpose and Scope

To ensure that Work Instructions are developed, when required, that adequately defines the client's specification requirements in a form that is understandable by the staff employed to do the work.

Contracts generally refer to TNZ F/1; Specification for Earthworks Construction but will vary or add to the requirements in particular areas and cases. The differences can be substantial and onerous and not easily understood directly from the contract specification by operators.

Responsibility

- Contracts Manager shall ensure that this standard operating procedure is attached to the Job Pack for the contract if required.
- Area Manager shall ensure that the requirements of this standard operating procedure are followed when undertaking responsibilities to site.
- Site Supervisor shall ensure that the listed stand operating procedure is part of the site induction for staff and its contents are abided by when undertaking earthworks tasks.

Associated Documents

Health and Safety at Work Act 2015.

- TNZ F/1; Transit New Zealand F/1, Specification for Earthworks Construction.
- TNZ G/1; Transit New Zealand G/1, Specification for Temporary Traffic Control.
- ARC Tech. Pub.2; Auckland Regional Council, Technical Publication No.2, Erosion and Sediment Control for Earthworks.
- CCC Civil Engineering Construction Standard Specifications

Important Step	Key Point
Safety, Traffic, Vehicles and Plant	1. The site must be kept safe at all times in accordance with the HSWA. 2. All hazards must be identified within the Tailgate form. The Tailgate form procedure must be followed prior to any works commencing. The Tailgate must be complete and kept onsite throughout the term on the activity. 3. On public roads, TNZ G/1; Spec. for Temporary Traffic Control, TTMCOP and the REL Temporary Traffic Management Program shall apply. 4. Pre-starts are to be completed prior to the operation of the plant and any issues are to be notified and corrected. 5. Vehicles must be well maintained, and log books and maintenance records present and up to date. 6. Vehicles are to be operated by people trained to do so (where applicable) and manufacturer's instructions followed in their operation. 7. Public vehicles and members of the public are to be kept away from the worksite, ensure that the following is in place: o Barriers to separate them from the worksite. o Warning signs, hazard boards, keep out signage. 8. Are people kept away from slewing vehicles, or, if not, can you use a zero tail swing machine? 9. Are vehicles and plant properly maintained, e.g.: o Do the steering, brakes, hydraulics, mirrors and any other vision aid work properly? o Are tyres in good condition and at the correct pressure? o Are reversing alarms active? 10. Can reversing be avoided, e.g. by using a one-way system or a turning area? If not, are properly trained spotters used?

Important Step	Key Point
	11. Have drivers received proper training and are they competent and fit to use the vehicles or plant they are operating? 12. Are loads properly secured? 13. Have you made sure that passengers are only carried on vehicles designed to carry them? 14. Have you made sure that plant and vehicles are not used on dangerous slopes? 15. If you need to work on or drive across sloping ground, have you checked that the plant and vehicles are safe to use? 16. Do you check that securing pins are in place on excavator quick hitches?
Surveying	1. The site **must** be extensively checked against supplied data or measured up before any surfaces are disturbed or after clearing where vegetation prevents earlier survey 2. Each subsequent surface should be picked up and must be where payment rates may change. 3. Set out work can be achieved at the same time and should be planned this way.
Stormwater Control	1. Consideration needs to be given to surface water entering the works, erosion of disturbed surfaces, how and where runoff will leave the works. This may require silt fences, sediment ponds with drain facilities and a system of drains or bunds controlling the water. See ARC Tech. Pub.2 in 'References' below. 2. Consideration is needed to prevent ponding of water on the works surface. 3. Consideration is needed for drainage of wet areas and temporary diversion of natural channels for permanent drainage work and cut or fill operations.
Clearing	1. Identify any features which are to be retained and protected. 2. Identify requirements restricting methods of clearing and handling of waste material. Can waste be burnt or buried or does it have to be carted off-site. 3. Identify limits of clearing. Ensure enough room on top of cut batters to work and protect against trees falling over.
Material Types	1. Identify material types under the contract and explain the differences in terms understandable by the operators. 2. Ensure they understand implications of separating in terms of payment and contamination. 3. Ensure the importance of samples being taken as evidence of change in material where required under the Spec. for payment purposes.
Topsoil Stripping	1. All organic soils should be stripped and stockpiled separately, with a minimum of compaction. This may also include 'subsoils'.
Cut to Fill or Waste	1. Identify types of material insitu, its characteristics and best use. 2. Record tallies of all loads by type, source, destination and condition particularly if wet. This must be recorded for comparison to measure ups, plant productivity and planning purposes. 3. Ensure all undercuts are measured before backfilling, even if by tape and photos relative to some landmark. 4. Record on day sheets, successful compaction methods by roller type, number of passes and apparent or measured moisture contents.
Testing	1. Identify the test methods and frequencies required by the Spec. Where standard Work Instructions have to be adapted, ensure that the specific contract requirements are identified on the form. 2. Check if 'qualified personnel' are required, and if this requires contracting out or training within the company.

Important Step	Key Point
Surface Shape. This is tighter than TNZ B/2	1. The shape of fills and subgrade should be controlled to the grades and cross falls of the subgrade finished surface. 2. Surface Finish Tolerances (TNZ F/1) are within 15mm from a 3m straight edge laid parallel to the centreline and from a cross-section camber board at right angles to centreline. 3. Reduced level of any point within zero above to 20mm below the designed or nominated level. 4. Where stringing to pegs is used, record on a Stringing Record Sheet.
Daily Records	1. In additions to timesheets for labour and plant, Daily Job Records need to be kept. 2. Daily Job Records must state what work is underway, particularly when new items start or work is held up. Any reason for holding up work must be recorded, such as rain (times and amount), breakdowns, shortage or delays. 3. Work relating to any instruction must also be recorded, with a cross reference to what labour and plant is used. 4. Records of material type and movement as described in 'Cut to Fill or Waste' above must also be kept.

Created by: Peter Downing on 23/05/2016.

Approved by: Colin Dixon on 26/07/2016.

Published by: Kylie Smith on 26/07/2016.

10.0 Safe Operating Procedure – ENVIRONMENTAL STORAGE

Purpose and Scope

To outline procedures for site storage of fuel and oil.

To ensure that procedures are available for safe operations, training and performance monitoring.

Responsibility

- Site Supervisor.
- Contracts Manager.
- Health and Safety Officer & Compliance Manager.
- All Operating and Labouring Staff.

Associated Documents

REL Site Specific Tailgate Form.

REL Health, Safety, Environmental and Quality Plan.

Procedure

Important Step	Key Point
Site Set-up.	When setting up a site including fuel and oil storage follow company procedures. Complete Contract Management Plan procedures: 3.5 Environmental & Resource Management Criteria 6.8 Site Risk Management
Obtain and manage Resource Consent Conditions.	Request Resource Consent Conditions from the client and record condition details in the Compliance Schedule. Manage the project within these conditions.
Establish fuel & oil storage facilities on site.	Factors to consider are: 1. Availability of tank type 2. Capacity required 3. Site security 4. Number of bowsers required
Construction of ground bunding.	1. Select flat ground away from haul and access roads. 2. Ensure adjacent water tables are protected through additional bunding if required. 3. Select fine grained material for bunding. 4. Compact the bund wall by wheel rolling as a minimum. 5. The height of the bund wall should be set to contain the total volume of fuel stored with 200mm of free-board.
Update and post emergency contact details.	1. Ensure all emergency contact details are completed for the site, are included in induction material, and posted on a site notice board and beside a landline where available.

11.0 Safe Operating Procedure – TRAFFIC CONTROL

Purpose and Scope

To provide a safe work area for our staff and road users, while working on the road, in compliance with Transit New Zealand requirements.

Responsibility

- The Site Traffic Management Supervisor (STMS) will be responsible for the management of the traffic management plan.
- The Traffic Controller (TC) will report directly to the STMS of the site and undertake his/her instructions.

Associated Documents

NZTA COPTTM. & RCA Regulations/Rules

Approved TMP.

Site inspection form.

Procedure

Important Step	Key Point
Develop the TMP	1. The TMP must be drawn up by a current STMS certification holder. 2. The TMP is to be submitted to the RCA for approval. 3. The approved TMP is to be implemented and monitored for safety and suitability throughout the contract.
Identify the Hazard area	1. Decide how much of the road will be affected with the work. 2. Allow room for excavators to swing their booms and trucks to park and drivers to safely get out of the cab. 3. Allow room for men to have their backs to the traffic.
Measure the lane widths left available. -3.5m between centreline and work -6m or more -less than 6m	1. When the work area is defined, the balance of the width of road is left for traffic. 2. If there is 3.5m min between the centreline and the work area, cone off that lane only. 3. If there is not 3.5m as above, but there is greater than 6m of sealed width left, form 2 lanes with cones. 4. If there is less than 6m, use traffic control and one lane..

2016.

14.0 Safe Operating Procedure – SET-OUT SURVEY

Purpose and Scope

This procedure applies to all set out survey, in conjunction with the Work Instruction applicable to the type of survey.

Responsibility

Specific Responsibilities and Authorities will be defined in the Contract Quality Plan. The following are listed as general requirements, subordinate to the Plan.

The Site Supervisor / Contract Manager is responsible for defining what needs to be set out and when, but must allow sufficient time for review of design, checking of Control Points and the existing surface. In the event of any dispute, the Engineering Manager has the authority over Surveyors and Engineers.

The Surveyor / Engineer is responsible for ensuring the design information is adequate, that sufficient checks are performed on site to confirm the existing surface, design is correct and set out is adequate. Where there is a shortage of information from the Client, any communication shall be through or with the knowledge of the Contractor's Representative.

The Site Supervisor is responsible for checking that the lines and levels appear to be sufficient before proceeding with the work, after the surveyors have been notified that their work is complete.

Everyone has the responsibility and authority to report Non-conformances and raise System Improvement Reports.

Associated Documents

Original Ground Contour Plan

Finished Surface Contour Plan

Safety

Observe any specific Site Safety Rules.

If working near machinery, notify operators where you will be and ensure they can see you. WEAR DAYGLO JACKETS

If working near a public road, ensure that all the required signs are out in accordance with the Traffic Control Procedure.

Procedure

To ensure that all works are setout to the specified requirements and the surface compared to source information.

Important Step	Key Point
Identify set out requirements	1. Ensure that instructions for setout are clear and understood. 2. Identify the required information and review. If insufficient, pursue the additional information through the 'Contractors Representative'.
Enter Design and check against given coordinates.	1. Check that calculated coordinates match those supplied. Report non-conformance and resolve differences.
Check survey Control Points	1. The given benchmarks and points with coordinates must be checked against each other, in relation to tie-in work at least and where possible to outside control. 2. Check for a misfit, i.e. new alignment not meeting the centreline of the tie-in road)
Set out required points and record	1. Set out shall be performed in accordance with the Survey - Work Instructions; 2. A record of all points must be created and printed to archive. Any ground information also needs to be collected for comparison to supplied surface data.

Important Step	Key Point
Pick up topographical features to establish existing surface.	1. Unless a topographical survey has been completed prior to set out, any information to confirm the supplied surface data must be picked up before modification and if the surface defines payment quantities.
Process data and compare surfaces	1. After processing any data, compare surfaces or points to supplied data. Where there is a difference, report as a non-conformance and resolve. 2. Produce reports to provide archive of work.
Identify As Built requirements and pick up any additional points	3. As Builts do not always have to wait for the end. It will be easier to pick up features during other work, even if plans, etc. are produced later.

Created by: Rebecca Hummelstad on 22/03/2016.

Approved by: Colin Dixon on 22/03/2016.

Published by: Peter Downing on 22/03/2016.

Appendix D – Testing Forms

ROONEY Earthmoving

NUCLEAR DENSIMETER TESTING

Reference:

Site: .... Date: ....

Material: .... Operator: ....

NDM Model & Number: .... Ass./Measured Solid Density (t/m³): ....

NDM TESTING	**Test ID**				
Location					
Comments:					
	Date:				
Test Mode	BS or DT & depth				
Average Wet Density	(kg/m³)				
Dry Density	(kg/m³)				
Average Dry Density	(kg/m³)				
Water Content	(%)				
Average Water Content	(%)				
Average Air Voids	(%)				
Target Dry Density	(kg/m³)				
% Compaction of MDD	(%)				

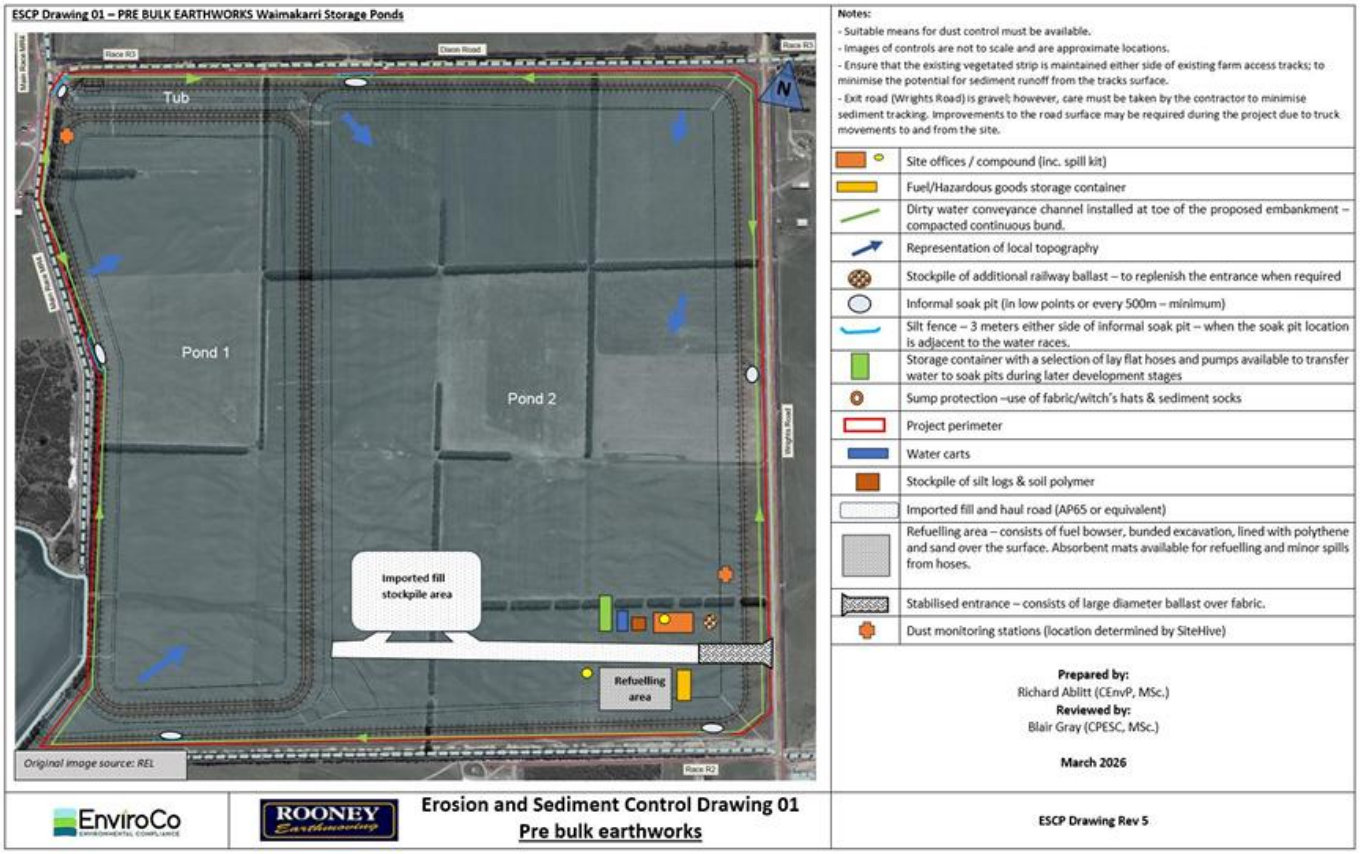
NDM TESTING	**Test ID**				
Location					
Comments:					
	Date:				
Test Mode	BS or DT & depth				
Average Wet Density	(kg/m³)				
Dry Density	(kg/m³)				
Average Dry Density	(kg/m³)				
Water Content	(%)				
Average Water Content	(%)				
Average Air Voids	(%)				
Target Dry Density	(kg/m³)				
% Compaction of MDD	(%)				

NDM TESTING	**Test ID**				
Location					
Comments:					
	Date:				
Test Mode	BS or DT & depth				
Average Wet Density	(kg/m³)				
Dry Density	(kg/m³)				
Average Dry Density	(kg/m³)				
Water Content	(%)				
Average Water Content	(%)				
Average Air Voids	(%)				
Target Dry Density	(kg/m³)				
% Compaction of MDD	(%)				

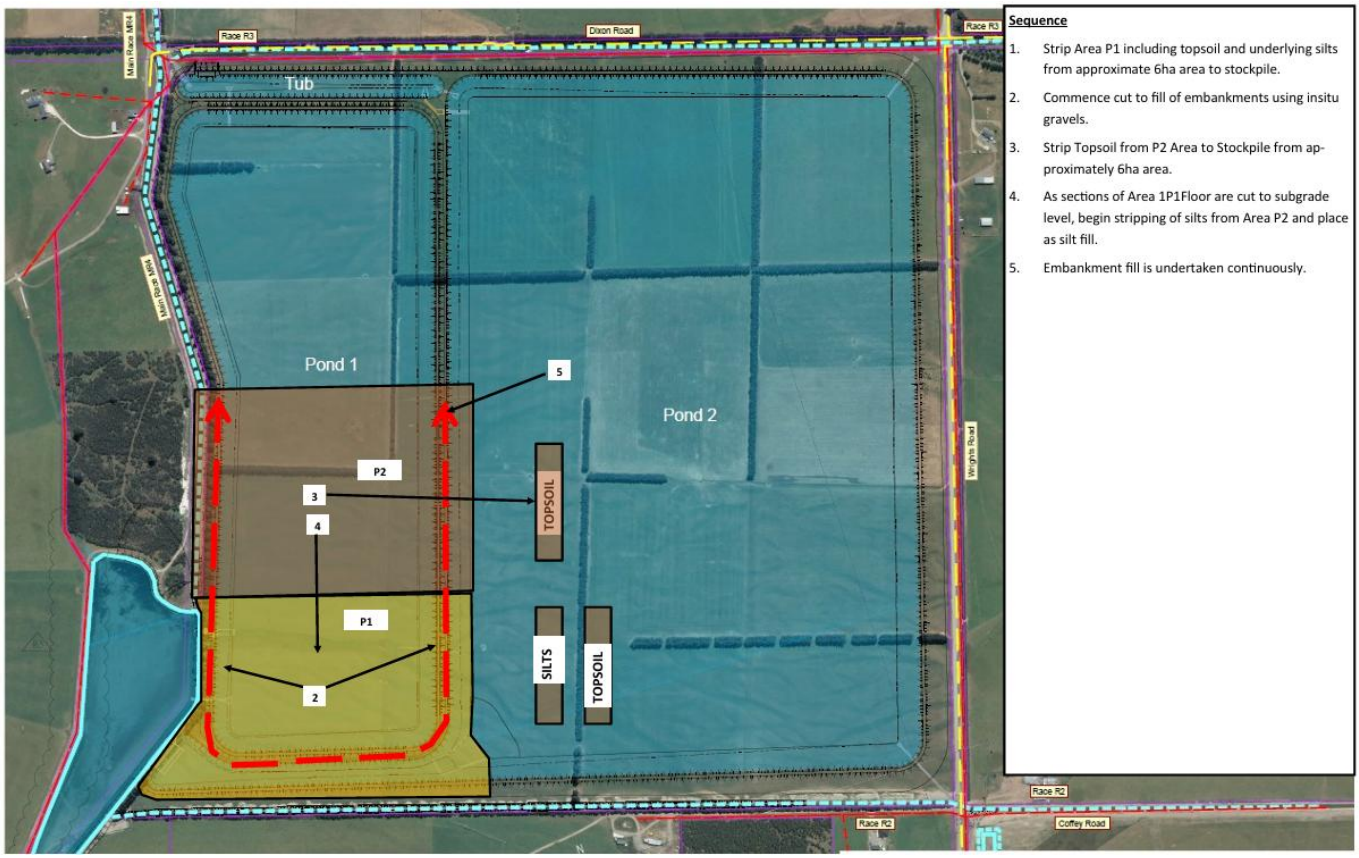
Local Form: REL NDM 001 Checked by: Date: Page of .

Appendix E – Earthworks Sequencing Plan

#1 Establish all Erosion Sediment Control prior to undertaking bulk earthworks,

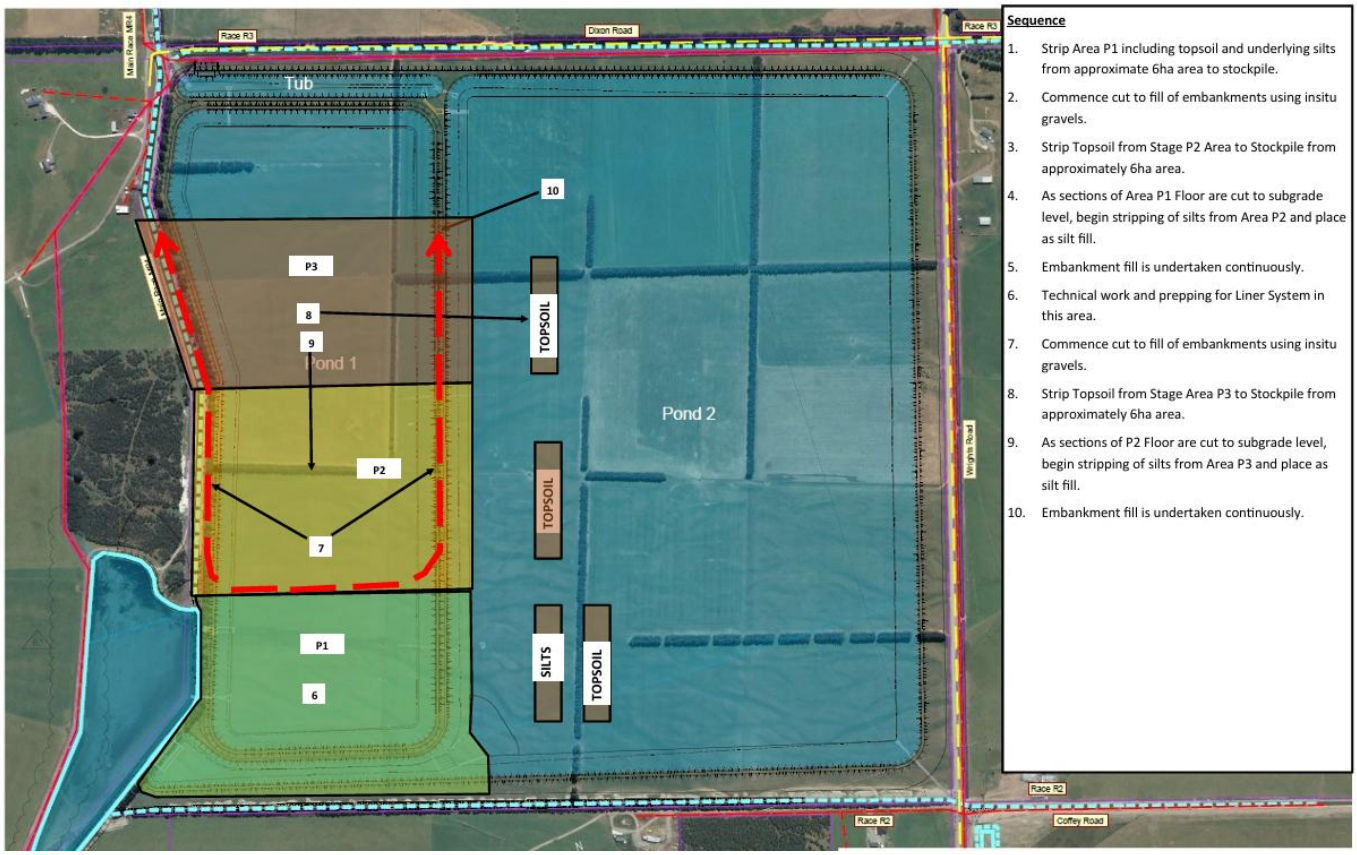


#2 Commence Earthworks Sequencing



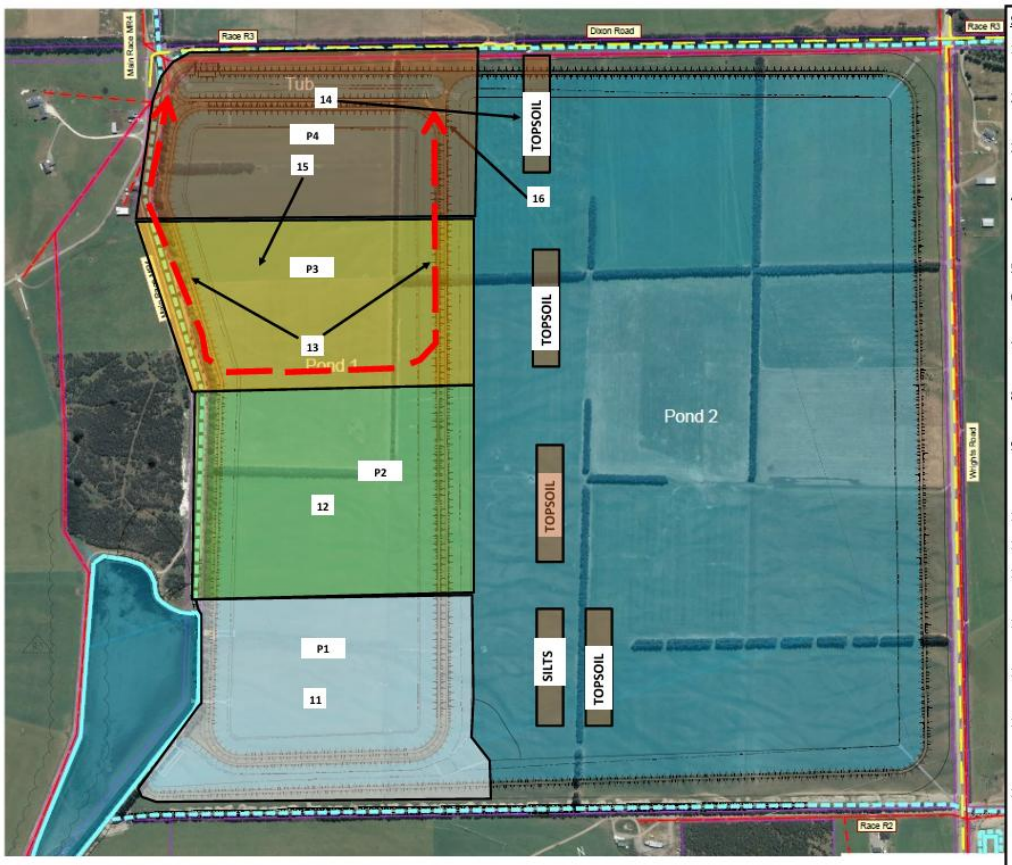
Sequence

1. Strip Area P1 including topsoil and underlying silts from approximate 6ha area to stockpile.
2. Commence cut to fill of embankments using insitu gravels.
3. Strip Topsoil from P2 Area to Stockpile from approximately 6ha area.
4. As sections of Area 1P1Floor are cut to subgrade level, begin stripping of silts from Area P2 and place as silt fill.
5. Embankment fill is undertaken continuously.



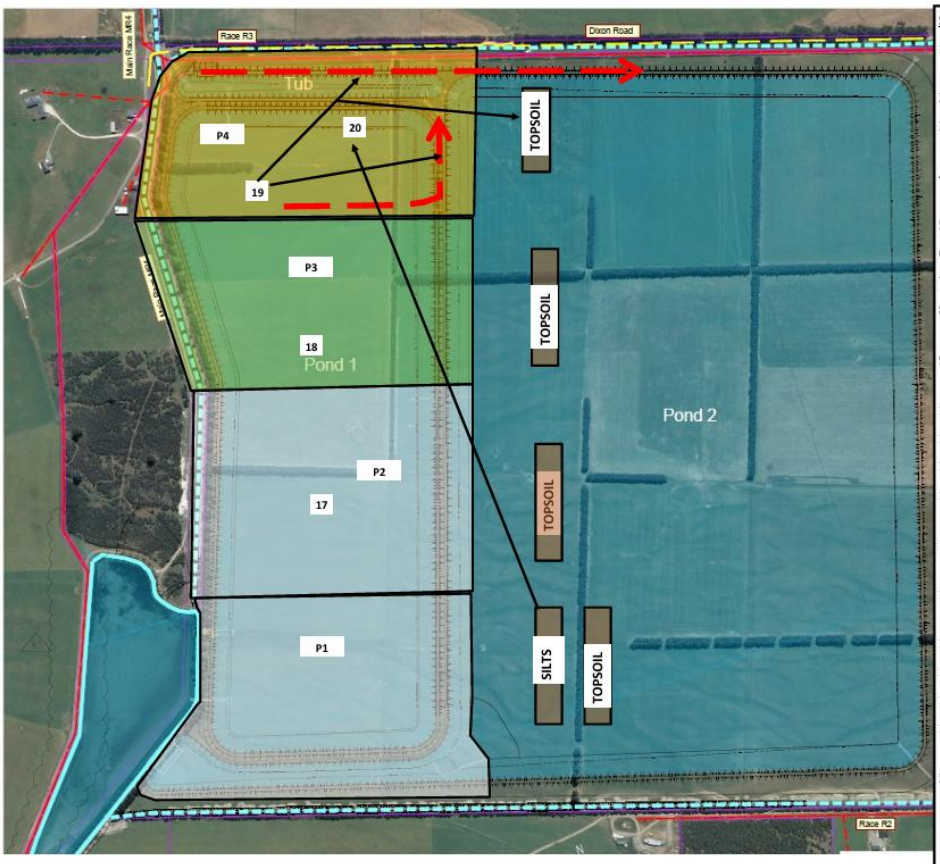
Sequence

1. Strip Area P1 including topsoil and underlying silts from approximate 6ha area to stockpile.
2. Commence cut to fill of embankments using insitu gravels.
3. Strip Topsoil from Stage P2 Area to Stockpile from approximately 6ha area.
4. As sections of Area P1 Floor are cut to subgrade level, begin stripping of silts from Area P2 and place as silt fill.
5. Embankment fill is undertaken continuously.
6. Technical work and prepping for Liner System in this area.
7. Commence cut to fill of embankments using insitu gravels.
8. Strip Topsoil from Stage Area P3 to Stockpile from approximately 6ha area.
9. As sections of P2 Floor are cut to subgrade level, begin stripping of silts from Area P3 and place as silt fill.
10. Embankment fill is undertaken continuously.



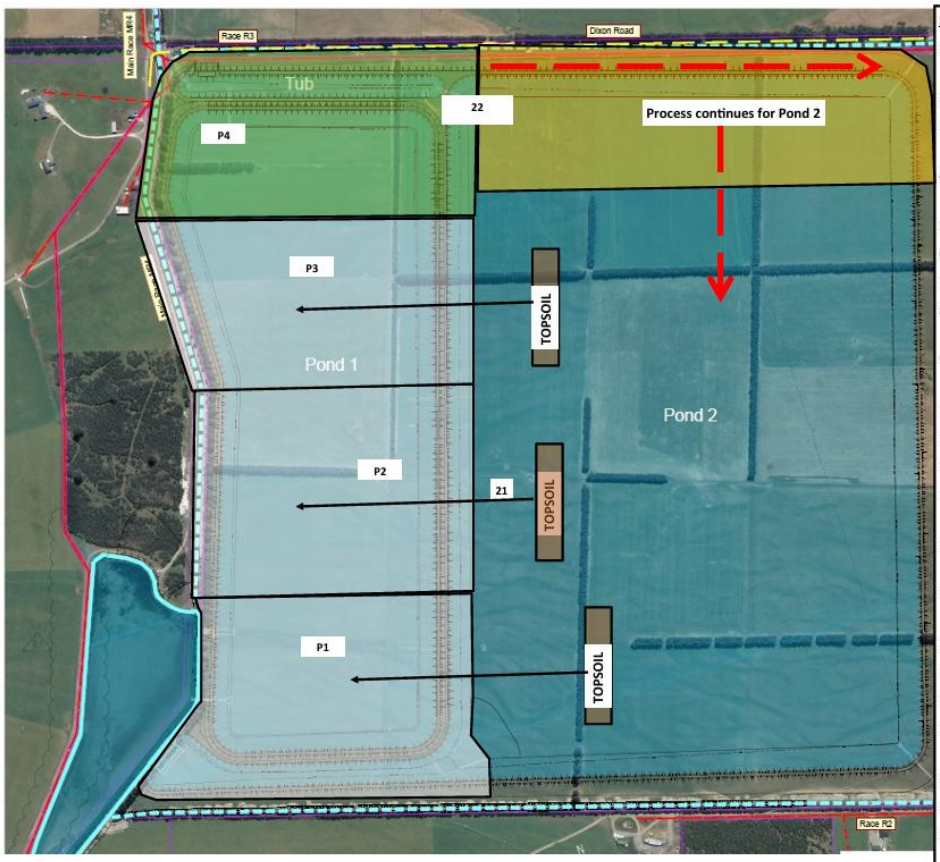
Sequence

1. Strip Area P1 including topsoil and underlying silts from approximate 6ha area to stockpile.
2. Commence cut to fill of embankments using insitu gravels.
3. Strip Topsoil from Stage P2 Area to Stockpile from approximately 6ha area.
4. As sections of Area P1 Floor are cut to subgrade level, begin stripping of silts from Area P2 and place as silt fill.
5. Embankment fill is undertaken continuously.
6. Technical work and prepping for Liner System in this area.
7. Commence cut to fill of embankments using insitu gravels.
8. Strip Topsoil from Stage Area P3 to Stockpile from approximately 6ha area.
9. As sections of P2 Floor are cut to subgrade level, begin stripping of silts from Area P3 and place as silt fill.
10. Embankment fill is undertaken continuously.
11. Area P1 is lined.
12. Technical work and prepping for Liner System in P2 area.
13. Commence cut to fill of embankments using insitu gravels Area P3
14. Strip Topsoil from Stage Area P4 to Stockpile from approximately 6ha area.
15. As sections of P3 Floor are cut to subgrade level, begin stripping of silts from Area P34 and place as silt fill.
16. Embankment fill is undertaken continuously.



Sequence

1. Strip Area P1 including topsoil and underlying silts from approximate 6ha area to stockpile.
2. Commence cut to fill of embankments using insitu gravels.
3. Strip Topsoil from Stage P2 Area to Stockpile from approximately 6ha area.
4. As sections of Area P1 Floor are cut to subgrade level, begin stripping of silts from Area P2 and place as silt fill.
5. Embankment fill is undertaken continuously.
6. Technical work and prepping for Liner System in this area.
7. Commence cut to fill of embankments using insitu gravels.
8. Strip Topsoil from Stage Area P3 to Stockpile from approximately 6ha area.
9. As sections of P2 Floor are cut to subgrade level, begin stripping of silts from Area P3 and place as silt fill.
10. Embankment fill is undertaken continuously.
11. Area P1 is lined.
12. Technical work and prepping for Liner System in P2 area.
13. Commence cut to fill of embankments using insitu gravels Area P3
14. Strip Topsoil from Stage Area P4 to Stockpile from approximately 6ha area.
15. As sections of P3 Floor are cut to subgrade level, begin stripping of silts from Area P34 and place as silt fill.
16. Embankment fill is undertaken continuously.
17. Area P2 is Lined
18. Technical work and prepping for Liner System in P3 area.
19. Cut to Fill is completed in P4 and any excess gravels are used in Pond 2
20. Silts from P1 are used to fill P4 floor where needed



17

Sequence

1. Strip Area P1 including topsoil and underlying silts from approximate 6ha area to stockpile.
2. Commence cut to fill of embankments using insitu gravels.
3. Strip Topsoil from Stage P2 Area to Stockpile from approximately 6ha area.
4. As sections of Area P1 Floor are cut to subgrade level, begin stripping of silts from Area P2 and place as silt fill.
5. Embankment fill is undertaken continuously.
6. Technical work and prepping for Liner System in this area.
7. Commence cut to fill of embankments using insitu gravels.
8. Strip Topsoil from Stage Area P3 to Stockpile from approximately 6ha area.
9. As sections of P2 Floor are cut to subgrade level, begin stripping of silts from Area P3 and place as silt fill.
10. Embankment fill is undertaken continuously.
11. Area P1 is lined.
12. Technical work and prepping for Liner System in P2 area.
13. Commence cut to fill of embankments using insitu gravels Area P3
14. Strip Topsoil from Stage Area P4 to Stockpile from approximately 6ha area.
15. As sections of P3 Floor are cut to subgrade level, begin stripping of silts from Area P34 and place as silt fill.
16. Embankment fill is undertaken continuously.
17. Area P2 is Lined
18. Technical work and prepping for Liner System in P3 area.
19. Cut to Fill is completed in P4 and any excess gravels are used in Pond 2
20. Silts from P1 are used to fill P4 floor where needed
21. Topsoil is place as ballast on liner
22. Pond 1 is completed as similar sequential process begins for Pond 2

Appendix F - Installation Quality Control And Quality Assurance Requirements

This section contains EcoTechs standard values for seam quality and non-destructive testing parameters. EcoTech will install material as per the following requirements.

Air Pressure Testing

Non-destructive air pressure testing of fusion welded seams shall conform to the following parameters:

Table 12: Primary Welds Pressure Test

HDPE Geomembrane Thickness (mm)	Minimum Pressure (kPa)	Maximum Pressure (kPa)
1.00	170	210
1.50	190	250
2.00	210	250
2.50	210	250

Maximum permissible pressure differential for HDPE after 5 minutes is:

Table 13: Primary Welds Pressure Difference

HDPE Geomembrane Thickness (mm)	Max Pressure Difference (kPa)
1.0	25
1.5	20
2.0	10
2.5	10

Destructive Testing

Destructive testing of welded seams shall conform to the following parameters;

Table 11: Minimum Seam Test Values for HDPE Geomembrane

Thickness				1.0 mm	1.5 mm	2.0 mm
Test	**Method***	**Units**	**Max/ Min**	**Value (N/25mm)**		
Hot wedge dual track seams						
Shear strength [1]	GRI GM19	N/25mm	Min	350	525	701
Shear elongation [2]	GRI GM19	%	Min	50	50	50
Peel strength [1]	GRI GM19	N/25mm	Min	263	333	530
Peel separation	GRI GM19	% of weld area	Max	25	25	25
Extrusion fillet seams						
Shear strength [1]	GRI GM19	N/25mm	Min	350	525	701
Shear elongation [2]	GRI GM19	%	Min	50	50	50
Peel strength [1]	GRI GM19	N/25mm	Min	225	340	455
Peel separation	GRI GM19	% of weld area	Max	25	25	25

[1]Shear and peel strength values are for 4 out of 5 test specimens. The 5th specimen must be at least 80% of the value.

[2]Elongation measurements should be omitted for field testing.

Appendix G –Solmax 1.5mm Geomembrane Technical Data Sheet

SOLMAX

Technical Data Sheet

GSE HX 1.50 mm White Reflective Smooth

PROPERTY(1)	TEST METHOD	FREQUENCY	UNIT Metric	1018082-23356-1
SPECIFICATIONS				
Thickness (min. avg.)	ASTM D5199	Every roll	mm	1.50
Thickness (min.)	ASTM D5199	Every roll	mm	1.35
Resin Density	ASTM D1505	One per batch	g/cc	> 0.932
Melt Index - 190°C/2.16 kg (max.)	ASTM D1238	One per batch	g/10 min	1.0
Density	ASTM D792	10,000 kg	g/cm³	≥ 0.940
Carbon Black Content	ASTM D4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D5596	Every 10 rolls	Category	Cat. 1 / Cat. 2
OIT - Standard (min. avg.)	ASTM D3895	30,000 kg	min	160
Tensile Properties (min. avg) (2)	ASTM D6693	Every 2 rolls		
Strength at Yield			kN/m	24
Elongation at Yield			%	13
Strength at Break			kN/m	47
Elongation at Break			%	750
Tear Resistance (min. avg.)	ASTM D1004	Every 5 rolls	N	187
Puncture Resistance (min. avg.)	ASTM D4833	Every 5 rolls	N	556
Dimensional Stability	ASTM D1204	Certified	%	± 2
Stress Crack Resistance (SP-NCTL) (avg.)	ASTM D5397	30,000 kg	hr	1000
Multi-Axial Tensile	ASTM D5617	Certified	%	15
Oven Aging - % retained after 90 days	ASTM D5721	Per formulation (5)		
OIT - Standard (min. avg.)	ASTM D3895		%	55
HP-OIT (min. avg.)	ASTM D5885		%	80
UV Resistance - % retained after 1,600 hr	ASTM D7238	Per formulation (5)		
HP-OIT (min. avg.)	ASTM D5885		%	50
SUPPLY SPECIFICATIONS(Roll dimensions may vary ±1%)				
Roll Dimension - Width	-		m	8.00
Roll Dimension - Length	-		m	140.0
Area (Surface/Roll)	-		m²	1120.00
Color (one side) (4)	-			White

NOTES

1. Testing frequency based on standard roll dimensions and one batch is approximately 180,000 lbs (or one railcar).
2. Machine Direction (MD) and Cross Machine Direction (XMD or TD) average values should be on the basis of 5 specimens each direction.
4. Smooth edge may not have the same consistent shade of color as the membrane itself. The colored layer may cause the carbon black content results to be higher than 3%.
5. Certified by core (black) formulation on geomembrane roll or molded plaque.

* All values are nominal test results, except when specified as minimum or maximum.
* The information contained herein is provided for reference purposes only and is not intended as a warranty or guarantee. Final determination of suitability for use contemplated is the sole responsibility of the user. SOLMAX assumes no liability in connection with the use of this information.

Solmax is not a design professional and has not performed any design services to determine if Solmax's goods comply with any project plans or specifications, or with the application or use of Solmax's goods to any particular system, project, purpose, installation or specification.

Appendix H –Certificate of Acceptance of Soil Subgrade Surface Example

EcoTech

CERTIFICATE OF ACCEPTANCE OF SOIL SUBGRADE SURFACE

PROJECT NAME: _____

PROJECT NUMBER: _____

OWNER: _____

LOCATION: _____

I the undersigned, a duly appointed representative of EcoTech, have visually observed the soil subgrade surface described below and found it to be an acceptable surface on which to install geomembrane.

This certification is based on observations of the surface of the subgrade only. No subterranean inspections or tests have been performed by EcoTech, and EcoTech makes no representations or warranties regarding conditions which may exist below the surface of the subgrade. EcoTech accepts no responsibility for conformance of the subgrade to this project's specifications.

Area being accepted: _____

_____

_____

EcoTech REPRESENTATIVE:

DATE: _____

SIGNATURE: _____

NAME: _____

TITLE: _____

OWNER REPRESENTATIVE:

DATE: _____

SIGNATURE: _____

NAME: _____

TITLE: _____

COMPANY: _____

Appendix I –Repair Report Record Sheet Example

EcoTech

REPAIR REPORT RECORD SHEET

PROJECT NAME: **POND Nr:** **MATERIAL DESCRIPTION:**

FIELD SEAM #	PANEL NUMBER	DATE	CREW	MACHINE NUMBER	TEST DATE	TEST CREW	TEST P / F	REPAIR or DETAIL	LOCATION / COMMENTS

QAQC Forms - Ver 1 -BH 03/09/2012

Appendix J –Non-Destructive Testing Record Sheet Example

EcoTech

NON-DESTRUCTIVE TESTING RECORD SHEET

PROJECT NAME: **POND Nr:** **MATERIAL DESCRIPTION:**

DATE / TIME	SEAM NUMBER	TESTER INITIALS	AIR TESTING PRESSURE (kPa) START	PRESSURE (kPa) END	+/-	TIME START	TIME END	COMPLETE Y / N	V BOX COMPLETE Y / N	LOCATION / COMMENTS

QAQC Forms - Ver 1 -BH 03/09/2012

Appendix K –Panel Seaming Record Sheet Example

EcoTech

PANEL SEAMING RECORD SHEET

PROJECT NAME: **POND Nr:** **MATERIAL DESCRIPTION:**

DATE / TIME	SEAM NUMBER	PANEL NUMBERS	SEAM LENGTH	SEAMER INITIALS	MACHINE NUMBER	TEMP SETTING	WEATHER	WINDS	AMBIENT TEMP	DES TEST P/F	COMMENTS

QAQC Forms - Ver 1 -BH 03/09/2012

Appendix L –Panel Placement Record Sheet Example

EcoTech

PANEL PLACEMENT RECORD SHEET

PROJECT NAME: **POND Nr:** **MATERIAL DESCRIPTION:**

DATE/ TIME	PANEL NUMBER	ROLL NUMBER	PANEL LENGTH	PANEL WIDTH	COMMENTS / PANEL LOCATION

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Appendix M – Trial Weld Information Record Sheet Example

EcoTech

TRIAL WELD INFORMATION RECORD SHEET

PROJECT NAME: **POND Nr:** **MATERIAL DESCRIPTION:**

DATE / TIME	AMBIENT TEMP	Q.C. INITIAL	MACHINE NUMBER	SEAMER INITIAL	EXTRUSION WELDS: BARREL TEMP SET	BARREL TEMP PRYO	PREHEAT TEMP SET	PREHEAT TEMP PYRO	FUSION WELDS: WEDGE TEMP SET	WEDGE TEMP PYRO	MEASURED SPEED	SPEED SETTING M/MIN	PEEL VALUES LBS / INCH			PASS FAIL	COMMENTS

QAQC Forms - Ver 1 -BH 03/09/2012

Appendix N – Destructive Test Record Sheet Example

EcoTech

DESTRUCTIVE TEST RECORD SHEET

PROJECT NAME: **POND Nr:** **MATERIAL DESCRIPTION:**

DATE	SAMPLE I.D.	SEAM NO.	MACHINE NUMBER	SEAMER INITIAL	PEEL VALVE LBS / INCH.						PASS FAIL	DATE TO LAB PKG SLIP #	LAB PASS/ FAIL	LOCATION / COMMENTS

Appendix O – Ecotech 500gsm Geotextile Underlay Data Sheet

EcoTech

EcoTech Polyester Needle-Punched Geotextiles
Specification Sheet

	Test	Test Method	Units	CL400	CL500
Physical Properties	Density	AS2001.2.13	g/m2	400	500
	Thickness	AS3706.1 : 2012	mm	3.25	4.0
	TNZ F/7 2003 Filtration Classes	AS3706.9 : 2012	-	1 – 4 Granular soils only	1 – 4
	TNZ F/7 2003 Strength Classes	AS3706.3&5, AS2001.2.3	-	A - B	A - C
	TNZ F/7 2003 G Rating	-	-	2200	2505

	Test	Test Method	Units	CL400	CL500
Mechanical Properties	Wide Strip Tensile Strength (MD/XMD)	AS3706.2 : 2012	N/mm *	12.0 / 14.0	15 / 21.5
	Elongation (MD/XMD)	AS3706.2 : 2012	%	94 / 91	100 / 90
	Trapezoidal Tear Strength (MD/XMD)	AS3706.3 : 2012	N	500 / 440	460 / 610
	CBR Burst Strength	AS3706.4 : 2012	N	2290	2740
	Grab Tensile Strength (MD/XMD)	AS2001.2.3 Method B-88	N	785 / 880	980 / 1270
	Drop Cone Puncture Test	AS3706.5 : 2000	mm	2500	2500
Hydraulic Properties	Pore Size	AS3706.7 : 2003	µm	191	170
	Permittivity	AS3706.9 : 2012	s^{-1}	1.20	1.30
	Coefficient of Permeability	AS3706.9 : 2012	m/s	3.60×10^{-3}	3.87×10^{-3}
	Flow Rate @ 100mm Head	AS3706.9 : 2012	$l/m^2/s$	120	130

* same as kN/m MD = Machine Direction Test, XMD = Cross Machine Direction Test October 2012