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- Landfill Engineering
- Landfill Gas Management
- Solid Waste Planning
- Environmental Monitoring
- Landfill Fire Control

December 13th, 2019

Hon. George Heyman

Office of the Minister
Ministry of Environment and Climate Change Strategy
Parliament Buildings
Victoria, B.C. V8V 1X4

cc. Tessa Graham, AJ Downie, Laurel Nash

RE: Cobble Hill Landfill Quality Management Plan

Dear Mr. Heyman,

Please find attached the Quality Management Plan (QMP) completed by Sperling Hansen Associates (SHA) for the Cobble Hill Landfill.

The QMP for the Cobble Hill Landfill Final Closure Construction project will establish the activities, processes, and procedures for ensuring a quality product upon the conclusion of the project. The purpose of this plan is to:

- Ensure quality of work is planned and managed accordingly
- Define how each portion of the construction work will be managed
- Define quality assurance activities
- Define quality control activities
- Define acceptable quality standards

Additionally, this plan has been developed to address and respond to GHD's Task 2 – Review of the Cobble Hill Landfill Updated Final Closure Plan 2019, regarding the continued use, and the cutting, removal and reinstallation of the existing geomembrane cover liner.

Sincerely,

Scott Garthwaite, AScT
Civil Technologist



December 13th 2019

SPERLING HANSEN ASSOCIATES

North Vancouver Office
8-1225 East Keith Road, North Vancouver, British Columbia, V7J 1J3
Phone (604) 986 7723 Fax (604) 986 7734

Kamloops Office
1332 McGill Road, Kamloops, British Columbia, V2C 6N6
Phone (778) 471 7088 Fax (778) 471 7089

**COBBLE HILL LANDFILL
FINAL CLOSURE CONSTRUCTION
QUALITY MANAGEMENT PLAN**

[Cobble Hill Holdings Ltd.]
COBBLE HILL LANDFILL FINAL CLOSURE CONSTRUCTION

13/12/2019

**Quality Management Plan
Cobble Hill Landfill Final Closure Construction**

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Quality Management Plan Cobble Hill Landfill Final Closure Construction

Introduction

The Quality Management Plan (QMP) for the Cobble Hill Landfill Final Closure Construction project will establish the activities, processes, and procedures for ensuring a quality product upon the conclusion of the project. The purpose of this plan is to:

- Ensure quality of work is planned and managed accordingly
- Define how each portion of construction work will be managed
- Define quality assurance activities
- Define quality control activities
- Define acceptable quality standards

Additionally, this plan has been developed to address and respond to GHD's Task 2 – Review of the Cobble Hill Landfill Updated Final Closure Plan 2019, regarding the continued use, and the cutting, removal and reinstallation of the existing geomembrane cover liner.

Purpose and Objectives

The purpose of the Cobble Hill Landfill Final Closure Construction Quality Management Plan is to establish the goals, processes, and responsibilities required to implement effective quality management functions for the Final Closure to be undertaken at the Cobble Hill Landfill in support of the Updated Final Closure Plan 2019. This QMP defines how the Project Team will implement, support, and communicate project quality practices during the Cobble Hill Landfill Final Closure Construction.

The Quality Management Plan will accomplish the following objectives for the Cobble Hill Landfill Final Closure Construction project:

- Outlines the purpose & scope of quality activities
- Defines how quality will be planned and managed
- Defines quality assurance (QA) activities
- Defines quality control (QC) activities
- Defines acceptable quality standards
- Defines roles and responsibilities for quality management activities

Quality Management Roles and Responsibilities

All members of the Cobble Hill Landfill Final Closure Construction project team will play a role in quality management. It is imperative that the team ensures that work is completed at an adequate level of quality from individual work packages to the final project deliverable.

Quality roles and responsibilities for the Cobble Hill Landfill Final Closure Construction Project are as follows:

Owner – *Cobble Hill Holdings Ltd.*

- Oversee and support the application of quality standards for the Cobble Hill Landfill Final Closure Construction
- Collaborate with the project team in the development of quality metrics and standards
- Participate in quality management reviews as required

Construction Project Manager - *Allterra Construction Ltd.*

- Overall implementation of the Final Closure Construction
- Implement the Quality Management Plan to ensure all tasks, processes, and documentation are compliant with the plan
- Ensure team member compliance with quality management processes
- Support the project team in securing resources to perform quality management
- Provide oversight to the closure of corrective actions arising from quality reviews
- Communicate quality standards to the project team
- Ensure proper scheduling of construction tasks and communicating status updates to the Project Team and ENV representatives
- Provide daily updates to the QP on progress and status of all construction activities and identify schedule changes weekly
- Maintain as-built surveys and drawings

Daily Qualified Professional Oversight

- Oversee and support the application of quality standards for the Cobble Hill Landfill Final Closure Construction Project processes and products
- Perform daily site inspections at the site (except for when SHA staff is present at the site)
- Perform QA / QC duties as identified in this QMP and prepare records
- Prepare daily site inspection reports
- Prevent, stop or correct QC deficiencies, defective work or noncompliance through daily inspections

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Cobble Hill Landfill Final Closure Construction**

Engineering Support and Critical Task Qualified Professional Oversight – *Sperling Hansen Associates*

- Oversee and support the application of quality standards for the Cobble Hill Landfill Final Closure Construction Project processes and products to their respective team members
- Collaborate with the project management team in the development of the quality plan, including quality metrics and standards
- Participate in quality management reviews as required
- Perform QA activities and QC inspections at least once per week during all construction activities, and daily during critical tasks
- Create and maintain Quality Control and Assurance Logs throughout the project
- Provide semi-monthly status reports to be distributed to appropriate parties
- Communicate results from assessments with appropriate parties
- Prevent, stop or correct QC deficiencies, defective work or noncompliance through inspections
- Ensure resolution of non-compliance instances and escalate any issues that cannot be resolved within the project
- Review and approve submittals

Quality Management Scope

This QMP defines the activities and processes related to managing the quality of the Final Closure Construction Works which will be undertaken at the Cobble Hill Landfill. The scope of this project includes:

- Project Management – Cobble Hill Holdings Ltd. & Allterra Construction Ltd.
- Construction of Closure Works (as defined below) – Allterra Construction Ltd.
- Daily On-site Engineering and QA / QC – To be Determined
- Critical Task Engineering and QA / QC – Sperling Hansen Associates
- Construction Progress Reporting – Sperling Hansen Associates

The construction tasks to be included in the Final Closure Construction Works, as outlined in SHA’s Updated Final Closure Plan and as required by the Ministry of Environment (ENV) are listed below. These tasks are described in the Construction Activities Workplan that has been prepared.

Pre-Construction Activities:

Soil Importation:

- Import, place, and/or stockpile common fill at toe of landfill
- Import and stockpile growing medium

Laboratory Testing on Soil and Liner:

- Liner Testing – Integrity from Exposure (OIT and Modulus)
- Liner Testing – Shear Strength Confirmation on Friction Sand

Other Pre-construction Activities Analysis and Reporting:

- Prepare Updated Stability Analysis Report
- Install Shallow Monitoring Wells (MW19-01 and MW19-02)
- Prepare Updated Environmental Monitoring Plan
- Decommission MW-4
- Install new SB-4 East of PEA

Construction Activities:

Leachate / Leak Detection / Seepage Blanket Infrastructure:

- Install Toe Drainage Soak Away Trench
- Cut Liner and Install / Weld piping for Cleanouts
- Inspect Leak Detection Layer
- Extend Cleanouts
- Extend Seepage Blanket Wells
- Repair Liner – Liner Boots around Leachate / Leak Detection Pipe Cleanouts

Construction of Soil Stabilizing Buttress & Associated Works:

- Place and Compact Common Fill Soil Stabilizing Wedge
- Place Growing Medium
- Hydroseed and Erosion Protection

Earthworks on Slope:

- Coarse Sand Layer (Liner Interface)
- Drainage Layer (Gravel)

PEA Liner Works

- Liner Inspection
- Cutting and Opening of Crest Liner
- Relocate SMA Soil and Compact on PEA Crest
- Reseal, Repair and Replacement of Liner

Earthworks on Crest

- Install Crest Drainage Layer
- Install Crest Subsoil Layer
- Place Growing Medium Layer

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- Hydroseed and Erosion Protection

Storm Water Management

- Ditching
- Erosion Control

Site Clean Up and Project Finalization

As discussed previously, a detailed construction work plan and schedule has been completed as a separate document titled “Detailed Construction Plan” where specific construction means and methods are provided in further detail.

Quality Management Approach

The quality management approach for Cobble Hill Landfill Final Closure Construction will help ensure quality is planned for both the construction works and the final closure of the landfill.

In the subsequent sections of this document, the following quality management approach elements are described and defined:

- Quality Planning, Quality Assurance, and Quality Control
- Quality activities & standards relevant to Cobble Hill Landfill Final Closure Construction
- Appropriate quality metrics and measures for standards for project processes, product functionality, project deliverables, project management performance, documentation, and testing
- QA & QC roles and responsibilities

Quality Planning

Quality planning is the process of identifying quality requirements and/or standards for the project and product, and documenting how the project will demonstrate compliance. The deliverables and processes to be reviewed for the Cobble Hill Landfill Final Closure Construction project, and their corresponding quality standards, are detailed in the Quality Assurance and Quality Control sections of this document.

Implementation of and compliance with the QMP is the shared responsibility of all project personnel. Both project management and technical staff are thus integrated with and committed to the success of overall quality management.

Quality planning also includes establishing the quality standards, identification of the quality metrics to be applied, creating the quality checklists, and conducting problem remediation activities. These processes are described at a high level below:

Review Compliance Requirements

The Closure design and construction of all associated works will be completed in accordance with the June 26th 2019 Conditions of Approval (letter from Minister Heyman), and the second amended Spill Prevention Order (SPO) MO1701. All members of the project team will be familiar with the site-specific regulatory requirements at the Cobble Hill Landfill.

Quality Management Plan Cobble Hill Landfill Final Closure Construction

Establish Quality Standards

This quality planning process establishes the QA & QC standards (the process descriptions, standards, and procedures) the Cobble Hill Landfill Final Closure Construction Project Team will use. Quality process descriptions, standards, and procedures that are applicable to the Cobble Hill Landfill Final Closure Construction project phases have been defined. The required tests and specifications are discussed further in the Quality Control Section of this plan.

Identify Quality Metrics

This quality planning process identifies the metrics the Team will use. The metrics, which are based on the quality standards established by the Project Team, will be refined during the different phases of the project, and documented in updates to this Quality Management Plan. The quality metrics will be used to evaluate whether the project is achieving its goals.

Document Construction Activities

Site inspections are an integral part of the process and product quality review. A Qualified Professional (QP) will be present during all aspects of construction works, with senior staff being present during critical tasks as identified in the *Detailed Construction Work Plan*. Site inspections will include preparatory meetings – to be performed before the start of work each day and to include a review of planned daily activities and the required health and safety; initial inspections – to be performed for each new construction task item and will establish a level of workmanship that meets design requirements; and follow-up inspections – to be performed following any non-conformance to ensure construction is following the elements of design.

Preparatory meetings are to be performed before the start of each work day and will include all members of the project team and associated contractors that will be working on site during this day. The meetings will include a review of planned daily activities and the required health and safety. Follow-up inspections will be performed by the QP at key stages in construction and following any non-conformance identifications.

Problem Remediation

The Cobble Hill Landfill Final Closure Construction Senior Project Manager will schedule separate meetings as needed to determine corrective actions and process improvements. The results of the activities are then acted on, where possible, to improve the success of future project phases by incorporating experiences and lessons learned into subsequent phase planning activities. Through the incorporation of quality management recommendations from the preceding review stage into the activities and related deliverables for the next stage, the quality of project activities and deliverables will increase incrementally throughout the project life cycle. This approach minimizes issues at the end of the project.

Qualifications

As required by Section 3 of the SPO, a Qualified Professional (QP) will be on site during construction activities. The specific qualifications of the proposed inspector(s) are outlined in the Detailed Construction Activities Workplan which has been prepared as a separate document.

In general, the requirements for the QP will be a person who:

- An engineer, scientist or technologist specializing in a particular applied science or technology,
- Is registered in British Columbia with a professional organization, is acting under that organization's code of ethics and is subject to disciplinary action by that organization, and
- Through suitable education, experience, accreditation and knowledge respecting solid waste management and related engineering disciplines for the management of leachate, surface water, ground water, storm water, and landfill gas and other specialist disciplines, may reasonably be relied upon to provide advice within his or her area of expertise and to carry out duties or functions in those areas.

Quality Assurance

Quality assurance, which is focused on the project processes, provides confidence that the quality requirements of closure can be fulfilled. Quality Assurance helps ensure the processes used to manage and deliver the construction of closure works are effective and being applied.

The quality assurance measures for the Cobble Hill Landfill Final Closure Construction are described below:

Project Schedule Management – the project schedule will be reviewed as works proceed. A project schedule review meeting will be held once weekly (mid-week) immediately following the morning construction preparatory meeting on site. Modifications to the project schedule will be tracked and reported to all parties including ENV. As outlined in the Conditions of Approval, notice of any changes to the work plan will be provided to ENV at least 48 hours before the work is undertaken on site.

Progress Documentation – As outlined in previous sections, daily site reports will be completed by the Contractor and provided to the QP for review. Weekly status reports will be completed by the QP and will be circulated to the project team to provide assurance the project quality is being achieved. Semi-monthly status reports will be completed and distributed to the project team and ENV.

Design Review – Design review meetings will occur at strategic points during construction prior to tasks commencing and at the completion of tasks. All construction works will be surveyed in place once completed, prior to the next stage of construction commencing. This will ensure construction is proceeding according to the engineered planned and ensure accurate as-built drawings are produced. Modifications to the construction design will be tracked and documented accordingly.

Quality Control

Quality control is focused on the products and deliverables of the project. It is the process of monitoring project components to verify that the construction works are of acceptable quality and are complete and correct. Quality Control includes the inspection, analysis, and actions required to ensure quality construction. The Cobble Hill Landfill Final Closure Construction QC process involves the following steps:

- Verifying, validating, and monitoring of work to ensure the requirements for quality and scope of work are being fulfilled.
- Inspecting construction works and documentation and comparing these items to applicable engineering standards.
- Monitoring construction progress, detecting problems and defects, and allowing for corrections prior to completion.

Progress & Construction Monitoring

Site inspection reports will be completed which will include a summary of work completed as well as work to be completed and discussions with contractors. The site inspection reports will be completed by the designated QP. Photo evidence of key construction tasks will be included in the site inspection reports as well as daily notes and photos provided by the Contractor to the QP.

As outlined in second amended Spill Prevention Order (SPO), QP will provide semi-monthly progress reports including status of closure activities, inspection results QC testing, inspection reports and supporting documents. Deviations to the construction work plan will be identified, and upcoming activities and associated timing will be outlined.

QA/QC Testing

The QP will review the testing requirements for each construction task in accordance with design documents and be present to witness the testing. Calibration certificates (if required) will be provided to the QP by the technician performing the test and included in the weekly inspection reports along with the test results. Failed tests can be cleared by one of the following methods:

1. Re-test
2. Re-work, re-inspect and re-test.
3. Remove and replace the failed material; re-inspect and re-test.

Critical Task Inspections

QA / QC observations and inspections will be specific per each construction task milestone. During regular construction, a QP approved by ENV will be present. Senior staff from Sperling Hansen will complete one site visit per week (at SHA's discretion) during regular (non-critical) construction activities. Critical tasks, as identified below, will be inspected and documented by SHA's QP. Critical Tasks for this construction project include:

1. PEA liner repairs and testing
2. Cutting & opening of PEA
3. Works during SMA soil relocation
4. Reseal, repair and replace liner as necessary

5. Liner interface installation
6. Well drilling and decommissioning
7. Leachate / leak detection pipe works
8. Final inspection

Quality Control Requirements

The QC requirements for the final closure construction at Cobble Hill Landfill, as they relate to the Item 5 of the June 26th Conditions of Approval, include the following. The Quality Control Requirements have been prepared using the same headings as presented in GHD's Task 2 Cover System Detailed Engineering Review.

Geomembrane Review

1. Liner Inspection

- a. The QP will complete an entire site walk over and identify and map all deficiencies including, tears, rips, punctures, un-finished patches, boots, tie-in seams, etc. prior to final closure work commencement and post liner repair works at the site.
- b. The existing wedge welds of the geomembrane should be inspected by the QP to determine if the fusion seam needs to be reinforced (as recommended by Solmax).

2. Stability Analysis

- a. A QP will address the comments and conclusions of GHD's Task 1 Slope Stability Engineering Review.
- b. Site-specific lab testing will be completed to mitigate concerns regarding the interface shear strength parameters and an updated stability analysis will be completed prior to construction.

Functionality of Existing Geomembrane

1. Liner Integrity Testing (Liner Exposure)

- a. The liner manufacturer has recommended the following tests be completed on the existing liner to confirm the integrity of the geomembrane:
 - i. ASTM D5323 (2% Secant Modulus)
 - ii. ASTM D3895 (Oxidative Induction Time by DSC)
- b. The recommended sample interval is one sample per 9,000 m². Since the 3D area of the PEA is less than 9,000 m², one sample will be taken and submitted for analysis.
- c. The liner sample should be taken from a visible flap of the geomembrane, so as to not interfere with the integrity of the PEA. Three samples of geomembrane will be required; each sample is to be at least 8" by 16" in size in the machine direction.

2. Manufacturer Warranty of Liner

- a. The manufacturer warranty is included in Appendix A.

Final Cover Construction

1. Soil Stabilizing Wedge Construction

a. Common Fill Material

- i. Placement of materials shall be completed in a way that does not disturb or damage other works.
- ii. Material shall be placed in uniform layers not exceeding 500 mm and compacted to Method Specification except in areas closer to the liner where minimal compaction should be performed (discussed below).
- iii. Placement in areas adjacent to the liner shall be completed in conjunction with placement of the sand friction layer, gravel drainage layer and associated geosynthetic products.
- iv. Compaction should be completed as per the following method:
 1. Common fill to be placed and graded to uniform layer not exceeding 500mm in height; and
 2. Maximum 500mm common fill lifts to be track-compacted by heavy construction equipment.
- v. No vehicles except balloon tire UTV's are allowed directly on the liner. Only low ground pressure equipment can be used near the leading edge of the soil cover. The depth of soil cover required under high ground pressure equipment will depend on the subbase, types of soils, and type of liner protection and must be determined by the project engineer.

Dozers can be used to spread the cover material but cannot be the only method used at the leading edge of the cover material. Pushing with a dozer pushes membrane slack in front of the leading edge into a slack wave which will accumulate causing stresses in the liner. To avoid this an excavator or similar must be used to dump material in front of the leading edge and trap the liner slack before it accumulates

- vi. A QP must inspect the liner as the cover material is placed. If damage to the liner is noted it must be marked and cleaned by hand using a plastic shovel for repair.

b. Growing Medium Materials

- i. Incoming materials should be stockpiled in a manner to protect the material from contamination.
- ii. The Contractor shall supply a topsoil with appropriate physical and chemical characteristics to facilitate drainage and support a self-sustaining community of vegetation.
- iii. A minimum 500 mm thick continuous layer of topsoil is to be placed over the subsoil layer. The topsoil should be manually spread around any obstacles.
- iv. The Topsoil will compact following placement, seed bed preparation and seeding. The Contractor shall ensure that sufficient volume of topsoil is applied to meet the minimum depth requirement after compaction.

c. Hydraulic Seeding

- i. Seeding of the growing medium should commence after installation of the growing medium is completed. Final grades shall be established and approved by the QP prior to seeding.
- ii. Hydraulic seeding shall not be applied in adverse field conditions (such as frozen soil, excessively wet or dry soil, ice or standing water, or when winds exceed 10 km/hr.
- iii. Carry out hydraulic seeding with care to ensure that any fertilizer in solution does not come in contact with foliage of any trees, shrubs or other susceptible vegetation. Do not spray seed or mulch on objects not expected to grow grass.
- iv. Soil should be kept moist during the germination period.

2. Liner Interface

a. Coarse Sand Friction Layer

- i. To be placed above existing smooth geomembrane liner.
- ii. The sand layer shall be placed in conjunction with the stabilizing soil wedge.
- iii. The sand shall be loosely placed in a single lift.
- iv. Equipment completing placement work shall be as per the minimum lift thickness table provided below (Table 5).
- v. Each lift shall advance vertically up the geomembrane covered slope 500 mm or less in height in conjunction with the soil stabilizing wedge.
- vi. The sand shall fall generally within the specifications outlined below, approved at the discretion of the QP.

Table 1: Sand Sieve

Sand			
Seive Designation (mm)	Percent Passing (%)		
12.5	100	-	100
4.75	50	-	100
2.36	30	-	80
0.6	10	-	50
0.15	0	-	20
0.075	0	-	0

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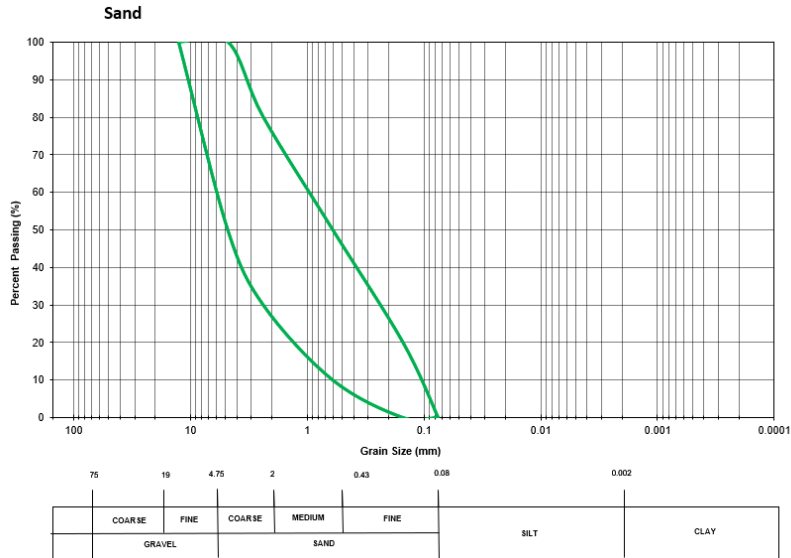


Figure 1: Sand Gradation

b. Geotextile Layer(s)

- i. 12 oz non-woven geotextile to be placed as separation layer between sand friction layer and clear crush gravel drainage layer on slope

Table 2: Heavy Weight Nonwoven Geotextile (12 oz./yd²)

Property	Required Value	Test Method
Unit Weight	405 g/m ²	ASTM D5261
Grab Tensile Strength	1,420 N	ASTM D4632
Grab Tensile Elongation	50%	ASTM D4632
Puncture	835 N	ASTM D4833
Trapezoid Tear Strength	555 N	ASTM D4533
Apparent Opening Size	150 μm	ASTM D4751

- ii. 8 oz non-woven geotextile to be placed as separation layer above the gravel drainage layer and below the common fill.

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Table 3: Light Weight Nonwoven Geotextile (8 oz./yd²)

Property	Required Value	Test Method
Unit weight	270 g/m ²	ASTM D5261
Grab Tensile Strength	975 N	ASTM D4632
Grab Tensile Elongation	50%	ASTM D4632
Puncture	525 N	ASTM D4833
Trapezoid Tear Strength	420 N	ASTM D4533
Apparent Opening Size	180µm	ASTM D4751

- iii. The geotextile shall be free of holes, tears, defects and patch repairs of defects.
- iv. The geotextile shall be labeled, stored, and handled in accordance with ASTM D4873.
- v. The geotextile shall be kept dry and wrapped in waterproof wrapping such that it is protected from UV light and the elements during shipping and storage.
- vi. The geotextile shall be laid smooth and free of tension with a minimum of wrinkles and creases so that the geotextile contact with the underlying soil or geosynthetic is maximized. Geotextile installation shall be performed to the satisfaction of the QP
- vii. During placement, the geotextile may be held in place with sand bags or tires.
- viii. The geotextile panels shall not be placed on wet or muddy surfaces, except where approved to do so by the Engineer.

c. DrainTube

- i. To be placed on crest as drainage layer – or gravel layer equivalent
- ii. The geomembrane surface shall be approved by the QP and DrainTube installation company prior to DrainTube placement
- iii. Care shall be taken not to entrap stone, excessive dust, or moisture in the DrainTube. The Contractor shall not operate equipment directly on the DrainTube. Trimming of the DrainTube should be performed in a manner that will not damage the geomembrane or other underlying materials.
- iv. The DrainTube shall be laid smooth and free of tension with a minimum of wrinkles and creases so that the contact with the underlying geomembrane is maximized. DrainTube installation shall be performed to the satisfaction of the QP.
- v. On slopes, the DrainTube shall be anchored at the top and unrolled down the slope. In the presence of wind, all DrainTube product shall be weighted with sandbags or other material that will not damage the product. Product uplifted by wind may be reused upon approval by the QP.

d. 5-25 mm Clear Crush Drainage Layer

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- i. To be placed on slope as a drainage layer
- ii. The aggregates shall be composed of inert, clean, tough and durable particles capable of withstanding the deleterious effects of exposure to water, freeze-thaw, handling and spreading.
- iii. The aggregate shall be 5-25 mm clear crush gravel with all particles composed of 100% fractured face, falling generally within the specifications outlined below, approved at the discretion of the QP.

5 to 25 mm Clear Crush Gravel

Seive Designation (mm)	Percent Passing (%)		
25	100		100
19	75	-	100
12.5	30	-	75
9.5	20	-	60
4.5	5	-	30
2.5	0	-	2
1.18	0		0

**Table 4: 5-25 mm Sieve
5 to 25 mm Clear Crush Gravel**

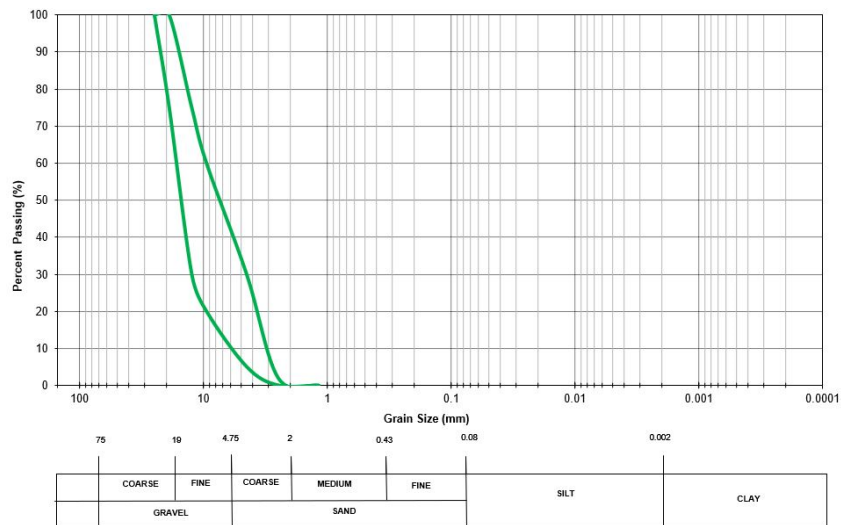


Figure 2: 5-25 mm Gradation Curve

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- iv. The drainage material shall be placed in a manner that does not damage or creep the geotextile layer. Damage to the geotextile layer as a result of placement of the drainage layer will be replaced or repaired at the discretion of the QP at the Contractor's expense.
- v. As with the coarse sand layer, the drainage gravel will be applied on the slope as the soil stabilizing wedge progresses vertically.

3. Cutting & Opening of PEA

- a. The PEA is to be carefully cut open along the alignment of the crest based on direction by the Onsite QP (Sperling Hansen).
- b. Works on the PEA are to be completed in dry weather only. Prior to cutting and opening of the PEA, the weather forecast shall allow for a minimum 3-5 days of minimal precipitation.
- c. Once cut, the liner should be rolled up and placed in a location outside of the working area. This location should be designated by the onsite QP.
- d. No machines shall be permitted to travel over or rest upon the stockpiled liner.
- e. The soil stabilizing wedge shall be constructed prior to the cutting and opening of the PEA to help prevent slippage of the liner.
- f. Should the QP and the Liner Contractor feel additional measures are required to prevent slippage (i.e. tacking the existing liner in place), these will be undertaken at the QP's discretion prior to work commencement.

4. Works during Soil Relocation (Open PEA)

a. Weather

- i. Work on the PEA is to be completed in dry weather only. Prior to cutting and opening of the PEA, the weather forecast shall allow for a minimum 3-5 days of minimal precipitation.
- ii. Should there be a risk of a rain event, temporary tarps should be applied to exposed areas and no "open" activities should take place on the PEA.

b. Soil Relocation

- i. Soil will be carefully loaded into trucks in the SMA and transported to the PEA for final closure.
- ii. Care shall be taken to not overfill trucks with soil so that material is not allowed to spill outside of the vehicle while in transit.
- iii. The loading area will be kept clean to minimize the amount of soil coming into contact with vehicle tires.
- iv. Onsite workers shall ensure that the SMA area be swept of soil that falls out of the trucks onto the asphalt after each loading event such that soil is not tracked away by vehicles.
- v. Access roads should be inspected at least daily for soil that may have spilled during transport.

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- vi. Transport vehicles shall maintain slow to moderate speeds while relocating soil from the SMA to the PEA to minimize dust emissions at the site. Introduction of water as a dust control measure is not recommended.
- vii. Surface water flow controls that will be implemented should there be a risk of a precipitation event include propping up the down-slope edge of the PEA liner (with tires or sandbags, etc.) to ensure the surface water that comes in contact with PEA soils is contained within the liner system and does not run-off over top of the existing liner.
An earthen “bridge road” will be constructed out of clean fill to access the PEA and will comply with restrictions on vehicle travel over top of geosynthetics (as outlined below). This road will provide access for the trucks to discharge soil into the PEA. The road will be decommissioned when all transportation and travel over the PEA has ceased, unless the road has been constructed to comply with crest closure specifications, in which case the road will remain.

Table 5: Minimum Lift Thickness for Working around LLDPE

Minimum Lift Thickness	
Backfill Thickness	Placement Equipment
No Backfill	Foot Traffic or Quad ATV Only
150 mm or less	Hand Placement or Stone Slinger
200 – 300 mm	D3 –D4 LGP Cat
300 mm	Bobcat (Skid-Steer)
300 mm	D4 – D6 LGP Style Cat
600 mm	D7 – D9 Style Cat
900 mm	Loaded Scrapers, Motor Graders
900 – 1200 mm	Loaded Tandem Axle Trucks

- viii. A QP shall inspect the final subgrade surface of the relocated soil to ensure the area is graded to promote positive drainage as per design drawings.

5. Reseal, Repair, Replace liner as necessary

a. Subgrade Preparation (PEA)

- i. Once all soil from the SMA has been relocated to the PEA, the surface shall be prepared to meet the requirements of the Liner Contractor.
- ii. The final soil surface shall be smooth and free of all rocks, stones, sticks, roots and sharp objects. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade. A QP shall inspect the final soil surface to ensure the area is graded as per design drawings.
- iii. The final grades on the PEA crest will be maintained at a minimum 4%, towards the outside slopes.
- iv. In the event that suitable soils are not readily available at the construction site, soils containing smooth rocks up to 1-1/2 inches in diameter or angular

**Quality Management Plan
Cobble Hill Landfill Final Closure Construction**

rocks up to ¾ inches may be utilized if covered with geotextile cushion having a minimum weight of 8 oz/yd². The weight of geotextile selected will depend on the actual soil used, thickness of liner, and service life or design considerations, but may be as high as 16 oz/yd². The proposed design plan includes provisions for a 12 oz geotextile.

b. Geomembrane Installation

- i. Installation / reinstallation of the Geomembrane will be completed by a certified contractor.
- ii. Before the installation begins, the QP shall inspect and certify all geomembrane materials are free from damage during transit or storage. Materials that cannot be repaired, in the QP’s judgment, shall be rejected and removed from the site.
- iii. Materials are to be handled and securely stored so as to prevent damage.
- iv. Materials shall be unrolled in a controlled manner directly into the final position.
- v. The geomembrane shall be kept clean and free of debris during placement.
- vi. The sheet geomembrane shall demonstrate the typical properties shown on the manufacturer’s specification sheet. The geomembrane rolls should meet the following specifications, or engineer approved equivalent:

Table 6: 40 mil LLDPE Geomembrane – Smooth (Solmax)

Property	Value Required	Test Method	Standard
Thickness (mm)	1.0 (40 mil)	ASTM D5994	Nominal
Thickness (mm)	0.90 (36 mil)	ASTM D5994	Minimum
Density g/cm ³	0.939	ASTM D1505	Minimum
Carbon Black Content (%)	2.0 – 3.0	ASTM D1603	Minimum
Tensile Break Strength (ppi)	160	ASTM D6693	Minimum
Tensile Break Elongation (%)	800	ASTM D6693	Minimum
Tear Resistance (lbf)	22	ASTM D1004	Minimum
Puncture Resistance (lbf)	62	ASTM D4833	Minimum
Dimensional Stability (%)	2	ASTM D1204	Maximum

- vii. The geomembranes shall not be allowed to bridge over voids or low areas in the subgrade. The geomembranes shall rest in intimate contact with the subgrade.
- viii. Temporary ballasting such as sand bags or tires shall be placed on the geomembrane to prevent wind damage during and after installation.
- ix. Should existing material be welded to new (surplus) material, the new material should be placed beneath the old material.
- x. The addition of new welds should be at least 1.5 metres from the crest of the top slope.
- xi. Confirmation testing of the integrity of the existing liner shall be completed prior to repair and reinstallation.

**Quality Management Plan
Cobble Hill Landfill Final Closure Construction**

- xii. All required repairs will be completed by the Liner Contractor under QP supervision.

c. Repairs and Testing

- i. The Liner Contractor will complete all repairs to the PEA based on best practices for liner works and in accordance with their QAQC Manual. Appendix B includes the QAQC manual supplied by Western Tank and Liner (proposed Certified Liner Contractor). In general, the following QAQC measures should be followed.
- ii. All welding machines will undergo qualification and testing prior to any welding in the field; appropriate reports and documentation will be included in weekly reporting.
- iii. All pre-weld testing shall be representative of field conditions.
- iv. All repairs that were completed with an extrusion welding machine will be tested with a Vac-Box.
- v. All repairs that were completed with a double wedge seam welding machine will be tested by way of air channel pressure test.
- vi. In the event that a weld of seam fails the required testing, the weld or seam should be marked, recorded, repaired or replaced, and retested.

Final Cover Design

1. Toe Drainage Soak Away Trench

- a. A toe drainage soak-away trench shall be constructed as per design drawings.
- b. Installation of the toe-drainage soak away trench shall be done in a manner that ensures the 1.0 m thick secondary clay basal liner is maintained between the primary basal geomembrane and the trench in order to contain a potential leak from the secondary clay basal liner system.
- c. All excavations shall be in open cut unless otherwise permitted by the QP.
- d. WCB work procedures for safe trenching work shall be strictly followed.
- e. Remove unsuitable material from trench or excavation bottom to extent and depth as directed by Engineer.
- f. Notify Engineer when bottom of excavation is reached and obtain Engineer approval of completed excavation.
- g. Dimensions of the trench shall be maximum 2,000 mm by 1,000 mm (width x depth) and shall be backfilled with clear crush shot-rock.
- h. Do not proceed with backfilling operations until Engineer has inspected and approved installations.

Non-Conforming Items

The QP will be responsible for documenting conditions that deviate from the closure design and preventing non-conformance items from being installed. Minor non-conformance items which are corrected in the same date will be documented in the site inspection report. All other non-conformances are to be documented in a Non-conformance report prepared by the QP sequentially numbered and dated.

The Non-conformance report will include:

- a) Description of the non-conformance including relevant details of the occurrence.
- b) Identification of material, component or system by part number, plan, shop drawing and/or specification number and intended installation location.
- c) Source of material or item (name of supplier, owner or subcontractor).
- d) Current status or item in shop, warehouse, lay-down yard or structure.
- e) Individual and organization which detected the non-conformance.
- f) Recommendation for corrective action including sketches, test data and/or repair procedures necessary to substantiate the recommendation.
- g) Cause of the non-conformance and steps taken to prevent reoccurrence indicating action(s) taken, positions or titles of persons contacted, letters written and/or procedural changes proposed.

The QP will sign and forward the Non-Conformance Report to the appropriate parties. Re-inspection and/or re-testing of the work in question will be completed by the QP and verification of correction will be included in an update to the Non-Conformance Report. Non-Conformance Reports will be included in weekly reporting activities.

Deficiency List

A “punch list” of deficiencies will be maintained throughout the life of the project. The punch list is to be consistently updated. The QP will perform follow-up inspections to ensure deficiencies have been corrected prior to final inspection.

Quality Management Records and Reports

The Cobble Hill Landfill Final Closure Construction project team will maintain records that document assessments performed on the project. Maintaining these records will provide objective evidence and traceability of assessments performed throughout the landfill closure. Example records include but are not limited to: daily inspection reports, QA/QC testing reports, environmental monitoring notes and reports, meeting minutes and weekly status reports.

APPENDICES

APPENDIX A
Liner Warranty



LIMITED WARRANTY

PROJECT:	CP-99-M		
WARRANTOR:	Solmax International Inc		
WARRANTOR ADDRESS:	2801 Boul Marie-Victorin, Varennes, QC, Canada, J3X 1P7		
WARRANTY TERM:	5 years from the Effective Date		
Project Address:	Shawnigan Lake, BC		
Owner:	Allterra Construction Ltd.	Warranty Number:	WTL-19-08-19
Sales Order N°:	108071,	Effective Date:	May 26, 2015
Product(s):	140-7000 LLDPE 40 mil smooth		
Roll Numbers:	5-13669, 5-13691, 5-13692,		

WHEREAS pursuant to the Sales Purchase Order referenced herein (the "Sales Order") between the Warrantor and the buyer identified in the said Sales Order (the "Buyer"), the Buyer purchased the Product for the Project and for which the owner of the Project is the end user/customer of the Product (the "Owner");

WHEREAS the Project was designed exclusively by the Owner and/or its general contractor, professionals (such as engineers, architects, surveyors), subcontractors, land experts, suppliers (collectively the "Owner's Professionals");

WHEREAS the Warrantor is not a design professional nor did the Warrantor participate in the design/conception of the Project;

NOW, THEREFORE, in consideration of the foregoing, and subject to the terms and conditions of this Limited Warranty, the Warrantor hereby represents and warrants to the Owner that as of the date of sale of the Product to the Purchaser for the said Project, the Product conforms to the Warrantor's specifications and that the Product will be free from manufacturing defects which appear during the Warranty Term for the Product's normal use in approved applications (the "Normal Use").

LIMITATIONS AND DISCLAIMERS

THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY, HABITABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE EXPRESSLY EXCLUDED HEREIN. Warrantor's liability hereunder is the sole and exclusive obligation of Warrantor with regard to the Product. Warrantor shall have no liability for any claim except as specified hereunder. Warrantor shall not be liable for labor or any other costs incurred in connection with the use, repair, removal, installation or replacement of any Product covered by this Limited Warranty, or for any direct or indirect damages, labor, removal, installation, incidental or consequential damages, loss of profits or sales, injury to property or any other damages, losses or contingencies due to or arising out of the Product, whether under alleged breach of contract, tort, personal injury, property damage, environmental liability or otherwise, regardless of whether or not the Product is subject to a defect.

The Warrantor shall not be held liable or responsible to the Owner nor be deemed to have defaulted under or breached this Limited Warranty for failure or delay in fulfilling or performing any term of this Limited Warranty when such failure or delay is caused by or results from causes beyond the reasonable control of the Warrantor, including but not limited to fire, floods, embargoes, war, acts of war (whether war is declared or not), insurrections, riots, civil commotions, the existence or administration of any laws, rules or regulations, strikes, lockouts or other labor disturbances, acts of God or acts, omissions or delays in acting by any governmental authority; provided, however, that the Warrantor shall use reasonable commercial efforts to avoid or remove such causes of non-performance, and shall continue performance hereunder with reasonable dispatch whenever such causes are removed. This Limited Warranty does not cover damages or defects resulting from normal wear and tear, faulty installation, maintenance or repair, misuse or negligent use of the Product as well as damages caused by acts of God, natural disasters such as earthquakes, floods, piercing hail, or tornadoes. The term "Normal Use" as used herein does not include usage for which the Product was not designed or intended, faulty design and/or construction of the facility into which the Product is installed, failure to install the Product in compliance with Warrantor's Product technical materials and/or bulletins, or exposure of the Product to harmful chemicals. Chemical resistance performance is the responsibility of the Owner since it has control over and of the Project's production/ design/composition and

exposure conditions (including chemicals, concentration, time and temperature). As such, any proposed product, including the Product, should be thoroughly evaluated for its intended application by the Owner and the Owner's Professionals. Also, the term "Normal Use" as used herein does not include damage to the Product by machinery, equipment, people, animals; improper site preparation or covering materials; existing conditions, including, but not limited to, subsurface conditions beneath the geomembrane such as a settlement of the ground, cave-in, etc., excessive pressures or stresses from any source or improper application. There shall be no intended or incidental third-party beneficiary hereof. In no event shall Warrantor have any liability for any patent defects or discrepancies which were or could have been discovered prior to the installation of the Product.

Subject to the terms and conditions hereof, after receipt of a timely valid claim hereunder, Warrantor will have the right to inspect and determine the cause of any alleged defect in the Product and if coverage is confirmed, then Warrantor shall have the option, in its sole discretion, to repair the affected area of the Product or to ship replacement product reasonably equivalent to the affected area of the Product proven to be subject to the covered defect. Warrantor is not a design professional and has not performed any design services for the Project and disclaims any alleged design liability regarding use of the Product at or for the Project, it being understood that any design was performed exclusively by the Owner or the Owner's Professionals. Warrantor shall not be obligated to perform repairs or replacements under this Limited Warranty until the area to be repaired or replaced is clean, dry and unencumbered, including, without limitation, the area having been made available for repair and/or replacement free from all water, dirt, sludge, residuals and liquids of any kind. If Warrantor determines that a claim is invalid, Owner shall reimburse Warrantor for its inspection and analysis costs.

Notwithstanding any contrary provision hereof, in no event shall any liability of Warrantor hereunder exceed the actual per square foot cost of the Product required to repair or replace (in Warrantor's sole discretion) in the affected area of the Product (the "Liability Limit"); provided however, that Warrantor's Liability Limit hereunder shall, starting on the first (1st) anniversary of the Effective Date, be reduced each year during the Warranty Term by a percentage, the numerator of which is the expired number of years in the Warranty Term prior to Warrantor's receipt of a written notice of claim, and the denominator of which is the Warranty Term.

Any claim for any alleged defect under this Limited Warranty must be made in writing, by certified mail, to Warrantor at the Warrantor's address specified above within ten (10) business days of the Owner becoming aware of the alleged defect. Any failure to timely issue such notice shall void any warranty coverage.

Warrantor makes no representations, expressed or implied, not specified herein. No representative, agent or employee of Warrantor, or any other person, including the Buyer, is authorized to assume for Warrantor any additional liability or responsibility except as described above. In the event any term or provision of this Limited Warranty is inconsistent with or in conflict with any writing, purchase order, representations, statements, contract, or any other document, then, to the extent such inconsistency or conflict exists, the terms and conditions of this Limited Warranty shall control in all respects. The Limited Warranty is valid only for the original Owner and is not assignable or transferable under any circumstances. The terms hereof shall be governed by the laws provided in the contract or Sales Order entered into between the Warrantor and the Buyer and any dispute arising out and in connection with this Limited Warranty shall be settled in accordance with the provisions of the said contract or Sales Order. If it is determined and adjudicated that the exclusive remedy provided herein fails in its essential purpose, then in that event only, Owner shall be entitled to a return of that portion of the purchase price equal to the Liability Limit (as reduced as provided above) for so much of the Product as Warrantor determines to be defective. If any provision of this Limited Warranty is held to be invalid or unenforceable, such provision shall be deemed to be modified to the extent necessary for the balance hereof to be enforceable, and this Limited Warranty shall be enforced to the maximum extent permissible.

NOTWITHSTANDING ANY CONTRARY PROVISION HEREOF, AN EXPRESS CONDITION PRECEDENT TO ANY AND ALL OBLIGATION OF WARRANTOR HEREUNDER SHALL BE WARRANTOR'S TIMELY RECEIPT OF FULL PAYMENT FOR THE PRODUCT.



LIMITED WARRANTY

PROJECT: CP-202-M
WARRANTOR: Solmax International Inc
WARRANTOR ADDRESS: 2801 Boul Marie-Victorin, Varennes, QC, Canada, J3X 1P7
WARRANTY TERM: 5 years from the Effective Date
Project Address: Shawnigan Lake, BC
Owner: Allterra Construction Ltd. **Warranty Number:** WTL-20-08-19
Sales Order N°: 108401, **Effective Date:** September 29, 2015
Product(s): 140-7000 LLDPE 40 mil smooth
Roll Numbers: 2-82148,

WHEREAS pursuant to the Sales Purchase Order referenced herein (the "Sales Order") between the Warrantor and the buyer identified in the said Sales Order (the "Buyer"), the Buyer purchased the Product for the Project and for which the owner of the Project is the end user/customer of the Product (the "Owner");

WHEREAS the Project was designed exclusively by the Owner and/or its general contractor, professionals (such as engineers, architects, surveyors), subcontractors, land experts, suppliers (collectively the "Owner's Professionals");

WHEREAS the Warrantor is not a design professional nor did the Warrantor participate in the design/conception of the Project;

NOW, THEREFORE, in consideration of the foregoing, and subject to the terms and conditions of this Limited Warranty, the Warrantor hereby represents and warrants to the Owner that as of the date of sale of the Product to the Purchaser for the said Project, the Product conforms to the Warrantor's specifications and that the Product will be free from manufacturing defects which appear during the Warranty Term for the Product's normal use in approved applications (the "Normal Use").

LIMITATIONS AND DISCLAIMERS

THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY, HABITABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE EXPRESSLY EXCLUDED HEREIN. Warrantor's liability hereunder is the sole and exclusive obligation of Warrantor with regard to the Product. Warrantor shall have no liability for any claim except as specified hereunder. Warrantor shall not be liable for labor or any other costs incurred in connection with the use, repair, removal, installation or replacement of any Product covered by this Limited Warranty, or for any direct or indirect damages, labor, removal, installation, incidental or consequential damages, loss of profits or sales, injury to property or any other damages, losses or contingencies due to or arising out of the Product, whether under alleged breach of contract, tort, personal injury, property damage, environmental liability or otherwise, regardless of whether or not the Product is subject to a defect.

The Warrantor shall not be held liable or responsible to the Owner nor be deemed to have defaulted under or breached this Limited Warranty for failure or delay in fulfilling or performing any term of this Limited Warranty when such failure or delay is caused by or results from causes beyond the reasonable control of the Warrantor, including but not limited to fire, floods, embargoes, war, acts of war (whether war is declared or not), insurrections, riots, civil commotions, the existence or administration of any laws, rules or regulations, strikes, lockouts or other labor disturbances, acts of God or acts, omissions or delays in acting by any governmental authority; provided, however, that the Warrantor shall use reasonable commercial efforts to avoid or remove such causes of non-performance, and shall continue performance hereunder with reasonable dispatch whenever such causes are removed. This Limited Warranty does not cover damages or defects resulting from normal wear and tear, faulty installation, maintenance or repair, misuse or negligent use of the Product as well as damages caused by acts of God, natural disasters such as earthquakes, floods, piercing hail, or tornadoes. The term "Normal Use" as used herein does not include usage for which the Product was not designed or intended, faulty design and/or construction of the facility into which the Product is installed, failure to install the Product in compliance with Warrantor's Product technical materials and/or bulletins, or exposure of the Product to harmful chemicals. Chemical resistance performance is the responsibility of the Owner since it has control over and of the Project's production/ design/composition and

exposure conditions (including chemicals, concentration, time and temperature). As such, any proposed product, including the Product, should be thoroughly evaluated for its intended application by the Owner and the Owner's Professionals. Also, the term "Normal Use" as used herein does not include damage to the Product by machinery, equipment, people, animals; improper site preparation or covering materials; existing conditions, including, but not limited to, subsurface conditions beneath the geomembrane such as a settlement of the ground, cave-in, etc., excessive pressures or stresses from any source or improper application. There shall be no intended or incidental third-party beneficiary hereof. In no event shall Warrantor have any liability for any patent defects or discrepancies which were or could have been discovered prior to the installation of the Product.

Subject to the terms and conditions hereof, after receipt of a timely valid claim hereunder, Warrantor will have the right to inspect and determine the cause of any alleged defect in the Product and if coverage is confirmed, then Warrantor shall have the option, in its sole discretion, to repair the affected area of the Product or to ship replacement product reasonably equivalent to the affected area of the Product proven to be subject to the covered defect. Warrantor is not a design professional and has not performed any design services for the Project and disclaims any alleged design liability regarding use of the Product at or for the Project, it being understood that any design was performed exclusively by the Owner or the Owner's Professionals. Warrantor shall not be obligated to perform repairs or replacements under this Limited Warranty until the area to be repaired or replaced is clean, dry and unencumbered, including, without limitation, the area having been made available for repair and/or replacement free from all water, dirt, sludge, residuals and liquids of any kind. If Warrantor determines that a claim is invalid, Owner shall reimburse Warrantor for its inspection and analysis costs.

Notwithstanding any contrary provision hereof, in no event shall any liability of Warrantor hereunder exceed the actual per square foot cost of the Product required to repair or replace (in Warrantor's sole discretion) in the affected area of the Product (the "Liability Limit"); provided however, that Warrantor's Liability Limit hereunder shall, starting on the first (1st) anniversary of the Effective Date, be reduced each year during the Warranty Term by a percentage, the numerator of which is the expired number of years in the Warranty Term prior to Warrantor's receipt of a written notice of claim, and the denominator of which is the Warranty Term.

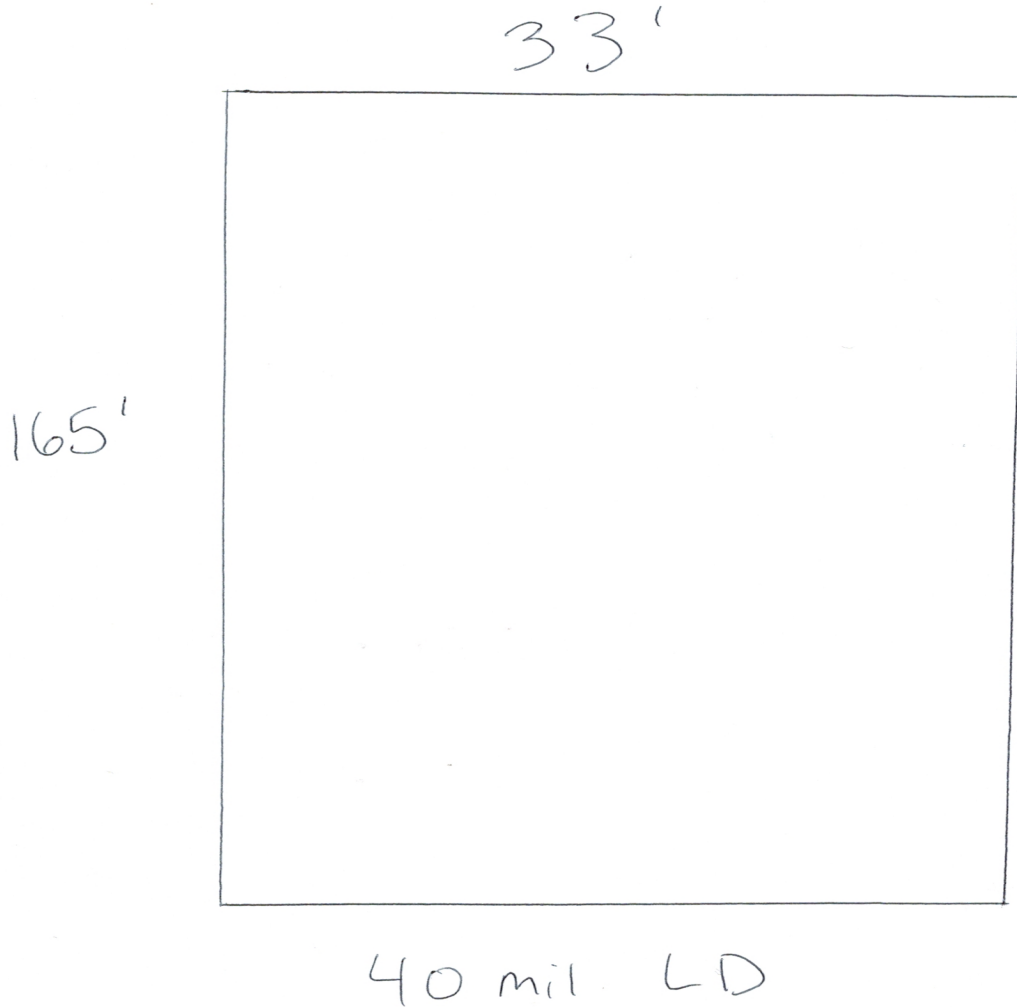
Any claim for any alleged defect under this Limited Warranty must be made in writing, by certified mail, to Warrantor at the Warrantor's address specified above within ten (10) business days of the Owner becoming aware of the alleged defect. Any failure to timely issue such notice shall void any warranty coverage.

Warrantor makes no representations, expressed or implied, not specified herein. No representative, agent or employee of Warrantor, or any other person, including the Buyer, is authorized to assume for Warrantor any additional liability or responsibility except as described above. In the event any term or provision of this Limited Warranty is inconsistent with or in conflict with any writing, purchase order, representations, statements, contract, or any other document, then, to the extent such inconsistency or conflict exists, the terms and conditions of this Limited Warranty shall control in all respects. The Limited Warranty is valid only for the original Owner and is not assignable or transferable under any circumstances. The terms hereof shall be governed by the laws provided in the contract or Sales Order entered into between the Warrantor and the Buyer and any dispute arising out and in connection with this Limited Warranty shall be settled in accordance with the provisions of the said contract or Sales Order. If it is determined and adjudicated that the exclusive remedy provided herein fails in its essential purpose, then in that event only, Owner shall be entitled to a return of that portion of the purchase price equal to the Liability Limit (as reduced as provided above) for so much of the Product as Warrantor determines to be defective. If any provision of this Limited Warranty is held to be invalid or unenforceable, such provision shall be deemed to be modified to the extent necessary for the balance hereof to be enforceable, and this Limited Warranty shall be enforced to the maximum extent permissible.

NOTWITHSTANDING ANY CONTRARY PROVISION HEREOF, AN EXPRESS CONDITION PRECEDENT TO ANY AND ALL OBLIGATION OF WARRANTOR HEREUNDER SHALL BE WARRANTOR'S TIMELY RECEIPT OF FULL PAYMENT FOR THE PRODUCT.



Alterra Construction
40 mil LLDPE
Liner #1



VANCOUVER:
CALGARY:

12180 Vickers Way, Richmond, BC V6V 1H9T: 604-241-9487 F: 604-241-9485
105 Stockton Pt., Okotoks, AB T1S 1A5 T: 403-938-4361 F: 403-938-4371

1-800-551-4355

Liner Quality Control Audit

Inspector **GINA** Crew _____ Date **29/09/2015**

Work Order # **WO-000804** Size / Style Length **165** Width **33** Style **LNR**

PO# **CP-202-M** Customer **Allterra Construction** Liner # **1**

Width Calculator (enter for size ordered) Sizes are expressed in Decimal feet

Liner Length (feet)	Liner width (Feet)	Roll Width (Inches)	Weld Width overlap (Inches)	Calculated Panels Needed	Even Panel no. (rounded up)	Total Width of Even Panels (Feet)	Actual Panel Count, added or subtracted material width ex: 8 panels + 2', +2' or 9 panels -11' (welds subtracted shown in actual width)
165	33	267	6	1.517241	2	44	2 PANELS -11'

1st panel length verification size/persons **165'6"** Finished Length **165.5** Actual Width **33**

Stepped Panel lengths **NA**

Step inset **NA**

Secondary measurements (cut welds) **NA**

Cross welds: **NONE** Inspected by: **GINA**

Seam lip pull checks (non-destructive) **GOOD. 5**

Special Instructions **BUTTERFLY FOLD**

Material **40 MIL LLDPE SOLMAX** Color Out **BLACK**

Rolling	Folding
Standard Roll <input type="checkbox"/>	Standard Fan <input type="checkbox"/>
Standard Roll with Webbing <input checked="" type="checkbox"/>	Butterfly Fold <input checked="" type="checkbox"/>
Scroll Rolled center mark W/Webbing <input type="checkbox"/>	Fan Fold to center 2" web markers <input type="checkbox"/>

Core Type Used: Metal Cardboard Other

(Standard = mil, size, unroll and unfold arrow)

Standard Information Written on Item Other:

Packaging Wrap/ Color : Standard Liner Other:
refer to E.I.C for standards

Standard Package Labeling Other:
refer to E.I.C for standards

Notes

Wedge/Extrusion Trial



12180 Vickers Way
Richmond BC V6V-1H9

Office 604.241.9487 Fax 604.241.9485

Toll-Free 1.800.551.4355

Customer: **Allterra Construction** PO # **CP-202-M**

Production Date: **29/09/2015** Time: **10:00 PM**

QA Test Person: **GINA** W./O. **WO-000804**

Welding Tech: **PAUL** Crew: **SHELDON/PAUL**

Welder Qualification For Liners: **#1** Time Ending:

size expressed in decimal feet

Material Type: **Solmax 40 mil LLDPE 140-7000/K7104** Liner Size:

Length	Width	Style
165	33	LRN

Welder Number: **D11**
 Welder Set Temp: **800**
 Welder Set Speed: **999** *Timed FPM* **22**
 Extrusion Rod: **NA**

Outside Temp: **59**
 Inside Temp: **59**
 Sheet Temp: **59**
 Welder Set up with bar Y/N **N**

Peel Data

	Inside (Lbs)	Outside (Lbs)	Failure Type	Seperation (%)	Comments
1	66	62	SE1	0	PASS
2	71	63	SE1	0	PASS
3	69	66	SE1	0	PASS
4	67	62	SE1	0	PASS
5	70	64	SE1	0	PASS

Shear Data

	Shear (Lbs)	Elongation (%)	Comments
1	62	200+%	PASS/STE
2	66	200+%	PASS/STE
3	67	200+%	PASS/STE
4	66	200+%	PASS/STE
5	73	200+%	PASS/STE

Notes: Tear Back Results on Sample Weld: **GOOD 5**

STE = sample stretch to end of test

SE1 = sample break in outer edge of seam

SE2= break at seam edge top sheet (extrusion shear only)

SE3= break at seam edge in bottom sheet (extrusion peel only)

Seam End Coupon Log



12180 Vickers Way
 Richmond Bc V6V-1H9
 Office 604.241.9487 Fax 604.241.9485
 Toll-Free 1.800.551.4355

Customer: Allterra Construction PO# CP-202-M

Production Date: 29/09/2015 Crew: SHELDON/PAUL

Welder Settings

Welder # D11 Operator PAUL Temp/Speed 800-999

Timed welder speed

Distance in feet 16.5 Timed Sec. 46 Feet per min. 22

QA Test Person: GINA W./O. WO-000804

Material Type: SOLMAX 40 MIL LLDPE

size in dec. ft. Length 165 Width 33 Style LNR Liner # #1

Seam Number	Test # P# / S#	Inside (Lbs)	Outside (Lbs)	Failure Type	Separation (%)	Shear (Lbs)	Elongation (%)	Comments
W1	P1/S1	70	63	SE1	0	62	200+	PASS/STE
W1	P2/S2	70	64	SE1	0	68	200+	PASS/STE

Notes: _____

STE = sample stretch to end of test SE1 = sample break in outer edge of seam Pull Checks (non-destructive seam lip pulls)



SOLMAX

LIST OF GEOMEMBRANE ROLLS

Solmax, 2801 Boul. Marie-Victorin, Varennes, Qc, Canada, J3X 1P7
Tél.: 1-450-929-1234 • Fax.: 1-450-929-2547 • www.solmax.com



Project Name : July - Abbotsford, BC

Reference Number : 108401

Project Number : CP-SML15-6

Packing Slip Number : 217375

Roll Number	Product Code	Resin Lot Number	Manufactured Date	Resin Melt Index	Resin Density	OIT	HPOIT	ESCR SP-NCTL
				190/2.16 g/10 min D1238	g/cc D1505	Spec Result min D3895	Spec Result min D5885	Spec Roll Tested hours D5397
2-82141	Solmax 140-7000	CFD810080	11-Jul-15	0.37	0.918	100 > 120		N/A
2-82143	Solmax 140-7000	CFD810080	11-Jul-15	0.37	0.918	100 > 120		N/A
2-82148	Solmax 140-7000	CFD810080	11-Jul-15	0.37	0.918	100 > 120		N/A
2-82149	Solmax 140-7000	CFD810080	11-Jul-15	0.37	0.918	100 > 120		N/A
2-82150	Solmax 140-7000	CFD810080	11-Jul-15	0.37	0.918	100 > 120		N/A
2-82151	Solmax 140-7000	CFD810080	11-Jul-15	0.37	0.918	100 > 120		N/A
2-82152	Solmax 140-7000	CFD810080	11-Jul-15	0.37	0.918	100 > 120		N/A
2-82154	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82157	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82159	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82160	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82161	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82162	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82163	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82164	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A
2-82165	Solmax 140-7000	CFD810080	12-Jul-15	0.37	0.918	100 > 120		N/A

Quantity (rolls) : **16**

Project Name : July - Abbotsford, BC

Reference Number : 108401

Project Number : CP-SML15-6

Packing Slip Number : 217375



Product : Solmax 140-7000

Properties	Thickness average	Geo-membrane Density	Carbon Black Content	Carbon Black Dispersion	Tensile				Tear Resist.	Puncture Resist.	Dimension. Stability	Asperity Height in / out
					Yield Strength	Elong.	Break Strength	Break Elong.				
Unit	mm	g/cc	%	Cat. 1 and 2	kN/m	%	kN/m	%	N	N	%	mm
Test Method	D5199	D1505/D792	D4218 / D1603	D5596	D6693				D1004	D4833	D1204	
Frequency	Each roll	1/Lot	1/2 ro	1/10 ro	1/5 ro				1/10 ro	1/10 ro	Cert	N/A
Specification	0.90	≤ 0.939	2.0 - 3.0	Cat. 1 / Cat. 2			31.5	1000	85	298	± 2	
2-82141 MD XD	0.94	0.927	2.60	10/10 Views			39.1 37.3	1224 1260	98 106	351		/
2-82143 MD XD	0.92	0.932	2.55	10/10 Views			38.0 35.9	1225 1250	91 100	351		/
2-82148 MD XD	0.93	0.932	2.58	10/10 Views			37.0 35.6	1200 1176	91 100	351		/
2-82149 MD XD	0.93	0.932	2.58	10/10 Views			37.0 35.6	1200 1176	91 100	351		/
2-82150 MD XD	0.93	0.932	2.79	10/10 Views			37.0 35.6	1200 1176	91 100	351		/
2-82151 MD XD	0.94	0.932	2.79	10/10 Views			37.0 35.6	1200 1176	91 100	351		/
2-82152 MD XD	0.94	0.932	2.62	10/10 Views			38.2 36.3	1199 1244	96 105	360		/
2-82154 MD XD	0.93	0.932	2.61	10/10 Views			38.2 36.4	1199 1244	96 105	359		/
2-82157 MD XD	0.93	0.932	2.61	10/10 Views			39.6 36.5	1256 1276	96 105	359		/
2-82159 MD XD	0.93	0.932	2.56	10/10 Views			39.6 36.6	1256 1276	96 105	359		/
2-82160 MD XD	0.93	0.932	2.66	10/10 Views			39.6 36.6	1256 1276	96 105	359		/
2-82161 MD XD	0.93	0.932	2.66	10/10 Views			39.6 36.6	1256 1276	96 105	359		/
2-82162 MD XD	0.93	0.933	2.59	10/10 Views			38.4 36.1	1257 1265	94 103	359		/
2-82163 MD XD	0.94	0.933	2.59	10/10 Views			38.5 36.1	1257 1265	94 103	359		/
2-82164 MD XD	0.93	0.933	2.56	10/10 Views			38.5 36.1	1257 1265	94 103	359		/
2-82165 MD XD	0.93	0.933	2.56	10/10 Views			38.5 36.1	1257 1265	94 103	359		/

PROPERTY	TEST METHOD	FREQUENCY ⁽¹⁾	UNIT Metric	Solmax 140-7000
SPECIFICATIONS				
Thickness (Nominal ±10%) (11)	ASTM D-5199	Every roll	mm	1.00
Resin Density	ASTM D-1505	Certification	g/cc	< 0.926
Melt Index - 190/2.16 (max.)	ASTM D-1238	Certification	g/10 min	1.0
Sheet Density (8)	ASTM D-1505	1/Batch	g/cc	≤ 0.939
Carbon Black Content (9)	ASTM D-4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D-5596	Every 10 rolls	Category	Cat. 1 / Cat. 2
OIT - standard (avg.)	ASTM D-3895	1/Batch	min	100
Tensile Properties (min. avg) (2)	ASTM D-638	Every 5 rolls		
Strength at Break			kN/m	31.5
Elongation at Break			%	1000
2% Modulus (max.)	ASTM D-5323	Per formulation	kN/m	420
Tear Resistance (min. avg.)	ASTM D-1004	Every 10 rolls	N	85
Puncture Resistance (min. avg.)	ASTM D-4833	Every 10 rolls	N	298
Dimensional Stability	ASTM D-1204	Certification	%	± 2
Multi-Axial Tensile (min. avg.)	ASTM D-5617	Per formulation	%	90
Oven Aging - % retained after 90 days	ASTM D-5721	Per formulation		
STD OIT (min. avg.)	ASTM D-3895		%	35
HP OIT (min. avg.)	ASTM D-5885		%	60
UV Resistance - % retained after 1600 hr	GRI-GM-11	Per formulation		
HP-OIT (min. avg.)	ASTM D-5885		%	35
SUPPLY SPECIFICATIONS (Roll dimensions may vary ±1%)				
Roll Dimension - Width	-		m	6.80
Roll Dimension - Length	-		m	237.7
Area (Surface/Roll)	-		m ²	1616.4

NOTES

1. Testing frequency based on standard roll dimensions and one batch is approximately 180,000 lbs (or one railcar).
2. Elongation is measured with a gage length of 1.5".
8. Correlation table is available for ASTM D792 vs ASTM D1505. Both methods give the same results.
9. Correlation table is available for ASTM D1603 vs ASTM D4218. Both methods give the same results.
11. The minimum average thickness is ± 10% of the nominal value.

* 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 of 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.

***MATERIAL CONFORMITY CERTIFICATE
ISSUED BY
THE MANUFACTURER***

Varenes, October 16th, 2014

Ref.: Stock Material
ATTN: Mr. Clint Powell

To whom it may concern,

Solmax International hereby certifies that 130-2000 and 140-7000 smooth LLDPE geomembrane supplied for the above-mentioned project meets the following:

- Axi-Symmetric Break Resistance Strain (min) ASTM D5617 90 %

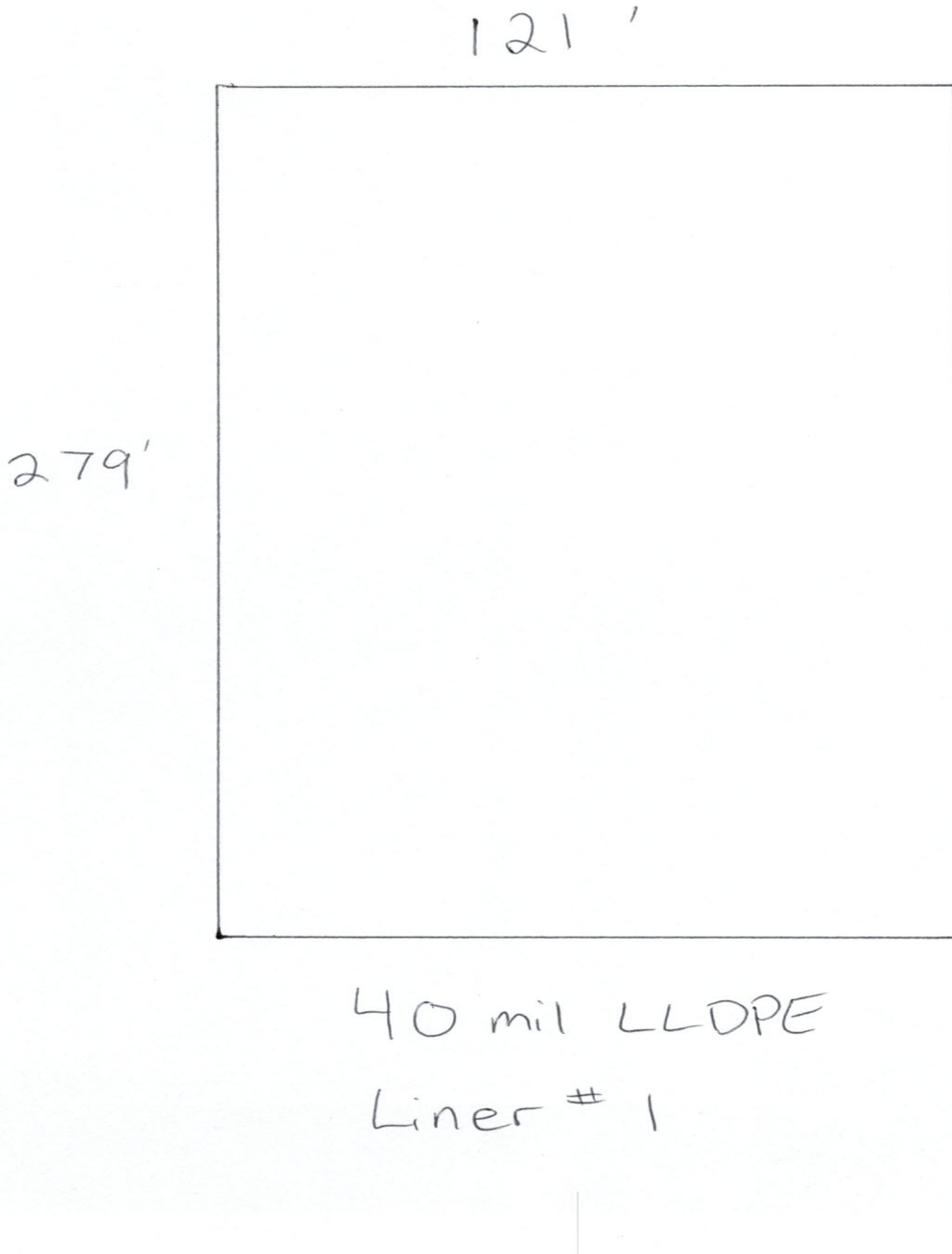
Hoping the above information is satisfactory. Do not hesitate to contact us if you require any additional information.

Sincerely,

Chantal Gagnon
Technical Services
Solmax International Inc.



Allterra Construction Ltd.
40mil LLDPE
Liner #1



VANCOUVER:
CALGARY:

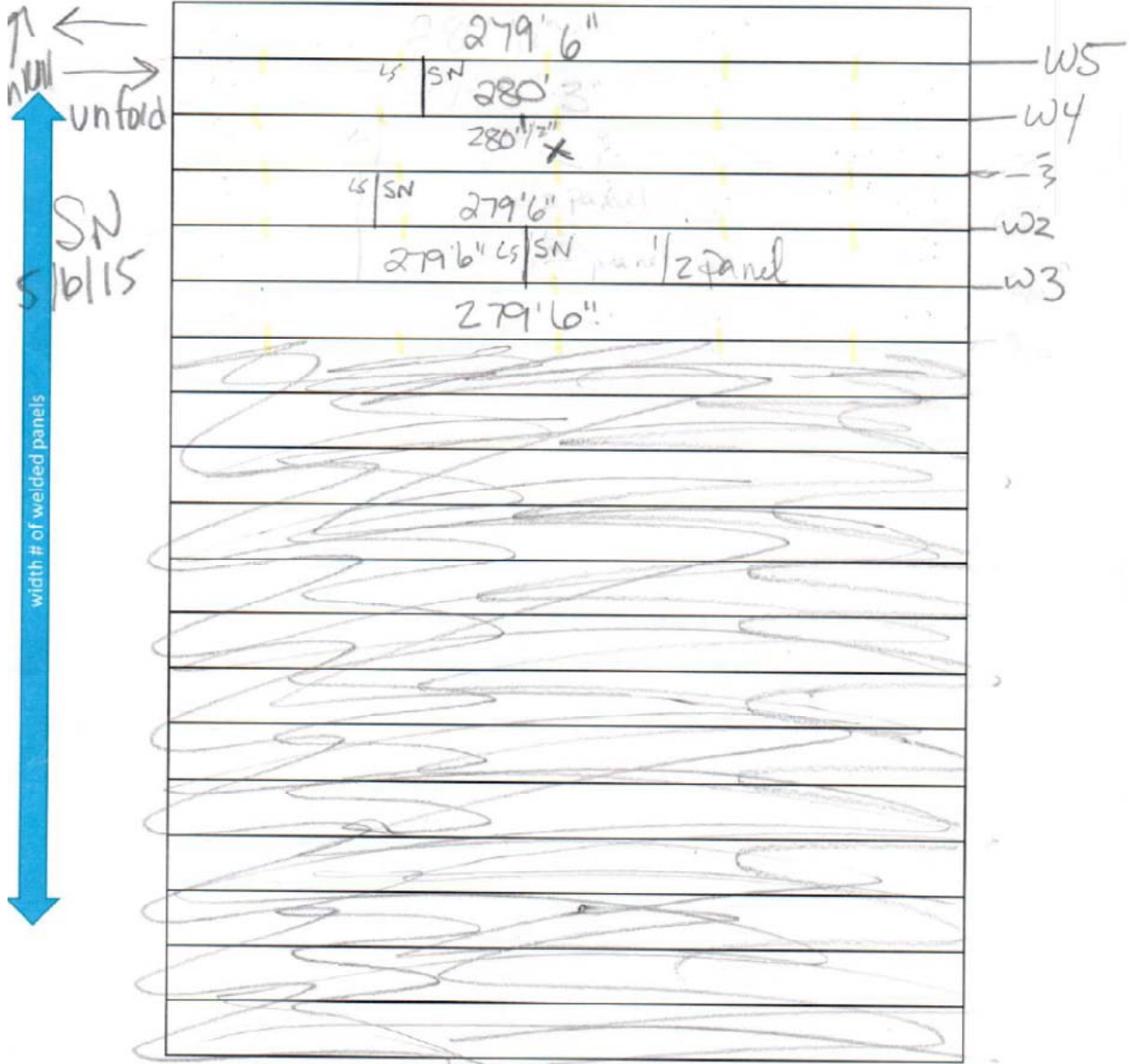
12180 Vickers Way, Richmond, BC V6V 1H9T: 604-241-9487 F: 604-241-9485
105 Stockton Pt., Okotoks, AB T1S 1A5 T: 403-938-4361 F: 403-938-4371

1-800-551-4355

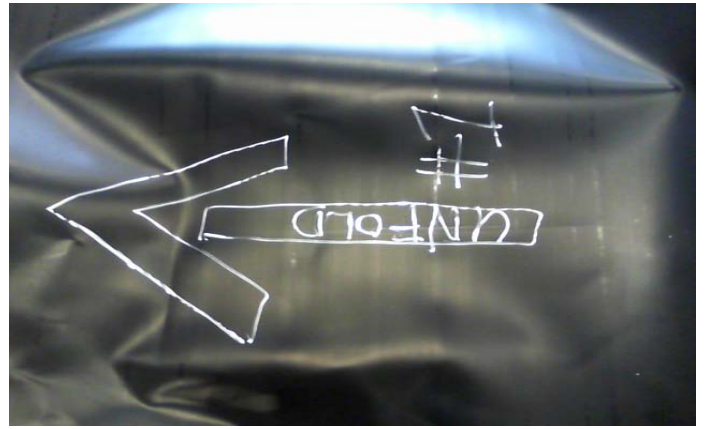
w/o LIS-042276 Size 279' x 121' Material 40m LLDPE

Customer Western Tank CP-99-m Liner Number #1

Material Width 22.3 Panel count 5.5 panels



#1



Liner Quality Control Audit

Inspector **SARA** Crew **PAUL/LENON/FREDDY/DAY CREW** Date **06/05/2015**

Work Order # **L15-042276** Size / Style **279** **121** **RECTANGLE LINER**

PO# **CP-99-M** Customer **Alterra Construction** Liner # **#1**

Width Calculator (enter for size ordered)

Liner Length (feet)	Liner width (Feet)	Roll Width (Inches)	Weld Width overlap (Inches)	Calculated Panels Needed	Even Panel no. (rounded up)	Total Width of Even Panels (Feet)	Actual add/subtract	Actual Panel Count
279	121	267	6	5.563218	6	131	-11'	5.5

1st panel length verification size/persons **280' 1/2" SN** Finished Length **279.5** Actual Width **120.125**

Stepped Panel lengths **N/A**

Step inset **N/A**

Secondary measurements (cut welds) **NO CUT WELD, 1 EXTRUSION WELD AT W1, 2 EXTRUSION WELDS AT W2, 1 EXTRUSION WELD AT W3, W4 AND W5**
5 PANELS AT 22.3' AND 1 PANELS PULLED 142'X22.3' THEN CUT IN HALF TO MAKE A PANEL 279' 6" X11' 1.5"
TEAR BACK TEST PERFORMED 20' FROM BEGINNING, MID CENTER, CENTER, MID CENTER, 20' FROM END

Special Instructions **MARKED CENTER WITH X, DEPLOYMENT ARROW, MARKED #1**

Material **Solmax 40 mil LLDPE 140-7000/K7104** Color Out **BLACK**

Rolling	Folding
Standard Roll <input type="checkbox"/>	Standard Fan <input type="checkbox"/>
Standard Roll with Webbing <input checked="" type="checkbox"/>	Butterfly Fold <input checked="" type="checkbox"/>
Scroll Rolled center mark W/Webbing <input type="checkbox"/>	Fan Fold to center 2" web markers <input type="checkbox"/>
Core Type Used: Metal <input checked="" type="checkbox"/>	Cardboard <input type="checkbox"/>
	Other <input type="checkbox"/>

(Standard = mil, size, unroll and unfold arrow)

Standard Information Written on Item Other: **MARKED #1**

Packaging Wrap/ Color : Standard Liner Other: **1.5X FELT, LLDPE, 5X 12 MIL B GRADE**

Standard Package Labeling Other: **ITL AND WTL LABELS**

Notes

Wedge/Extrusion Trial



WESTERN TANK & LINING LTD.

12180 Vickers Way
Richmond BC V6V-1H9

Office 604.241.9487 Fax 604.241.9485

Toll-Free 1.800.551.4355

Customer: **Allterra Construction** PO # **CP-99-M**

Production Date: **05/05/2015** Time: **4:45PM**

QA Test Person: **SARA** W./O. **L15-042276**

Welding Tech: **PAUL** Crew: **PAUL/LENIN/FREDDY**

Welder Qualification For Liners: **#1** Time Ending:

Material Type:	Length	Width	Style
Solmax 40 mil LLDPE 140-7000/K7104	279	121	RECTANGLE LINER

Welder Number:	D4	Outside Temp:	61
Welder Set Temp:	840	Inside Temp:	60
Welder Set Speed:	899 <i>Timed FPM</i> 16	Sheet Temp:	61
Extrusion Rod:	N/A	Welder Set up with bar Y/N	N

Peel Data

	Inside (Lbs)	Outside (Lbs)	Failure Type	Seperation (%)	Comments
1	68	65	SE1	0	PASS
2	65	64	SE1	0	PASS
3	67	65	SE1	0	PASS
4	65	62	SE1	0	PASS
5	68	65	SE1	0	PASS

Shear Data

	Shear (Lbs)	Elongation (%)	Comments
1	73	200+%	PASS/STE
2	71	200+%	PASS/STE
3			
4			
5			

Notes: _____

STE = sample stretch to end of test

SE1 = sample break in outer edge of seam

SE2= break at seam edge top sheet (extrusion shear only)

SE3= break at seam edge in bottom sheet (extrusion peel only)

Wedge/Extrusion Trial



12180 Vickers Way
Richmond BC V6V-1H9

Office 604.241.9487 Fax 604.241.9485

Toll-Free 1.800.551.4355

Customer: **Allterra Construction** PO # **CP-99-M**

Production Date: **06/05/2015** Time: **5:30AM**

QA Test Person: **SARA** W./O. **L15-042276**

Welding Tech: **PAUL** Crew: **PAUL/LENIN/FREDDY**

Welder Qualification For Liners: **#1** Time Ending:

Material Type:	Length	Width	Style
Solmax 40 mil LLDPE 140-7000/K7104	279	121	RECTANGLE LINER

Welder Number:	D4	Outside Temp:	42
Welder Set Temp:	860	Inside Temp:	50
Welder Set Speed:	999 <i>Timed FPM</i> 17	Sheet Temp:	42
Extrusion Rod:	N/A	Welder Set up with bar Y/N	N

Peel Data

	Inside (Lbs)	Outside (Lbs)	Failure Type	Seperation (%)	Comments
1	69	71	SE1	0	PASS
2	69	70	SE1	0	PASS
3	69	69	SE1	0	PASS
4	68	69	SE1	0	PASS
5	66	69	SE1	0	PASS

Shear Data

	Shear (Lbs)	Elongation (%)	Comments
1	71	200+%	PASS/STE
2	70	200+%	PASS/STE
3			
4			
5			

Notes: _____

STE = sample stretch to end of test

SE1 = sample break in outer edge of seam

SE2= break at seam edge top sheet (extrusion shear only)

SE3= break at seam edge in bottom sheet (extrusion peel only)

Wedge/Extrusion Trial



12180 Vickers Way
Richmond BC V6V-1H9

Office 604.241.9487 Fax 604.241.9485

Toll-Free 1.800.551.4355

Customer: **Allterra Construction** PO # **CP-99-M**

Production Date: **06/05/2015** Time: **5:45AM**

QA Test Person: **SARA** W./O. **L15-042276**

Welding Tech: **LENIN** Crew: **PAUL/LENIN/FREDDY**

Welder Qualification For Liners: **#1** Time Ending:

		Length	Width	Style	
Material Type:	Solmax 40 mil LLDPE 140-7000/K7104	Liner Size:	279	121	RECTANGLE LINER

Welder Number:	EXTRUSION	Outside Temp:	42
Welder Set Temp:	400PREHEAT/440 PLASTIC HEAT	Inside Temp:	50
Welder Set Speed:	HAND Timed FPM N/A	Sheet Temp:	42
Extrusion Rod:	SOLMAX LL	Welder Set up with bar Y/N	N/A

Peel Data

	Inside (Lbs)	Outside (Lbs)	Failure Type	Seperation (%)	Comments
1	73	X	SE3	0	PASS
2	68	X	SE3	0	PASS
3	72	X	SE3	0	PASS
4	68	X	SE3	0	PASS
5	68	X	SE3	0	PASS

Shear Data

	Shear (Lbs)	Elongation (%)	Comments
1	75	200+%	PASS/STE
2	73	200+%	PASS/STE
3	75	200+%	PASS/STE
4	72	200+%	PASS/STE
5	73	200+%	PASS/STE

Notes: _____

STE = sample stretch to end of test
 SE1 = sample break in outer edge of seam
 SE2= break at seam edge top sheet (extrusion shear only)
 SE3= break at seam edge in bottom sheet (extrusion peel only)

Seam End Coupon Log



12180 Vickers Way
 Richmond Bc V6V-1H9
 Office 604.241.9487 Fax 604.241.9485
 Toll-Free 1.800.551.4355

Customer:		Allterra Construction	PO#	CP-99-M	
Production Date:		05/05/2015	Shift:	DAY	
<i>Welder Settings</i>					
Welder #	D4	Operator	PAUL	Temp/Speed	860/999
<i>Timed welder speed</i>					
Distance in feet	34	Timed Sec.	122	Feet per min.	17
QA Test Person:		SARA	W./O.	L15-042276	
Material Type:		Solmax 40 mil LLDPE 140-7000/K7104			
<i>Liner Size</i>					
		<i>Length</i>	<i>Width</i>	<i>Style</i>	
Liner Size:	279	121	RECTANGLE LINER	Liner #	#1

Seam Number	Test # P# / S#	Inside (Lbs)	Outside (Lbs)	Failure Type	Seperation (%)	Shear (Lbs)	Elongation (%)	Comments
W1	P1/S1	71	72	SE1	0	77	200+	PASS/STE
W1	P2/S2	72	69	SE1	0	72	200+	PASS/STE
W2	P1/S1	69	68	SE1	0	75	200+	PASS/STE
W2	P2/S2	65	69	SE1	0	72	200+	PASS/STE
W3	P1/S1	70	70	SE1	0	75	200+	PASS/STE
W3	P2/S2	67	66	SE1	0	74	200+	PASS/STE
W4	P1/S1	67	70	SE1	0	74	200+	PASS/STE
W4	P2/S2	65	63	SE1	0	69	200+	PASS/STE
W5	P1/S1	68	67	SE1	0	72	200+	PASS/STE
W5	P2/S2	66	69	SE1	0	73	200+	PASS/STE

Notes: 1 EXTRUSION WELD AT W1, 2 EXTRUSION WELDS AT W2, 1 EXTRUSION WELD AT W3, W4 AND W5



**WESTERN TANK
& LINING LTD.**

ASTM D 5199 MATERIAL THICKNESS LLDPE

12180 Vickers Way
Richmond BC V6V-1H9

Office 604.241.9487 Fax 604.241.9485

Toll-Free 1.800.551.4355

Date MFG date	Mil Mfg	Roll ID #	Roll Width	sample area	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Avg.	QA
5/5/2015 9/14/2014	Solmax 40 mil LLDPE 140-7000/K7104	5-13692	22.3	PARTIAL	37.7	37.5	37.2	37.2	37.2	37.9	37.4	37.2	37.9	37.4	37.46	SARA
5/6/2015 3/13/2015	Solmax 40 mil LLDPE 140-7000/K7104	5-13669	22.3	BEGIN	36	36.7	37	37.6	37.4	40.5	37.3	36.7	38.1	38.1	37.54	SARA
5/6/2015 3/14/2015	Solmax 40 mil LLDPE 140-7000/K7104	5-13691	22.3	BEGIN	35.7	38.6	38.7	38.7	39.2	39.9	39.7	39.8	39.1	37.3	38.67	SARA



SOLMAX

LIST OF GEOMEMBRANE ROLLS

Solmax, 2801 Boul. Marie-Victorin, Varennes, Qc, Canada, J3X 1P7
Tél.: 1-450-929-1234 • Fax.: 1-450-929-2547 • www.solmax.com



Project Name : Abbotsford, BC

Reference Number : 108071

Project Number : CP-SML15-4

Packing Slip Number : 216764

Roll Number	Product Code	Resin Lot Number	Manufactured Date	Resin Melt Index 190/2.16 g/10 min D1238	Resin Density g/cc D1505	OIT Spec Result min D3895	HPOIT Spec Result min D5885	ESCR SP-NCTL Spec Roll Tested hours D5397
5-13668	Solmax 140-7000	CFB810520	13-Mar-15	0.36	0.919	100 > 120		N/A
5-13669	Solmax 140-7000	CFB810520	13-Mar-15	0.36	0.919	100 > 120		N/A
5-13670	Solmax 140-7000	CFB810520	13-Mar-15	0.36	0.919	100 > 120		N/A
5-13671	Solmax 140-7000	CFB810520	13-Mar-15	0.36	0.919	100 > 120		N/A
5-13672	Solmax 140-7000	CFB810520	13-Mar-15	0.36	0.919	100 > 120		N/A
5-13673	Solmax 140-7000	CFB810520	13-Mar-15	0.36	0.919	100 > 120		N/A
5-13674	Solmax 140-7000	CFB810520	13-Mar-15	0.36	0.919	100 > 120		N/A
5-13680	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13681	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13684	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13687	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13688	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13689	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13690	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13691	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A
5-13692	Solmax 140-7000	CFB810520	14-Mar-15	0.36	0.919	100 > 120		N/A

Quantity (rolls) : **16**

Project Name : Abbotsford, BC

Reference Number : 108071

Project Number : CP-SML15-4

Packing Slip Number : 216764



Product : Solmax 140-7000

Properties	Thickness average	Geo-membrane Density	Carbon Black Content	Carbon Black Dispersion	Tensile				Tear Resist.	Puncture Resist.	Dimension. Stability	Asperity Height in / out
					Yield Strength	Elong.	Break Strength	Break Elong.				
Unit	mm	g/cc	%	Cat. 1 and 2	kN/m	%	kN/m	%	N	N	%	mm
Test Method	D5199	D1505/D792	D4218 / D1603	D5596	D6693				D1004	D4833	D1204	
Frequency	Each roll	1/Lot	1/2 ro	1/10 ro	1/5 ro				1/10 ro	1/10 ro	Cert	N/A
Specification	0.90	≤ 0.939	2.0 - 3.0	Cat. 1 / Cat. 2			31.5	1000	85	298	± 2	
5-13668 MD XD	0.92	0.931	2.49	10/10 Views			34.1 34.9	1021 1152	94 104	354		/
5-13669 MD XD	0.92	0.931	2.53	10/10 Views			34.1 34.9	1021 1152	94 104	354		/
5-13670 MD XD	0.93	0.931	2.53	10/10 Views			34.1 34.9	1021 1152	94 104	354		/
5-13671 MD XD	0.93	0.931	2.55	10/10 Views			34.1 34.9	1021 1152	94 104	354		/
5-13672 MD XD	0.93	0.931	2.55	10/10 Views			37.2 34.3	1166 1163	94 104	354		/
5-13673 MD XD	0.93	0.931	2.29	10/10 Views			37.3 34.3	1166 1163	94 104	354		/
5-13674 MD XD	0.94	0.931	2.29	10/10 Views			37.3 34.3	1166 1163	94 104	354		/
5-13680 MD XD	0.92	0.932	2.42	10/10 Views			36.6 33.8	1145 1156	94 102	353		/
5-13681 MD XD	0.93	0.932	2.55	10/10 Views			36.6 33.8	1145 1156	94 102	353		/
5-13684 MD XD	0.91	0.930	2.54	10/10 Views			33.8 34.3	1076 1121	94 102	353		/
5-13687 MD XD	0.92	0.930	2.45	10/10 Views			36.6 35.5	1176 1165	96 102	363		/
5-13688 MD XD	0.93	0.930	2.45	10/10 Views			36.6 35.6	1176 1165	96 102	363		/
5-13689 MD XD	0.92	0.930	2.57	10/10 Views			36.6 35.6	1176 1165	96 102	363		/
5-13690 MD XD	0.92	0.930	2.57	10/10 Views			36.6 35.6	1176 1165	96 102	363		/
5-13691 MD XD	0.93	0.930	2.38	10/10 Views			36.6 35.6	1176 1165	96 102	363		/
5-13692 MD XD	0.92	0.930	2.38	10/10 Views			35.9 33.5	1127 1143	96 102	363		/

PROPERTY	TEST METHOD	FREQUENCY ⁽¹⁾	UNIT Metric	Solmax 140-7000
SPECIFICATIONS				
Thickness (Nominal ±10%) (11)	ASTM D-5199	Every roll	mm	1.00
Resin Density	ASTM D-1505	Certification	g/cc	< 0.926
Melt Index - 190/2.16 (max.)	ASTM D-1238	Certification	g/10 min	1.0
Sheet Density (8)	ASTM D-1505	1/Batch	g/cc	≤ 0.939
Carbon Black Content (9)	ASTM D-4218	Every 2 rolls	%	2.0 - 3.0
Carbon Black Dispersion	ASTM D-5596	Every 10 rolls	Category	Cat. 1 / Cat. 2
OIT - standard (avg.)	ASTM D-3895	1/Batch	min	100
Tensile Properties (min. avg) (2)	ASTM D-638	Every 5 rolls		
Strength at Break			kN/m	31.5
Elongation at Break			%	1000
2% Modulus (max.)	ASTM D-5323	Per formulation	kN/m	420
Tear Resistance (min. avg.)	ASTM D-1004	Every 10 rolls	N	85
Puncture Resistance (min. avg.)	ASTM D-4833	Every 10 rolls	N	298
Dimensional Stability	ASTM D-1204	Certification	%	± 2
Multi-Axial Tensile (min. avg.)	ASTM D-5617	Per formulation	%	90
Oven Aging - % retained after 90 days	ASTM D-5721	Per formulation		
STD OIT (min. avg.)	ASTM D-3895		%	35
HP OIT (min. avg.)	ASTM D-5885		%	60
UV Resistance - % retained after 1600 hr	GRI-GM-11	Per formulation		
HP-OIT (min. avg.)	ASTM D-5885		%	35
SUPPLY SPECIFICATIONS (Roll dimensions may vary ±1%)				
Roll Dimension - Width	-		m	6.80
Roll Dimension - Length	-		m	237.7
Area (Surface/Roll)	-		m ²	1616.4

NOTES

1. Testing frequency based on standard roll dimensions and one batch is approximately 180,000 lbs (or one railcar).
2. Elongation is measured with a gage length of 1.5".
8. Correlation table is available for ASTM D792 vs ASTM D1505. Both methods give the same results.
9. Correlation table is available for ASTM D1603 vs ASTM D4218. Both methods give the same results.
11. The minimum average thickness is ± 10% of the nominal value.

* 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 of 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.

***MATERIAL CONFORMITY CERTIFICATE
ISSUED BY
THE MANUFACTURER***

Varenes, October 16th, 2014

Ref.: Stock Material
ATTN: Mr. Clint Powell

To whom it may concern,

Solmax International hereby certifies that 130-2000 and 140-7000 smooth LLDPE geomembrane supplied for the above-mentioned project meets the following:

- Axi-Symmetric Break Resistance Strain (min) ASTM D5617 90 %

Hoping the above information is satisfactory. Do not hesitate to contact us if you require any additional information.

Sincerely,

Chantal Gagnon
Technical Services
Solmax International Inc.

APPENDIX B
Western Tank & Lining Ltd. QAQC Manual



WESTERN TANK & LINING LTD.
YOUR CONTAINMENT SPECIALISTS SINCE 1985

Destructive Test

7192 Vantage Way, Delta, BC V6V 1H9
Tel: 604-241-9487 Fax: 604-241-9485
Toll: 800-551-4355

Project Name: _____	Start Date: _____	HDPE Seam Strengths(PPI)*GM19*:				Page (____) of (____)	LLDPE Seam Strengths (PPI)*GM19*:			
		MIL	Shear	Fusion	Ext		MIL	Shear	Fusion	Ext
Materials Used: _____	Finish Date: _____	40	80	60	50		40	60	50	44
		60	120	91	78		60	90	75	66
		80	160	121	104		80	120	100	88
		100	200	151	130		100	150	125	114

Seam Number	DST #	Date	Time	QA Tech	QA Monitor	Peel Strength (ppi)					Shear (ppi)							
						#	1	2	3	4	5	#	1	2	3	4	5	
						in						PPI						
						out						%	50	50	50	50	50	50
						FTB	Yes	Yes	Yes	Yes	Yes	P/F	Pass	Pass	Pass	Pass	Pass	Pass
						P/F	Pass	Pass	Pass	Pass	Pass							
						in						PPI						
						out						%	50	50	50	50	50	50
						FTB	Yes	Yes	Yes	Yes	Yes	P/F	Pass	Pass	Pass	Pass	Pass	Pass
						P/F	Pass	Pass	Pass	Pass	Pass							
						in						PPI						
						out						%	50	50	50	50	50	50
						FTB	Yes	Yes	Yes	Yes	Yes	P/F	Pass	Pass	Pass	Pass	Pass	Pass
						P/F	Pass	Pass	Pass	Pass	Pass							
						in						PPI						
						out						%	50	50	50	50	50	50
						FTB	Yes	Yes	Yes	Yes	Yes	P/F	Pass	Pass	Pass	Pass	Pass	Pass
						P/F	Pass	Pass	Pass	Pass	Pass							
						in						PPI						
						out						%	50	50	50	50	50	50
						FTB	Yes	Yes	Yes	Yes	Yes	P/F	Pass	Pass	Pass	Pass	Pass	Pass
						P/F	Pass	Pass	Pass	Pass	Pass							



QUALITY CONTROL MANUAL

P.E. GEOMEMBRANE INSTALLATION

- (Geo Textile)
- (Draintube)
- (Geo Composite)
- (Geo Net)
- (GCL)
- (Petrogard 6)

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INTRODUCTION

This manual details the practices and procedures used by Western Tank and Lining Ltd.'s crews during installation of PE liners to ensure a quality installation and to produce the quality control report. We also included Geotextile, Geonet, Geocomposite, and DRAINTUBE manual.

1. SUBGRADE PREPARATION

1.1 Requirements for Soil Subgrade

The Owner, General Contractor, or Earthworks Contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of the liner unless specifically agreed otherwise. WTL and others install geosynthetic lining materials on earth surfaces prepared for liner installation by others. No liner shall be placed on surfaces not previously found acceptable by the WTL site supervisor. On projects installed by WTL, it is our practice to require written "Subgrade Surface Acceptance" documentation.

Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. No stones or other hard objects that will not pass through a 3/8" screen shall be present in the top 4" of the surfaces to be covered. All fill shall consist of well-graded material free of organics, trash, clay balls, sharp stones or any other deleterious material that may cause damage to the liner.

The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade.

The subgrade shall be compacted in accordance with design specifications but in no event below the minimum required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subgrade without causing rutting or other deleterious effects. The subgrade shall have no sudden sharp or abrupt changes in grade, especially at pipes or concrete structures.

Typical preparation sequence involves trimming of the compacted excavation as smooth as possible with heavy equipment, hand raking and rock picking, and rolling of the surface with a smooth drum compactor. Rule of thumb for acceptable surface is "ready to lay sod". Under no circumstances will the integrity of the liner be compromised due to the presence of rocks, lumps, or incomplete subgrade preparation.

- (1) **Surface Acceptance:** Upon request, Western Tank and Lining shall provide the Owner/Inspector with a written acceptance of the surface to be lined that day.

1.2 Geotextile Liner Cushion

In the event that suitable soils are not readily available at the construction site, soils containing smooth rocks up to 1-1/2 inches in diameter or angular rocks up to 3/4 inches may be utilized if covered with geotextile cushion having a minimum weight of 8 oz/yd². The weight of geotextile selected will depend on the actual soil used, thickness of liner, and service life or design considerations, but may be as high as 16 oz/yd².

See Appendix A for installation procedures.

1.3 Geonet Drainage Layer

See Appendix B for installation procedures.

2. PLACING COVER SOILS ON TOP OF PE GEOMEMBRANES

Cover soils deployed over synthetic liners should be free of all sharp objects--sharp rocks, and sharp sticks. The stones present in the soil should be rounded and smooth and no larger than 3/4 inch in diameter. Cover materials should be deployed using bulldozers separated from the membrane by at least one foot of cover soil for the smallest size dozers, and at least 18 inches of cover soil separation for the larger size dozers. The spreading operation should begin with placement of a mound of soil such that as the dirt covers the liner, it must ascend up the mound and then down the mound suppressing the formation of wrinkles. The movement of the soil must have this vertical descent to it as the dirt is spread over the membrane, rather than be pushed horizontally across the membrane. This type of action will suppress the formation of wrinkles in the path of the cover soil as it is being spread over the membrane and avoid burying wrinkles in the liner. Alternatively, a front-end loader can be used to place the cover soil out ahead of the path of the dozer to minimize spreading of the dirt and suppress wrinkle formation. If these procedures are followed, there should be no threat of puncture to the membrane due to cover soil operations, and buried wrinkles should be minimized.

In the event that suitable soils are not readily available at the construction site, soils containing smooth rocks up to 1-1/2 inches in diameter or angular rocks up to 3/4 inches may be utilized if a cushion geotextile having a minimum weight of 8 oz/yd². The weight of geotextile selected will depend on the actual soil used, thickness of liner, and service life or design considerations, but may be as high as 16 oz/yd².

The following are recommended procedures for placing of soil cover layers on top of HDPE Geomembrane liners using heavy equipment:

2.1 Liner Temperature

The liner must always be covered during the coolest portion of the day. As HDPE geomembrane is black and has a high coefficient of thermal expansion many "slack wrinkles" will form during sunlight hours. If the membrane is covered when it is warm these slack wrinkles will fold over or the slack will be displaced causing undue stresses on the liner.

2.2 Anchor Trenches

Anchor trenches should only be backfilled after the liner has undergone at least one nighttime contraction cycle after deployment and welding. The backfilling must take place when the membrane temperature is at its lowest - i.e. not at midday with the sun causing solar heating and expansion of the material.

2.3 Covering Sequence

When covering sloped areas, the covering must always proceed from the bottom of the slope to the top of the slope. This will avoid "dragging" the liner down the slope, which will stress the liner, or "sloughing" of the cover soils and heavy equipment.

2.4 Ground Pressure

No vehicles except balloon tire UTV's are allowed directly on the liner. Only low ground pressure equipment can be used near the leading edge of the soil cover. The depth of soil cover required under high ground pressure equipment will depend on the subbase, types of soils, and type of liner protection and must be determined by the project engineer.

2.5 Dozers

Dozers can be used to spread the cover material but cannot be the only method used at the leading edge of the cover material. Pushing with a dozer pushes membrane slack in front of the leading edge into a slack wave which will accumulate causing stresses in the liner. To avoid this an excavator or similar must be used to dump material in front of the leading edge and trap the liner slack before it accumulates.

2.6 Inspection

A responsible person must inspect the liner as the cover material is placed. If damage to the liner is noted it must be marked and cleaned by hand using a plastic shovel for repair.

3. LAYOUT PLAN & RECORD DRAWINGS

3.1 Layout Plan

Wherever possible a proposed layout plan will be prepared before mobilizing to the site. The layout plan will show:

- (1) slope lines
- (2) seams
- (3) panel numbers and dimensions
- (4) pipes of other penetration locations

3.2 Record Drawing

As installation progresses the following information will be recorded for the record drawing.

- (1) changes to the layout plan's panels, seams and penetrations
- (2) roll number for each panel
- (3) locations and extrusion #'s of destructive tests, patches, repairs and extrusion beads
- (4) seam numbers
- (5) the approximate length of main panels

NOTE: The intent of the record drawing is to show the correct number and orientation of panels, seams and details and their approximate location. The locations are not surveyed as would be done for a true "asbuilt" drawing.

4. LINER DEPLOYMENT

Unloading, handling and deployment of the liner is completed using slings and axles without contacting the roll directly with heavy equipment to minimize the potential for damage to the liner.

Panels and seams are oriented parallel to the slope unless approved otherwise by Western Tank and Linings' design department for that particular application. The only vehicles allowed on the liner are low ground pressure ATV's.

As the liner is deployed the following quality control procedures will be performed:

- (1) The roll number used is marked on the panel by the rollout crew.

- (2) The panel number corresponding to the layout plan is marked on the panel by the rollout or Q.C. crews.
- (3) A general visual inspection of the panel laid is performed by the rollout crew. A detailed visual inspection is performed by the Q.C. crew within 24 hrs. of deployment. Any defects in the sheet are circled with a permanent marker. A final visual inspection is performed at the completion of the installation.
- (4) Any changes to the layout plan and any sheet defects are recorded on record drawings. Each sheet defect will also receive an extrusion number.
- (5) No geomembrane materials shall be deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Owners Represented. The specified minimum temperature for material deployment may be adjusted by the Owners Representative. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed

5. SEAM WELDING

5.1 Wedge Welding

To the maximum point practical all main seams will be produced using Western Tank and Linings' hot wedge welders. Once a wedge welder has passed a qualification weld (see 6.3) production seaming can proceed with the following quality control procedures performed and recorded on the attached wedge welder seam log:

- (1) The date, welder number, operator initials, welder speed, and sheet temperature will be recorded on the liner next to each seam with a permanent marker by the operator.
- (2) The above information is recorded by a Q.C. technician.
- (3) The operator cuts one specimen from the end of the weld and performs a "vice-grip peel test" (see 6.1.1) on both weld tracks at the end of each seam. The specimen must pass on both tracks before proceeding to the next seam. The tested specimen is left at the end of the seam for inspection by the Q.C. technician who records the result.
- (4) The Q.C. technician cuts one specimen from the end of the seam and performs a tensiometer peel test (see 6.1.2) on both tracks within 24 hrs. and records both values.
- (5) The Q.C. technician performs the "Air Test" (see 6.2.2) on the completed seam as soon as possible and records the pressures and start and finish times.
- (6) Any defects such as burnouts, single seams, etc. are marked on the liner by the operator and recorded and numbered on record drawings for extrusion repair.
- (7) No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:
 1. Seaming of the geomembrane at material temperature below 0 degrees C (32 degrees F) if allowed if the Geomembrane installer can demonstrate to the Owner's Representative, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and the geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at subfreezing temperatures
 2. The Geomembrane Installer shall submit to the Owner Presentative for approval, detailed procedures for seaming.

5.2 Extrusion Welding

Extrusion welding is used for penetration seals, detail welding, patches, butt seam "T" intersections and nip folds, cap strips, seam defects, and sheet defects or damage. Once an extrusion welder/operator combination has passed a qualification weld (see 6.3) extrusion welding can proceed with the following quality control procedures performed and recorded on the extrusion welding log.

- (1) Each extrusion weld is given an identification number which is marked on the liner with a permanent marker and recorded on the record drawings. The section of extruding done on a butt seam may be marked using a single identification number from start to finish of that section.
- (2) The date, operator and welder number is marked on the liner with a permanent marker by the extrusion crew and recorded by a QC technician.
- (3) Each *extrusion weld is leak tested by vacuum testing (see 6.2.4) or in the case of butt seams (see 5.3) air tested or vacuum tested.
***NOTE:** Some extrusion welds cannot be leak tested due to the geometry; i.e. pipe boot sleeves or plate to pipe welds.
- (4) Each extrusion weld is "pick tested" (see 6.2.5) to evaluate bond strength.
- (5) Each extrusion weld is visually inspected for overgrind, heat distortion, thin bead, etc.
- (6) Any welding defects found are marked and recorded for repair and retesting.

5.3 Butt Seams

Butt Seams (also known as "Tie-In Seams") are used to join main sections of liner that have seams oriented in more than one direction. Butt seams require a combination of wedge welding and extrusion welding to be leak free.

In general butt seams are not welded until the main sections of liner have undergone at least one thermal contraction cycle. Often additional slack is "built in" at the butt seams during wedge welding by using more than 6" of overlap. The overlap is measured and trimmed at cool times of the day.

A qualified wedge welder is used to weld the seam which is tested and documented according to 5.1 except that the "Air Test" must be performed after the extrusion welding is complete. A qualified extrusion welder is used to reinforce and seal the wedge weld at the nip folds and the "T" intersections on both tracks. Extrusion testing and documentation is as per 5.2 except that extrusion beads that pass the high pressure test are not vacuum tested. To the maximum point practical all butt seams will be high pressure air tested. If a section of seam is not high pressure tested it is vacuum tested for leaks.

6. **WELD TEST PROCEDURES**

6.1 Destructive Test Procedures

Destructive tests require cutting "coupons" from a trial weld or production weld or from the parent material for strength testing. If the coupon is cut from a production weld within the finished seam length or installed liner it requires a patch using extrusion welding. Western tank and Linings' philosophy is to minimize coupon cut outs requiring extrusion weld patches by using data from non-destructive testing, especially our "High Pressure Air Test", qualification weld destructive testing, and gathering production seam destructive test data from small coupons that are outside

the finished seam length (i.e. in the anchor trench or at the tie-in seams excess overlap).

6.1.1 Vice Grip Peel Test

Weld specimens cut perpendicular to the weld track(s) approximately 1 inch wide are tested for peel adhesion by placing one flap from each sheet of the weld into two vice grip sheet metal pliers and applying peel stress by levering the backs of the pliers against each other until break occurs. A Film Tear Bond and good visual appearance are the criterion for a pass. A Film Tear Bond indicates good fusion. Visually the break should be ductile with a consistent clean appearance; i.e. no unfused spots.

6.1.2 Tensiometer Peel Test

Weld specimens are cut using a coupon cutter with 1" x 8" die. Care must be taken to cut the specimens perpendicular and centred on to the weld tracks. Specimens are placed in a field tensiometer in the peel mode with the grips approximately 2 from either side of the weld and the specimen perpendicular to the jaws. Specimens are pulled at 2"/minute until break occurs (for both weld tracks for wedge welds). The peak load in pounds is displayed on the tensiometer and recorded for determining acceptance. A Film Tear Bond is also required on all specimens. If some peel separation should occur the % incursion is determined by dividing the area of separation by the total weld area (nominally 2" x 1" = 2 in5) x 100.

NOTE: The peel strength is related to parent material break strength and should not be compared to parent material yield strength.

6.1.3 Tensiometer Tensile Test

Parent material tensile yield strength as well as weld tensile strength (also known as the shear test) and elongation are determined using a tensiometer. Specimens are cut using a coupon cutter with a 1" x 8" die.

The purpose of testing the parent material is to gauge the effects of field testing temperature (strengths will be higher at less than 20°C and lower at higher than 20°C). Parent material specimens are pulled at a speed of 2"/minute and an initial grip separation of 2" with the specimen perpendicular to the jaws. The initial peak load is recorded. The test is terminated after the initial peak load is reached. This test is only performed if the temperature effects on the test results are deemed significant.

When testing weld specimens, the specimens must be cut perpendicular to the weld track(s) and placed in the tensiometer square to the jaws. Also note that nicks in the cutter die can cause premature breaks. The specimens are marked at 1" outside the weld edge on both sides of the weld for grip placement. Testing speed is 2"/minute. The initial peak load is recorded and the distance the grips travel after the grips first pull tight is monitored. The % elongation is defined as the grip travel/1" x 100 (as almost all the elongation occurs on one side of the weld the initial gauge length is defined as 1" = the distance from the grip to the edge of the weld). The test is terminated after the minimum elongation specified has been achieved.

6.2 Non-destructive Testing

The following tests are performed to evaluate the continuity and bond strength of completed seams and detail welds in a non-destructive manner. The "High Pressure Air Test" and "Pick Test" can become destructive tests only if the weld bond strength is inferior. These tests can detect areas of poor strength that would not be located by other test procedures.

6.2.1 Visual Inspection

Visual inspections are performed by both the welder operators and the QC technicians. Wedge welds are inspected for burnouts, spinouts, single seams, inclusions, etc. Extrusion welds are inspected for overgrind, excessive heat distortion, thin bead, etc. Any welding defects found are marked on the liner and recorded on record drawings for repair and testing.

6.2.2 High Pressure Air Test

Purpose The air test was developed to provide a non-destructive test to evaluate the bond strength of double wedge welded seams.

Description The pressurized air channel forms a tube which is then visually inspected. Areas of the seam with partial fusion will show up as a bulge or widening of the air channel, or a weld separation resulting in a complete loss of pressure.

Specification

- (1) Pressurize the seam to a minimum of 30 psi
- (2) Allow the pressure to stabilize for 5 minutes while performing a visual inspection.
- (3) Record the pressure at the beginning and the end of the next 5 minutes. There should be no more than a 10% pressure drop.

Test Procedure

- (1) Seal off both ends of the seam.
- (2) Connect the WTL pressure gauge assembly to the air channel.
- (3) Pressurize the air channel with a compressor to a minimum pressure of 30 psi
- (4) Allow the pressure to stabilize in the air channel for 5 minutes. While the seam is pressurized perform a visual inspection of the air channel to look for bulges which would indicate incomplete fusion.

- (5) There should be no more than 10% pressure drop for a period of 5 minutes.
- (6) If a rapid pressure drop occurs, perform a visual inspection of the seam. If a flaw is detected in the seam, pressure test the seam on either side of the flaw. Record and repair the flaw using extrusion welding and test the extrusion weld using the vacuum test. If the entire weld is suspect, replace the weld.
- (7) Record the results of the test on the seam log.

6.2.3 Vacuum Box Soap Test

The vacuum box test is used to check extrusion welds (or wedge welds that cannot be practically tested using the High Pressure Test) for leaks.

Vacuum Test Procedure

- (1) Trim off any flaps on the wedge weld and coat the seam with a strong soap solution.
- (2) Place the vacuum chamber over the test area and depressurize to 5 inches of mercury.
- (3) Observe the weld inside the vacuum chamber. Any leaks will allow atmospheric pressure air from beneath the liner to enter the vacuum chamber. Soap bubbles will form at the leak.
- (4) Mark any leaks that are found, repair and retest.
- (5) Record the results of the test.

NOTE: Some extrusion welds such as at boots, etc. cannot be vacuum tested due to the geometry involved.

6.2.4 Pick Test

The pick test is used to evaluate the bond strength of extrusion welds. The test is performed by welder operators and QC technicians by prying at the edges of an extrusion weld using a blunt screwdriver. Areas of weakly bonded extrudate can be pried off the parent material. Any flaws are marked and recorded for repair and testing.

6.3 Welder Qualification Seams

Each welding machine for wedge welders, and each welder/operator combination for extrusion welding, produces qualification seams each day before starting production welding. Qualification seams are made using strips of material approximately 300 mm wide and are a minimum of 1 m long for extrusion welding and 3 m long for wedge welding. These seams are destructively tested and the results recorded on the welder qualification data sheets attached.

7. **MINIMUM ACCEPTANCE CRITERIA**

The following limits are the minimum acceptable for a completed installation.

7.1 Destructive Weld Testing

TEST		MINIMUM ACCEPTANCE CRITERIA				
Thermally Bonded Smooth and Textured High Density Polyethylene (HDPE) Geomembranes						
Vice Grip Peel Test		FTB (on both tracks for wedge welds)				
Material Thickness		30 mils	40 mils	60 mils	80 mils	100 mils
Peel Strength, lb/in	Wedge	45	60	91	121	151
	Extrusion	39	52	78	104	130
Peel Separation (Incursion)		<ul style="list-style-type: none"> - FTB for all specimens - Avg of 5 must be less than 25% - Single specimen test for production end coupon – less than 10% 				
Shear Strength, lb/in <small>(Wedge/Extrude)</small>		57	80	120	160	200
Shear Elongation at break, %		50	50	50	50	50
Thermally Bonded Smooth and Textured Linear Low Density Polyethylene (LLDPE) Geomembranes						
Vice Grip Peel Test		FTB (on both tracks for wedge welds)				
Material Thickness		30 mils	40 mils	60 mils	80 mils	100 mils
Peel Strength, lb/in	Wedge	38	50	75	100	125
	Extrusion	34	44	66	88	114
Peel Separation (Incursion)		<ul style="list-style-type: none"> - FTB for all specimens - Avg of 5 must be less than 25% - Single specimen test for production end coupon – less than 10% 				
Shear Strength, lb/in <small>(Wedge/Extrude)</small>		45	60	90	120	150
Shear Elongation at break, %		50	50	50	50	50

7.2 Non-Destructive Weld Testing

TEST	MINIMUM ACCEPTANCE CRITERIA
Visual Inspection	No unrepaired flaws.
Air Lance	Produce a stream of continuous air along the flap of the weld edge
High Pressure Air Test	No more than 10% pressure drop for 5 minutes at 1.0 PSI/mil thickness/inch of air channel width.
Vacuum Box Test	Produce up to 4 inches of Hg (2psi)
Pick Test	Non unbonded areas.
Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.	

8. MINIMUM TEST FREQUENCIES

The following test frequencies are the minimum required for a complete installation.

8.1 Wedge Weld Qualification Seams

TEST	FREQUENCY
Vice Grip Peel	2 specimens / qualification tested on both tracks
Tensiometer Peel	5 specimens / qualification tested on both tracks
Weld Tensile (Shear)	2 specimens / qualification

Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.

8.2 Extrusion Welder / Operator Qualification Seams

TEST	FREQUENCY
Vice Grip Peel	2 specimens / qualification
Tensiometer Peel	5 specimens / qualification
Weld Tensile (Shear)	2 specimens / qualification
Each welder will produce a minimum of 1 qualification seam for each day that welder is used for production.	

8.3 Wedge Weld Production Seams

TEST	FREQUENCY
Vice Grip Peel	1 specimen tested on both tracks / seam (except panel width cross seams). Specimen to be taken from the end of the seam – no repair patch required.
Visual Inspection	Full seam length.
Air Lance	Only used when the seam is welded with a full wedge assembly
High Pressure Air Test	Full length of all seams to the maximum point practical.
Vacuum Test	Only used where High Pressure Testing is impractical.

8.4 Extrusion Weld Seams or Beads

TEST	FREQUENCY
Visual Inspection	Full seam length.
Vacuum Test	Full seam length except for beads previously pressure tested which are not vacuum tested.
Pick Test	1 pick / lineal foot of seam.
High Pressure Air Test	Only applies to butt seam, "T's".

9. FAILED TEST PROCEUDRES

If a weld or seam fails one or more of the required tests the following procedures are performed.

TEST	FREQUENCY
Welder Qualification Seam	Adjust welder, reweld, and retest.

(wedge or extrusion)	
Visual Inspection and Vacuum Box Test	Mark liner, record defect, repair and retest. If the defect already has an extrusion number renumber as 47A (initial extrusion #47) for records.
Pick Test	Mark, record and repair as above. If the weld is suspect due to many flaws, cap or replace the weld.
High Pressure Air Test	Retest on either side of the defect. Mark, record and repair as above. If there are more bulges than 1/20' of seam length (average) replace the weld.
Production Wedge Weld Vice Grip Peel Test or Tensiometer Peel Test	If single specimen fails track along the seam and retest using 3 specimens. If 1 (or more) of the 3 specimens fail track along the seam and retest using 5 specimens (or replace the seam). If the 5 specimens test fails the acceptance criteria track to obtain a 5 specimen coupon that passes the acceptance criteria and repair the area to the passing sample or place the seam and retest.

10. PENETRATIONS

Any structures such as pipes, sumps, concrete, etc. that penetrate the liner require mechanical attachment and/or welding are an anchor point and can result in stresses on the liner under some conditions. For stress considerations and possibilities of leakage the number of penetrations should be minimized where practical. In addition, the final liner penetration detail should be considered during design and construction of the earthworks and piping. Please consult Western Tank and Lining during the design phase to optimize the end product. Attention to compaction around pipes or structures is a must to avoid shear or tensile forces on the liner due to subsidence. Western Tank and Lining takes careful consideration of penetration location during panel layout design, panel deployment, and slack incorporation.

10.1 HDPE Pipe

Where possible HDPE piping should be used for pipelines, or for the last section of pipe, penetrating the liner. For all but the highest molecular weight pipe resins (Drisco 8600), geomembrane and pipe resins are compatible for welding. Typical methods include cutting the HDPE pipe flush with the side slope and welding geomembrane or HDPE plate, directly to the pipe.

The resulting weld is more reliable than boots and does not require any steel banding or rubber gaskets. Pump out sumps can also be constructed of HDPE pipe or plate and welded directly to the liner.

10.2 Concrete

Sealing to concrete structures of pipe collars are accomplished with anchor bolts, clamping bar, and rubber gaskets. Clamping to vertical surfaces is not recommended. To ensure a complete seal, using horizontal (or flush with slope) concrete surfaces which are smooth and stringline flat. Rebar should be located away from the anchor bolt line or more than 4 inches below the surface. Concrete pipe collars should include anchor rings and/or waterstops on the pipe. Satisfactory pipe seals for many applications can be constructed using a concrete collar with waterstop and a liner to concrete clamp seal. Some applications involving new concrete are best handled using cast-in HDPE inserts.

10.3 Pipe Boots

Pipe boots can be field or factory fabricated from HDPE geomembrane and sealed to piping or round pilings using stainless steel bands and neoprene gaskets. A 90degree pipe boot is always preferred to a slope angle boot for a pipe entering near the bottom of a reservoir. Pipe boots should be avoided for horizontal pipes penetrating the sideslopes.

10.4 Corrugated Culverts

Corrugated Culverts should be avoided as the only method of sealing is a concrete collar with waterstop, but the waterstop is very difficult to construct.

10.5 Pipe Support Pilings

Pipe Support Pilings should be cylindrical concrete or pipe to facilitate boot seals. Rectangular or "I" beam shapes pose serious sealing problems and should be avoided.

11. **SLACK INCORPORATION**

Most HDPE liner installations require some slack incorporation due to the materials high coefficient of thermal expansion (approximately 1% / 75°C), solar heating that takes place during construction due to its black colour, and the minimum temperature the liner will see during its service life.

In general, exposed liners will require more slack than buried applications. In all cases slack incorporation is a compromise between too little slack which will result in bridging at corners or toes of slopes, or excessive stresses at fixed points during cold temperatures, and too much slack resulting in slack "wrinkles" that will fold over when covered with soils or fluids, with resultant stresses at the folds. Covered applications should be built to fit the subgrade at the temperature that the liner will be covered at. Exposed applications should be built so that no significant stresses are developed at the minimum service temperature.

The following techniques are used to "size" the liner:

- (1) The main sections of liner must be allowed to undergo at least one thermal contraction cycle before the anchor trench is backfilled or the butt seams are welded or liner is covered.
- (2) The butt seam(s) overlaps are measured and trimmed at the cool times (early morning or evening) of the day.
- (3) If additional slack is required it can be placed at the anchor trench before backfilling or at the butt seams (or seams between fixed points) by using extra overlap.
- (4) The project superintendent determines the amount of slack to be incorporated based on field experience, calculations, and the expected service life of the liner.

12. **QUALITY CONTROL REPORT**

A quality control report is produced after the project is completed. The report contains the following information:

- (1) The manufacturing material certifications.
- (2) The wedge welder and extrusion welder / operator qualification data sheets.
- (3) The wedge welding and extrusion welding seam logs.

- (4) The record drawing showing:
- a. approximate location of all panels and seams;
 - b. the panel numbers;
 - c. the seam numbers;
 - d. the roll number used for each panel;
 - e. the approximate lengths of main panels;
 - f. the approximate location of all penetrations; and
 - g. the extrusion weld number and approximate location of all extrusion weld patches, beads, and repairs.

13. STANDARD INSTALLATION WARRANTY

WESTERN TANK & LINING LTD.

12180 Vickers Way
 Richmond, B.C., V6V-1H9
PHONE (604) 241-9487
FAX (604) 241-9485

WORKMANSHIP WARRANTY

PURCHASER/USER	
LOCATION OF INSTALLATION	
DESCRIPTION OF INTENDED USE	

WESTERN TANK & LINING LTD. (the "Installer") warrants to the party named above as the Purchaser/User ("Purchaser") that the tank and/or lining membrane system ("the Liner System") as installed by the Installer will be free from installation-related defects for normal use in approved applications, on the terms and conditions set forth in this Workmanship Warranty (the "Warranty"). This Warranty shall be in effect from the above noted **Acceptance Date** for the above noted **Warranty Period**.

The term "normal use" means uses reasonably consistent with the above noted Description of Intended Use, and does not include, among other things, the exposure of the Liner System to harmful chemicals; abuse of the Liner System by machinery, equipment or people; excessive pressures or stresses from any source; subsurface or overburdened soil conditions; and total or differential soil settlements and the effect those settlements may have on the Liner System. The Purchaser acknowledges that the sale of the Liner System is for commercial or industrial use only.

This Warranty does **not** include damages or defects in the Liner System resulting from: (i) acts of God, casualty or catastrophe, including earthquakes, floods, weather, tornadoes, explosion, war, acts of any public authority, or any other cause beyond the Installer's reasonable control; (ii) faulty materials, or any defects in the workmanship, design or manufacturing of the materials comprising the Liner System; (iii) defects arising on account of third party action; (iv) defects arising from improper maintenance, use, repair, replacement or alteration of the Liner System by the Purchaser; (v) subsidence of the land around the Liner System; or (vi) surface defects in workmanship and materials apparent and accepted by the Purchaser at the date of delivery.

Any claim for an alleged breach of this *Warranty* must be made in writing, by registered mail or fax, to the President of the Installer at the address above within thirty (30) days of the Purchaser becoming aware of the alleged defect. If the Purchaser fails to deliver notice as required under this Warranty, the defect and all warranties shall be deemed to have been waived and the Purchaser will have no right of recovery against the Installer. Should defects within the scope of the above Warranty occur, the Installer will, at its option, repair or replace the Liner System or defective portion thereof. The Installer will have the right to inspect and determine the cause of any alleged defect in the Liner System and to take appropriate steps to repair or replace the Liner System if a defect exists for which the Installer is liable under the terms of this Warranty. The Installer will not be required to make such repairs and/or replacements until the Purchaser has ensured that the area surrounding the Liner System is clean, dry, and in an unencumbered condition, including without limitation free from all water, dirt, sludge, residuals, and liquids of any kind.

The Installer's liability under this Warranty shall in no event exceed the lesser of: (i) the replacement cost of the Liner System or defective portion thereof; or (ii) the total amount paid by the Purchaser to the Installer in respect of the Liner System. Further, under no circumstances shall the Installer be liable to the Purchaser or any other party for any special, direct, indirect, or consequential damages arising from any defect in the installation of the Liner System. This Warranty is given in lieu of all other possible warranties by the Installer in respect of the Liner System and by accepting delivery of the Liner System, the Purchaser waives all other such possible warranties, except those specifically given.

THE INSTALLER MAKES NO WARRANTY OF ANY KIND OTHER THAN AS EXPRESSLY SET OUT HEREIN, AND HEREBY DISCLAIMS ALL OTHER WARRANTIES, BOTH EXPRESSED AND IMPLIED, OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS WARRANTY IS NOT EFFECTIVE AND THE INSTALLER IS NOT BOUND BY THE TERMS HEREOF UNTIL RECEIPT OF FULL AND FINAL PAYMENT FOR THE LINER SYSTEM FROM THE PURCHASER.

I hereby state I have read and understand the above and foregoing Warranty and agree to such by signing hereunder.

	PURCHASER/USER	WESTERN TANK & LINING LTD.
NAME		
SIGNATURE		
TITLE		
DATE (dd/mm/yy)		

APPENDIX "A"

GEOTEXTILES

Handling and Placement

All geotextiles shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to:

- On slopes, the geotextiles shall be secured in the anchor trench and then rolled down the slope when practical. In any event it should be deployed in such a manner as to continually keep the geotextile sheet in sufficient tension to reduce folds and wrinkles.
- In presence of wind, all geotextiles shall be weighted with sandbags or the equivalent.
- Geotextiles shall be cut using an approved cutter. If the material is being cut in place, special care must be taken to protect other geosynthetic materials from damage.
- Care shall be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

Seams and Overlaps

Geotextiles may be seamed by thermal bonding or by sewing.

- On slopes steeper than ten (10) horizontal to one (1) vertical, it is recommend that geotextiles be continuously seamed along the entire length of the panel. Geotextiles shall be overlapped approximately four (4") inches prior to seaming.
- On bottoms and slopes shallower than ten (10) horizontal to one (1) vertical, geotextiles can be either seamed, as indicated above or overlapped. If not thermally bonded the geotextile shall be overlapped a minimum of twelve (12") inches prior to seaming.

Repairs

Any holes or tears in the geotextile shall be repaired as follows:

- On Slopes - a patch made from the same geotextile shall be seamed into place.
- Horizontal Areas - a patch made from the same geotextile shall be spot seamed in place with a minimum of twelve (12") inches overlap in all directions.

APPENDIX "B"

GEONET

Handling and Placement

The geonets shall be handled in such a manner as to ensure the geonets are not damaged in any way.

- On slopes, the geonets shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet shall be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e. across the slope) in some special locations (i.e. where extra layers are required or where slope is less than 10:1).
- Such locations shall be identified by the Design Engineer in the project drawings.
- Geonets shall not be welded to geomembranes. Geonets shall be cut using approved cutters, i.e. hook blade, scissors, etc. Care should be taken to prevent damage to underlying layers.
- Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane.

Layering and Tying of Geonet

When several layers of geonets are installed, care should be taken to prevent the strands of one layer from penetrating the channels of the next layer. Adjacent geonets shall be joined according to the following requirements.

- Adjacent rolls shall be overlapped by at least four (4") inches and securely tied.
- Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
- Tying shall be five (5') feet to ten (10') feet along the bottom, every five (5') feet along the slope every two (2') feet across the slope and at top of berm and into anchor trench at least with one (1') foot intervals.
- In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be unrolled along the slope, on top of the previously installed geonets, from top to bottom of the slope.
- When more than one layer of geonet is installed, overlaps must be staggered and layers tied together.

Repairs

Any holes or tears in the geonet shall be repaired by placing a patch extending two (2') feet beyond edges of the hole or tear. The patch shall be secured to the original geonet by tying every twelve (12") inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area shall be cut out and the two (2) portions of the geonet shall be joined.

APPENDIX "C"

GEOCOMPOSITE

Handling and Placement

All geocomposite shall be handled in a manner to ensure they are not damaged.

- On slopes, the geocomposite can be secured in the anchor trench and then rolled down the slope when practical. The geocomposite shall be deployed in a manner to continually keep the geocomposite sheet in sufficient tension to reduce folds and wrinkles.
- In the presence of high wind, all geocomposite shall be weighted with sandbags or the equivalent.
- Geocomposite shall be cut using an approved cutter. If material is being cut in place, special care should be taken to protect other geosynthetic materials from damage.
- Care should be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

Seams and overlaps

- Geocomposite shall be seamed by thermal bonding or by sewing.
- No horizontal seams shall be allowed on side slopes greater than 4H:1V. Owners Represented. The horizontal seams on side slopes greater than 4H:1V can be adjusted by the Owners Representative to utilize material to its entirety.
- Tying of the geonet shall be with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
- Tying shall be every 1.5 m across the cell floor, every 1.5 m along the side slopes and every 750 mm at the top of berms and into anchor trenches. End to end joints on the cell floor shall be overlapped 600 mm. Tying shall be every 0.3 m across the end to end joint. All tying shall be covered with geotextile, sewn or heat bonded.

Repairs

The damage shall be observed, and if smaller than one (1) m by one (1) m, the geocomposite shall be repaired. If the tear or hole is larger, then the roll shall be cut to remove the damaged area, fasteners shall be used to attach the geonet with the geotextile being heat seamed. Minimum overlaps to be as specified.

- If the geonet is undamaged, and the geotextile is damaged, a patch of geotextile shall be placed. The geotextile patch shall be thermally bonded in place with a minimum of 300 mm overlap in all directions.
- If the geonet is damaged, the geonet shall be removed. A section of geonet shall be cut to replace the removed section. The geonet shall be tied to the existing geonet using plastic fasteners placed at least every 150 mm. A geotextile patch shall be placed over the repaired geonet section. The geotextile patch shall be thermally bonded in place with a minimum of 300 mm overlap in all directions.

APPENDIX "D"

GEOSYNTHETIC CLAY LINER (GCL)

Handling and Placement

All rolls GCL shall be handled in a manner to ensure they are not damaged.

- GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL should be in accordance with the Engineer's or manufacturer's recommendations.
- Proper equipment, spreader-bar and core-bar assembly and/or a forklift with stinger attachment shall be used during handling and deployment as per manufacturer's recommendations.
- Equipment which could damage the GCL shall not be allowed to travel directly on it. If the installation equipment causes rutting of the sub-grade, the sub-grade must be restored to its originally accepted condition before placement continues.
- The GCL shall be placed so that seams are parallel to the direction of the slope. Seams should be located at least 1 m from the toe and crest of slopes steeper than 4H:1V. The horizontal seams on side slopes greater than 4H:1V can be adjusted by the Owners Representative to utilize material to its entirety.
- Placement shall be from highest elevation to the lowest elevation to facilitate drainage in the event of precipitation unless the Engineer and or the Owners Representative assure that the subgrade is porous and free draining.
- All GCL panels should lie flat on the underlying surface, with minimal wrinkles and no folds, especially at the exposed edges of the panels. Panels shall be placed with non-woven side up.
- Only as much GCL shall be deployed as can be covered with soil, a geomembrane, or a temporary waterproof tarpaulin at the end of the working day.
- The GCL shall be placed in an anchor trench at the top of the slope as per the drawings. The front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor, but not the rear trench wall.

Field Seams

- The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required in the overlap zone.
- The minimum dimension of the longitudinal overlap should be 225 mm. End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 600 mm.
- Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.
- Where the GCL product requires bentonite-enhanced seams as recommended by the GCL manufacturer, bentonite-enhanced seams shall be constructed by overlapping adjacent panels as instructed above, exposing the underlying edge and then applying a continuous bead of granular sodium bentonite along a zone defined by the edge of the

underlying panel and the 150 mm line. The bentonite shall be applied at a minimum application rate of 0.4 kg/m. Where bentonite-enhanced seams are not required by the GCL product as recommended by the GCL manufacturer, GCL installer shall receive approval from the Engineer.

- GCL may be seamed by thermal bonding to prevent the movement of material while covering it with a geomembrane, covering it with soil or a temporary waterproof tarpaulin

Detail Work

- The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the drawings.
- Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are required to avoid damage to the geotextile components of the GCL during the cutting process.

Repair

- If the GCL is damaged (torn, puncture, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll or scrape piece and shall be cut to size such that minimum overlap of 300 mm (12 inches) is achieved around all of the damaged area. Dry bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive or heat bonded to affix the patch in place so it is not displaced during cover placement.
- Any solvent or adhesive in contact with the GCL must be approved by the Manufacturer.

APPENDIX "E"

DRAIN TUBE

Handling and Placement

Rolls of DRAINTUBE shall be handled in a manner to ensure they are not damaged.

- DRAINTUBE Drainage Geocomposite shall not be placed, seamed/joined, or repaired during periods of heavy precipitation, excessively high winds, or in areas of ponded water or excessive moisture.
- DRAINTUBE Drainage Geocomposite shall be installed in accordance with manufacturer's recommendations, and as shown on the Drawings and specified herein.
- DRAINTUBE Drainage Geocomposite shall be installed in the direction of the slope such that the pipe components are oriented with the intended flow direction (typically perpendicular to the contours) unless otherwise specified by the ENGINEER.
- The DRAINTUBE Drainage Geocomposite shall be kept clean prior to and during installation.
- Folds or excessive wrinkling of deployed DRAINTUBE Drainage Geocomposite shall be removed to the extent practicable.
- Installers shall exercise care not to entrap stones, excessive dust, or foreign objects in the material.
- DRAINTUBE Drainage Geocomposite shall be adequately weighted, using sand bags or equivalent until the subsequent soil or geosynthetic layer is placed. In the presence of wind, the sandbags or the equivalent shall be placed along the leading edge and removed once cover material is placed.
- If the project contains slopes steeper than 5 horizontal to 1 vertical, special care should be taken to use full length rolls from the top of the slope. If the roll length cannot cover entire slope, then the next roll should be situated towards the toe of the slope. The locations of horizontal connections of adjacent panels should be staggered at least 10 feet apart.
- Overlaps shall be singled down the slope and/or in the direction that backfilling will occur.
- If the project includes an anchor trench to secure the DRAINTUBE Drainage Geocomposite, then the panels shall be secured in the anchor trench as indicated on the Drawings.

Field Seams

Adjacent sheets of DRAINTUBE Drainage Geocomposite shall be overlapped as described below.

- Connections at along the side of the DRAINTUBE Drainage Geocomposite roll shall be overlapped 4 inches, and shall be secured using sewn seams, additional overlap, or welds (hot air or flame) [*ENGINEER to select one or more alternatives*].

- Connection at the leading or terminating edge of the DRAINTUBE Drainage Geocomposite shall be overlapped such that the upper geotextile layer can be rolled back 12 to 18 inches and the end of the next roll inserted into the opening. Pipes shall be connected either using a snap coupler fitting supplied by the geocomposite manufacturer or by overlapping the pipes by 12 to 18 inches [*ENGINEER to select the alternative*].

Connections to an interceptor drain and/or vacuum pipe shall conform to the Drawings and be at the direction of ENGINEER.

Repair

Prior to covering the deployed DRAINTUBE Drainage Geocomposite, each roll shall be inspected for damage.

- Any rips, tears or damaged areas on the geocomposite shall be removed and patched.
- If a section of pipe is damaged during installation, add a piece of undamaged pipe of the same diameter next to the damaged pipe, extending a minimum of 8 inches beyond each end of the damaged section of pipe.
- If the geotextile is ripped or torn, install an undamaged piece of the same material under the hole that extends a minimum of 6 inches beyond the hole in all directions to insure that protection of the geomembrane is maintained.
- If the area to be repaired is more than 50 percent of the width of the panel, then the damaged area shall be cut out and replaced with undamaged material. Damaged geotextile shall be replaced by the same type of geotextile.

APPENDIX "F"

PETROGARD VI

Preparation

- Ensure subgrade is compacted and surface finished to not impair installed membrane.
- Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade. A smooth drum rolled surface is preferable.
- Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.
- If a suitable sub-grade is not available, then a cushion layer of clean sand or non woven geotextile shall be placed prior to liner placement.
- Excavate anchor trench to line, grade, and width indicated on drawings, prior to liner placement. Provide slightly rounded corners in the trench to avoid sharp bends in the geomembrane.
- Prepare mechanical attachments according to ASTM D6497 Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.
- All concrete surfaces to which the liner will attach shall have "smooth trowel" finish. All the corners should have radius to a minimum 25mm as per the drawing.
- Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.
- A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.

Handling and Placement

- Installation of the geomembrane shall be performed in a logical sequence.
- Place panels according to the drawings, the panel layout, and the label on each panel.
- Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service.
- Ensure personnel working on geomembrane do not use damaging footwear.
- Protect completed panels from damage; handle carefully to avoid damaging the liner.
- Equipment and methods used to unroll liner panels should not damage the prepared subgrade.
- Ballast used to prevent uplift by wind must not damage the geomembrane. A continuous load is recommended along the edges of panels to eliminate the risk of wind uplift.

Weather Conditions at Time of Installation

- Site welding may proceed at any temperature providing a suitable qualification weld can

be prepared at site conditions using the operator, equipment, and materials intended for the project.

- Installation of membrane in winds above 20 km/h can proceed only if the installer can demonstrate that the liner will not be at risk of damage.
- Do not install membrane during precipitation or in the presence of excessive moisture.
- Do not install in weather conditions that may be detrimental to the function of the membrane.

Qualification

- A qualification seam will be run prior to any field seams.
- A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.
- Machine conditions, and operator used for welding must be the same as those used for the qualification weld.
- Qualification seam must be tested in shear and peel, and meet the specified requirements for the material.
- A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every 4 hours.

Seaming

- Cleaning solvents shall not be used unless product is approved by membrane manufacturer.
- Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.
- Over lap of a seam shall be a minimum of 150mm
- Technician shall record the machine number, date, technician initials and start the time of every wedge weld.

Destructive and Seam Testing

- Field seams will be sampled for testing in a way that does not compromise the installed liner One sample to be tested for every 150m of field seam
- Test samples are to be removed from the ends of seams, from the anchor trench, or other location that does not introduce a defect into the liner.
- Samples to be approximately 100 mm long to permit testing of one shear and two peel specimens (ASTM D6392).
- Test samples shall be taken within 24hrs after seaming
 - Record date, location and pass/fail description
- Field seams must meet the specified requirements in peel and shear for the material.
- A written record will be maintained for all field seam tests.

All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).

- .
- Destructive Test Failure:
 - Cut out seam and re-weld; or,
 - Retrace welding path to <3 m> <<10 feet>> from location of failed test. Take sample for additional test. If passed - cap strip or extrusion weld between failed location and original failed location.

Repairs

- Inspect seams and non-seam areas for defects, holes, blisters, undispersed raw materials.
- Identify any sign of foreign matter contamination.
- Repair all through-thickness defects.
- Defective Seams: Cap strip or replace.
- Tears: Patch and seal round sharp ends of tears on slope or stressed area prior to patching.
- Repair blisters, large cuts and undispersed raw materials with patch.
- Secure Patches by Hot Air Welding:
 - Hot Air Welding
 - Hand hot air welding is permitted for patching liner.
 - Clean area to be patched.
 - Hand weld the patch with a hot air gun and suitable roller.
- Patches: Round or oval, of same geomembrane. Extend minimum 75 mm beyond the edge of the defect.
- Verification of Repairs: All repairs to be non-destructively tested using
 - Air Lance Test, ASTM D4437 Method 7.2
 - Vacuum Box Test ASTM D5641
- Redo failed repairs and re-test.
- Keep records of all repairs and the results of repair testing.

Cleaning solvents shall not be used unless product is approved by membrane manufacturer. Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.