AEM

AGNICO-EAGLE MINES LTD
MELIADINE GOLD PROJECT

TEMPORARY FUEL STORAGE INSTALLATIONS

TECHNICAL SPECIFICATIONS
OF CONSTRUCTION MATERIALS

FOR THE CONSTRUCTION

OF

PHASE 2 (2011)

TEMPORARY FUEL STORAGE INSTALLATIONS

TECHNICAL SPECIFICATIONS OF CONSTRUCTION MATERIALS

PREPARED BY :

Patrick Giard, P.Eng.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Agnico-Eagle Mines Limited is currently in the process of planning the construction of temporary installations for an advanced gold exploration project in the Kivalliq region of Nunavut, about 25 km north of Rankin Inlet.

The current operations for the Tiriganiaq underground exploration program require storage of almost three million four hundred thousand liters (3,400,000 L) of diesel fuel on a yearly basis.

PHASE 1

During 2010, Agnico-Eagle Mines has installed ten (10) fuel bladders, each with 113,500 L capacity, and also eleven (11) double-walled steel tanks, each with 50,000 L capacity. The combined fuel storage capacity currently in place stands at one million six hundred eighty-five thousand liters (1,685,000 L) of diesel fuel.

An impervious secondary enclosure was built around the fuel bladders, in order to provide secondary containment.

PHASE 2

To allow the completion of underground exploration activities that are planned for 2012, Agnico-Eagle Mines needs to proceed to installation of another eight (8) fuel bladders, each with 113,500 L capacity, and also eight (8) double-walled steel tanks, each with 100,000 L capacity. The combined fuel storage capacity that is planned in Phase 2 stands at one million seven hundred and eight thousand liters (1,708,000 L) of diesel fuel.

Another impervious secondary enclosure is planned to be built around these additional fuel bladders, in order to provide secondary containment.

Section 5 of this document also summarizes the proposed work methods for construction of the secondary containment area, during the first quarter of 2012. The work will be done by a qualified local Contractor, with the field supervision to be provided by A&A Technical.

Description of Mandate

Agnico-Eagle Mines gave a mandate to the undersigned Professional Engineer in order to verify the compliance with applicable regulations of its fuel storage installations at the Meliadine Gold Project, Nunavut.

According to the terms of reference, the mandate consists summarily in the following activities.

A. Review and compilation of the available documentation ;

B. Collection of any information that may be missing ;

C. REVISION OF CONSTRUCTION DRAWINGS

a. Review of the *AS BUILT* drawings after construction of PHASE 1 ;

b. Preparation of *IFC* drawings for the construction of PHASE 2 ;

c. Preparation of *Technical Specifications* for materials to be used for construction of PHASE 2.

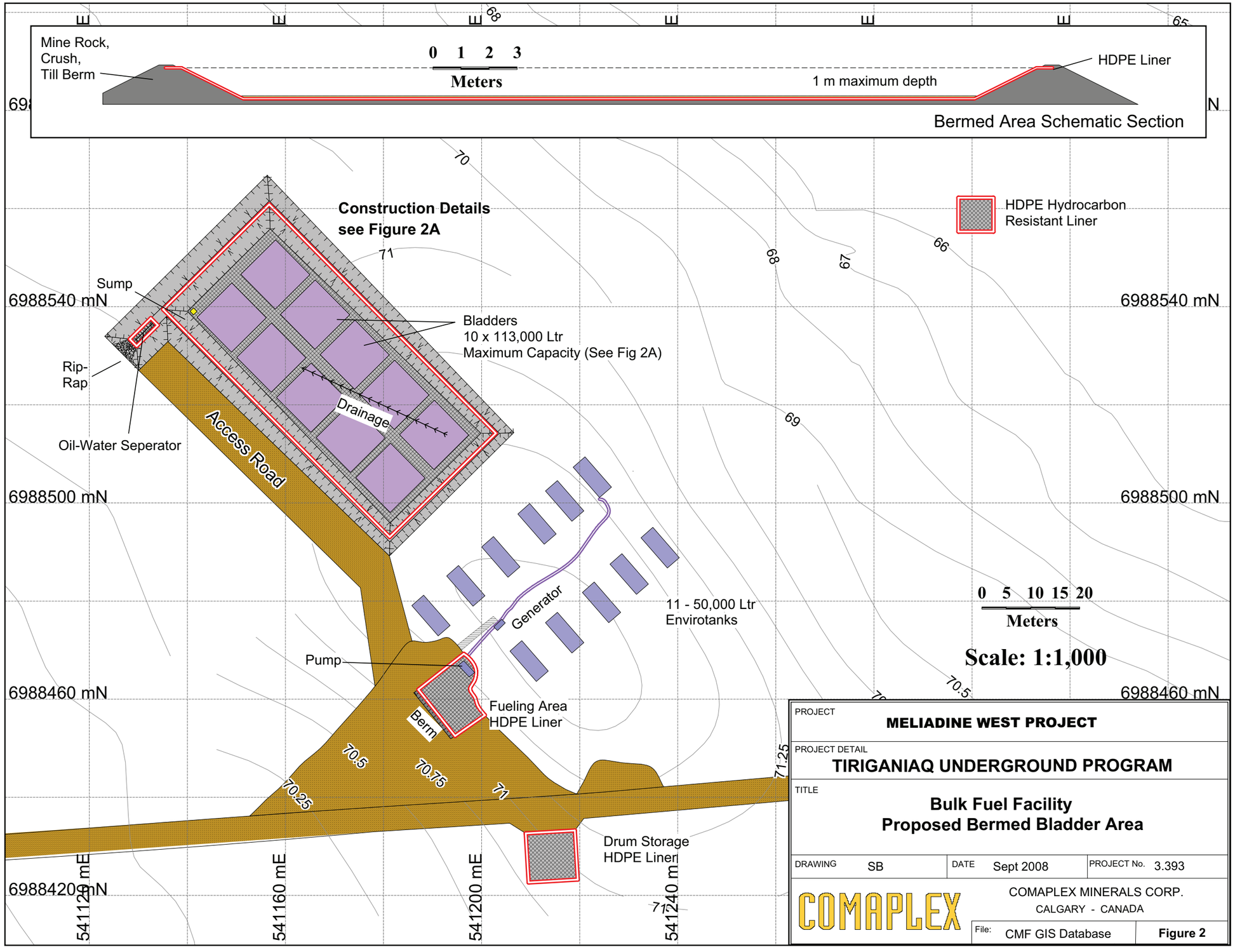
1. Drawings issued for environmental permitting : PHASE 1

Some general arrangement drawings have already been provided to the Nunavut Water Board on 2008-09-15, within a request for Amendment to Water License 2BB-MEL0709.

These drawings are reproduced hereunder, but only with the intent to demonstrate the similarities between the civil design of the proposed expansion of fuel storage facilities described herein and the original concept which had been submitted at the time of the earlier communications with the KIA, INAC, and the Nunavut Water Board.

It should be noted that in one of the said drawings, entitled "Figure 2A, Project 3.393" which was issued by **T.A. Morrisson, P.Eng**., an impermeable enclosure has already been planned for the recovery of very small quantities of oil that may be released due to the relative permeability of fabric materials used in such *Collapsible Fabric Storage Tanks* (Bladders).

This impermeable enclosure has been planned in order to have a minimum capacity of 6,000 L and the recommended recuperation method, should any oil be present in the surface water accumulated in the secondary containment area, consists in the use of a skimmer or oil boom prior to discharging the treated water in the outfall for this installation.



PROJECT
MELIADINE WEST PROJECT

PROJECT DETAIL
TIRIGANIAQ UNDERGROUND PROGRAM

TITLE
Bulk Fuel Facility
Proposed Bermed Bladder Area

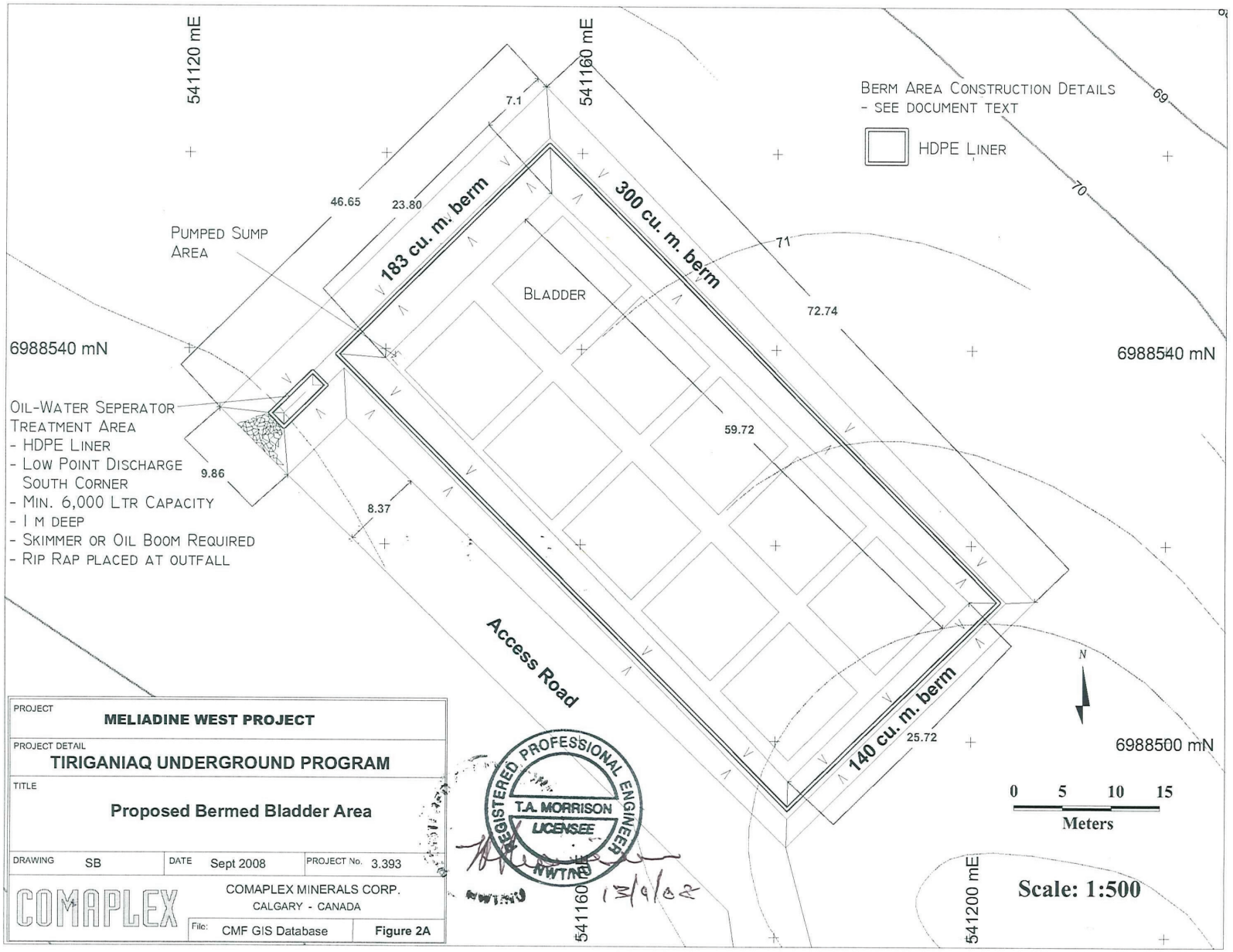
DRAWING	SB	DATE	Sept 2008	PROJECT No.	3.393

COMAPLEX

COMAPLEX MINERALS CORP.
CALGARY - CANADA

File: CMF GIS Database

Figure 2



PROJECT	**MELIADINE WEST PROJECT**		
PROJECT DETAIL	**TIRIGANIAQ UNDERGROUND PROGRAM**		
TITLE	**Proposed Bermed Bladder Area**		
DRAWING SB	DATE Sept 2008	PROJECT No. 3.393	
COMAPLEX	COMAPLEX MINERALS CORP. CALGARY - CANADA		
	File: CMF GIS Database	Figure 2A	

2. Drawings issued for construction : PHASE 2

A preliminary version of the expansion project for fuel storage facilities was prepared by Technical Services Division of Agnico-Eagle Mines, and issued on September 19, 2011. After a review of the proposed location by some personnel at the project site, it was decided to relocate the secondary containment expansion around the fuel to an area with more favorable soil conditions.

The revised drawing, found on the next page and entitled "018-210-005-R1.pdf", shows the latest revision of the project location, details the dimensions of the secondary containment , and was issued "for construction".

Project Description

1. The secondary containment berms will be located at the Meliadine Project site adjacent to the currently installed tank farm. The tank farm is situated mid-way between the Camp site and the underground portal site.

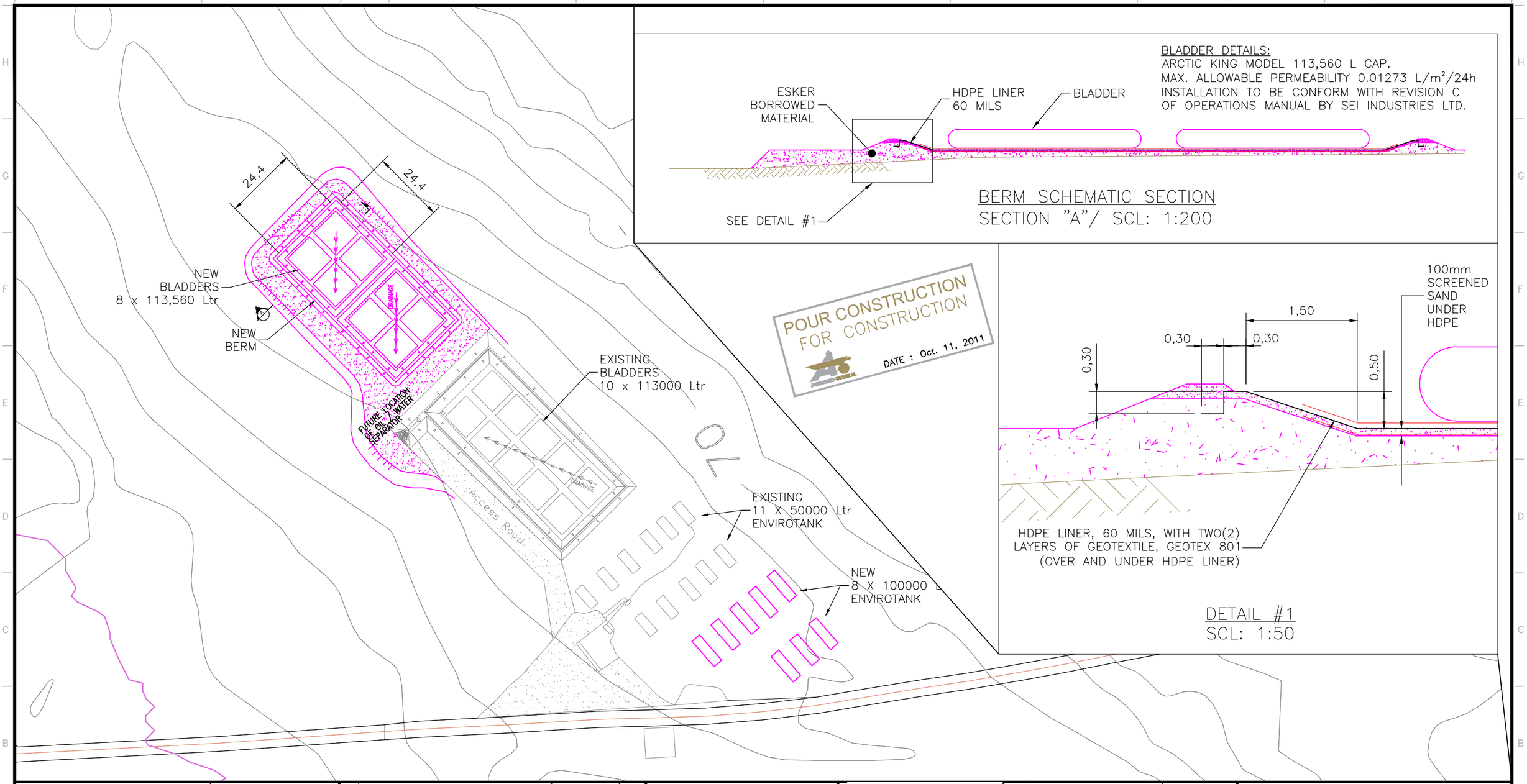
2. Access to the project site is by road from the camp. Labour will be fed and housed on site for the duration of their portions of the work. Transport to the work will be via site vehicles. Communications on site will be by radio.

3. A rectangular outline will be built prior to installation of the berm Liner – type GSE with 60 mil (1500 µm) thickness, single textured HDPE. The berm construction will be carried out by the Earthworks contractor and monitored by AEM supervision staff at site. All the installation will be verified with by a qualified person provided by the bladder manufacturer.

4. The construction of the pad and the installation of the berm liner will be done following the supplier recommendations (see the enclosed document - 2009 Arctic King Manual, issued March 2011).

NO. DESSIN
DRAWING NO.

FORMAT ANSI B–11x17



BLADDER DETAILS:
ARCTIC KING MODEL 113,560 L CAP.
MAX. ALLOWABLE PERMEABILITY 0.01273 L/m²/24h
INSTALLATION TO BE CONFORM WITH REVISION C
OF OPERATIONS MANUAL BY SEI INDUSTRIES LTD.

BERM SCHEMATIC SECTION
SECTION "A"/ SCL: 1:200

POUR CONSTRUCTION
FOR CONSTRUCTION
DATE : Oct. 11, 2011

DETAIL #1
SCL: 1:50

		1	NEW BERM RELOCATION – FOR CONSTRUCTION	2011–09–27	J.C.
TITRE / TITLE	# DWG	REV	DESCRIPTION	DATE	PAR BY
DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS		REVISIONS			

AGNICO-EAGLE

REGISTERED PROFESSIONAL ENGINEER
B.A.P. GIARD
LICENSEE
NWT/NU

DESSINÉ PAR / DRAWN BY	JOCELYN CRETE	DATE 2011–09–27
VÉRIFIÉ PAR / CHECKED BY	B. CARON, P.Eng.	2011–09–29
APPROUVÉ PAR / APPROVED BY	PATRICK GIARD P.Eng.	2011–10–11
No. PROJET / PROJECT No.	065	
DATE	2011–10–11	

TITRE / TITLE
AGNICO–EAGLE – MELIADINE DIVISION
018 Site Fuel Tank Farm
210 GENERAL ARRANGEMENT
MELIADINE WEST PROJECT
PROPOSED FUEL STORAGE EXPANSION 2012

ÉCHELLE/ SCALE 1:1250	FICHIER / FILE .DWG		
No. DESSIN/ DRAWING NO. 018–210–005		REVISION 1	FEUILLE/SHT 1 / 1

AE–CART–ANSI B

:\Seagate Backup\BUSINESSES\CAPITAL CORP\PROJECTS\2011 Projects\AEM Meliadine\Drawings\Master Drawing\018–210–005–R1.dwg, 09 Oct 2011

3. Verifications to storage capacity within secondary containment area

Within the current fuel storage expansion project, the construction of a secondary containment area is not required for the double-walled steel tanks that are projected (a.k.a. ENVIROTANKS).

For the additional fuel bladders, they will be four (4) of them grouped together within a berm.
The requirement of containment volume, as described in Section 3.9 of Publication PN 1326 of the CCME, has been calculated as shown below.

100% of the biggest bladder (113,560 L) plus 10% of the combined volume of the other three bladders (10% x 3 x 113,560).

	Volume	
Secondary Containment Requirement	**147,628**	**L**
according to ref. PN-1326, Section 3.9.1(1) 2-b-ii	130%	

DESIGN OF BERM DIMENSIONS

height (m)	width (m)	length (m)	surface (m2)			cumulative volume (m3)
0.00	**24.4**	**24.4**	595.4	**slope ratio N-S**		0.0
0.10	25	25	625.0	horizontal	vertical	122.0
0.20	25.6	25.6	655.4	3	1	250.1
0.30	26.2	26.2	686.4			384.3
0.40	26.8	26.8	718.2	**slope ratio E-W**		524.7
0.50	27.4	27.4	750.8	horizontal	vertical	671.6
				3	1	

annual precipitation

350 mm

GROSS CONTAINMENT	**671,620**	**L**
DEDUCTION OF BLADDER VOLUME @ 0.5 m height	**-227,120**	**L**
ALLOWANCE FOR SURFACE WATER VOLUME	**-262,766**	**L**
NET CONTAINMENTAVAILABLE	**181,734**	**L**

4. Technical Specifications for Construction Materials

The specific requirements that pertain to materials for this project are the following :

1) Fuel Bladders : The materials and piping used will be conform to **Environment Canada's** *Technical Requirements for Collapsible Fabric Storage Tanks*, issued on December 2009 (this document is enclosed hereafter). The fuel bladder system that has been selected is the Arctic King™ Model with 113,560 L capacity, which is manufactured by SEI Industries.

2) Granular Materials : The granular materials used to construct the secondary containment area will be free from ice and till ; being mostly composed of selected esker material, along with the use of some screened materials when deemed appropriate to insure adequate protection of the HDPE membrane.

3) Geotextile : The materials and work methods used will conform to Section 31 32 19 01 of the National Master Specification format, an edited version of which is also enclosed.

4) HDPE membrane (a.k.a. *LINER*) : The materials and work methods used will conform to Section 31 32 19 02 of the National Master Specification format, an edited version of which is also enclosed.

TECHNICAL REQUIREMENTS

FOR

COLLAPSIBLE FABRIC STORAGE TANKS

(BLADDERS)

ENVIRONMENT CANADA

December 17, 2009

TABLE OF CONTENTS

TABLE OF CONTENTS

INTRODUCTION

On June 12, 2008, Environment Canada registered the *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations*. The Regulations came into force on the date that they were registered. The purpose of the Regulations is to reduce the risk of soil and groundwater contamination due to spills and leaks of petroleum products and allied petroleum products from storage tank systems.

The Regulations set forth requirements for the design and construction of storage tank systems installed on or after the day the Regulations came into force. One requirement is that storage tanks must be designed and built to one of the recognized standards identified in the Regulations.

The Regulations cover storage tank systems that are designed to be installed in a fixed location. Although there is no recognized standard available for the design and construction of collapsible fabric storage tanks, Environment Canada recognizes these storage tanks as a legitimate option for storing petroleum products and allied petroleum products. As such, Environment Canada is publishing these Technical Requirements until a recognized standard is developed to replace them.

These Technical Requirements cover minimum requirements for design and construction of a collapsible fabric storage tank that is used for the aboveground storage of petroleum products and allied petroleum products up to and including a capacity of 125,000 L. Installations that have storage tank systems built around collapsible fabric storage tanks will be required to meet all applicable sections of the Regulations.

TECHNICAL REQUIREMENTS FOR COLLAPSIBLE FABRIC STORAGE TANKS (BLADDERS)

1. SCOPE

1.1 These Technical Requirements provide minimum requirements for collapsible fabric storage tanks ("bladders") intended for the above-ground storage of petroleum products and allied petroleum products with a relative density not greater than 1.

1.2 These Technical Requirements cover the fabrication of bladders for use in a fixed location. Bladders fabricated in accordance with these Technical Requirements are not intended for the transportation of product nor are they intended to be transported while containing product.

1.3 These Technical Requirements cover bladders which are fabricated, inspected and tested for leakage before shipment from the factory.

1.4 These Technical Requirements cover bladders that are shop-fabricated from reinforced coated fabrics or polymer films laminated onto textile substrates.

1.5 These Technical Requirements cover the design and performance of bladders having a capacity not greater than 125 000 L.

2. DEFINITIONS

2.1 "**Above-ground tank**" means a tank that operates at atmospheric pressure and that has all of its volume either above-grade or encased within an unfilled secondary containment.

2.2 "**Permeability**" is the rate of liquid transmission through a unit area and unit thickness of flat material, induced by a pressure difference (static head) between two specific surfaces, under specified temperature and humidity conditions. Expressed as $g/h/m^2/mm$.

2.3 "**Permeance**" is the rate of liquid transmission through a unit area of flat material induced by a pressure difference (static head) between two specific surfaces, under specified temperature and humidity conditions. Expressed as $g/h/m^2$.

2.4 "**Radio frequency welding**" is the method of welding thermoplastics using electromagnetic energy to generate the necessary heat and bond two parts together under pressure.

2.5 "**Secondary containment**" means containment that prevents liquids that leak from a storage tank system from reaching outside the containment area.

2.6 "**Substrate (scrim)**" is a woven, open-mesh, reinforced fabric made from continuous filament yarn.

2.7 "**Thermoplastics (thermoplastic materials)**" are polymeric materials that can be repeatedly heated to their softening point. These materials harden when cooled. This action of heating and cooling can be repeated several times without any significant change in the properties of the material.

Table 1 – Reference Documents

Document Number	Edition	Title of Document
ASTM D814	95(2005)	Standard Test Method for Rubber Property – Vapour Transmission of Volatile Liquids
ASTM D471	06	Standard Test Method for Rubber Property – Effect of Liquid
ASTM D751	06	Standard Test Methods for Coated Fabrics
ASTM D2136	02(2007)	Standard Test Method for Coated Fabrics – Low-Temperature Bend Test
ASTM D2565	99(2008)	Standard Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications
ASTM G154	06	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Non-metallic Materials
ANSI/ASME B1.20.1	1983 (R2006)	Pipe Treads – General Purpose (Inch)

3. CONSTRUCTION

3.1 CAPACITY

3.1.1 A bladder shall have a capacity no greater than 125 000 L.

3.1.2 When a nominal capacity of a bladder manufactured in accordance with these requirements is specified, the actual capacity shall be not less than the nominal capacity but not greater than the nominal capacity plus 2.5%.

3.1.3 As product is withdrawn, a bladder shall collapse so that there is no vapour space.

3.2 MATERIALS

3.2.1 The material property of the bladder shall be designed to provide continued use under the conditions expected to be encountered in the installed environment.

3.2.2 Materials that may be immersed in, or exposed to, petroleum products and allied products, or their vapours, shall have properties that will not be affected by such exposure in a manner that may cause a physical failure of the bladder or a hazardous condition during the life of the bladder.

3.2.3 A bladder shall be manufactured from a polymer fabric that consists of substrate (scrim) and topcoat:

3.2.3.1 The topcoat and substrate must be made of material that is compatible with the petroleum products and allied products being stored.

3.2.3.2 The topcoat and substrate must be able to provide continuous use under the conditions expected to be encountered at the installation site.

3.2.3.3 The topcoat must consist of a double layer of coating applied in two passes on the interior of the bladder.

3.2.4 The polymer fabric shall have a minimum tensile strength of 2000 N (787 N per cm width) when tested in accordance with ASTM D751.

3.3 WELDING

3.3.1 All seams shall be radio-frequency welded by high-frequency dielectric equipment.

3.3.2 All welding shall be done by trained individuals.

3.4 SEAMS

3.4.1 All seams shall provide a permanent bond and shall exhibit characteristics equivalent to the polymer fabric itself.

3.4.2 All seams shall be radio-frequency welded, complete with top and bottom cap strips, and body panels shall be segregated.

3.4.3 Exposed substrate along top and bottom cap strips shall be sealed inside and outside the bladder.

3.5 CORNERS

3.5.1 Corners shall be designed in accordance with good engineering practice to ensure that structural bladder integrity is maintained.

3.5.2 Corners shall be protected from abrasion.

3.6 FITTINGS

3.6.1 All fittings shall be leak-tight stainless steel flanges. If threaded fittings are used, the minimum thread length shall be in accordance with ANSI/ASME B1.20.1, Table 2.

3.6.2 All fittings shall have reinforcement patches, made of the same polymer fabric of the bladder, attached to the tank by high-frequency dielectric welding.

3.6.3 Seaming techniques and methods used to join polymer fabric to the fittings shall be such that bladder integrity is maintained.

3.6.4 All fittings shall have a design pressure of 1035 kPa (gauge) (150 psi).

3.6.5 A minimum of two fittings shall be provided on the top surface of all bladders having a capacity of 2000 L or less:

- 38 mm vent fitting
- 38 mm or 50 mm fill/drain fitting

3.6.6 A minimum of two fittings shall be provided on the top surface of all bladders having a capacity of more than 2000 L:

- 50 mm vent fitting
- 50 mm or 75 mm fill/drain fitting

3.6.7 Only one fitting may be provided below liquid level.

3.6.7.1 If this fitting is provided, it may only be used for draining the bladder when the bladder is being withdrawn from service and removed.

3.6.7.2 This fitting shall be resistant to the product that the bladder is intended to store.

3.6.7.3 This fitting shall be visible for inspection.

3.6.8 All fittings shall be equipped with weather-tight closures at the point of manufacture.

3.6.9 The closures shall be resistant to degradation in the atmosphere.

3.7 FILL OPENING

3.7.1 A wear patch shall be attached to the interior of the bladder directly below the fill opening.

3.8 TEST STRIPS

3.8.1 A minimum of nine 64-mm test strips shall be attached to the exterior top of the bladder.

3.8.2 Each test strip shall contain a 51 mm weld.

3.9 PRODUCTION TESTING

The bladder shall be evaluated for structural integrity in accordance with the following procedure:

3.9.1 Each bladder assembly shall be tested by the manufacturer after all fittings and appurtenances that are appropriate to its use have been fitted.

3.9.2 Each bladder shall be proved tight against leakage at all points including seams, threaded joints and fittings, by applying air pressure of 2 kPa (gauge) measured internally.

3.9.3 While the pressure is maintained, a liquid-soap seam test solution, or equivalent liquid, shall be brushed or poured over all seams, threaded joints and fittings, etc.

3.9.4 A complete inspection of the entire tank surface, including top and bottom, shall be conducted to detect leakage.

3.9.5 Bladders showing evidence of leakage shall be rejected. The pressure shall be removed and the bladder shall be made leak-tight and then retested.

3.9.6 After testing, the plugs in all openings shall be backed off to a hand-tight position.

3.10 SHOP-FABRICATED SECONDARY CONTAINMENT REQUIREMENTS

3.10.1 If a shop-fabricated dyke is provided as a means of secondary containment, the dyke must be capable of supporting the hydrostatic load when full of liquid.

3.10.2 The bladder must be placed entirely within a dyked area

3.11 FIELD REPAIR KIT

3.11.1 Each bladder shall include a field repair kit that contains items necessary to perform on-site repairs of punctures, tears, leaks, etc., and that is readily available in an emergency situation.

3.12 MARKING

3.12.1 Each bladder shall be marked in a permanent manner with the following information, in letters written in a height equal to or greater than that indicated below (all non-bracketed items are to be written exactly as worded; all square-bracketed items indicate the type of information to be marked):

- DANGER, FLAMMABLE OR COMBUSTIBLE LIQUID STORAGE (50 mm)
- SMOKING PROHIBITED WITHIN 6 METRES (50mm)
- KEEP ALL SOURCES OF IGNITION AT LEAST 6 METRES FROM THIS STORAGE TANK (50mm)
- MAXIMUM CAPACITY (50 mm)
- DO NOT OVERFILL – Overfilling may result in permanent damage or failure of the bladder (50 mm)
- Collapsible Fabric Storage Tank (Bladder) (12 mm)
- [Name of manufacturer] (12 mm)
- [Year/month of manufacture] (12 mm)
- Name of certifying agency (12 mm)
- [Fabrication material] (12 mm)

Information must be clearly visible to the owner or operator of the bladder. The markings must be visible when the bladder is empty and resistant to product stored."

4. PERFORMANCE

4.1 GENERAL

4.1.1 Bladder fabric shall meet the performance requirements laid out in this section.

4.1.2 The tank manufacturer shall ensure that performance testing is in conformance with a method certified by a third party testing organization in conformance with this document, using:

4.1.2.1 A document and validated test method; and

4.1.2.2 Technicians that are trained in the maintenance and use of the test equipment

Table 2 – Performance Requirements

Test	Paragraph	Test Reference	Performance
Permeance	4.2	ASTM D814	Less than 10 g/m^2/h over 24 h
Compatibility	4.3	ASTM D471 Rubber Property – Effects of Liquids	Degradation visible under 7X lens
Seam resistance	4.4	Applicable standard test method	Separation = tensile strength
Puncture resistance	4.5.1	ASTM D751 Section 18	No perforation
Bursting strength	4.5.2	ASTM D751 test method with ring clamps	Min 4000 N of bursting strength
Rough handling	4.5.3	ASTM D2136	No visible cracking
Accelerated weathering	4.7.1	ASTM D2565 or ASTM G154	No cracks or deterioration; bladder retains 80% of its tensile strength
Heath aging	4.7.2	Applicable standard test method	90% of tensile strength
Tear strength	4.8	ASTM D751 (tongue tear)	Min. tear strength: as received – 195 N conditioned – 175 N

4.2 PERMEANCE

4.2.1 Bladder fabric shall have a permeance to the liquids listed in Table 3 equal to or less than 10 g/h/m^2 over a 24-hour period.

4.2.1.1 At least three representative samples of bladder fabric shall be exposed to the liquids shown in Table 3 for 28 days at an ambient temperature of 23±2°C and a relative humidity of 50±2%.

Table 3: Exposure Liquids

A	Premium unleaded gasoline
B	ASTM reference fuel F
C	Fuel JP-8
D	Distilled water
E	Sodium chloride (saturated)

4.2.1.2 The tests shall be conducted in accordance with ASTM Test Method D814.

4.2.1.3 Calculations shall be made as per Appendix A.

4.2.2 All samples shall pass.

4.3 COMPATIBILITY

4.3.1 Mass and volume change and loss of tensile strength shall be within the limits designated in clauses 4.3.3, 4.3.4 and 4.3.5 when exposed to the liquids specified in Table 3.

4.3.1.1 At least three representative samples of bladder fabric shall be exposed to the appropriate test liquid in Table 3 for 30 days at an ambient temperature of 23±2°C.

4.3.1.2 Following exposure, the samples shall be wiped clean and dried for 2 hours at a temperature of 21±2°C.

4.3.1.3 Any presence of delamination or other degradation visible with 7X lens shall be noted.

4.3.2 Samples shall be tested in accordance with sections 10, 11 and 15 of ASTM D471.

4.3.3 The samples shall not exhibit a change in mass in excess of 10%.

4.3.4 The samples shall not exhibit a volume change in excess of 15%.

4.3.5 The samples shall retain not less than 50% of their tensile strength.

4.4 SEAM RESISTANCE

4.4.1 Seam strength shall exceed or be equal to the specified tensile strength of the polymer fabric (clause 3.2.4).

4.4.1.1 At least five specimens that are representative of the bladders shall be bonded in accordance with the manufacturer's instructions. A similar set of specimens shall be prepared from the parent fabric.

4.4.1.2 Each specimen for testing shall be cut to the size of 150 by 100 mm; for the seamed samples, the long dimension shall be perpendicular to the seam and the seam shall be equidistant from the ends of the specimen (Figure 1).

4.4.1.3 The specimens shall be conditioned for a minimum of 24 hours at 23°C ± 2°C.

4.4.1.4 Each specimen shall be secured centrally in the clamps of the testing machine, in such a way that the long dimension is parallel to the direction of application of the load. Care must be taken to ensure that the tension in the specimen is uniform across the clamped width.

4.4.1.5 The load shall be applied by the machine at a velocity of 5±0.1 mm/s until separation occurs.

4.4.2 Maximum load at separation of the seamed samples shall be equal to or exceed the specified tensile strength.

4.5 PHYSICAL RESISTANCE

Bladders shall exhibit puncture resistance, bursting strength and rough handling that meet the requirements of clauses 4.5.1 and 4.5.4.

4.5.1 Puncture Resistance

4.5.1.1 Bladders shall resist the impact of a blunt object without perforation.

4.5.1.2 Polymer fabric shall be subjected to the impact of a 1 kg instrument drop-weight impact apparatus, as illustrated by Figure 2, dropped from a height of 1 m at a temperature of 20°C.

4.5.1.3 Not less than three samples of reinforced polymer fabric, each consisting of 1 m^2 of fabric, shall be spread individually on a bed of drained wet brick-layers' sand 150 mm deep, with the impact made at the centre of the fabric sample. After the impact, the samples shall be examined for perforation.

4.5.1.4 None of the fabric samples shall be perforated.

4.5.2 Bursting Strength

4.5.2.1 Bladders shall exhibit bursting strength that meets the requirements of clause 4.5.2.4.

4.5.2.2 Representative samples shall be subjected to slowly increasing pressure until rupture or failure occurs as described in ASTM D751 Section 18.

4.5.2.3 A minimum of 10 specimens shall be prepared, each measuring at least 12.5 mm greater in diameter than the outside diameter of the testing machine.

4.5.2.4 Samples shall exhibit a bursting strength of not less than 4000 N when tested in accordance with ASTM D751 Test Method with ring clamps.

4.5.3 *Rough Handling*

4.5.3.1 Bladders shall exhibit their ability to withstand rough handling by meeting the requirements of clause 4.5.3.1.1.

4.5.3.1.1 Not less than three samples shall withstand, without failure, rough handling at temperatures of 40°C and −46°C when tested in accordance with modified ASTM D2136 as follows:

4.5.3.1.2 Test samples of fabric, each 10 mm wide occurring along 300 mm length, shall be folded over through 180 degrees.

4.5.3.1.3 A 10 kg roller, 150 mm in diameter, shall be passed over the folded sample ten times.

4.5.3.1.4 The test shall be conducted on all samples at ambient temperatures of 40°C and −46°C.

4.5.3.2 The samples shall not show visible cracking under 5X magnification.

4.6 PROOF OF DESIGN TEST

4.6.1 The representative bladder sample shall be tested to demonstrate the strength of design.

4.6.2 The test sample shall represent the bladder having the largest designed capacity in a series.

4.6.3 The tank shall be filled with water to its design capacity ± 5% and allowed to stand for a minimum of 4 hours.

4.6.4 A complete inspection of the entire tank surface shall be conducted to detect leakage.

4.6.5 Bladders showing evidence of leakage shall not have demonstrated proof of design.

4.6.6 After testing, the plugs in all openings shall be backed off to a hand-tight position.

4.6 RESISTANCE TO ACCELERATED WEATHERING AND AGING

Samples (minimum 3) of the polymer fabric, following a 480-hour exposure to ultraviolet light and water, shall not crack or deteriorate, and when tested for tensile strength, shall retain at least 80% of the values obtained in the “as received” condition.

4.7.1 *Resistance to Accelerated Weathering*

4.7.1.1 Representative samples (minimum 3) of bladders shall be subjected to accelerated weathering for 480 hours, using either of the following two options:

Option 1

Perform xenon arc exposure in accordance with ASTM D2565, using apparatus Type B, BH or E. Appropriate filters shall be used to simulate the spectral power distribution of natural daylight. For Type B or BH apparatus, use borosilicate glass, inner and outer. For Type E apparatus, use three Suprax filters. The exposure cycle shall be 102 minutes of light and 18 minutes of light and water spray (using deionized water) at a black panel temperature of 63±3°C and a relative humidity of 30±5%. The spectral irradiance shall be 0.35 W/m^2 at 340 mm.

Option 2

Perform fluorescent UV/condensation exposure in accordance with ASTM G154, using UV340 bulbs. The exposure cycle shall be 8 hours of light and 4 hours of condensation, at a black panel temperature of 63±3°C and a condensation temperature of 50±3°C.

4.7.1.2 Subsequent to the weathering, the following test shall be conducted:

4.7.2.2.1 Tensile strength as described in section 4.3

4.7.2 *Resistance to Heat Aging*

Representative samples (minimum 3) of polymer fabric shall be placed in an air-circulating oven for 60 days at 80±1°C. After a 24-hour recovery period at 21°C, the test for tensile strength shall demonstrate 90% retention of its tear strength properties as described in clause 4.8.

4.8 TEAR STRENGTH

4.8.1 Samples (10) of the polymer fabric, when tested in accordance with ASTM D751 (tongue tear), shall have a tear strength of not less than 195 newtons in the "as received" condition (i.e. without exposure to test liquids) and 175 N after exposure to the test liquids as specified in clause 4.3.

4.8.1.1 The tear strengths shall be determined on "as received" samples and on samples immersed in the test liquids.

4.8.1.2 The tear strength shall be determined on 10 samples: 127 mm (5 samples) in the longitudinal direction and 127 mm (5 samples) in the cross-roll direction. Each specimen for testing shall measure 75 mm by 200 mm and shall be cut in the centre of the shorter edge for 75 mm to form tow "tongues," each of which shall be gripped in the clamps of a recording tensile testing machine and pulled to simulate a tear.

4.8.1.3 After the tearing action is initiated, the pulling action will continue until the moving jaw has travelled for a minimum of 75 mm. The rate of travel shall be approximately 50 mm/min and shall be uniform at all times.

4.8.1.4 The tearing strength of the sample shall be calculated as the average of the tearing strengths obtained for the tested samples. If multiple-ply samples are used, the average obtained shall be divided by the number of plies per specimen.

5. LIFE EXPECTANCY

5.1 SHELF LIFE

5.1.1 Shelf life applies to all bladders. The optimal conditions to store bladders are between 10°C and 43°C with humidity between 50% and 75%. The maximum shelf life of a bladder is 10 years from the date of manufacture.

5.1 SERVICE LIFE

5.2.1 The service life begins when a petroleum product or allied petroleum product is transferred into the bladder.

5.2.2 Service life shall be tested by the manufacturer following section 4.8, using test strips as listed in section 3.8. These tests should be performed as per Table 4, beginning in year 2 and then annually.

5.2.3 The service life cannot be stopped or reversed. Service life is dependent upon climatic conditions and maintenance but shall never exceed 10 years.

Table 4: Frequency of Re-Testing

Frequency	Number of samples per test	Test
Year 2	1 sample	Tensile strength to retain 80%
Year 3 to 7, tested annually	1 sample	Tensile strength to retain 70%
Year 8 to 10, tested annually	1 sample	Tensile to strength retain 50%

6 INSTALLATION, MINIMUM INSTALLATION DISTANCES, AND MAINTENANCE

6.1 Each bladder shall be accompanied by detailed installation and maintenance requirements from the manufacturer.

6.2 Each bladder shall be accompanied by detailed repair instructions.

6.3 MINIMUM REQUIRED DISTANCES FOR INSTALLATION

6.3.1 Bladders shall be installed and maintained to have a minimum distance between the secondary containment and buildings based on the size of the secondary containment and construction or use of the building.

6.3.1.1 The distance between the secondary containment and buildings of ordinary or combustible construction having extensive window areas or associated combustible yard storage shall be two times the secondary containment diameter (if round) or diagonal (if not).

6.3.1.2 The distance between the secondary containment and buildings containing hazardous materials shall be two times the secondary containment diameter or diagonal.

6.3.1.3 The distance between the secondary containment and buildings of unknown construction or varying or unknown storage and yard storage shall be two times the secondary containment diameter or diagonal.

6.3.1.4 The distance between the secondary containment and buildings of ordinary or combustible construction not having extensive window areas, hazardous materials storage or associated combustible yard storage shall be one times the secondary containment diameter or diagonal.

6.3.1.5 The distance between the secondary containment and buildings of fire-resistive or non-combustible construction not having extensive window areas, hazardous materials storage or associated combustible yard storage shall be 0.5 times the secondary containment diameter or diagonal.

Figure 1

SAMPLE – SEAM STRENGTH

MODIFIED ASTM D 751 GRAB METHOD

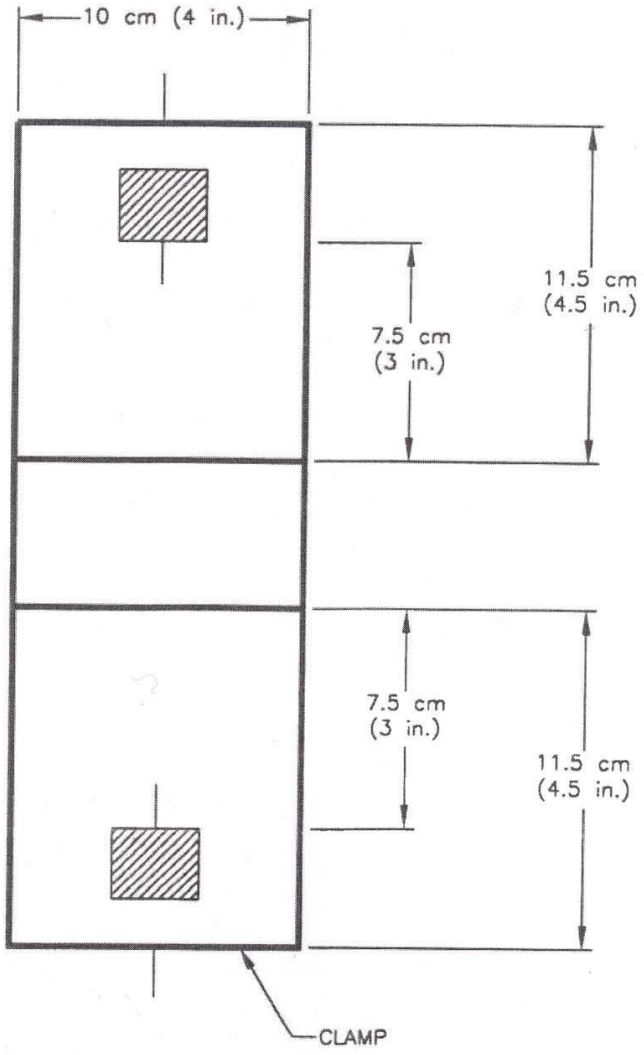
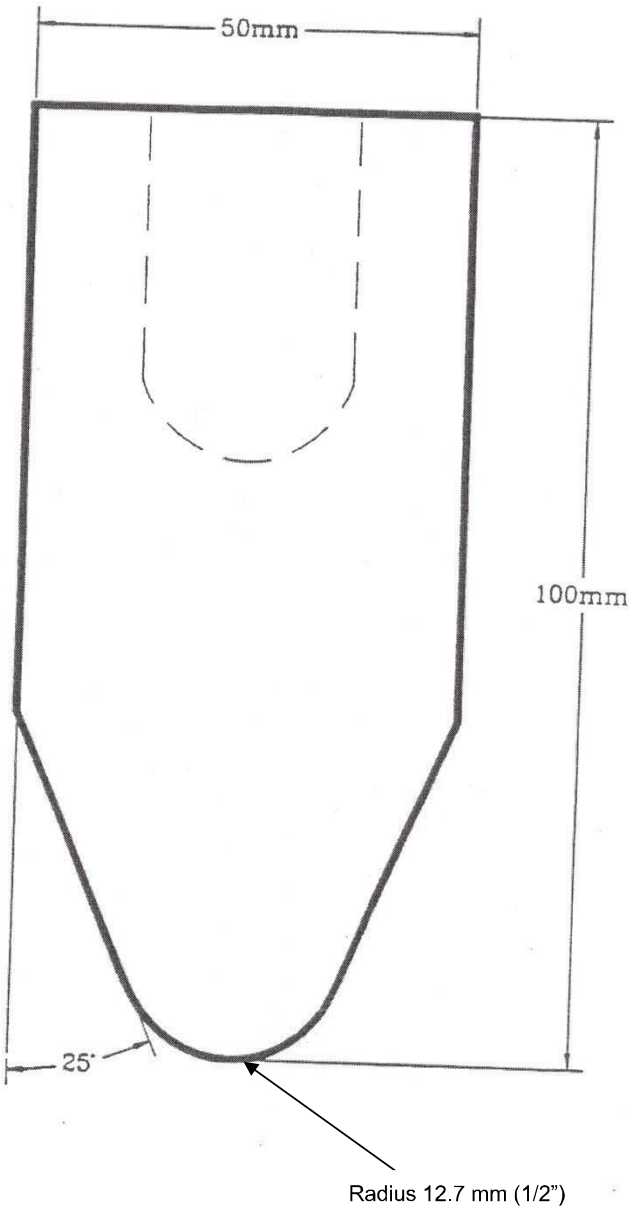


Figure 2

1 kg INSTRUMENT DROP-WEIGHT IMPACT APPARTUS



APPENDIX A

PERMEANCE AND PERMEABILITY CALCULATIONS

Using the method described in subsection 4.2, determine the mass of liquid lost over a 28-day period. From this value, together with the known exposed area of the test specimen, the following calculation can be made:

Mass of liquid lost per hour

$$= \frac{\text{Mass of liquid lost over 28 days}}{28 \times 24}$$

$$= \frac{(W1 - W28)}{672}$$

Permeance (Pc) $= \frac{\text{Mass of liquid lost per h}}{\text{area of test specimen, cm}} \times 10\,000$

$$= \frac{(W1 - W28) \times 10\,000}{672 \times a}$$

or $$= \frac{(W1 - W28) \times 14.881}{a}$$

$$= \text{\_\_\_\_\_} \ g/h/m^2$$

Where: W1 = original mass of liquid before test (g)

W28 = mass of liquid after 28 days (g)

a = exposed area of test specimen (cm^2)

Permeability (Pb) = permeance x liner thickness in $g/h/m^2/mm$

Partie 1 General

1.1 SECTION INCLUDES

.1 Materials and installation of polymeric geotextiles used in revetments, breakwaters, retaining wall structures, filtration, drainage structures, roadbeds and railroad beds purpose of which is to:

- .1 Separate and prevent mixing of granular materials of different grading.
- .2 Act as hydraulic filters permitting passage of water while retaining soil strength of granular structure.

1.2 RELATED SECTIONS

.1 Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.2 Section 31 32 19.13 - Geogrid Soil Reinforcement.

1.3 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)

- .1 ASTM D4491-99a, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- .2 ASTM D4595-86(2001), Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
- .3 ASTM D4716-01, Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
- .4 ASTM D4751-99a, Standard Test Method for Determining Apparent Opening Size of a Geotextile.

.2 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-4.2 No. 11.2-M89(April 1997), Textile Test Methods - Bursting Strength - Ball Burst Test (Extension of September 1989).
- .2 CAN/CGSB-148.1, Methods of Testing Geotextiles and Complete Geomembranes.
  - .1 No.2-M85, Methods of Testing Geosynthetics - Mass per Unit Area.
  - .2 No.3-M85, Methods of Testing Geosynthetics - Thickness of Geotextiles.
  - .3 No.6.1-93, Methods of Testing Geotextiles and Geomembranes - Bursting Strength of Geotextiles Under No Compressive Load.
  - .4 No.7.3-92, Methods of Testing Geotextiles and Geomembranes - Grab Tensile Test for Geotextiles.
  - .5 No. 10-94, Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size.

.3 Canadian Standards Association (CSA International)

.1 CAN/CSA-G40.20/G40.21-98, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.2 CAN/CSA-G164-M92(R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.

.4 Ontario Provincial Standard Specifications (OPSS)

.1 OPSS 1860-March 1998, Material Specification for Geotextiles.

1.4 DELIVERY, STORAGE AND HANDLING

.1 During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

Partie 2 Products

2.1 MATERIAL

.1 Geotextile: non-woven synthetic fibre fabric, supplied in rolls.

.1 Width: 3.5m minimum.

.2 Length: no restriction.

.3 Composed of: minimum 85% by mass of polypropylene polyester with inhibitors added to base plastic to resist deterioration by ultra-violet and heat exposure for 60 days .

.2 Physical properties:

.1 Mass per unit area: to ASTM D5261, minimum 300g/.

.2 Tear Resistance: to ASTM D4533, minimum 400 N.

.3 Hydraulic properties:

.1 Apparent opening size (AOS): to ASTM D4751, 0.212 mm.

Partie 3 Execution

3.1 INSTALLATION

.1 Place geotextile material by unrolling onto graded surface in orientation, manner and locations indicated and retain in position with pins.

.2 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.

.3 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.

.4 Overlap each successive strip of geotextile 600 mm over previously laid strip.

.5 Join successive strips of geotextile by overlapping 1000mm.

.6 Pin successive strips of geotextile with securing pints at 500 mm interval at mid point of lap.

.7 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.

.8 After installation, cover with overlying layer within 4 h of placement.

.9 Replace damaged or deteriorated geotextile to approval of Consultant.

.10 Place and compact soil layers in accordance with Section 31 23 33.01 – Excavating Trenching and Backfilling.

3.2 CLEANING

.1 Remove construction debris from Project site and dispose of debris in an environmentally responsible and legal manner.

3.3 PROTECTION

.1 Vehicular traffic not permitted directly on geotextile.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation of geomembranes for use in containment structures as an impermeable membrane.

1.2 RELATED SECTIONS

.1 Section 31 32 19 01 - Geotextiles.

1.3 MEASUREMENT PROCEDURES

.1 Geomembranes will be measured in square metres of surface covered by material. No allowance will be made for seams and overlaps.

1.4 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM D 413-[98(2002)e1], Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
- .2 ASTM D 638-[02a], Standard Test Method for Tensile Properties of Plastics.
- .3 ASTM D 746-[98e1], Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
- .4 ASTM D 792-[00], Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- .5 ASTM D 1004-[94a(2003)], Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
- .6 ASTM D 1204-[02], Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
- .7 ASTM D 1238-[01e1], Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
- .8 ASTM D 1593-[99], Standard Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting.
- .9 ASTM D 1603-[01], Standard Test Method for Carbon Black in Olefin Plastics.
- .10 ASTM D 1693-[01], Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- .11 ASTM D 882-[02], Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
- .12 ASTM D 1203-[94(1999)e1], Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods.
- .13 ASTM D 1790-[02], Standard Test Method for Brittleness Temperature of Plastic Sheeting by Impact.

1.5 QUALITY ASSURANCE

.1 Test quality of resin and membrane to ensure consistency of raw material and geomembrane quality in accordance with manufacturer's recommendations.

.2 Test seams in strength and peel at beginning of each seaming period, and at least once every [4] h if welding operation is interrupted, for each seaming apparatus and seamer used that day. Also test at least two samples from each panel, with samples taken from extra material, such that panel is not damaged and blanket geometry is not altered.

.3 If seam test specimen fails in seam, repeat on new specimen. If new specimen fails in seam, material will not be used for seaming until deficiencies are corrected and two consecutive successful test seams are achieved.

.4 Test seams by non-destructive methods over their full length, using vacuum test unit or air pressure test.

.1 Vacuum chamber to contain glass viewport and seal for sealing chamber to seam area. With chamber sealed in place and after partly filling chamber with water, apply vacuum of 17.2 kPa. Seam failure is detected by presence of air bubbles through water.

1.6 DELIVERY, STORAGE AND HANDLING

.1 During delivery and storage, protect geo-membranes from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

2 – PRODUCTS

2.1 MATERIALS

.1 Geomembrane: extruded synthetic sheet.

.1 Supplied in Prefabricated panels of size 30 m x 30 m .

.2 Composed of high density polyethylene resin with inhibitors added to base plastic to resist deterioration by ultra-violet and heat exposure.

.2 Physical properties:

.1 Specific gravity of resin: to ASTM D 1505, minimum 0.940 g/cc.

.2 Melt index of resin: to ASTM D 1238, minimum 0.05 g/min.

.3 Thickness: to ASTM D 5199,

.1 Minimum average thickness : 1500 microns.

.2 Lowest individual thickness reading : 1350 microns

.4 Tensile strength and elongation at yield: to ASTM D 6693:

.1 Yield tensile strength: minimum 22 N/mm.

.2 Yield elongation: minimum 12 %.

.5 Tensile strength and elongation at break: to ASTM D 6693:

.1 Break tensile strength: minimum 40 N/mm.
.2 Break elongation: minimum 700 %.

.6 Modulus of elasticity: to ASTM D 638, minimum 550 kPa.
.7 Tear resistance: to ASTM D 1004, Die C, minimum 187 N.
.8 Puncture resistance: to ASTM D 4883, minimum 480 N.
.9 Resistance to soil burial: maximum 10%.
.10 Dimensional stability, each direction: to ASTM D 1204, 100 degrees C, 1 hour, maximum 1%.
.11 Environmental stress crack: to ASTM D 5397 minimum 300 h.
.12 Low temperature brittleness: to ASTM D 746, Procedure B, minus 40 degrees C.
.13 Brittleness temperature: to ASTM D 1790.
.14 Carbon black content: to ASTM D 1603, minimum 2.5%, maximum 3.5% by mass.
.15 Seam strength (at yield point): 280 N and film tear bond.
.16 Seam peel adhesion: to ASTM D 6392.
.17 Total content of additives, fillers or extenders: maximum 3 % by weight.
.18 Geomembrane: free of striations, roughness, pinholes, bubbles, blisters, un-dispersed raw materials and any sign of contamination by foreign matter.

.3 Seams: welded in accordance with manufacturer's recommendations. Physical properties for resin used for welding to be same as those for resin used in manufacture of membrane.

3 - EXECUTION

3.1 INSTALLATION

.1 GEOMEMBRANE INSTALLATION

.1 Materials Logistics

.1 Transportation and On-site Storage

The geomembrane rolls shall be shipped by flatbed trailer to the job site. The geomembrane shall be stored so as to be protected from puncture, dirt, grease, moisture and excessive heat. Damaged material shall be stored separately for repair or replacement. The rolls shall be stored on a prepared smooth surface(not wooden pallets) and should not be stacked more than two rolls high.

.2 Earthwork

.1 General

The owner or his representative (soil quality assurance inspector) shall inspect the subgrade preparation. Prior to liner installation the subgrade shall be compacted in accordance with the project specifications. Weak or compressible areas which cannot be satisfactorily compacted should be removed and replaced with properly compacted fill. All surfaces to be lined shall be smooth and free of all foreign and organic material, sharp objects, or debris of any kind. The subgrade shall provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade. Standing water or excessive moisture shall not be allowed. The installer, on a daily basis, shall approve the surface on which the geomembrane will be installed. After the supporting soil surface has been approved, it shall be

the installer's responsibility to indicate to the inspector any changes to its condition that may require repair work.

.2 Anchor Trench

The anchor trench shall be excavated to the line, grade, and width shown on the project construction drawings, prior to liner system placement. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the geomembrane.14

.3 LINER specifications Method of Placement

The installer shall be responsible for the following:

.1 Equipment or tools shall not damage the geomembrane during handling, transportation and deployment.

.2 Personnel working on the geomembrane shall not smoke or wear damaging shoes.

.3 The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.

.4 Adequate loading (e.g., sand bags or similar items that will not damage the geomembrane) shall be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

.4 Weather Conditions

Geomembrane deployment shall proceed between ambient temperatures of 32° F and 104° F. Placement can proceed below 32° F only after it has been verified by the inspector that the material can be seamed according to the specification. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew) or in the presence of excessive winds, as determined by the installation supervisor.

.5 Field Seaming

.1 This Design with Prefabricated HDPE Panels involves no field seaming. The design requires only the unfolding of panels of 30 m x 30 m size.

.2 Non-Destructive Seam Testing (if repairs to HDPE panels are required)

Non-destructively test all field seams over their full length.

A. Vacuum Box Testing Equipment for testing extrusion seams shall be comprised of the following:

.1 A vacuum box assembly consisting of a rigid housing, a transparent viewing window, asoft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuumgauge.

.2 Soapy solution in a plastic bucket with a mop.

.1 The following procedures shall be followed by the installer:

.1 Excess sheet overlap shall be trimmed away.

.2 Wet a strip of geomembrane approximately 12 inches wide by the length of box with the soapy solution.

.3 Place the box over the wetted area and compress.
.4 Create a vacuum of 3 - 5 psig.
.5 Ensure that a leak-tight seal is created.
.6 For a period of approximately 10 seconds, examine the geomembrane through the viewingwindow for the presence of animated soap bubbles. 16
Poly-Flex LINER specifications
.7 If no animated bubbles appear after 10 seconds, close the vacuum valve and open thebleed valve, move the box over the next adjoining area with a minimum 3 inches overlapand repeat the process.
.8 All areas where animated soap bubbles appear shall be marked, repaired and then retested. The following procedures shall apply to locations where seams cannot be non-destructivelytested.
.1 If the seam is accessible to testing equipment prior to final installation, the seam shall benon-destructively tested prior to final installation.
.2 If the seam cannot be tested prior to final installation, the seams shall be spark testedaccording to the spark tester manufacturer's procedures.

B. Air Pressure Testing (For Double Fusion Seams Only) Equipment for testing double fusion seams shall be comprised of the following:
.1 An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi.
.2 A pressure gauge equipped with a sharp hollow needle. The following procedures shall be followed by the installer:
.1 Seal one end of the seam to be tested.
.2 Insert needle or other approved pressure feed device through the sealed end of the channelcreated by the double wedge fusion weld.
.3 Energize the air pump to verify the unobstructed passage of air through the channel.
.4 Seal the other end of the channel.
.5 Energize the air pump to a pressure between 25 and 30 psi, close valve, allow 2 minutesfor the injected air to come to equilibrium in the channel, and sustain pressure for approximately 5 minutes.
.6 If loss of pressure exceeds 4 psi, or pressure does not stabilize, locate faulty area, repair and retest.
.7 If pressure does not drop below the acceptable value after five minutes, cut the air channelopen

at the opposite end from the pressure gauge. The air channel should deflateimmediately indicating that the entire length of the seam has been tested.

.5 Destructive Seam Testing
NOT APPLICABLE

.6 Defects and Repairs
All seams and non-seam areas of the geomembrane shall be inspected by the inspector for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection.

A. Evaluation
Each suspect location in seam and non-seam areas shall be non-destructively tested as appropriate in the presence of the inspector. Each location that fails the non-destructive testing shall be marked by the inspector, and repaired accordingly.

B. Repair Procedures
.1 Defective seams shall be cap stripped or replaced.
.2 Small holes shall be repaired by extrusion welding a bead of extrudate over the hole. If the hole is larger than 1/4 inch, it shall be patched.
.3 Tears shall be repaired by patching. If the tear is on a slope or an area susceptible to stress and has a sharp end it must be rounded prior to patching.
.4 Blisters, large cuts and undispersed raw materials shall be repaired by patches.18
Poly-Flex LINER specifications
.5 Patches shall be completed by extrusion welding. The weld area shall be ground no more than 10 minutes prior to welding. No more than 10% of the thickness shall be removed by grinding. Welding shall commence where the grinding started and must overlap the previous seam by at least 2 inches. Reseaming over an existing seam without regrinding shall not be permitted. The welding shall restart by grinding the existing seam and rewelding a new seam. Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects.

C. Verification of Repairs
Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved. The inspector shall

keep daily documentation of all non-destructive and destructive testing. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

.5 Cover Material and Backfilling of Anchor Trench

The geomembrane shall be covered as soon as possible. The covering operation shall not damage the geomembrane. The cover soil material shall be free of foreign and organic material, sharp objects, or debris of any kind, which could potentially damage the geomembrane. No construction equipment or machinery shall operate directly on the geomembrane. The use of lightweight machinery (i.e., generator, etc.) with low ground pressure is allowed. The anchor trench shall be backfilled by the earthwork contractor. Trench backfill material shall be placed and compacted in accordance with the project specifications. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. If damage occurs, it shall be repaired prior to backfilling.

.6 Geomembrane Acceptance

The installer shall retain all ownership and responsibility for the geomembrane until accepted by the owner. Final acceptance is when all of the following conditions are met:

.1 Installation is finished.

.2 Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

3.3 PROTECTION

.1 Do not permit vehicular traffic directly on membrane.

END OF SECTION

5. Projected Construction Methods

a. Native Materials

i. Selected Esker material for pad foundation

ii. Screened Esker material for top finish layer

b. Manufactured Materials

i. Geotextile Membrane – GSE NW16 non-woven

ii. Berm Liner – GSE 60 mil single textured HDPE liner – one piece no welding

iii. Fuel Bladders – 8 x ~113,500 liter (each)

iv. Fuel Hose – 3" hose x 16', 3" hose x 33', Tee connections, Cross connections

v. Ball valves where required

vi. Pressure relief valves will be installed, if ever permanent steel piping is used.

vii. Dispensing Pump, 50 USGPM

c. Equipment required (already on-site)

i. Cat 966 Loader

ii. Cat 320 Excavator

iii. 9 cu.yd. tandem haul truck

iv. Spreader bar and chains – for liner installation

v. Light Plant

vi. Frost Fighter unit c/w fan & ducting

d. Manpower

i. 1 x AEM construction supervisor

ii. 3 x Earthwork contractor employees - construction of the pad

iii. 4 x laborers for liner install

iv. 1 x Specialized Technician from bladder manufacturer for quality control. (SEI Industries Ltd.) consultants on field

v. 1 x Mechanic – Install fuel filters & meter to existing pump station

Arctic King Fuel Tanks meet the Environment Canada TECHNICAL REQUIREMENTS FOR COLLAPSIBLE FABRIC STORAGE TANKS (BLADDERS) - December 17, 2009

1. **Fuel Bladders**
   a. The fuel bladder should be manufactured from a polymer fabric that consists of substrate (scrim) and topcoat (polyester) or (polyether) based polyurethane. The top coating must be compatible with the fuel being stored and the climate at the installation site. The substrate (scrim) is typically polyester or nylon woven base material.

   b. Material shall be suitable for environmental conditions found in Arctic operations:

      i. Fabric should have strength characteristics equal to or exceed Mil-T-52983E.
      ii. Fabric should have double off-set urethane coating facing the fuel.
      iii. Fabric shall have passed low temperature bend per ASTM D-2136.

   c. All seams shall be radio frequency (RF) welded, complete with top and bottom cap strips, and body panels should be segregated. The welded seam strength shall be equal to or greater than the base material strength.

   d. Exposed substrate along top and bottom cap strips should be sealed inside and outside of the bladder.

   e. Tank capacity should be engineered to ensure the tank dimensions are correct for the intended volume with min 5% over capacity for volume expansion due to temperature changes. Static loading on base fabric and seams shall be less than one fifth the tensile strength of the base fabric.

   f. Corners should be designed according to acceptable engineering practices. Square corners should be protected from abrasion.

   g. Tanks shall be leak-tested at place of manufacturing and certified by the manufacturer to be free from leaks. Furthermore, tanks should include a vent and any interconnecting piping shall be pressure tested for leaks.

   h. Tanks shall include test strips for nine years of annual integrity testing.

   i. The bladders shall include design criteria and drawings that are stamped by a professional engineer.

   j. Bladders are designed for static storage only.

   k. Bladders should not exceed 125,000 litres in capacity.

2. **Secondary Containment Above Ground Berms**
    a. Secondary containment above ground berms should be constructed from a material impervious to petroleum products and be suitable for the environment they are being used in.

    b. Above ground berm wall supports should be made from aluminum metal and be able to hold the entire berm while full of liquid.

    c. Metal frame-supported above ground berms with single or double horizontal wall supports and vertical wall supports at every 5' (1.5 m) intervals should be used for bladder tanks.

    d. Each above ground berm should be engineered specifically for the supplied fuel bladder or installation to ensure the berm is able to accommodate 110% of the maximum bladder volume in the event of spillage including catastrophic failure.

    e. Above ground berms to be used with fuel bladder storage tanks should be supplied with stamped professional engineered drawings and engineering approval check list.

    f. Above ground berms should include corner drains with plugs installed in four corners of the berm.

    g. Above ground berm fabric should be fire resistant to ULC ORD C58.9.

3. **Secondary Containment Berm Liners**
    a. Secondary containment berm liners should be constructed as per ULC-ORD-C58.9-1997.

    b. The material shall be impervious to petroleum products and be suitable for the environment they are being used in.

    c. 6" (15 cm) of clean sand should be placed on top of the berm liner.

    d. Each berm liner should be engineered specifically for the supplied fuel bladder or installation to ensure the berm is able to accommodate 110% of the maximum bladder volume in the event of spillage including catastrophic failure.

    e. Each berm liner should include a sump to collect rain water/snow melt and include a provision for an oil/water separator.

        i. **Note:** Decommissioning of secondary containment berm liner systems must include on/off site soil reclamation that should be specified by a soil scientist. Consult local regulations for further information.

4. **Oil/Water Separator**
    a. An oil water separator shall be used to treat precipitation collected in the bermed secondary containment prior to discharge.

    b. The oil water separator must be designed to produce a discharge of water that will not contain more than 15 mg/L of free oil and grease.

    c. The oil/water separator must be designed to withstand freezing of liquid inside the system.

5. Installation

a. All fuel bladders should be installed as a system that includes a secondary containment system, as listed above, with an oil/water separator

b. Systems should be installed on level ground.

c. The installation of fuel bladder systems should be under the direction of a trained field service representative. Upon completion, as-built drawings and an installation report should be provided to the operator.

d. The operator should be trained on the proper use and maintenance procedures for fuel bladder systems and shall be provided operator manuals.

e. As per *Environment Canada Regulations* bladders shall be installed and maintained to have a minimum distance between the secondary containment and buildings based on the size of the secondary containment and construction or use of the building.

The distance between the secondary containment and buildings of ordinary or combustible construction having extensive window areas or associated combustible yard storage shall be two times the secondary containment diameter (if round) or diagonal (if not).

The distance between the secondary containment and buildings containing hazardous materials shall be two times the secondary containment diameter or diagonal. The distance between the secondary containment and buildings of unknown construction or varying or unknown storage and yard storage shall be two times the secondary containment diameter or diagonal.

The distance between the secondary containment and buildings of ordinary or combustible construction not having extensive window areas, hazardous materials storage or associated combustible yard storage shall be one times the secondary containment diameter or diagonal.

The distance between the secondary containment and buildings of fire-resistive or non-combustible construction not having extensive window areas, hazardous materials storage or associated combustible yard storage shall be .5 times the secondary containment diameter or diagonal.

6. **Maintenance and Inspection**
   a. Regular monthly maintenance inspections shall be conducted for fuel bladders, secondary containment and oil/water separator systems and records should be kept.

   b. Fuel bladders are equipped with nine (9) integrity strips. A strip is cut from the bladder after the second year of use and annually after year two. The test strips are sent to the manufacturer where they are tested for integrity. Reports are returned to operators for inspection purposes. Wet date and fuel type should be recorded once the bladder is installed.

   c. Operators shall provide provisions for fuel inventory reconciliation at timed intervals.

   d. Operators should ensure that snow loads do not exceed manufacturer's specifications.

   e. Operators should keep the surface of the tank clean, removing any sand or dirt that has fallen on it.

   f. Operators should clean out dirt or sand and make sure the vent is working properly.

   g. Operators should ensure that secondary containment berms are drained of water. This can be accomplished by an oil/water separator.

7. **Other**
   a. A spill prevention plan should be developed for each site in accordance with local regulations.
   b. A spill kit should be provided at site.
   c. Fire suppression equipment should be provided at site.
   d. No smoking signs should be provided at site.
   e. Secondary containment should be placed around all fuel transfer areas and equipment.
   f. The site must be clearly marked and access restricted to trained personnel.
   g. Addition requirements should be reviewed with local regulation and legislation and must be adhered to.

8. **Website**
   www.sei-ind.com

9. **Comments**
   Please forward comments to:

Paul Reichard, Division Manager, Email: paul@sei-ind.com
SEI Industries Ltd, Tel: (604) 946-3131