

HDPE LINER

PART 1 GENERAL

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| 1.01 OTHER CONTRACT DOCUMENTS | The General Conditions of the Contract, General Requirements, and Supplemental Conditions attached hereto shall apply to and be part of this Section. |
| 1.02 DESCRIPTION OF WORK | The Work described herein is for the supply and installation of a High Density Polyethylene (HDPE) geomembrane hydraulic liner, including quality control testing and associative work. |
| 1.03 RELATED WORK | Section 02700 Sewers |
| 1.04 SUBMITTALS | <p>The Contractor shall provide the Engineer with the following submittals.</p> <ul style="list-style-type: none"> .1 Written confirmation stating the liner and extrusion welding wire supplied conforms to the requirements of the Specifications and all products used for the installation of the liner are compatible with any other product being used in the installation of the liner. .2 The onsite quality control program that will be implemented by the Contractor including sampling, testing, and repair procedures. .3 A drawing of the proposed panel layout showing all seams and special details including the seal around the leachate collection pipe. .4 Written confirmation from the manufacturer of the HDPE liner stating the Contractor is an authorized installation agent certified to install geomembranes produced by the manufacturer. <p>Work shall not commence until the Engineer has received and reviewed all submittals.</p> |
| 1.05 WARRANTY | The geomembrane manufacturer shall provide a 20 year written warranty, signed by an authorized officer of the manufacturer, to the City stating the geomembrane conforms to the Specifications and is free of defects at the time of installation. Should defects or loss of use occur during the Warranty period, the manufacturer of the geomembrane shall supply replacement materials and undertake all necessary repairs. The City will reimburse the manufacturer on a pro rata basis only for that portion |

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of the warranted 20 year life which has elapsed since the installation of the geomembrane was first accepted.

PART 2 PRODUCTS

2.01 HDPE RESIN

The geomembrane liner panels and extrusion welding wire shall be manufactured from new High Density Polyethylene (HDPE) resin with no additives or fillers added with the exception of carbon black which may be added to increase ultra violet resistance.

The HDPE resin shall meet the following specifications:

Specific Gravity ASTM D729	>0.940
Melt Index ASTM D1238E	<0.4 g/10 min
Carbon Black Content ASTM D1603	2-3%

2.02 MEMBRANE

The thickness of the geomembrane liner shall be as stated in Section 01001 Supplemental Conditions.

The geomembrane panels shall be new, free of striations, roughness, holes, bubbles, blisters, gouges, rips, edge tears, undispersed raw materials, reworked materials, or contamination by foreign matter. The geomembrane shall be supplied on 6.7 metre (minimum) wide rolls. Each roll shall be seamless across its entire width and shall have factory applied labels which clearly identify the manufacturer of the geomembrane, the date of manufacture, the product type, nominal thickness of the material, the resin batch and roll numbers, and the length, width and weight of each roll.

**2.03 EXTRUSION
WELDING WIRE**

Extrusion welding wire or beads shall be manufactured from the same material as the geomembrane to be seamed. The extrusion welding wire shall be supplied on rolls with labels which clearly identify the manufacturer of the welding wire, the date of manufacture, the product type, nominal diameter of the material, and the resin batch number.

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PART 3 EXECUTION

**3.01 STORAGE AND
HANDLING**

Geomembrane materials shall be transported, handled and stored in accordance with the manufacturer's recommendations and in such a manner to protect them from ultraviolet rays, chemical damage, dirt, dust, grease, puncture, abrasion, moisture, excessive heat, or any other damage. Upon arrival at the Site, the Contractor shall record all the data from the labels attached to each roll of geomembrane material and/or extrusion wire. Off-loading of all materials shall be done only when the Engineer is present to observe. Any damaged roll shall be separated from the undamaged rolls until the disposition of the material has been determined by the Engineer.

**3.02 MEMBRANE
SAMPLES**

In the presence of the Engineer, the Contractor shall remove, from across the entire width of each roll of geomembrane, a one (1) metre wide sample. Each sample shall be divided into two parts, one to be retained by the Engineer for his records with the other retained by the Contractor. The Contractor shall clearly record on each sample, the date of sampling and the roll number.

3.03 LINER PLACEMENT

The Contractor shall place the geomembrane in accordance with the manufacturer's recommendations and reviewed panel layout drawing. Placement shall proceed between the ambient temperatures of 5° C to 40° C. Geomembrane deployment will NOT be conducted during any precipitation, in the presence of excessive moisture, in an area of standing water, or during high winds. The Contractor shall not deploy more geomembrane material than can be welded on the same Working Day.

The method used to unroll the geomembrane shall not cause scratches or crimps in the geomembrane panels or damage to the supporting sub-grade. Panels shall be floated into place and not dragged, and be deployed with slack to allow for typical thermal expansion. Equipment shall be low ground pressure units. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane. Direct contact with the geomembrane in

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traffic areas shall be prevented by using a geotextile, additional geomembrane or another material as a temporary protective cover.

3.04 PANEL INSPECTION

The upper face of each geomembrane panel shall be permanently marked with a unique number. The Contractor shall deploy the geomembrane panels parallel to the line of maximum slope (down not across the slope) and in corners and odd shaped geometric areas the panels shall be orientated to minimize the number of welds and seams.

The geomembrane shall be placed down the side and across the base of the anchor trench as shown on the Drawing. In general, seams shall be oriented along not across the slopes. Whenever possible, horizontal seams shall be located on the base of the cell, no closer than 2.0 metres from the toe of a slope and shall be aligned with the least possible number of wrinkles.

When in position, the Contractor shall weight down each panel with sandbags to prevent movement by wind or other disturbances. Panels which are wind blown or dragged shall be inspected for blemishes, scratches, and other imperfections and repaired or replaced as directed by the Engineer.

Geomembrane panels shall have a minimum smooth continuous overlap of 125 mm for split wedge welded fusion seams and 100 mm for extrusion welded seams. The Contractor shall mark the overlap on the underlying sheet with white indelible ink prior to welding. Failure to maintain adequate overlap may be cause for rejection of the seam.

Side slope material may be deployed for welding on a horizontal surface. However, care must be taken during relocation to prevent the underside of the panels from being excessively scratched or gouged and to protect the edge flaps from dirt, sand or gravel intrusion.

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The Contractor shall visually inspect each geomembrane panel after placement and mark with white indelible ink and record the location of any abnormality or damage which may affect the physical properties of the geomembrane liner. For each length of roll of geomembrane installed, the total number of defects allowed before replacement is required shall not exceed ten per 500 square metres.

The Contractor shall measure the thickness of each geomembrane panel along its entire length (minimum of 5 measurements) and across the width (minimum of 3 measurements) with a micrometer. Each measurement shall be recorded on a written table and on the face of the liner at the location of the measurement and shall be within the nominal specified thickness of the geomembrane by no more than ten percent (10%). The mean of the measurements along the length plus the measurements across the width of the geomembrane shall be greater than the nominal specified thickness of the geomembrane. Failure to meet the thickness tolerances will be cause for rejection of the entire geomembrane panel.

3.05 TRIAL WELDING

Prior to welding the geomembrane panels, specimen trial welds shall be made and tested for each welding machine and operator combination as follows:

- at the start of each shift of welding; or
- when a new operator or machine starts welding;
or
- when a machine is adjusted or repaired; or
- when welding operations have ceased for more than one hour; or
- when requested by the Engineer: or
- when there is a change in ambient conditions.

Trial welds shall be made at a location adjacent to the proposed work and where the panels are in contact with the sub-grade. Weld lengths shall be a minimum of one (1) metre for fillet extrusion welding machines and a minimum of two (2) metres for split wedge fusion welding machines, with the seam centered lengthwise along the sample. Each trial weld shall be marked with

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white indelible ink listing the date, time of day, ambient temperature, and welding machine number and shall be subjected to destructive testing for shear and peel as outlined in Part 3.08 of this Section.

No welding machine or operator shall be allowed to perform any field welds until a successful trial weld test has been approved by the Engineer.

3.06 FIELD WELDING

All field welds shall be constructed in accordance with EPA 530/SW89/069 'A Technical Guidance Document: The Fabrication of Polyethylene FML Field Seams' and in accordance with the geomembrane manufacturer's recommendations. Field welding shall be done by a qualified welder, experienced in welding HDPE membranes using the fillet extrusion or split wedge fusion welding equipment recommended or provided by the membrane manufacturer.

The welding equipment shall be capable of continuously monitoring and controlling temperatures in the zone of contact where the machine is actually fusing the lining to prevent a change in temperature from affecting the integrity of the weld or geomembrane material.

All welds shall be split wedge fusion wherever possible. Fillet extrusion welds shall be used for patches, repairs, overlays, or around pipe connections. Welding shall only be done when the ambient temperature is between 10°C and 30°C. If the temperature is below 10°C a hot air gun shall be used to preheat the area to be welded. No welding shall be done when the ambient temperature is below 0°C, or in the presence of excessive moisture (fog, rain, dew) or excessive winds.

The Contractor shall inspect and repair all panel edges prior to any welding. Any excess sheet overlap shall be trimmed away and the membrane panels shall be aligned and the surfaces to be welded shall be maintained in a clean, smooth and wrinkle free condition until the weld is completed. Also, for extrusion fillet welds both membrane surfaces shall be lightly buffed with a hand grinder (80 grit paper), no more than 10 minutes prior to

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seaming, to remove any surface contamination and tension. Grinding shall not extend more than 6 mm past the edge of the area covered by the extrudate during welding. Grind marks shall be covered with extrudate whenever possible.

The Contractor shall purge the extruder prior to beginning any seam to remove all heat degraded extrudate from the barrel. All welds shall be tightly bonded and shall be inspected for defects by the Engineer.

All seams shall extend through the anchor trench. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day, to allow for typical thermal expansion of the geomembrane. Prior to welding cross/butt seams, the top and bottom overlap of intersecting fusion welded seams shall be trimmed to 150 mm. Intersecting extrusion fillet- welded seams shall be ground to flatten the extrusion bead prior to welding butt seams. All 'T' joints produced as a result of cross/butt seams shall be extrusion fillet welded. Overlap on each leg of the 'T' joint will be trimmed back 150 mm, and then grind 75 mm minimum of each of the 3 legs of the 'T' and extrusion weld all of the area prepared by grinding.

**3.07 NON DESTRUCTIVE
TESTING**

The Contractor shall non destructively test all field seams over their full length. All test equipment required to perform non destructive testing shall be supplied and maintained by the Contractor and approved by the Engineer prior to use.

Fillet extrusion welds, including patch welds shall be tested with a vacuum box. The Contractor shall wet a 300 mm by 1200 mm (length of box) section of geomembrane seam with a soapy solution, place the vacuum box over the wetted area (maintain a 75 mm overlap with any previously tested seam) and compress to produce a leak tight seal. A 250mm mercury vacuum is applied for 15 seconds during which time the seam is examined through the viewing window for the presence of soap bubbles. All areas where soap bubbles appear shall be marked, repaired and tested again.

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Split wedge welded seams shall be tested by air pressure applied to the enclosed space created between the two fusions paths of the seam. The Contractor shall seal one end of the seam to be tested and insert a manometer equipped with a sharp hollow needle through the end of the channel between the double weld. The air pump shall be energized to verify an unobstructed passage of air through the channel. The Contractor shall then seal the other end of the channel, apply and sustain a pressure of between 175 kPa and 210 kPa for 10 minutes. If the loss of pressure exceeds 20 kPa, or the pressure fails to stabilize, the Contractor shall locate and repair the leak as outlined in Part 3.09 of this Section and retest the seam. At the end of a successful test, the Contractor shall cut the end of the seam furthest from the pressure supply and observe the rapid and total loss of pressure in seam. If the pressure does not release in cutting, the Contractor shall locate the pressurized area by cutting the seam closer to the pressure supply and repeat the pressure test until the entire seam length has been acceptably tested. The Contractor shall then seal both ends of the seam and repair any damages caused by the testing procedure.

If a weld cannot be tested prior to final installation, the seam shall be cap stripped over the entire length which is inaccessible.

**3.08 DESTRUCTIVE
TESTING**

For every 5,000 square metres of geomembrane installed, the Contractor shall supply a letter of certification from a previously approved independent laboratory documenting test results for the following;

Thickness	ASTM D5199
Carbon Black Dispersion	ASTM D3015
Density	ASTM D1505
Melt Index	ASTM D1238
Stress at yield and at break	ASTM D638
Elongation at yield and at break	ASTM D638

In addition to the requirements for submitting trial welds for destructive testing, the Contractor shall provide the Engineer with a minimum of one series of destructive tests per 200 metres of field welded seam length. The Engineer shall determine the location of each sample and

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shall observe it's removal. The sample shall be 300 mm wide by 1000 mm long with the weld centered lengthwise and shall be obtained while the membrane panels are being field welded. Each sample shall be cut into two equal length pieces, half to be given to the Engineer for his records with the remaining half used by the Contractor for the destructive testing. The Contractor shall maintain a record of the date, time, location, roll number, seam number, and ambient temperatures and attach a copy of this information to each half of the sample. All holes in the geomembrane resulting from the sampling shall be repaired as outlined in Part 3.09 of this Section.

Each test sample or trial weld shall be cut into ten (10) 25mm wide test tabs which shall be subjected to qualitative destructive testing in peel and shear modes using a calibrated electronic or hand cranked tensiometer. Both tracks of a split wedge fusion weld shall be tested.

**3.09 MEMBRANE
REPAIRS**

All field seams and trial welds shall meet the following specifications:

Shear Strength ASTM D308 (as modified in App A of NSF 54) > 90% of yield strength Film Tear Bond

Peel Strength ASTM D413 (as modified in App A of NSF 54) > 70% of yield strength Film Tear Bond

NSF : National Sanitation Foundation Standard 54 Flexible Membrane Liners.

FLB : Film Tear Bond, defined as failure of one of the sheets by tearing, instead of separating from the other sheet at the weld interface areas (sheet fails before weld fails).

For individual specimens, separation shall not occur within the weld. A break through the weld or at the weld sheet interface shall be considered a Non FG TB (failure) in both shear and peel tests. If any specimen is non-conforming, the entire procedure shall be repeated. The Contractor shall clearly mark each location and fully document all actions taken in conjunction with destructive test failures. The Engineer reserves the right to have the remaining portion of a sample tested by an independent laboratory to verify field results.

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All test equipment required to perform destructive testing shall be supplied and maintained by the Contractor and approved by the Engineer prior to use.

If a sample fails a destructive or non destructive test the Contractor shall either isolate the area where the welding is unacceptable by removing and testing additional samples from either side of a failed sample location (at a minimum of 3.0 metres from the location of the failed test), or he may reconstruct the entire weld or apply an additional piece of geomembrane over the entire area where the seam welds have failed.

All welds and surface areas of the geomembrane shall be inspected by the Contractor and the Engineer for defects. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembranes shall be clean at the time of inspection. The geomembrane surface shall be brushed, blown, or washed by the Contractor if the amount of dust or mud inhibits inspection. This inspection shall be done immediately after placement of the liner panel. Any membrane area showing injury due to excessive scuffing, puncture or distress from any cause shall be replaced or repaired in accordance with HDPE repair procedures.

Pockmarks and pinholes smaller than the tip of the extruder shall be repaired by buffing and applying an extrusion bead of HDPE. Punctures, holes, tears, blisters, undispersed raw materials, and contamination by foreign matter wider than the tip of the extruder shall be repaired with fusion or extrusion welded patches. Sharp ends shall be rounded prior to patching. Patches shall be round or oval in shape and manufactured from the same compound and to the same thickness as the geomembrane specified, and shall extend a minimum of 150 mm beyond the edge of any defect. All patches shall have the top edge bevelled and buffed with no more than 10% of the thickness of the liner material removed. Wrinkles or fish mouths within seams shall be repaired by cutting and over-lapping the membrane material and seaming with an extrusion fillet weld.

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Re welding of a failed fusion seam shall begin with the removal of the upper overlap of the fusion seam. This shall be done without damage to the liner beneath. Sufficient lap shall be left to allow grinding of upper and lower sheets without producing grinding marks deeper than 10% of the liner thickness. Split wedge fusion welding shall commence where the grinding started and must overlap the previous seam by at least 300mm. Re-welding over an existing seam without regrinding shall not be permitted.

All repairs shall be non destructively tested. In addition, the Engineer may request samples of any repaired seam be taken for destructive testing as outlined in Part 3.08 of this Section. Repairs that pass the non-destructive testing shall be considered adequate. Repairs that fail the non destructive tests shall be repaired and again tested until the repaired seam is judged satisfactory by the Engineer.

The Contractor shall document all non destructive and destructive testing shall form part of the as built report. This documentation shall identify all seams that initially failed the test and include evidence that these seams have been repaired and successfully re tested.

3.10 DRAINAGE LAYER

Procedure and equipment must be approved by the Engineer prior to starting the Work. Sand shall be placed in 300 mm lifts and in such a manner to prevent any damage to the geomembrane liner. The sand shall be spread with a wide pad tracked loader (or backhoe on the slopes). No rubber tired equipment shall be allowed on the liner unless a minimum of 900 mm of sand is placed on top of the liner in the area of travel. All rocks over 25mm in diameter, sharp objects and debris shall be removed before material is spread. All grade stakes or markers shall be constructed of Styrofoam (wood stakes will not be allowed on the Site).

3.11 AS BUILT RECORDS

The Contractor shall provide a written and signed report following completion of the Work which shall certify the geomembrane liner has been installed in accordance with the manufacturer's recommendations, is ready for use by the City of Brandon, and the warranty is in effect.

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**3.12 GEOMEMBRANE
ACCEPTANCE**

The report shall include all of the Contractor's quality control test results, a record drawing indicating product deployment, panel identification, pipes, repairs and destructive test locations and types of repairs.

The Contractor shall retain all ownership and responsibility for the geomembrane until acceptance by the Engineer.

The geomembrane liner shall be accepted by the Engineer when all of the following conditions are met:

Installation of liner and drainage layer is completed; and

All field welds and repairs have been tested and have meet the intent of the Specifications; and

Certification, including as built records have been received and accepted by the Engineer.

END OF SECTION