1 General

1.1 **SECTION INCLUDES**

.1 Labor, Products, equipment and services necessary for the installation of a cold fluid-applied (poly-rubber gel) waterproofing system for underground station surfaces, as shown on the Contract Drawings and as specified in this contract specification.

.2 Work in this Section is indicated on Contract Drawings as indicated.

1.2 **REFERENCES**

.1 ASTM C 836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.

.2 ASTM C 1135 - Standard Test Method for Determining Tensile Adhesion Properties of Structural Sealants.

.3 ASTM D 56 - Standard Test Method for Flash Point by Tag Closed Cup Tester.

.4 ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

.5 ASTM D 751 - Standard Test Methods for Coated Fabrics.

.6 ASTM D 1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.

.7 ASTM D 2196-05 – Standard Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer.

.8 ASTM E 96 (Method B) - Standard Test Methods for Water Vapor Transmission of Materials.

.9 ASTM E 154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

.10 ASTM E 1745 - Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

.11 ACI 302.1R – Guide for Concrete Floor and Slab Construction

.12 ICC-ES AC29 – Acceptance Criteria for Cold, Liquid-Applied, Below-Grade, Exterior Damproofing and Waterproofing Materials.

.13 National Institute of Standards and Technology (NIST) Voluntary Product Standard PS 1-07, Structural Plywood.

1.3 SUBMITTALS

.1 Submit Product Data for the type of waterproofing specified, including manufacturer's printed instructions for evaluating and preparing the substrate, technical data, and tested physical and performance properties.

.2 Submit manufacturer's waterproofing materials Application Guidelines for Installation manual.

.3 Project Data - Submit Shop Drawings showing locations and extent of waterproofing, including details for substrate joints and cracks, penetrations, construction joints, seismic expansion joints, backfilling of voids behind protection board, and other termination conditions.

.4 Samples – Submit representative samples of the following for approval:

.1 Poly-rubber gel material

.2 16 mil High-density polyethylene (HDPE) MTSsheet with 25 mil fleece backing

.3 Protection board

.4 Geocomposite mesh (MTMesh)

.5 Water-soluble film

.5 Installer Certificates – Submit certificates signed by manufacturer certifying that Installers comply with requirements under Article 1.06 herein.

.6 Leakage repair details.

.7 Submit documentation that demonstrates that the specified poly-rubber gel has been successfully installed for a minimum of 5 years on projects of similar complexity.

1.4 QUALITY ASSURANCE

.1 Installer Qualifications: Installer shall be licensed, certified in writing, and approved by the material manufacturer.

.2 Waterproofing material manufacturer shall have available an in-house technical staff to assist the Contractor, when necessary, in application of the products and final inspection of the assembly.

.3 Waterproofing Material Qualification: The specified poly-rubber gel has been successfully installed for a minimum of 5 years on projects of similar complexity.

.4 Pre-Installation Meeting(s): Contractor shall convene at least one pre-installation meeting at the job site with the manufacturer of the waterproofing system and the Commissions Representative to discuss project conditions as they relate to the installation of the waterproofing system.

.5 All of the materials on Site shall be a specified product.

.6 All components of the waterproofing system shall be provided by the same manufacturer.

.7 Each product and component shall have labelled with name, size, manufacturing date, and manufacturer's name and location.

.8 Product shall be protected from ultraviolet rays when packed and during on-site storage.

.9 Products shall be inspected and approved upon arrival at site. Submit signed copies of the recorded documents for verification.

.10 Discontinue the application when raining and resume work only after the area has been dried and ready for re-application as determined by the Commissions Representative.

.11 When viscosity increases due to cold temperature as determined by the Engineer, use a warming up method recommended by the manufacturer. Recirculation through pump can also be used. Adding a solvent is strictly prohibited.

.12 Waterproofing material manufacturer shall have a representative full time on site to supervise and coordinate all the waterproofing work specified herein. The representative shall sign off on the approval of the substrate for each location of the application of the waterproofing material.

.13 Mock-up Tests – The Contractor shall conduct two mock-up test panels of the waterproofing installation similar in configuration to the subway wall section and the concrete slab on grade in accordance with the Contract Drawings, to verify the performance of the waterproofing material during placement of concrete at the base and full height of the wall as well as at the concrete slab on grade. The test wall panel shall be a minimum of 1525 mm wide by 6096 mm high by 762 mm thick, while the test concrete slab shall be 1525 mm wide by 1572 mm long by 1067 mm thick. The waterproofing shall be installed in accordance with the manufacturer's recommendations.

.1 The waterproofing material shall be installed and concrete of similar mix to be used on the project shall be cast against the waterproofing material. Each of two test panels shall be installed and observed during concrete placement by the Commissions Representative. Coring through the test wall panel and the test concrete slab on grade shall be as follows:

Mock-up Test	Frequency of Coring Tests	Location
Test Wall Panel Panel shall be divided into two equal segments. One segment is covered with 90-mil thick poly-rubber gel, the other with 180-mil thick poly-rubber gel	Four at the bottom of the wall panel Four elsewhere	305 mm above the bottom of the test wall panel or otherwise directed by the Commissions Representative - To be determined by the Commissions Representative in the field
Test Concrete Slab on Grade (with 90-mil thick poly-rubber gel)	Six	- To be determined by the Commissions Representative in the field

.2 The Contractor shall provide video tape documentation of the installation and placement/testing of test panels and a report to the Commissions Representative of the performance of the waterproofing material during/after concrete placement. The test panels shall be formed prior to any waterproofing on the project and shall be considered as part of the submittal process.

.3 If test panel coring results indicate that the poly-rubber gel thickness is less than the required 90 mils at the normal application and 180 mils at the expansion joints, the Contractor shall propose remedial measures to ensure the minimum thickness of the poly-rubber gel can be achieved. Remedial measures shall be taken and test panels shall be retested at no additional expense to the Commission.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials to the jobsite in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and recommendations.

.2 Store materials in a secure, clean, dry area in accordance with manufacturer's instructions at a temperature above 18 ^{0}C.

.3 Protect materials during handling and application to prevent damage or contamination.

1.6 SITE CONDITIONS

.1 Product shall be protected from abuse or permanent exposure to the elements and shall be stored on Site in accordance with the requirements specified in Article 1.5 above.

1.7 WARRANTIES

.1 A prorated warranty shall be provided by the manufacturer of the waterproofing material and shall include all labor, materials, and incidentals required to seal all leaks that occur within the subway and ancillary structures as a result of failure of the waterproofing system. The warranty shall be guaranteed by a performance bond as described herein. The Commission shall be named as the bond holder and the bond shall be issued by a bank or financial institution registered with the province of Ontario, for the purpose of issuing performance bonds.

.2 The Warranties shall be as follows:

.1 0 to 5 years - 100 percent of bond value

.2 5 to 10 years - 50 percent of bond value

.3 10 to 15 years - 25 percent of bond value

.4 15 years after completion of the project, the bond shall be null and void.

.3 The bond value shall be as follows: 0 to 5 years $150,000, 5 to 10 years $100,000, 10 to 15 years $50,000.

2 Products

2.1 **MATERIALS**

.1 Waterproofing system shall consist of 16 mil High-density polyethylene (HDPE) sheet with 25 mil fleece backing (HDPE MTSheet), poly-rubber gel (Mountain Seal poly-rubber gel), geocomposite mesh (MTMesh), and water-soluble film (protection release sheet), or approved equal.

.2 Waterproofing system: Cold Fluid-Applied Waterproofing shall be a single component, polymer-modified, waterproofing system composed of poly-rubber gel (a non-Newtonian thixotropic gel) and ancillary components as manufactured by Green Mountain international LLC. or approved equal.

.3 Waterproofing poly-rubber gel is preferred to be comprised of over 20 percent recycled content.

.4 Waterproofing system shall have the following performance properties:

.1 Self-healing at water pressures up to .31 MPa.

.2 Self-adhering and completely bonded to the entire surface of the concrete with no voids or lack of discontinuity.

.3 Resistant to chemical attack.

.4 Not affected by wet/dry cycling.

.5 Contain less than 1 percent volatile organic compounds (VOC).

.6 Non-toxic and non-flammable.

.7 Seamless.

.8 One-part gel type material.

.9 Applied without primer.

.10 Waterproofing poly-rubber gel remains flexible and never completely cures.

.5 The waterproofing system components shall have the following physical properties:

POLY - RUBBER GEL

Property	Test Method	Results
Solids Content	ASTM Dl353	75%
Resistance to Decay	ASTM 5154-88	0% moisture permeation and weight change
Puncture Resistance*	ASTM D 1709	2200 g
Flash Point	ASTM D56	>93 degrees C
Tensile Strength*	ASTM D-412-98	1.31 MPa +/-.01
Elongation %	ASTM C1135	394%
Hydrostatic Pressure Resistance*	ASTM D-751	1.10 MPa
Adhesion to Concrete	ASTM D-412-98	Rating of 1 (Excellent)
Crack Bridging Flexibility	ASTM C-836-89	No cracks
Moisture Permeability*	ASTM E-96-80	.0185 perm
Viscosity	ASTM D2196	150,000 CPS; 3,100,000 CPS @ 22°C

*Results based on composite system of poly-rubber gel and HDPE sheet

16 mil (HDPE) sheet with 25 mil fleece backing

Property	Test Method	Results
Classification	ASTME1745	A
Water Vapor Permeability	ASTM E-96	0.0185 perms
Tensile Strength	ASTM E154-93; ASTM D 882	1.31 MPa +/-.01
Puncture resistance	ASTM 1709	2200 g

6. Geocomposite mesh “HDPE MTSheet” applied to the poly-rubber gel prior to concreting shall be a UV black high density polypropylene 2 mm thick with the following properties:

.1 Mesh size: 12 mm by 12 mm +/- 1.6 mm

.2 Weight: 6.35 kg/ 92 square meters (minimum)

.3 Transverse Direction (TD) Strand Count: .77 strands/cm +/- 0.15

.4 Machine Direction (MD) Strand Count: .87 strands/cm +/- 0.4

.5 Nominal Hole Size: 12.7 mm; 80 percent open area nominal

.7 Water-soluble film shall have the following properties:

.1 Soluble resin composed of:

.1 90 percent polyvinyl alcohol (PVA), polymerization degree: 1,700 to 1,800
.2 Hydrolyzation degree: minimum 86 percent
.3 10 percent plasticizers and organic additive.

.2 Water soluble and biodegradable without any toxic residue.

.3 Stable at normal environmental conditions.

.8 Protection board: Plywood sheathing shall be 12.7 mm by 1219 mm by 2438 mm fire-rated sheathing or 12.7 mm fire rated sheathing Structural I in accordance with NIST Product Standard PS 1-07.

2.2 ACCESSORIES

.1 Concrete Repair Materials: Concrete Repair Mortars or suitable alternative approved by manufacturer.

.2 Waterproofing Protection Course: 16 mil HDPE sheet with 25 mil fleece backing or MTSheet approved equal.

.3 Seaming Tape: 16-mil (minimum), laminated, self-adhering, rubberized asphalt to polyethylene film or suitable alternate approved by the manufacturer.

3 Execution

3.1 EXAMINATION

.1 Examine all surfaces to receive the waterproofing material to verify with the manufacturer, that the surface preparation is acceptable and proper for the application of the material.

.2 Do not proceed with the installation of the waterproofing material until all unacceptable surfaces or defects have been corrected according to the manufacturer's Application Guidelines for Installation manual.

3.2 SURFACE PREPARATION

.1 Protect adjacent surfaces not designated for waterproofing application.

.2 Prepare surfaces designated for waterproofing application in accordance with manufacturer's instructions.

.3 Surfaces shall be clean, relatively smooth, and free of standing water.

.4 Patch all holes and voids and smooth out all substrate surface misalignments.

.5 Remove all concrete form ties and patch form tie holes.

3.3 APPLICATION

.1 Detailing and Flashing

.1 Prepare as required by the Contract Documents detailing and flashing as required in accordance with the manufacturer's standard installation guideline recommendations.

.2 Complete all detailing and flashing as required before installing the waterproofing system over the substrate.

.2 Waterproofing System Application

.1 Install 16 mil (HDPE) sheet with 25 mil fleece backing sheet as shown on the Contract Drawings and as recommended by the manufacturer.

.2 Apply the poly-rubber gel at a rate to provide a continuous, monolithic coat of 90-mils minimum, onto the HDPE MTSheet or concrete surfaces as recommended by the manufacturer.

.3 Poly-rubber gel may be applied to green concrete, as recommended by the manufacturer.

.4 After application, apply protection release sheet or protection board as shown on the Contract Drawings and recommended by the manufacturer.

.5 Apply the poly-rubber gel to the construction joints and seismic expansion joints as described in Articles 3.07 and 3.08 of this Specification.

3.4 SEPARATION/PROTECTION LAYER APPLICATION

.1 Protection Board:

.1 Apply protection board as shown on the Contract Drawings and as recommended by the manufacturer.

.2 Do not overlap the protection board materials.

.2 Protection Layer:

.1 Embed the HDPE sheets as shown on the Contract Drawings, and as recommended by the manufacturer.

.2 Overlap adjoining sheet edges (dry) a minimum of 50 mm to 76 mm to ensure complete coverage.

.3 Tape all seams.

.4 The completed material/protection assembly shall be covered with subsequent topping materials within 1 Day of application.

3.5 APPLICATION BLIND SIDE

.1 Protection Board: Apply a protection board against the cutoff wall (CDSM or sheet pile wall). Fasten the plywood board with large head nails or staples. Stagger the protection board vertical joints at 1/3 to ½ the length of the protection board. Backfill all voids between the protection board and CDSM or sheet pile wall to prevent the protection board from deflecting during concrete pour. Construct the protection boars in such a manner that the joints between the boards are to be flush.

.2 Apply 16 mil High-density polyethylene (HDPE) MTSheet with 25 mil fleece backing against the protection board with large head nails or staples, as recommended by the manufacturer.

.3 HDPE seams shall be taped as recommended by the manufacturer prior to the application of the poly-rubber gel material.

.4 Apply the poly-rubber gel material at a rate to provide a continuous, monolithic coat of 90-mil minimum as recommended by the manufacturer.

.5 Fasten a geocomposite mesh (MTSheet) or approved equal) into the poly-rubber gel as recommended by the manufacturer. Installation of the geocomposite mesh must not compromise the water tightness of the poly-rubber gel material.

.6 Apply water-soluble film onto the structural mesh prior to concreting.

.7 Keep the workplace clean during the application process and after the workday is complete.

3.6 APPLICATION POSITIVE SIDE

.1 Apply, as recommended by the manufacturer, the poly-rubber gel at a rate to provide a continuous, monolithic coat of 90-mil minimum at the positive side waterproofing section as shown on the Contract Drawings.

.2 Apply 16 mil (HDPE) MTSheet with 25 mil fleece backing against the poly-rubber gel as recommended by the manufacturer. Do not nail or staple through the poly-rubber gel.

.3 Install protection board against the HDPE MTSheet. Do not fasten the protection board to the walls with staples or nails.

3.7 CONSTRUCTION JOINT APPLICATION

.1 Prior to starting work on construction joints, reinforce both sides for 6-inch centering on the joint using the following methods:

.1 Prepare surface as specified herein.

.2 Install protective waterproofing layers as specified herein.

3.8 EXPANSION JOINT APPLICATION

.1 Prior to starting work on expansion joints, reinforce both sides for 150 mm centering on the joint using the following methods:

.1 Apply adhesive and sealant 100 mm into the seismic expansive joint according to manufacturer's recommendations.

.2 Apply the poly-rubber gel at a rate to provide a continuous, monolithic coat of 180-mil minimum at least 305 mm on each side of the seismic expansion joint.

3.9 WATER TEST

.1 Areas of the tunnel roof, decks or portions thereof shall be water tested by means of electronic testing or ponding water to a minimum depth of 50 mm for a period of 48 hours to check the integrity of the waterproofing system installation. Prior to backfilling any section of the subway, not less than 10 percent of the roof area shall be water tested. The Commissions Representative will determine the specific areas to be treated.

.2 If leaks should occur, the water shall be drained completely and the waterproofing system installation repaired and retested at no cost to the Commission.

.3 Place subsequent topping materials as soon as possible.

3.10 **JOB COMPLETION**

.1 Contractor and a representative of the waterproofing system manufacturer shall inspect the waterproofing assembly and notify the Engineer of defects. All defects shall be corrected at the expense of the Contractor.

.2 After final inspection of the work and acceptance by the manufacturer's representative, the manufacturer's representative shall provide a signed document identifying, by location areas, acceptance to the Engineer..

.3 Clean up all debris and equipment and remove from Site.

END OF SECTION