Part 1 General

1.1 RELATED REQUIREMENTS

.1 CW 3010 – Clearing and Grubbing.

.2 Section 31 32 19.03 – Engineered Clay Liner.

.3 Section 31 23 33.02 – Fill.

1.2 MEASUREMENT AND PAYMENT

.1 Section 01 29 00 – Price and Payment Procedures.

.2 Excess Soil Excavation and Stockpiling:

.1 Measurement Basis: By cubic metre of excavated material by subtracting survey readings taken before and after excavation.

.2 Payment Basis: Unit price. Includes general excavation, loading, hauling, stockpiling and shaping in on-Site stockpiles of excess soil.

.1 Over-excavating: No payment will be made for over-excavated work or for replacement materials.

1.3 REFERENCES

.1 Definitions:

.1 Common Excavation: Excavation of materials, of whatever nature, not included under definition of rock excavation.

.2 Unclassified Excavation: Excavation of deposits, of whatever nature, encountered in the Works.

.3 Unsuitable Materials:

.1 Weak, chemically unstable, and compressible materials.

.2 Refuse, asphalt, concrete or granular materials.

.3 Material containing loam, roots, or organic matter.

.4 Frozen material or material containing snow or ice.

.5 Clays which are classified as inorganic clays of high plasticity in accordance with applicable ASTM specifications.

.6 Soft and/or organic clays and silts of low strength.

.7 Frost susceptible silts or clays.

.8 Swelling clays.

.9 Rock and lumps of material with dimensions greater than 100 mm.

.10 Trees, stumps, branches, roots, or other wood or lumber.

.11 Wire, steel, cast iron, cans, drums, or other foreign material.

.12 Materials containing hazardous or toxic constituents at hazardous or toxic concentrations.

.13 Waste Material: Excavated material unsuitable for use in work or surplus to requirements.

.2 Reference Standards:

.1 ASTM International:

.1 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.2 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.

.3 ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

.4 ASTM D1140 - Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-μm) Sieve.

.5 ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

.2 City of Winnipeg Standard Construction Specifications:

.1 CW1120 - Existing Services, Utilities and Structures.

.2 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.

.3 CW3170 - Earthwork and Grading.

.4 CW2030 – Excavation Bedding and Backfill

1.4 COORDINATION

.1 Section 01 73 00 - Execution Requirements: Coordination

.2 Coordinate interruptions of utility services to existing facilities which become necessary either directly or indirectly due to work required under the Contract through Contract Administrator. Down time for service disruptions may be limited as to duration and time (weekend, nights, or holidays). Perform the Works during the period designated.

.3 Coordinate and sequence excavation operations to minimize the need for temporarily stockpiling excavated materials until required for backfilling. Make every effort to balance cut and fill operations and to ensure that excavated material designated for backfill is immediately placed as backfill in the Works. Keep the time during which excavations remain open to the practicable minimum.

1.5 SCHEDULING

.1 Section 01 33 00 – Submittal Procedures: Detailed Work Schedule.

.2 Sequence and schedule excavation activities with work of other Sections.

.3 Do not commence excavation operations until the Safe Work Plan has been reviewed by City of Winnipeg and Contract Administrator and implemented.

.4 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.6 AMBIENT CONDITIONS

.1 Protect open excavations against damage due to surface runoff and runon. Take necessary precautions to prevent erosion of excavated or disturbed surfaces.

.2 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing fill to the requirements of this Section.

.3 After occurrence of heavy rains, do not operate equipment on approved excavations until the material has dried sufficiently to prevent occurrence of excessive rutting.

.4 Where excavations have been softened or eroded, remove soft and yielding material or otherwise objectionable or damaged areas and replace with fill as specified by Contract Administrator.

.5 Do not obstruct flow of surface drainage or natural watercourses.

.6 Provide dust and particulate control as specified in Section 01 50 00.

Part 2 Products

Not Used

Part 3 Execution

3.1 EXAMINATION

.1 Section 01 73 00 – Execution Requirements.

.2 Verify that survey bench marks and intended elevations for the Works are as shown on the Drawings.

.3 Do not allow or cause any of the work performed or installed to be covered up or enclosed by work of this Section prior to required inspections, measurements, tests, or approvals.

.4 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of successive lifts.

.5 Obtain approval from Contract Administrator prior to placing fill against structures or around exposed buried utilities.

.6 Ensure areas to be backfilled are free from debris and water.

.7 Do not permit traffic in restored/repaired area without approval from Contract Administrator.

3.2 PREPARATION

.1 Identify required lines, levels, contours, and datum locations.

.2 Locate, identify, and protect utilities that remain from damage. Confirm locations of buried utilities and structures by careful test excavations or other suitable means.

.3 Protect plant life, trees, and other features remaining as a portion of final landscaping.

.4 Protect benchmarks, survey control points, existing structures, fences, paving, and curbs from excavating equipment and vehicular traffic.

.5 Maintain and protect from damage wells, utilities, and structures encountered. In event of disturbance or damage to well, utility, or structure, immediately notify Contract Administrator. Repair or replace well, utility, or structure damaged by Contractor operations.

.6 Protect existing surface features which may be affected during progress of work.

.7 Protect existing structures where temporary unbalanced earth pressures may develop on walls or other structures utilizing bracing, shoring, or other approved method to counteract imbalance.

.8 Protect monitoring wells and other structures and pipelines from uplift and displacement or disturbance during excavation operations.

.9 Employ procedures for excavation and trenching that avoid disturbance of utilities and structures.

.10 Protect excavations and trenches from contamination.

.11 Obtain direction from Contract Administrator before moving or otherwise disturbing utilities or structures.

.12 Remove surface features or obstructions including, but not necessarily limited to, trees, shrubs, bush, and other vegetation from surfaces to be excavated, as required to construct the Works. Dispose of such obstructions as directed by Contract Administrator.

.13 Remove debris, snow, ice, water, soft soils, organic materials, or frozen ground from areas to be backfilled.

.14 Compact subgrade to required density for subsequent backfill materials.

.15 Proof roll subgrade surface to identify soft spots. Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved native fill and compact to density equal to or greater than specified requirements for subsequent fill material.

.16 Utilize excavated material suitable for backfill prior to importing fill materials.

3.3 TRENCHING

.1 Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with work.

.2 The banks of trenches shall be as nearly vertical as allowable and in accordance with Occupational Health and Safety Act and other applicable regulations and standards.

.3 In no case during performance of the Works shall trenching advance ahead of the active installation more than necessary to facilitate proper placement.

.4 Accurately excavate and grade the bottom of trenches to provide uniform bearing and support for each section of the pipe on full thickness of approved bedding material at every point along its entire length.

.5 Hand trim, make firm, and remove loose material and debris from trenches. Where natural or fill material at bottom of excavation is disturbed, compact disturbed soil to density at least equal to undisturbed soil or to the density specified for the succeeding layer of backfill, whichever is greater, or remove disturbed soil and refill the space as directed by Contract Administrator.

.6 Do not disturb soil within the branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

.7 Open trenches shall be Contractor's sole responsibility.

.8 Temporarily stockpile excavated material that is approved for backfilling adjacent to the Works.

.9 Dispose of surplus material, including all excavated waste, as directed by Contract Administrator.

3.4 EXCAVATION

.1 Perform excavation in accordance with Province of Manitoba “W210 The Workplace Safety and Health Act” and “Guidelines for Excavation Work”.

.2 Excavate to lines, grades, elevations, and dimensions shown on the Drawings or as directed by Contract Administrator.

.3 Slope banks with machine to safe angle.

.4 Grade top perimeter of excavation to prevent surface water from draining into excavation.

.5 Trim excavation. Remove loose matter.

.6 Remove lumped subsoil, boulders, and rock. Remove debris and other obstructions encountered. Stockpile in location(s) approved by Contract Administrator.

.7 Notify Contract Administrator of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

.8 Stockpile excavated material in designated on-Site areas as shown on the Drawings.

.9 Repair or replace items designated to remain, damaged by excavation.

.10 Hand trim, make firm, and remove loose material and debris from excavations. Where natural or fill material at bottom of excavation is disturbed, compact disturbed soil to density at least equal to undisturbed soil or to the density specified for the succeeding layer of backfill, whichever is greater, or remove disturbed soil and refill the space as directed by Contract Administrator.

.11 Material generated as a result of excavation, grading, and construction activities associated with completing the Work that are deemed unsuitable for use by Contract Administrator will be loaded, hauled, and placed in an area on the Site designated by Contract Administrator. This includes water or frost impacted material as a result of Contractor negligence.

.12 Do not disturb soil within the branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

.13 Open excavations shall be Contractor's sole responsibility. Secure using temporary fencing in accordance with the Occupation Health and Safety Act.

3.5 OVER EXCAVATION

.1 Correct areas over-excavated.

.2 Notify Contract Administrator when soil at base of excavation appears unsuitable; proceed as directed by Contract Administrator. Where, in Contract Administrator's opinion, the undisturbed condition of the soils is inadequate to support installations, over-excavate to adequate supporting soils as directed by Contract Administrator and refill the excavated space with approved material to the proper elevation, as specified for backfilling.

.3 When directed by Contract Administrator and except as otherwise specified, the excavation and removal of inadequate material as specified, and supply and installation of such material in excess of limits shown on the Drawings, will be paid for by Change Order. Use over-excavated material in the Work or stockpile on the Site as approved by Contract Administrator.

.4 Should unauthorized excavation be carried below the lines and grades as shown on the Drawings and in excess of the specified depth and tolerance because of Contractor's operations including errors, methods of construction, or to suit his convenience, correct unauthorized excavation as follows:

.1 Fill under concrete structures with concrete.

.2 Fill under unauthorized over-excavation areas by extending the indicated bottom elevation of the base of the material specified to be placed to the unauthorized excavation bottom without altering the required top elevation and compact as specified unless otherwise directed by Contract Administrator.

.5 Additional excavation to remove weakened or disturbed soil caused by unsuitable construction methods or procedures or to suit Contractor's convenience and subsequent additional backfill and compaction to correct deficiencies shall be to Contractor's account at no additional cost to City of Winnipeg.

3.6 STOCKPILING

.1 Obtain Contract Administrator's approval for locations of all stockpiles. Obtain Contract Administrator's approval prior to placing surplus excavated materials in such stockpiles.

.2 Construct stockpile sites so that they are level, well drained, free of foreign materials, and of adequate bearing capacity to support the weight of the materials to be placed thereon prior to adding new materials to the stockpile area.

.3 Stockpiles shall be constructed with two access points, one on each end.

.4 Existing stockpiles shall be stripped of topsoil prior to stockpiling additional excavated material.

.5 Protect the perimeters of the soil stockpiles in the stockpile area with silt fence approved by Contract Administrator following the stockpiling of the material.

.6 Provide and maintain access to stockpiles.

.7 Prevent intermixing of soil types or contamination or segregation.

.8 Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

.9 Materials that are wet within the work area or require dewatering prior to placement in the stockpiles to be temporarily placed within bermed areas constructed by Contractor in the stockpile area. Control all runoff water from the bermed area including operation of pumps, placement of additional silt fencing, and construction of settling ponds as required to control the runoff and dewater the materials.

.10 All stockpiles will be constructed with 2:1 side slopes providing adequate slope stability and drainage.

.11 Upon completion of stockpiling and restoration, the remaining soil stockpiles will receive a final shaping to a maximum 2:1 slope by Contractor. All perimeter silt fence will remain in place.

.12 Maintain area surrounding stockpiles in neat and tidy condition.

3.7 UTILITIES

.1 Excavate trenches for utilities to lines, grades, elevations, and dimensions shown on the Drawings.

.2 Backfill trenches for utilities in accordance with Section 31 23 33.02. Do not backfill any condition damaged or interrupted until written authorization is received by Contract Administrator.

.3 Any interruption or damage to an existing service due to Contractor's negligence is Contractor's responsibility. Immediately notify City of Winnipeg and Contract Administrator and mitigate condition before end of working day. Repair promptly. Contractor shall submit repair plan to Contract Administrator and employ a certified trade, as necessary, to make the repair.

3.8 TOLERANCES

.1 Correct surface irregularities by loosening and adding or removing material until the surface is within the specified tolerances.

.2 Payment will not be made for material placed outside the tolerance limits unless directed by Contract Administrator.

.3 The final locations of all earth works will be constructed within a tolerance of 50 mm. All grading will be performed to maintain slopes and positive drainage as shown on the Drawings.

3.9 ADJUSTING

.1 Section 01 73 00 – Execution Requirements: Adjusting.

.2 Finish compacted soil surfaces to within 50 mm of grades shown on the Drawings but not uniformly high or low. Correct surface irregularities by loosening and adding or removing material until the surface is within specified grade.

.3 Leave work areas in a properly graded condition sloped as required to permit proper drainage and free of depressions that will pond or collect water or debris that will restrict flow.

3.10 PROTECTION

.1 Section 01 73 00 – Execution Requirements: Protection of Installed Work.

.2 Prevent displacement or loose soil from falling into excavation; maintain soil stability.

.3 Protect bottom of excavations from freezing.

.4 Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

.5 Verify that survey bench marks and intended elevations for Works are as shown on the Drawings.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 32 19.01 – Geotextile.

.2 Section 31 23 33.01 – Excavation.

.3 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

.1 Section 01 29 00 – Price and Payment Procedures.

.2 Leachate Collection System Granular Drainage Blanket:

.1 Measurement Basis: By square metre measured in place to elevations shown on the Drawings.

.2 Payment Basis: Unit price. Includes supplying granular drainage blanket, stockpiling, placing where required, and compacting.

1.3 REFERENCES

.1 Definitions:

.1 SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined according to ASTM D698.

.2 Reference Standards:

.1 ASTM International:

.1 ASTM C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.

.3 ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.4 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.5 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.

.6 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

.7 ASTM D1140 - Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-µm) Sieve.

.8 ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

.9 ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

.10 ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

.11 ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

.12 ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.

.13 ASTM D2974 - Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.

.14 ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

.15 ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

.16 ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

.17 ASTM D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

.18 ASTM D6473 - Standard Test Method for Specific Gravity and Absorption of Rock for Erosion Control.

.19 ASTM D6928 - Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.

.20 ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

.2 City of Winnipeg Standard Construction Specifications:

.1 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.

.2 CW3170 - Earthwork and Grading.

.3 CW2030 – Excavation Bedding and Backfill

1.4 SEQUENCING

.1 Coordinate interruptions of utility services to existing facilities which become necessary either directly or indirectly due to work required under the Contract, through Contract Administrator. Down time duration and time (weekend, nights, or holidays) for service disruptions may be limited. Perform work of this Section during scheduled times.

.2 Coordinate and sequence excavation operations to minimize temporary stockpiling of excavated materials until required for backfilling. Make every effort to balance cut and fill operations and ensure excavated material designated for backfill is immediately placed in the Works. Minimize time excavations remain open.

1.5 SCHEDULING

.1 Section 01 33 00 – Submittal Procedures: Detailed Work Schedule.

.2 Do not allow or cause work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.6 SUBMITTALS

.1 Section 01 33 00 – Submittal Procedures.

.2 Materials Source: Submit name of proposed imported fill material source at least 14 days prior to commencing transport of materials to the Site.

.3 Provide schedule of service disruptions to utilities no later than 3 weeks prior to proposed date of disruption. Contract Administrator will review schedule with City of Winnipeg and respond within 7 days.

.4 Geotechnical Data: Submit geotechnical data at least 7 days prior to commencing transport to the Site.

.1 Aggregate Materials: Submit grain size distribution curves, density, and moisture content for each aggregate material. Show average distribution and minimum and maximum variation in gradation for each grain size distribution curve.

.5 Test Reports: Submit test reports certifying compliance with specified requirements at least 7 days prior to commencing transport to the Site.

.6 Samples: Submit 45 kg Sample of Leachate Collection System Granular Drainage in airtight bag or container.

.7 Suppliers' Certificates: Submit certificate indicating that each type of imported fill material meets or exceeds specified requirements.

.8 Weigh Tickets: At the end of each work day submit delivery weigh tickets of imported fill materials delivered to the Site.

.9 Field Quality Control: Submit field data on same day testing is performed. Submit laboratory data within 24 hours of completion of test.

.10 Qualification Statements:

.1 Independent Geotechnical Testing Firm: At least 14 days prior to commencing transport of soil materials to the Site, submit name and qualifications of independent geotechnical testing firm to provide geotechnical testing services for work of this Section.

.2 Independent Analytical Laboratory: At least 14 days prior to commencing transport of soil or aggregate materials to the Site, submit name and qualifications of independent testing laboratory to provide chemical analysis for work of this Section.

.11 Certificates: Certify that products meet or exceed specified requirements.

1.7 QUALIFICATIONS

.1 Geotechnical Testing Firm: Company specializing in performing work of this Section and complying with ASTM D3740 to perform testing of fill materials including density, moisture content, permeability, and particle size analysis for both soil and aggregate samples.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Section 01 61 00 – Product Requirements

.2 Deliver, handle, and transport fill materials in a manner and with equipment that will prevent intermixing of soil, aggregate, segregation, or contamination.

.3 Minimize stockpiling requirements. Transport material from source directly to final position where possible.

.4 Stockpile fill materials in on-Site locations approved by Contract Administrator.

1.9 AMBIENT CONDITIONS

.1 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing fill to the requirements of this Section.

.2 Do not operate equipment on approved excavations after heavy rain until material has dried sufficiently to prevent excessive rutting.

Part 2 Products

2.1 MATERIALS

.1 Imported from an approved source.

.2 Free of unsuitable materials including:

.1 Frozen material or material containing snow or ice.

.2 Trees, stumps, branches, roots, or other wood or lumber.

.3 Wire, steel, cast iron, cans, drums, or other foreign material.

.4 Materials containing hazardous or toxic constituents at hazardous or toxic concentrations.

.3 Compactable to specified density at specified moisture content.

2.2 COMMON FILL

.1 Native Backfill: Clean excavated soil, no clay, free of organics including roots, weeds, topsoil, foreign material, and stones greater than 150 mm; in situ moisture content less than 10 percent; and approved by Contract Administrator. To be used as structural backfill, as approved by Contract Administrator.

2.3 GRANULAR DRAINAGE BLANKET

.1 Material for Granular Drainage Blanket shall be 20 mm round clean stone, natural, manufactured, or processed clean, dry, unfrozen, sound, non-cohesive, dense granular material. Contractor shall provide the proposed material gradation to Contract Administrator for approval.

2.4 SOURCE QUALITY CONTROL

.1 Section 01 45 00 – Quality Requirements.

.2 Testing and Analysis of Coarse Aggregate:

.1 Maximum Dry Density and Optimum Moisture Content, ASTM D698: One sample per 1,000 m^3 or portion thereof of material required.

.2 Grain Size, ASTM C117 and ASTM C136: One sample per 1,000 m^3 of material required.

.3 Carbonate content, ASTM D4373: One sample per 7,600 m^3 (minimum one sample per source of drainage aggregate) of material required.

.4 Los Angeles degradation: to ASTM C131: One sample.

.3 If tests indicate materials do not meet specified requirements, change material or material source and retest.

.4 Provide materials of each type from the same source throughout the Works.

.5 In the event of changes to approved sources of materials during performance of the Works, immediately advise Contract Administrator of revised locations and obtain approval of such locations and materials prior to use in the Works.

.6 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

Part 3 Execution

3.1 EXAMINATION

.1 Section 01 73 00 – Execution Requirements.

.2 Verify that survey bench marks and intended elevations for the Works are as shown on the Drawings.

.3 Verify foundation or basement walls are braced to support surcharge forces imposed by backfilling operations.

.4 Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

.5 Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

.6 Verify structural ability of unsupported walls to support loads imposed by fill.

.7 Verify that trench cut for pipe culvert is ready to receive work.

.8 Verify that excavations, dimensions, and elevations are as shown on the Drawings.

3.2 PREPARATION

.1 Locate, identify, and protect utilities that remain from damage. Confirm locations of buried utilities and structures by careful test excavations or other suitable means. Provide support for aboveground utility poles and lines. Provide documentation to Contract Administrator.

.2 Identify required lines, levels, contours, and datum locations.

.3 Notify Contract Administrator of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

.4 Maintain and protect existing utilities designated to remain.

.5 Obtain direction from Contract Administrator before moving or otherwise disturbing utilities or structures.

.6 Protect plant life, trees, lawns, and other features remaining as portion of final landscaping.

.7 Protect benchmarks, survey control points, hydrants, existing structures, fences, paving, and curbs from excavating equipment and vehicular traffic.

.8 Maintain and protect from damage wells, utilities, and structures encountered. In event of disturbance or damage to well, utility, or structure, immediately notify Contract Administrator. Repair or replace well, utility, or structure damaged by Contractor operations.

.9 Protect monitoring wells and other structures and pipelines from uplift and displacement or disturbance during excavation operations.

.10 Protect existing structures where temporary unbalanced earth pressures may develop on walls or other structures utilizing bracing, shoring, or other approved method to counteract imbalance.

.11 Protect excavations and trenches from contamination.

.12 Employ procedures for excavation and trenching that avoid disturbance of utilities and structures.

.13 Remove surface features or obstructions including, but not necessarily limited to, trees, shrubs, bush, and other vegetation from surfaces to be excavated, as required to construct the Works. Dispose of such obstructions as directed by Contract Administrator.

.14 Proof roll subgrade surface to identify soft spots. Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved native fill and compact to density equal to or greater than specified requirements for subsequent fill material.

.15 Utilize excavated material suitable for backfill prior to importing fill materials.

3.3 OVER EXCAVATION

.1 Correct over-excavated areas.

.2 Notify Contract Administrator when soil at base of excavation appears unsuitable; proceed as directed by Contract Administrator. Where, in Contract Administrator's opinion, undisturbed condition of soils is inadequate to support installations, over-excavate to adequate supporting soils as directed by Contract Administrator and refill excavated space with approved material to proper elevation, as specified for backfilling.

.3 When directed by Contract Administrator, and except as otherwise specified, the excavation and removal of inadequate material as specified, and supply and installation of such material in excess of limits shown on the Drawings, will be paid for by Change Order. Use over-excavated material in the Works or stockpile on Site as approved by Contract Administrator.

.4 Should unauthorized excavation be carried below the lines and grades shown on the Drawings and in excess of specified depth and tolerance because of Contractor's operations including errors, methods of construction, or to suit its convenience, correct unauthorized excavation as follows:

.1 Fill under concrete structures with concrete.

.2 Fill under unauthorized over-excavation areas by extending the indicated bottom elevation of the base of the material specified to be placed to the unauthorized excavation bottom without altering the required top elevation and compact as specified unless otherwise directed by Contract Administrator.

.5 Additional excavation to remove weakened or disturbed soil caused by unsuitable construction methods or procedures or to suit Contractor's convenience and subsequent additional backfill and compaction to correct deficiencies will be at no additional cost to City of Winnipeg.

3.4 BACKFILLING

.1 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of successive lifts of fill materials.

.2 Do not cause excavations to be backfilled until Contract Administrator has approved excavation as complete and completed field measurements for payment purposes, and sampling and testing for analytical purposes.

.3 Obtain approval from Contract Administrator prior to placing fill against structures or around exposed buried utilities.

.4 Remove debris or water from areas to be backfilled.

.5 Ensure areas to be backfilled are free from debris, snow, ice, water, soft soils, organic materials, or frozen ground.

.6 Proof roll subgrade surface to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

.7 Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved native fill and compact to density equal to or greater than requirements for subsequent fill material.

.8 Compact subgrade to density requirements for subsequent backfill materials.

.9 Place woven geotextile fabric over unstable subsoil.

.10 Backfill areas to contours and elevations. Use unfrozen and unsaturated materials.

.11 Employ a placement method that does not disturb or damage other work.

.12 Do not use backfill material which is determined unsuitable by Contract Administrator.

.13 Use fill types as specified. Completely use select native fill approved for backfilling before using imported fill.

.14 Backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

.15 Except as specified otherwise, place backfill continuously and in uniform layers not exceeding specified compacted thickness up to grades shown on the Drawings.

.16 Drop height for leachate collection system granular drainage blanket material to be no more than 300 mm.

.17 Place fill materials as shown on the Drawings.

.18 Protect geomembrane and geotextiles during placement operations.

.19 Place material in continuous layers as follows:

.20 Soil Materials: Maximum 150 mm compacted depth.

.21 Maintain optimum moisture content of backfill materials to attain required compaction density.

.22 Backfill against supported foundation walls. Do not backfill against unsupported structures.

.23 Do not operate heavy compaction equipment closer than 1 m to foundations, underground utilities, or monitoring wells.

.24 Backfill around exposed utilities by placing layers simultaneously on all sides to equalize loading. Do not dump directly against monitoring wells, utilities, or foundations.

.25 Make gradual grade changes. Blend slope into level areas.

.26 Slope grade away from building minimum 2 percent slope for minimum distance of 3 m, unless otherwise specified.

.27 Backfill around installations as follows:

- .1 Place bedding and surround material as specified in this Section.
- .2 Place layers simultaneously, on both sides of installed work to equalize loading and minimize movement.
- .3 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
  - .1 Permit concrete to cure for minimum 7 days or until it has sufficient strength to withstand earth and compaction pressure, and obtain approval from Contract Administrator to backfill.

.2 If approved by Contract Administrator, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Contract Administrator.

.3 Place material under, around, and over installations until 0.6 m of cover is provided. Do not dump material directly on installations.

.28 Do not backfill around or over cast-in-place concrete within 7 days of concrete placing. Backfill after concrete has attained design strength.

.29 Remove sheeting and shoring required during excavation during backfilling operations. Do not remove bracing until backfilling has reached the respective level of such bracing. Pull sheeting in increments that will ensure compacted backfill is maintained at an appropriate elevation above toe of sheeting.

.30 Compact each layer to the density specified before placing succeeding layers.

3.5 COMPACTION

.1 Excavated Material Suitable for Backfill: Compact to 98 percent SMDD.

.2 Apply potable water as necessary during compaction to obtain specified density. If material to be compacted is excessively moist, aerate with suitable equipment and method until moisture content is corrected. In areas not accessible to rolling equipment, compact material to specified density using mechanical tamper. Supply and pay for water.

.3 When granular material is wetted by sprinkling, do not direct jets of water at fill with such force that finer materials will be washed out.

.4 Compaction Equipment: Use type, size, and efficiency of compaction equipment capable of achieving specified degree of compaction. When operating equipment adjacent to and immediately above structures, avoid causing damage or displacement of structure.

.5 Compaction equipment must pass over the completed area a minimum number of five passes before testing.

3.6 TOLERANCES

.1 Section 01 45 00 – Quality Requirements: Tolerances.

.2 Top of Granular Drainage Blanket, and Backfill: Plus or minus 25 mm.

.3 Correct surface irregularities by loosening and adding or removing material until the surface is within the specified tolerances.

.4 Payment will not be made for material placed outside the tolerance limits unless directed by Contract Administrator.

.5 All grading will be performed to maintain slopes and positive drainage as shown on the Drawings.

3.7 FIELD QUALITY CONTROL

.1 Section 01 45 00 – Quality Requirements.

.2 Perform laboratory material tests according to ASTM D698.

.3 Perform in place compaction tests according to the following:

.1 Density Tests: ASTM D6938.

.4 Testing by Contractor:

.1 Select samples of uncompacted fill intended for the Works and samples of compacted fill in the Works.

.2 Perform tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Testing of imported fill will include analyses for the presence of contaminants, grain size analyses, moisture content determination, bulk wet density, maximum dry density, and hydraulic conductivity. Testing for backfill will include moisture content determination, maximum dry density, and bulk wet density. Measure cap layer thickness in place.

.5 Testing by Contract Administrator:

.1 Contract Administrator will select samples of uncompacted fill intended for the Works and samples of compacted fill in the Works.

.2 Contract Administrator will perform quality assurance tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Quality assurance testing will include analysis for moisture content determination, bulk wet density, maximum dry density, and hydraulic conductivity.

.3 Testing by Contract Administrator will in no way relieve Contractor of responsibility to test all material prior to notifying Contract Administrator of materials' suitability for the work involved.

.6 Methods of Testing:

.1 Maximum dry density and optimum moisture content will be determined in the laboratory according to ASTM D698.

.2 Bulk wet density will be determined in the field according to ASTM D6938.

.3 Moisture content will be determined in the field according to ASTM D6938. One in every ten moisture content determinations done by ASTM D6938 shall be verified according to ASTM D2216.

.4 Particle size analysis will be performed according to ASTM D422 or ASTM C117 and ASTM C136, whichever is appropriate to material being tested.

.5 Compaction testing will be performed in accordance with ASTM D6938.

.7 Frequency of Testing:

.1 Native Backfill:

.1 At least one in-place density and moisture for each lift for each 1,000 m^2 of area.

.2 At least one maximum dry density and optimum moisture content for each change of material.

.2 Imported Backfill:

.1 At least one in-place density and moisture for each lift for each 1,000 m^2 of area.

.2 At least one maximum dry density and optimum moisture content for each change of material.

.3 One hydraulic conductivity will be made for each 400 m^2 of fill placed.

.3 Leachate Collection System Granular Drainage Blanket: At least one particle size analysis.

.8 Failure to Meet Specified Requirements: If tests indicate that material specifications have not been achieved or cannot be obtained with equipment in use, procedure being followed, or material being incorporated, remove and replace work and modify operations

so that equipment, procedures, and materials will produce required results. Additional testing required by Contract Administrator will be at no additional cost to City of Winnipeg.

.9 Proof roll compacted fill surfaces under slabs on grade and around structures.

3.8 ADJUSTING

.1 Section 01 73 00 – Execution Requirements: Adjusting.

.2 Finish compacted surfaces to within 25 mm of grades shown on the Drawings but not uniformly high or low. Correct surface irregularities by loosening and adding or removing material until the surface is within specified grade.

.3 Leave work areas in a properly graded condition sloped as required to permit proper drainage and free of depressions that will pond or collect water or debris that will restrict flow.

3.9 CLEANING

.1 Section 01 74 11 - Cleaning.

.2 Clean and reinstate work areas and areas affected by equipment outside areas specified to be excavated, to specified restoration condition.

.3 Upon completion of backfilling, remove excess material and debris from work areas and travel routes.

3.10 PROTECTION

.1 Section 01 73 00 – Execution Requirements: Protection of Installed Work.

.2 Reshape and re-compact fills subjected to vehicular traffic.

.3 Protect pipe and bedding from damage or displacement until backfilling operation is complete.

.1 Do not allow heavy equipment to cross culvert until minimum 600 mm cover is installed above culvert.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 32 19.02 – Geomembrane.

.2 Section 31 23 33.01 – Excavation.

.3 Section 31 23 33.02 – Fill.

.4 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

.1 Section 01 29 00 – Price and Payment Procedures.

.2 Non-Woven Geotextile:

.1 Measurement Basis:

.1 Item measured by the square meter in place for the surface area of non-woven geotextile installed.

.2 No separate measurement will be made for any required overlapping, anchoring, or seams of non-woven geotextile.

.2 Payment Basis: Unit price. Includes supply, installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.

1.3 REFERENCES

.1 Definitions:

.1 AOS: Apparent Opening Size.

.2 Geotextile: Synthetic fabric for use in geotechnical filter, separation, stabilization, or erosion control applications.

.3 MARV: Minimum Average Roll Value, means the average value for a specified parameter less two standard deviations.

.2 Reference Standards:

.1 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.

.2 ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in an Xenon Arc Type Apparatus.

.3 ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

.4 ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

.5 ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

.6 ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

.7 ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

.8 ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.

.9 ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.

.10 ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

1.4 COORDINATION

.1 Section 01 73 00 - Execution Requirements: Coordination

.2 Coordinate the installation of geotextile with drainage aggregate installation.

1.5 PRE-INSTALLATION MEETINGS

.1 Section 01 31 19 – Project Meeting: Pre-installation meeting.

.2 Convene 1 week prior to commencing work of this Section.

.3 Purpose of Meeting:

.1 Define the responsibilities of each party.

.2 Establish lines of authority and lines of communication.

.3 Establish Site-specific quality control and monitoring procedures.

.4 Define installation procedures.

.5 Define method of acceptance of completed geotextile.

.6 Define installation schedule.

.7 Discuss submittals.

.8 Review personal protective equipment (PPE) and applicable regulations.

.9 Review Construction Safety Plan and procedures.

.10 Review methods for measuring production.

.11 Review procedures for incremental acceptance.

.12 Review methods for protecting installed work.

.13 Establish rules for writing on the geotextile (i.e., who is authorized to mark on the liner and in what colours).

1.6 SUBMITTALS

.1 Section 01 33 00 – Submittal Procedure.

.2 Manufacturer's Qualifications: Submit no later than 14 days prior to ordering, list of previous projects including name of project, description of project, area, client's name and address, contacts, and telephone numbers; engineer's name, address, contact, and telephone number; installer's name, address, contact, and telephone number; and date installed.

.3 Manufacturer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.

.4 Installer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.

.5 Submit samples as follows at least 4 weeks prior to commencing the Works.

.6 Minimum length of 2 m of roll width of geotextile.

.7 Product Data: Submit no later than 30 days prior to ordering.

.8 Interface Shear Testing: Submit 10 days prior to ordering.

.9 Manufacturers Installation Instructions: Submit at least 14 days prior to installation. Include written installation, handling, storage, and repair instructions.

.10 Daily Field Installation Report: Submit no later than 1 day following date covered by report, include:

.1 Total amount and location of geotextile placed.

.2 Identifiers of rolls.

.3 Changes in layout drawings.

.4 Record of defects caused during transportation and handling.

.5 Observations of weather conditions, and results.

.6 Observations of anchor trench excavation, backfilling, and compaction.

.7 Observations of repairs, including locations and name of repairer.

.8 Observations of placement around appurtenances and connection to appurtenances.

.9 Installer Qualifications: submit a copy of manufacturer's approval letter or license to Contract Administrator no later than 14 days prior to installation.

.10 Submit copies of manufacturer's test data and certificate at least 4 weeks prior to commencing the Works.

.11 Manufacturer's Certificates: Certificates pertaining to rolls of material delivered to the Site shall accompany rolls. Each roll shall be identified by a unique manufacturing number.

.12 Quality Control Certificate:

.1 Include results of at least the following tests:

.1 Unit weight, tensile strength, elongation at break, Mullen Burst strength, puncture strength, permittivity, apparent opening size, and ultraviolet stability.

.2 Include manufacturer's records for storage, handling, and shipping of geotextile.

.3 Sign quality control certificates by a responsible party employed by geotextile manufacturer. Materials and rolls which are in non-compliance with minimum required properties will be rejected.

1.7 CLOSEOUT SUBMITTALS

.1 Section 01 78 00 – Closeout Submittals.

.2 Record Documents: Indicate panel layout, including panel identifier, date placed, installer’s name, location of seams, and location and details of repairs.

.3 Warranties: Completed original warranty forms filled out in City of Winnipeg's name and registered with manufacturer.

1.8 QUALITY ASSURANCE

.1 Provide manufacturer's quality assurance plan or manual to ensure that geotextile is manufactured and will perform as specified in this Section and according to the noted references.

.2 Provide installer's quality assurance plan or manual to ensure that the geotextile will be installed as specified in this Section and according to the noted references.

1.9 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 20 projects, 3 million square metres of installation, and 3 years documented experience.

.2 Installer: Trained and qualified to install the type of geotextile to be used for the Project and an approved or licenced installer of geotextile manufacturer with minimum five projects, 1 million square metres of installation, and 2 years documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 Section 01 61 00 – Product Requirements.

.2 Deliver geotextile bearing manufacturer's seals and labels intact. Clearly label each roll to show geotextile identification, date of manufacture, lot number, analysis of contents, and special instructions. Manufacturer is responsible for initial loading and shipping of geotextile. Methods of unloading geotextile shall be approved by manufacturer prior to shipment.

.3 Store and handle geotextile according to manufacturer's recommendations and to in manufacturer's original covers, and protect from moisture, dust, light, and heat.

.4 Use appropriate handling equipment when moving geotextile from one place to another.

.5 Notify Contract Administrator 3 days in advance of delivery to the Site. Perform joint inspection with Contract Administrator upon delivery. Defects or damage from shipping and handling will be grounds for rejection of a portion of geotextile or of entire geotextile roll at discretion of Contract Administrator. Remove roll from the Site and replace with new material.

1.11 AMBIENT CONDITIONS

.1 Install geotextile in dry conditions and according to manufacturer’s written installation instructions.

.2 Suspend installation operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing geotextile to the requirements of this Section.

.3 Weather conditions for seaming: comply with manufacturer’s installation instructions.

1.12 WARRANTY

.1 D22- Supplemental Conditions: Warranty.

.2 Section 01 78 00 – Closeout Submittals: Warranties and Bonds

.3 Provide 1 year manufacturer's warranty.

.4 Include coverage for:

.1 Defective product found to be not in compliance with the requirements of this Section.

.2 Replacement of the geotextile with new material including costs associated with geotextile installation.

Part 2 Products

2.1 NON-WOVEN GEOTEXTILE (CUSHION)

.1 TE-E116 or approved alternate supplied in a minimum roll width of 4.6 m.

.2 Rot proof, mildew proof, and not subject to attack by insects or rodents.

.3 Capable of retaining its structure during handling, placement, and long term service.

.4 Non-woven, needle punched fabric to act as a cushion between the HDPE geomembrane and granular drainage blanket.

2.2 NON-WOVEN GEOTEXTILE (FILTER)

.1 TE-E180 or approved alternate supplied in a minimum roll width of 4.6 m.

.2 Rot proof, mildew proof, and not subject to attack by insects or rodents.

.3 Capable of retaining its structure during handling, placement, and long term service.

.4 Non-woven, needle punched fabric to act as a filter between the waste and granular drainage blanket.

2.3 SOURCE QUALITY CONTROL

.1 Section 01 45 00 – Quality Requirements.

.2 Manufacturer Quality Control:

.1 Sample and test geotextile material, at a minimum, once every 10,000 m^2 for unit weight, tensile strength, elongation, hydraulic burst strength, puncture strength, and trapezoid tear strength to demonstrate that the material conforms to requirements specified in this Section. Test for UV stability and apparent opening size, at a minimum, once every month.

.2 In general, perform sampling on sacrificial portions of the material such that repair of the material is not required.

.3 If geotextile sample fails to meet the quality control requirements of this Section, sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Continue sampling and testing of rolls until a pattern of acceptable test results is established.

.4 At geotextile manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and/or to qualify individual rolls.

Part 3 Execution

3.1 EXAMINATION

.1 Section 01 73 00 – Execution Requirements.

.2 Obtain Contract Administrator’s approval prior to installing geotextile and prior to placing subsequent materials on geotextile.

3.2 INSTALLATION

.1 Notify Contract Administrator at least 24 hours in advance of intention to commence placement of geotextile.

.2 Do not permit placement of overlay materials until Contract Administrator has inspected and approved installation of geotextile.

.3 Obtain approval of Contract Administrator prior to installation of geotextile.

.4 Place geotextile on prepared base as indicated.

.5 Unfold or unroll geotextile according to manufacturer's written instructions, directly on prepared base, in conditions which will prevent damage to both geotextile and granular material. Unsuitable conditions include, but are not limited to moderate to high wind conditions.

.6 Overlap dimensions and the method of joining adjacent sheets shall, as a minimum, be in strict conformance with manufacturer's written instructions. Ballast geotextile according to manufacturer's written instructions and as indicated.

.7 Do not entrap stones in geotextile during placement of geotextile.

.8 Do not expose geotextile to sunlight for more than 30 days or less, if recommended by manufacturer.

.9 Position and deploy geotextile to minimize handling. Lay smooth and free of tension, stress, folds, or creases. Protect properly placed geotextile from displacement, contamination by surface runoff, or damage, until and during placement of overlaid materials.

.10 Place geotextile on sloping surfaces in one continuous length from top of slope to lower extent of geotextile.

.11 Do not permit passage of vehicular traffic directly on geotextile at any time.

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

.13 Place geotextile by unrolling onto graded surface and retain in position as specified.

.14 Remove and replace damaged or deteriorated geotextile as directed by Contract Administrator.

.15 Placement and compaction of drainage aggregate according to Section 31 23 33.02.

3.3 CONFORMANCE TESTING AND PERFORMANCE EXPECTATIONS

.1 Conformance Testing:

.1 Samples of geotextiles may be removed by Contract Administrator and sent to laboratory for testing to ensure conformance with requirements of this Section.

.2 Testing will be carried out prior to installation of geotextile.

.3 Samples will be taken at a minimum frequency of one sample per 10,000 m^2 with a minimum of one sample per lot.

.4 Contract Administrator may increase the frequency of sampling in the event that test results do not comply with requirements of this Section. Additional testing will be performed at the Contractor's expense.

.5 As a minimum, the following conformance tests will be performed on each geotextile sample:

.1 Mass per unit area.

.2 Tensile strength.

.3 Grab strength.

.4 Tear strength.

.5 Puncture strength.

.6 AOS and permittivity tests will be performed at a frequency of one per lot.

.6 Any geotextile material that is not certified according to this Section, or that conformance testing indicates non-compliance with this Section, will be rejected by Contract Administrator. Replace rejected material with suitable material, at no additional cost to Contract.

3.4 FIELD QUALITY CONTROL

.1 Section 01 45 00 – Quality Requirements.

.2 Contract Administrator may inspect geotextile in place for tears, overlaps, and consistency before placing materials thereon. Damaged sections, as judged by Contract Administrator, will be marked and their removal recorded. Repair minor damage and minor defects as specified in manufacturer's procedures when approved by Contract Administrator to Contract Administrator's satisfaction.

.3 Contract Administrator may verify that weather conditions (air temperature, non-excessive wind, and lack of precipitation) are acceptable for panel placement.

3.5 PROTECTION

.1 Section 01 73 00 – Execution Requirements: Protection of Installed Work.

.2 Protect finished work from damage.

.3 Maintain sufficient ballast on geotextile to prevent uplift.

.4 Do not permit traffic or construction equipment directly on geotextile.

3.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling.

.2 Remove and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal or recycling paper, plastic, polystyrene, corrugated cardboard, and packaging material.

.4 Fold up metal banding, flatten and remove to appropriate recycling facilities.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 32 19.01 – Geotextiles.

.2 Section 31 32 19.03 – Engineered Clay Liner.

.3 Section 31 23 33.02 – Fill.

.4 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

.1 Section 01 29 00 – Price and Payment Procedures.

.2 HDPE Liner:

.1 Measurement Basis:

.1 Item measured by the square metre in place of the base and sidewall area covered with HDPE liner, from the top of anchor trench.

.2 No separate measurement will be made for any required overlapping or anchoring of geomembrane.

.2 Payment Basis: Unit price, Includes supply, installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.

.3 GCL Liner:

.1 Measurement Basis:

.1 Item measured by the square metre in place of the area overlapping and between the exposed GCL liner from Cell 30 and the new installed HDPE liner from Cell 31.

.2 No separate measurement will be made for any required overlapping or anchoring of geomembrane.

.2 Payment Basis: Unit price, Includes supply, installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.

1.3 REFERENCES

.1 Definitions

.1 HDPE: High Density Polyethylene.

.2 SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined according to ASTM D698.

.3 Wrinkles: Corrugations in HDPE liner which will fold over during placement of materials overlying HDPE.

.4 Minimum Average Value: Average of test values calculated according to specified standard at minimum frequency specified in GRI Standard GM13.

.5 Conform to ASTM D4439 for interpretation of terms used in this Section.

.6 Geosynthetic Clay Liner (GCL) - A factory manufactured hydraulic barrier consisting of granular sodium bentonite clay, sandwiched between, supported and encapsulated by two geotextiles, held together by needle punching.

.7 Sodium Bentonite - The high swelling clay component of GCLs consisting primarily of the mineral Montmorillonite.

.2 Reference Standards:

.1 ASTM International:

.1 ASTM D422-63 - Standard Test Method for Particle-Size Analysis of Soils.

.2 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

.3 ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

.4 ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.

.5 ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.

.6 ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

.7 ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics.

.8 ASTM D3895 - Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.

.9 ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

.10 ASTM D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

.11 ASTM D4439 - Standard Terminology for Geosynthetics.

.12 ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

.13 ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

.14 ASTM D5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

.15 ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

.16 ASTM D5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

.17 ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.

.18 ASTM D5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembrane.

.19 ASTM D6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Method.

.20 ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

.21 ASTM D7007 - Standard Practices for Locating Leaks in Geomembranes Covered with Water or Earth Materials

.22 ASTM D7238 - Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.

.23 ASTM D7466 - Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.

.2 Geosynthetic Research Institute (GRI):

.1 Test Method GM6 - Pressurized Air Test for Dual Seamed Geomembranes.

.2 Test Method GM9 - Cold Weather Seaming of Geomembranes.

.3 Test Method GM13 - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

.4 Test Method GM20 - Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts.

.5 Test Method GM29 - Field Integrity Evaluation of Geomembrane Seams (and Sheet) using Destructive and/or Nondestructive Testing.

.6 ASTM D 5887, "Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"

.7 ASTM D 5888, “Standard Guide for Storage and Handling of Geosynthetic Clay Liners”

.8 ASTM D 5889, “Standard Practice for Quality Control of Geosynthetic Clay Liners”

.9 ASTM D 5890, “Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners”

.10 ASTM D 5891, “Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners”

.11 ASTM D 5993, "Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners"

.12 ASTM D 6102, "Standard Guide for Installation of Geosynthetic Clay Liners"

.13 ASTM D 6243, "Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method"

.14 ASTM D 6496, "Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners"

.15 ASTM D 6768, "Standard Test Method for Tensile Strength of Geosynthetic Clay Liners"

.16 ASTM E 96, "Standard Test Methods for Water Vapor Transmission of Materials"

.3 International Association of Geosynthetic Installers (IAGA).

1.4 COORDINATION

.1 Section 01 73 00 - Execution Requirements: Coordination

.2 Coordinate the installation of HDPE and GCL liners with surface preparation work and non-woven geotextile installation.

1.5 PRE-INSTALLATION MEETINGS

.1 Section 01 31 19 – Project Meeting: Pre-installation meeting.

.2 Convene 1 week prior to commencing work of this Section.

.3 Purpose of Meeting:

.1 Define the responsibilities of each party.

.2 Establish lines of authority and lines of communication.

.3 Establish Site-specific quality control and monitoring procedures.

.4 Define installation procedures.

.5 Define method of acceptance of completed geocomposite.

.6 Define installation schedule.

.7 Discuss submittals.

.8 Review PPE and applicable regulations.

.9 Review Construction Safety Plan and procedures.

.10 Review methods for measuring production.

.11 Review procedures for incremental acceptance.

.12 Review methods for protecting installed work.

.13 Establish rules for writing on the geocomposite (i.e., who is authorized to mark on the liner and in what colours).

1.6 SUBMITTALS

.1 Section 01 33 00 – Submittal Procedure.

.2 Bid submissions:

.1 Identify the material selected for use.

.2 Identify name of proposed installation supervisor and project experience.

.3 Identify the Quality Control program to be followed during HDPE and GCL liners installation.

.3 Manufacturer's Qualifications: Submit no later than 14 days prior to ordering list of previous projects totaling 300,000 m^2 of installation, and five projects including name of project, description of project, area, client's name and address, contacts, and telephone numbers; engineer's name, address, contact, and telephone number; installer's name, address, contact, and telephone number; and date installed.

.4 Manufacturer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.

.5 Installer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.

.6 Samples: Submit the following at least 4 weeks prior to beginning work.

.7 Minimum 2 m length of standard width HDPE geomembrane and a representative sample, approximately 75 mm x 125 mm of proposed GCL.

.8 Shop Drawings: Indicate installation layout, dimensions and details, including field seams, anchor trenches and protrusion details.

.9 Product Data: Submit no later than 30 days prior to ordering.

.10 Interface Shear Testing: Submit 10 days prior to ordering.

.11 Manufacturer's Installation Instructions: Submit at least 14 days prior to installation. Include written installation, handling, storage and repair instructions.

.12 Daily Field Installation Report. Submit no later than 1 day following date covered by report. Include:

.1 Subgrade surface acceptance form signed by manufacturer's representative.

.2 Total quantity, type, and location of HDPE and GCL placed.

.3 Identifiers of rolls and fabricated blankets correlated with manufacturer's number.

.4 Quality control tests of materials used during the day.

.5 Total quantity and location of seams completed, identification of seamer, and welding equipment used.

.6 Changes in layout drawings.

.7 Observations of test seams, including seaming unit number and identification of names of seamers, weather conditions, speed, temperature setting, and results.

.8 Location and results of non-destructive testing.

.9 Location and results of destructive testing.

.10 Reasons for and observations of repairs and retesting, including locations, type of repair, name of repairer, and seaming equipment or product used.

.11 Observations of anchor trench excavation, backfilling, and compaction.

.12 Observations of field seaming operations, including weather conditions, cleaning, overlaps, rate of seaming, names of seamers, and units used.

.13 Observations of seams around appurtenances, and connection to appurtenances.

.14 Installer Qualifications: Submit no later than 14 days prior to installation the following:

.1 A copy of the manufacturer's approval letter or license.

.2 A copy of the IAGI's Certified Contractor Status.

.3 IAGI's Certificates and Certified Welding Technician Certificates for each seamer.

.15 Record Documents: indicate panel layout, including panel identifiers, date placed, installer's name, location of seams, and location and details of repair, and liner quality control/quality assurance documentation.

.1 Written installation report shall be signed and certify that the geomembrane is installed in accordance with the manufacturer’s recommendations, is ready for operation, and that the warranty is in effect.

.2 One draft hard copy and electronic copy and three final hard copies and one final electronic copy are required to be submitted to Contract Administrator.

.16 Submit copies of manufacturer's test data at least 4 weeks prior to commencing the Works.

.17 Submit certificates, including test results, at least 2 weeks prior to delivery to the Site.

.18 Submit certificates based on GRI GM13 test frequency as follows:

.1 Certificates pertaining to rolls of geomembrane delivered to the Site shall accompany rolls. Each roll shall be identified by a unique manufacturing number. Quality control certificate shall include results of at least the following tests: density, carbon black content, thickness, tensile strength, puncture resistance, and tear resistance. Quality control certificates shall be signed by a responsible party employed by manufacturer.

.2 Certificates pertaining to raw materials and manufactured rolls shall be provided by geomembrane manufacturer. Contract Administrator will review test results for completeness and for compliance with minimum properties specified for both raw materials and manufactured rolls. Materials and rolls which are in non-compliance with minimum properties specified will be rejected.

1.7 CLOSEOUT SUBMITTALS

.1 Section 01 78 00 – Closeout Submittals.

.2 Record Documents: Indicate panel layout, including panel identifier, date placed, installer's name, location of seams, and location and details of repairs.

.3 Warranties: Completed original warranty forms filled out in City of Winnipeg's name and registered with manufacturer.

1.8 QUALITY ASSURANCE

.1 Provide manufacturer's quality assurance plan or manual to ensure that the HDPE liner is manufactured and will perform as specified in this Section and according to the noted references.

.2 Provide an installer's quality assurance plan or manual to ensure that the HDPE liner will be installed as specified in this Section and according to the noted references.

1.9 QUALIFICATIONS

.1 Manufacturer: company specializing in manufacturing products specified in this Section with minimum 20 projects, 3,000,000 m^2 installed, and 3 years documented experience.

.2 Installer:

.1 Company specializing in installing products specified in this Section with minimum five projects, 1,000,000 m^2, 3 years documented experience, certified/licensed by manufacturer, and a holder of the IAGI's Certified Contractor Status.

.2 Seamers: Certification by the IAGI's and Certification as a Certified Welding Technician is required for all personnel performing seaming operations.

.3 Master Seamer: Same certification requirements as seamer, with at least 1,000,000 m^2 of HDPE liner of the same generic type as HDPE liner used for project using the same type of seaming method. The master seamer will provide direct supervision over all seamers and will be present during all seaming operations.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 Section 01 61 00 – Product Requirements.

.2 Package and label HDPE and GCL rolls or blankets prior to shipment to the Site. The label shall indicate HDPE and GCL liner manufacturer, type of HDPE and GCL liner, thickness, lot number, roll number, and roll dimensions. Manufacturer is responsible for initial loading and shipping of HDPE liner. Methods of unloading HDPE and GCL liner shall be approved by manufacturer prior to shipment.

.3 When transported to the Site, handle HDPE and GCL rolls or blankets by appropriate means so that no damage is caused, as recommended by HDPE liner manufacturer.

.4 During delivery and storage, protect HDPE and GCL rolls from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

.5 Take adequate measures to keep HDPE and GCL materials away from possible deteriorating sources (i.e., vandalism, theft).

.6 Use appropriate handling equipment when moving rolled or folded HDPE and GCL from one place to another. Lift rolls by inserting bar, sized to limit deflection detrimental to HDPE and GCL liner, through roll core. Attach slings or lifting chains at both ends of bar.

Use a spreader bar to support and spread slings. Bar and support pipe shall be long enough to prevent damage to edges of liner during Hoisting.

.7 Notify Contract Administrator 3 days in advance of HDPE and GCL liner delivery to the Site. Perform joint inspection with Contract Administrator upon delivery. Defects or damage from shipping and handling will be grounds for rejection of a portion of HDPE and GCL liner or of the entire HDPE and GCL roll at the discretion of Contract Administrator. Remove roll from the Site and replace with new material.

1.11 AMBIENT CONDITIONS

.1 Suspend installation operations whenever climatic conditions, as determined by Contract Administrator or manufacturer's representative, are unsatisfactory for placing HDPE liner to the requirements of this Section.

.2 Weather Conditions for HDPE Placement:

.1 Comply with manufacturer's recommendation.

.2 Do not unroll, unfold, or place HDPE at an ambient temperature below 0 degrees C or above 40 degrees C, unless Contractor obtains written approval from HDPE liner manufacturer and Contract Administrator.

.3 Install on dry ground.

.4 HDPE liner placement shall take into account Site drainage, wind direction, landfill cap construction, access to the Site and production schedule of the Works.

.5 HDPE liner placement shall not proceed if subgrade conditions have deteriorated due to moisture, or in the presence of high winds, as determined by Contract Administrator, which might damage the HDPE liner.

.6 Adequately ballast deployed HDPE liner at all times to limit the risk of wind damage.

.3 Weather Conditions for HDPE Liner Seaming:

.1 Comply with manufacturer's recommendations.

.2 Make no weld below 1 degree C unless:

.1 Contractor strictly follows the guidelines for field seaming of HDPE liner in cold weather, as identified in GRI Test Method GM9.

.2 Contractor obtains written approval from HDPE liner manufacturer to weld at temperature below 0 degrees C according to GRI Test Method GM9.

.3 Between 1 degree C and 10 degrees C, seaming is possible if HDPE liner is preheated by either sun or hot air device, and if there is not excessive cooling resulting from wind.

.4 Make no weld below minus 15 degrees C.

.5 In all cases, HDPE liner must be dry while being welded.

1.12 WARRANTY

.1 Part D- Supplemental Conditions: Warranty.

.2 Section 01 78 00 – Closeout Submittals: Warranties and Bonds

.3 Provide minimum 1 year manufacturer's warranty against manufacturing defects.

.4 Include coverage for:

.1 Defective product found to be not in compliance with the requirements of this Section.

.2 Replacement of the HDPE liner with new material including costs associated with HDPE liner installation.

Part 2 Products

2.1 HDPE LINER

.1 Manufactured from virgin resin with no more than 10 percent rework. Rework shall be of same formulation as the parent material. No post consumer resin permitted.

.2 Design and manufacture rolls specifically for the purpose of fluid containment.

.3 Free of holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

.4 Melt Flow Index: to ASTM D1238 (190/2.16), less than or equal to 1.0 g/10 min.

.5 Textured membrane shall have uniform texturing appearance of same texturing as shear tested Sample, free from agglomerated texturing and defects that may affect the specified properties.

.6 Complying with the properties listed in this Section.

.7 Textured HDPE Liner:

.1 1.5 mm textured (double-sided) HDPE.

.2 Conform to the following standard specifications:

Property	**Unit**	**Test Method**	**Minimum Average Value**[1]
Thickness • Lowest of 10 coupon values • Lowest of 8 of 10 coupon values	mm	ASTM D5994	1.5 1.35 1.33
Density	g/cm^3	ASTM D1505/D792	0.94
Tensile Strength at Yield	kN/m	ASTM D6693, Type IV	23.1
Tensile Strength at Break	kN/m	ASTM D6693 Type IV	23.1
Elongation at Yield	percent	ASTM D6693 Type IV	13
Elongation at Break	percent	ASTM D6693 Type IV	350
Stress Crack Resistance[3]	hour	ASTM D5397 (Appendix)	500
Carbon Black Content	percent	ASTM D1603/ASTM D4218	2 to 3 (range)
Carbon Black Dispersion for 10 Different Views • 9 in Categories 1 or 2 and 1 in Category 3	--	ASTM D5596	Cat 1 or 2
Puncturing Resistance	N	ASTM D4833	534
Tear Resistance	N	ASTM D1004	200
Asperity Height	mm	ASTM D7466	0.51

Property	Unit	Test Method	Minimum Average Value[1]
Oxidation Induction Time (OIT)			
• Standard	minute	ASTM D3895	140
• High Pressure	minute	ASTM D5885	400
Oven Aging at 85 degrees C	NA	ASTM D5721	NA
• Standard OIT retained after 90 days; or	percent	ASTM D3895	55
• High Pressure OIT retained after 90 days	percent	ASTM D5885	80
UV Resistance[2]	NA	ASTM D7238	NA
• Standard OIT; or	percent	ASTM D3895	NR[4]
• High Pressure OIT retained after 1,600 hours	percent	ASTM D5885	50

Notes:
1 - Except as indicated.
2 - 20-hour UV cycle at 75 degrees C, followed by 4 hours condensation at 60 degrees C.
3 - Mean value determined by manufacturer's quality control testing.
4 - Not recommended.

.8 Smooth HDPE Liner:

.1 1.5 mm HDPE.

.2 Conform to the following standard specifications:

Property	Unit	Test Method	Minimum Average Value[1]
Thickness	mm	ASTM D5994	1.5
• Lowest of 10 coupon values			1.35
Density	g/cm^3	ASTM D1505/D792	0.940
Tensile Strength at Yield	kN/m	ASTM D6693, Type IV	22
Tensile Strength at Break	kN/m	ASTM D6693 Type IV	40
Elongation at Yield	percent	ASTM D6693 Type IV	12
Elongation at Break	percent	ASTM D6693 Type IV	700
Carbon Black Content	percent	ASTM D1603/ASTM D4218	2 to 3 (range)
Carbon Black Dispersion for 10 Different Views	--	ASTM D5596	Cat 1 or 2
• 9 in Categories 1 or 2 and 1 in Category 3			
Puncturing Resistance	N	ASTM D4833	480
Tear Resistance	N	ASTM D1004	187
Oxidation Induction Time (OIT)			
• Standard	minute	ASTM D3895	100

Property	Unit	Test Method	Minimum Average Value[1]
• High Pressure	minute	ASTM D5885	400
Oven Aging at 85 degrees C	NA	ASTM D5721	NA
• Standard OIT retained after 90 days; or	percent	ASTM D3895	55
• High Pressure OIT retained after 90 days	percent	ASTM D5885	80
UV Resistance[2]	NA	ASTM D7238	NA
• Standard OIT; or	percent	ASTM D3895	NR[4]
• High Pressure OIT retained after 1,600 hours	percent	ASTM D5885	50

Notes:
1 - Except as indicated.
2 - 20-hour UV cycle at 75 degrees C, followed by 4 hours condensation at 60 degrees C.
3 - Mean value determined by manufacturer's quality control testing.
4 - Not recommended.

2.2 EXTRUDATE ROD

.1 Solid core rod free of voids and contamination by moisture or foreign matter.

2.3 SOURCE QUALITY CONTROL

.1 Refer to Section 01 45 00 – Quality Requirements.

.2 Manufacturer shall perform test for parameters shown in Subparagraph 2.1.7.2 at a minimum frequency specified in GRI Test Method GM13.

2.4 GCL LINER

.1 GSE BentoLiner NSL or Engineer approved alternative.

.2 Alternative Materials:

.1 Prior to considering an alternative GCL material, the Contractor shall submit certified test results and statements of quality from the proposed GCL supplier to Manufactured

.3 The GCL product supplied to the project shall be in full accordance with the requirements of this section.

.4 The GCL shall be manufactured by mechanically bonding the geotextiles using a needle punching process as described in Section 1.3 to enhance frictional and internal shear strength characteristics.

.5 The needle punched GCL shall thermally heat set the nonwoven fibers where they protrude from the second geotextile (woven or nonwoven depending upon product) to more permanently secure the reinforcement in place. Other means may be used to lock the fibers in place if the process demonstrates similar performance to the thermal heat set process.

.6 In order to maintain these characteristics, no glues, adhesives or other non-mechanical bonding processes shall be used in lieu of the needle punch process. Their use to enhance the physical properties of the GCL is permitted.

.7 The GCL material shall be in accordance with the test methods, test frequencies and material physical properties as listed in the following data sheets.

.8 Dimensions - The minimum acceptable dimensions for the GCL panels shall be 4.5 m and 38 m. Short rolls (rolls less than 38 m long) may be supplied, but at a rate not to exceed 5% of the total square footage produced for this project.

.9 Overlap Markings - A minimum overlap guide-line and a construction match-line delineating the overlap zone shall be imprinted with non-toxic ink on both edges of the GCL panel to ensure the accuracy of the seam. These lines shall be used during CQA to ensure the minimum overlap is achieved. The minimum overlap guideline shall indicate where the edge of the panel must be placed in order to achieve the correct overlap for each panel.

.10 The GCL will have seam overlaps a minimum of 150 mm for all woven/nonwoven GCLs. GCL's comprised of a nonwoven/nonwoven geotextiles will have a minimum seam overlap of 150 mm for scrim reinforced and 300 mm minimum for all non-scrim reinforced nonwoven GCLs. End of panel or butt end seams shall be a minimum of 300 mm for all woven/nonwoven GCLs, 300 mm for all scrim-reinforced double nonwoven GCLs, and 600 mm for non-scrim reinforced double nonwoven GCLs.

.11 Accessory Bentonite - Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same granular bentonite as used in the production of the GCL itself.

.12 Conform to the following standard specifications:

Tested Property	Test Method	Frequency	Value
Geotextile Property			
Cap Nonwoven, Mass/Unit Area	ASTM D 5261	1/20,000 m^2	200 g/m^2 MARV[(1)]
Carrier Woven, Mass/Unit Area	ASTM D 5261	1/20,000 m^2	105 g/m^2 MARV
Bentonite Property			
Swell Index	ASTM D 5890	1/50,000 kg	24 ml/2 g min
Moisture Content	ASTM D 4643	1/50,000 kg	12% max
Fluid Loss	ASTM D 5891	1/50,000 kg	18 ml max
Finished GCL Property			
Bentonite, Mass/Unit Area[(2)]	ASTM D 5993	1/4,000 m^2	3.66 kg/m^2 MARV
Tensile Strength[(3)]	ASTM D 6768	1/4,000 m^2	5.3 kN/m MARV
Peel Strength	ASTM D 6496 ASTM D 4632[(4)]	1/4,000 m^2	610 N/m MARV 93 N MARV
Hydraulic Conductivity[(5)]	ASTM D 5887	1/Week	5×10^{-9} cm/sec max
Index Flux[(5)]	ASTM D 5887	1/Week	1×10^{-8} m^3/m^2/sec max
Internal Shear Strength[(6)]	ASTM D 6243	Periodically	24 kPa Typical
TYPICAL ROLL DIMENSIONS			
Width x Length[(7)]	Typical	Every Roll	4.7 m x 45.7 m
Area per Roll	Typical	Every Roll	216 m^2
Packaged Weight	Typical	Every Roll	1,179 kg

Part 3 Execution

3.1 EXAMINATION

.1 Section 01 73 00 – Execution Requirements.

.2 Obtain Contract Administrator's and manufacturer's approval in writing prior to installing HDPE and GCL liners and prior to placing subsequent layers on HDPE and GCL liners.

.3 Coordinate activities such that Contract Administrator can observe testing. Contract Administrator will observe all testing and collect samples for destructive testing.

3.2 CONFIRMATION TESTING

.1 Interface Shear: compacted clay and HDPE liner

.1 Perform testing between compacted clay material and HDPE liner according to ASTM D5321 to determine friction angle and cohesion intercept.

.2 Utilize sample representative of materials to be installed.

.3 Perform grain size analysis on clay material according to ASTM D422.

.4 Utilize minimum 300 mm by 300 mm shear box.

.2 Perform testing for clay material and HDPE liner as follows:

.1 Presoak HDPE liner in shear box between free draining sand at 4.8 kPa for 3 days. Disassemble and install immediately in test apparatus.

.2 Compact clay material in shear box to at least 95 percent SMDD at 2 over optimum moisture content.

.3 Assemble materials in shear box. Apply normal pressure of 4.8 kPa. Submerge interface to be tested in water for 24 hours.

.4 Apply normal pressure of 4.8 kPa, measure vertical displacement, and maintain until there is no further displacement. Record amount of displacement and time to stabilize.

.5 Perform test parallel to machine roll direction at a rate of 0.25 mm per minute. Maintain submerged condition. Record displacement and shear force. Terminate at no less than 100 mm total travel.

.6 Disassemble test apparatus. Observe and record condition of sand protective cover material and HDPE liner. Retain HDPE liner, label, and submit to Contract Administrator in sealed container.

.7 Determine moisture content on representative sample with weight of no less than 25 percent of shear box sample.

.8 Utilize new clay material and new HDPE liner and repeat steps 1 through 7, except that for step 4 test at 9.6 kPa.

.9 Utilize new clay material and HDPE liner and repeat steps 1 through 7, except that for step 4 test at 19.2 kPa.

.10 Generate graphs of displacement versus shear stress for each of the three tests.

.11 Generate graph of normal stress versus peak shear stress and normal stress versus minimum post peak shear stress.

.12 Develop values of peak friction angle and cohesion and post peak friction angle and cohesion.

3.3 PREPARATION

.1 Surface Preparation:

.1 Do not begin installation of HDPE and GCL liner until a proper subbase has been prepared and approved by Contract Administrator and HDPE and GCL liner manufacturer's representative. The prepared surface shall be free from abrupt changes in grade, water, loose earth, exposed rocks, rubble, protrusions, vegetation, and other foreign matter which may be damaging to HDPE or GCL liners. Compact the subgrade uniformly to a minimum of 98 percent SMDD and smooth with a drum roller for HDPE liner.

.2 Do not place HDPE liner in an area which has become softened by precipitation and which will not support liner installation equipment without rutting.

.3 Immediately prior to deployment of the GCL, the subgrade shall be final compacted to fill in any remaining voids or desiccation cracks and to ensure that no sharp irregularities or abrupt elevation changes exist greater than 25 mm. The surfaces to be lined shall be maintained in this condition and free of standing water. GCL can be deployed on a frozen subgrade, if the subgrade would meet all the conditions as previously outlined if unfrozen.

.4 The subgrade surface and preparation should be inspected and certified by the CQA inspector prior to GSE BentoLiner placement. Upon approval by the CQA inspector, it is the geosynthetic installer's responsibility to communicate to the engineer of any changes in the condition of the subgrade that might render it out of compliance, with any of the requirements of the project specification or ASTM Standard D 6102.D.

3.4 INSTALLATION HDPE

.1 Maintain area of installation free of water and snow accumulations.

.2 Prepare excessively soft supporting material as directed by Contract Administrator.

.3 Do not proceed with panel placement and seaming when ambient temperatures are below minus 5 degrees C or above 40 degrees C, during precipitation, in presence of excessive moisture (e.g., fog, dew), nor in presence of high winds.

.4 Place according to panel layout submittal and seam panels according to manufacturer's recommendations on graded surface in orientation and locations indicated. Minimize wrinkles, avoid scratches and crimps to geomembranes, and avoid damage to supporting material.

.5 Designate each roll or blanket with an individual panel number and correlate with manufacturer's identification number. Mark each designation in each roll as it is deployed.

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

.7 Require workers to wear shoes which will not damage HDPE liner.

.8 Minimize pulling of HDPE liner panels to reduce permanent tension.

.9 Minimize dragging of textured HDPE liner to prevent damage to texturing.

.10 Label each panel with panel number and material roll number.

.11 Take the following precautions to minimize the risk of damage by wind during panel placement:

.1 Orientate work according to the direction of prevailing winds if possible, unless otherwise specified.

.2 Provide adequate securement of HDPE liner panels to prevent uplift by wind, using sand bags, tires, or any other means which will not damage HDPE liner.

Along the edges, ensure loading is continuous, to avoid possible wind flow under the panels.

.3 Replace damaged, torn or permanently twisted panels to approval of Contract Administrator. Remove rejected damaged panels from site.

.12 Keep field seaming to minimum. Locate field seams up and down slopes, with no horizontal field seam less than 1.5 m beyond toe or crest of slope.

.13 Keep seam area clean and free of moisture, dust, dirt, debris and foreign material.

.14 Make field seam samples according to requirements specified in PART 2, HDPE LINER on fragment pieces of geomembrane and test to verify that seaming conditions are adequate.

.15 Test field seams as seaming work progresses by non-destructive methods over their full length, according to ASTM D4437. Repair seams which do not pass non-destructive test. Reconstruct seam between failed location and any passed test location, until non-destructive testing is successful.

.16 Repair minor tears and pinholes by patching until non-destructive testing is successful. Patches to be round or oval in shape, made of same geomembrane material, and extend minimum of 75 mm beyond edge of defect.

3.5 INSTALLATION GCL

.1 GCL Material shall be placed in general accordance with the procedures specified below, or modified to account for site specific conditions.

.2 GCL Orientation - GCL panels are typically placed with the nonwoven side up (heat burnished side down) to maximize the shear strength characteristics. However, the heat burnished side up if it maximizes the shear strength characteristics of a site specific interface. In base or flat areas, the GCL does not require any particular orientation.

.3 GCL Panel Position - Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation.

.4 Panel Deployment - GCL materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.

.1 Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.

.2 The GCL may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.

.3 Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize “dragging” the GCL. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.

.4 The GCL will have seam overlaps a minimum of 150 mm for all woven/nonwoven GCLs. GCL’s comprised of a nonwoven/nonwoven geotextiles will have a minimum seam overlap of 150 mm for scrim reinforced and 300 mm minimum for all non-scrim reinforced nonwoven GCLs. End of panel or butt end seams shall be a minimum of 300 mm for all woven/nonwoven GCLs, 300 mm for all scrim-reinforced double nonwoven GCLs, 600 mm for non-scrim reinforced double nonwoven GCLs, and be free of wrinkles, folds or “fish-mouths”.

.5 The contractor shall only install as much GCL that can be covered at the end of the day. No GCL shall be left exposed overnight. The exposed edge of the GCL

shall be covered by a temporary tarpaulin or other such water resistant sheeting until the next working day.

3.6 INSTALLATION AROUND APPURTENANCES

.1 Install HDPE liner around wells, vents, or other appurtenances protruding through HDPE liner as shown on the Drawings.

.2 Obtain Contract Administrator's written approval for materials to be used to seal gaps between the liner skirt and appurtenances.

.3 Perform installation on rough surfaces carefully to minimize HDPE liner damage. Additional loosely placed HDPE liner sections may be used by HDPE liner installer as protection for HDPE liner, if approved by Contract Administrator.

.4 Ensure clamps, clips, bolts, nuts, or other fasteners used to secure HDPE liner around each appurtenance have a lifespan equal to or exceeding HDPE liner.

3.7 FIELD SEAMING HDPE

.1 Overlap the HDPE panels a minimum of 100 mm for extrusion welds and a minimum of 125 mm inches for hot wedge welds.

.2 The overlap shall be sufficient to leave a loose flap of geomembrane at a minimum 25 mm wide adjacent to both sides of the seam.

.3 Panel Preparation: Prior to seaming, clean the seam area and ensure it is free of moisture, dust, dirt, debris of any kind, and foreign material.

.4 Seaming Equipment and Products: Seam HDPE liner using extrusion (repairs and details only) or hot wedge welding equipment and installation methods recommended by manufacturer. For extrusion welding, use an extrudate composition identical to that of the liner material, or weld all panels together using the hot wedge welding system. Include thermometers on the extrusion welding equipment to measure temperature of the extrudate in the machine extruder and at the nozzle. Use wedge welding equipment capable of continuously monitoring and controlling the wedge temperature.

.5 Orient seams downslope so that direction of seaming will not hinder flow of water over top of HDPE liner. Specifically for hot welded seams, overlap the HDPE liner on the downslope side of the seam. Extend seaming to the outside edge of panels to be placed in the anchor trench.

.6 If the supporting soil is yielding, provide a firm substrate by using a homogeneous board, a conveyor belt, or similar hard surface directly under the seam overlap to effect proper rolling pressure.

.7 Seaming Wrinkles: Cut fishmouths and corrugations so as to effect a flat overlap. Seam the cut fishmouths or wrinkles as well as possible, and then install patch of the same generic HDPE liner extending a minimum of 150 mm beyond the cut in all directions.

.8 Do not cross-slope seam less than 1.5 m from the toe of slope unless slope is less than 10 percent. Cross-slope seams may be utilized if cut at an angle of approximately 45 degrees and staggered a minimum of 1.0 m.

.9 Label each seam with date, seamer, equipment seaming temperature and speed, and time seam started and completed.

.10 Seaming Tie-ins: Seaming of HDPE liner tie-ins shall not proceed unless all panels to be seamed are at a uniform temperature (i.e., early in the morning or late in the day) so as to avoid excessive distortion in the liner due to HDPE liner contraction and expansion.

3.8 FIELD SEAMING GCL

.1 Seams

.1 Woven/Nonwoven and Scrim Reinforced Nonwoven GCLs

.1 Overlap seams shall be a minimum of six inches on panel edges and one foot on panel ends.

.2 Non-Scrim Reinforced Nonwoven GCLs

.1 Overlap seams shall be a minimum of 300 mm on panel edges and 0.6096 m on panel ends.

.2 Loose granular bentonite shall be placed between panel overlaps at a rate of 372 grams per lineal meter.

3.9 REPAIR PROCEDURES HDPE

.1 All repairs shall be completed within 24 hours from identification, except by approval of Contract Administrator.

.2 Clean and dry surfaces at the time of repair.

.3 Repair pinholes by applying a patch, and defective seams by re-seaming, flap welding, or applying a patch, as approved by Contract Administrator.

.4 Repair tears, blisters, larger holes, undispersed raw materials, and contamination by foreign matter, or corrugations determined by Contract Administrator to be excessive, by patches.

.5 Patches:

.1 Abrade surfaces as appropriate.

.2 Label each patch with date, number, and seamer and equipment.

.3 Ensure patches are round or oval in shape.

.4 Make of the same generic HDPE liner.

.5 Patches straddling textured and non-textured liners shall be textured.

.6 Extend patch a minimum of 100 mm beyond the edge of defects.

3.10 REPAIR PROCEDURES GCL

.1 Prior to cover material placement, damage to the GCL shall be identified and repaired by the installer. Damage is defined as any rips or tears in the geotextiles, delamination of geotextiles or a displaced panel.

.2 Rip and Tear Repair (Flat Surfaces) - Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 300 mm on all edges. Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a continuous six inch fillet.

.3 Rip and Tear Repair (Slopes) - Damaged GCL material on slopes shall be repaired by the same procedures above, however, the edges of the patch should also be adhered to the repaired liner with an adhesive to keep the patch in position during backfill or cover operations.

3.11 FIELD QUALITY CONTROL

.1 Section 01 45 00 – Quality Requirements.

.2 Test quality of resin and HDPE to ensure consistency of raw material and geomembrane quality according to manufacturer's recommendations.

.3 Inspect each panel after placement and prior to seaming for damage. Mark damaged panels or portions of damaged panels which have been rejected, as judged by Contract Administrator, and record their removal from the work area.

.4 Verify that weather conditions (air temperature, non-excessive wind, and lack of precipitation) are acceptable for panel placement.

.5 Field Seaming Operations: Verify as follows:

.1 Seaming personnel have the specified qualifications.

.2 Overlaps meet specified requirements.

.3 Seaming area is clean and dry, as specified.

.4 A hard substrate such as a board or a piece of conveyor belt is used if the supporting soil is soft or uneven.

.5 Seaming equipment is available and meets specified requirements.

.6 Weather conditions for seaming are acceptable, as specified.

.7 Seaming procedures as specified are followed.

.8 Panels are properly positioned to prevent wrinkling.

.9 Equipment for testing seams is available on the Site and operational.

.10 Field tensiometer has been correctly calibrated.

.6 Test Seams:

.1 Perform test seams in shear and peel according to ASTM D4437 or ASTM D6392 to verify that the seaming conditions are adequate. Conduct test seams at the discretion of Contract Administrator and at least two times each day (at the beginning of the day and at least 4 hours thereafter), when welder settings are changed, when welding operations have stopped for two hours or more and when there is a change in ambient conditions including a temperature change of 10 degrees C or greater, for each seaming equipment used that day. Perform test seaming under the same conditions as production seaming. Provide 1.2 m test seams for extrusion welds and 3.0 m test seams for hot wedge welds. Perform test seams on scrap HDPE liner not to be incorporated into the Works.

.2 Cut 25 mm wide coupons from the test seam and assign to peel or shear test alternatively as they are cut across panel. Test coupons in shear and peel using a calibrated field tensiometer.

.1 Minimum strength of HDPE liner test seams when tested in shear shall be 90 percent of the specified tensile strength at yield of the unseamed HDPE liner.

.2 Minimum strength of HDPE liner test seams when tested in peel shall be 60 percent of the specified tensile strength at yield of the unseamed HDPE liner.

.3 In addition, the test coupons must not delaminate. Passing test results must be obtained from four or five coupons when tested in shear, and four or five coupons when tested in peel. For HDPE liner test seams performed using a hot wedge welder, perform peel tests on both the inside and outside welds; both welds must pass the peel test. If a test seam fails, reject the seaming equipment for field seaming until the deficiencies are corrected and a successful test seam is produced.

.3 A passing test seam will be an indicator of the adequacy of the seaming unit and seamer working under prevailing Site conditions, but not necessarily an indicator of field seam adequacy.

.4 Coordinate completion of test seams such that Contract Administrator can observe such seams. Contract Administrator will observe all test seams. Retain a Sample from each test and label with the date, ambient temperature, number of seaming unit, seamer, and pass or fail description. One half of the Sample will be retained by Contract Administrator.

.7 Non-destructive Seam Testing:

.1 Non-destructively test field seams over their full length by pressure testing to GRI GM6. Pressure test results will be written on liner near seam. Number or otherwise designate each seam. Record location, date, test unit, name of tester, and outcome of all non-destructive testing.

.2 Passing non-destructive test of field seams, meeting or exceeding requirement to GRI GM6, indicates the adequacy of field seams, subject to the results of destructive seam testing, as identified in Paragraph 3.8 G.

.3 Coordinate activities such that Contract Administrator can observe all testing. Contract Administrator will observe all testing. Non-destructive testing performed in absence of Contract Administrator shall be repeated. Conduct testing as the seaming work progresses. Number and mark all defects found during testing immediately after detection. Repair, retest, and remark all defects found to indicate completion of the repair and acceptability. If pressure testing is performed, following testing, repair hole resulting from pressure needle.

.8 Destructive Seam Testing: Collect 600 mm long HDPE liner field seam samples at a frequency of approximately one sample per 150 linear metres of field seam at locations directed by Contract Administrator, or more frequently if requested, and at least two samples from each panel taken from extra material, such that panel is not damaged and blanket geometry is not altered. Field test five coupons in peel and five coupons in shear according to ASTM D4437, using a calibrated field tensiometer. Perform peel tests on the inside and outside weld. If at least four of each of the five coupons do not delaminate and pass the tensile strength requirements, based on the field testing, then collect additional 600 mm long sample from the same location and provide to Contract Administrator for quality assurance laboratory shear and peel testing. Minimum shear strength of HDPE liner field seams when tested in shear shall be 90 percent of the specified tensile strength at yield of the unseamed HDPE liner for both the field and laboratory tests. Minimum strength of HDPE liner field seams when tested in peel shall be 60 percent of the specified tensile strength at yield of the unseamed HDPE liner for both the field and laboratory tests. If either field or laboratory tests fail, isolate the defective seam and re-test as follows:

.1 Collect additional 600 mm long samples from field seam for testing using a field tensiometer, within 3 m of each side of the failing sample as determined by Contract Administrator, until passing test locations are identified. Collect additional 600 mm long sample from each passing field test location and provide to Contract Administrator for laboratory shear and peel testing.

.2 Repair the field seam between the passing test locations (based on field tensiometer results) by extrusion welding or patching.

.3 Non-destructively test the patch or extrusion weld and repair, as required, until non-destructive test standards are achieved.

.4 If the additional laboratory shear or peel tests fail, then additional destructive seam field Samples will be collected and field tested to isolate the failing seam, then laboratory tested.

.5 Repeat the above-noted procedure until passing field and laboratory test results are achieved, thereby delineating extent of defective seam.

.9 Contract Administrator may increase the frequency of sampling in the event that test results do not comply with requirements of this Section according to GRI GM20. Additional testing will be performed at the expense of Contractor.

.10 Verification of Seams in Special Locations:

.1 Non-destructively test seams in special locations (i.e., appurtenances) if the seam is accessible to testing equipment. Contract Administrator will observe all seam testing operations. If the seam cannot be tested in place, it will be observed by Contract Administrator and Contractor for uniformity and completeness.

.2 In the case of visual inspections, record the seam number, date of inspection, name of tester, and outcome of the inspection.

.3 Promptly repair, retest, and re-mark defective seams to indicate completion of the repair.

.11 Defects and Repairs:

.1 Identification: Inspect seams and non-seam areas of HDPE liner for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

.2 Evaluation: Non-destructively test each suspect location, both in seam and non-seam, using the methods described in Paragraph 3.8 F. Mark and repair each location which fails the non-destructive testing.

.3 Verification of Repairs: Non-destructively test each repair using the method described in Paragraph 3.8 F. Tests which pass the non-destructive test standards will serve as an indication of an adequate repair. Re-repair and test failed test locations until a passing test results. Record the number of each repair, date, location, repair personnel initials, and test outcome. Contract Administrator will observe non-destructive testing of repairs.

.12 HDPE Liner Acceptance: HDPE liner placement will be accepted by Contract Administrator when:

.1 Installation is finished.

.2 Documentation of installation is completed and submitted to Contract Administrator.

.3 Verification of the adequacy of field seams and repairs, and associated testing, is complete.

.13 Quality Assurance Testing: quality assurance laboratory engaged by Contract Administrator will perform laboratory tests on HDPE liner Samples as identified in this Section to determine if HDPE liner seams meet specified requirements. Copies of test reports will be supplied to Contractor on request. Retesting of previously failed HDPE liner seams will be at no additional cost to Contract.

3.12 MANUFACTURER'S FIELD SERVICES

.1 Section 01 45 00 – Quality Requirements: Manufacturer’s Field Services and Reports.

.2 Manufacturer shall provide a qualified representative to observe placement of HDPE liner, subgrade preparation, liner installation, and backfilling operations. Manufacturer's representative shall guide the installer into proper installation techniques but shall not assume liability or responsibility in the overall installation.

.3 Manufacturer's representative shall have extensive knowledge of HDPE liner product, specifically as it pertains to proper construction techniques for waste management applications.

.4 Manufacturer's representative shall remain on the Site until, in his opinion, Contractor and/or installer can adequately complete the installation in strict accordance with specifications and the installation procedure specified in this Section.

3.13 PROTECTION

.1 Section 01 73 00 – Execution Requirements: Protection of Installed Work.

.2 Protect finished work from damage.

.3 Do not permit traffic or construction equipment directly on HDPE liner.

.4 Cover overlying materials as indicated.

.5 Place interim soil cover/grading layer material from lower elevations to higher elevations. Push interim soil cover/grading layer by traveling only on previously placed material, never directly on HDPE liner, and by avoiding sudden turns or accelerations.

3.14 COVER MATERIAL

.1 The cover materials shall be compatible as well as suitable for use over the GCL, and placed in a manner appropriate to the particular subgrade. Regardless of the cover material, the uncovered edge of GCL panels shall be protected at the end of the working day with a waterproof sheet which is secured adequately with ballast.

.2 Earthen Cover Soil - If the cover material is soil or gravel, a minimum thickness of 300 mm shall be placed over the GCL. The soil cover shall be free of sharp-edged stones greater than 12.7 mm in size.

.1 Equipment - Soil cover shall be placed with low ground pressure equipment. Care should be taken to avoid damaging the GCL by making sharp turns or pivots with equipment as well as sudden starts or stops.

.2 Placement - Soils may be placed on the GCL by pushing with a track dozer or by carefully placing it with a loader or a back-hoe. The use of scrapers or pans directly over the GCL is strictly prohibited.

.3 Thickness - A minimum thickness of 300 mm of cover shall be kept between heavy equipment and the GCL at all times. No heavy vehicles should be driven directly on the GCL until the proper thickness of cover has been placed.

.4 Compaction - To prevent damage to the GCL, the initial lift(s) of soil cover shall not be compacted in excess of 85 percent Modified Proctor density or as specified by the engineer.

.5 Slope Placement - When covering GCL on sloped areas, cover soil should be pushed up-slope to minimize tension on the GCL.

.3 Geosynthetic Cover - Precautions shall be taken to prevent damage to the GCL by restricting the use of heavy equipment over the liner system.

.1 Equipment - Installation of the overlying geosynthetic component can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

.2 Placement - Smooth HDPE may be dragged across the GCL surface with equipment or by hand labor during positioning. Similarly, the HDPE may be unrolled with the use of low ground pressure equipment.

.3 Use of Textured Liners - If a textured geomembrane is placed over the GCL, a slip sheet (such as 0.5 mm smooth HDPE) may first be placed over the GCL in order to allow the geomembrane to slide into its proper position. Once the overlying geomembrane is properly positioned, the slip-sheet shall be carefully removed paying close attention to avoiding any movement to the geomembrane.

3.15 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling.

.2 Remove and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal or recycling paper, plastic, polystyrene, corrugated cardboard, and packaging material.

.4 Fold up metal banding, flatten and remove to appropriate recycling facilities.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 32 19.02 – Geomembrane.

.2 Section 31 23 33.01 – Excavation.

.3 Section 31 23 33.02 – Fill.

.4 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

.1 Section 01 29 00 – Price and Payment Procedures.

.2 Engineered Clay Liner:

.1 Measurement Basis: Item measured by the square metre in place using the surface area of the engineered clay liner.

.2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, placing, grading, compaction, and finishing of clay for construction of engineered clay liner.

.1 Payment includes any temporary stockpiling required under Contractor's method of construction.

1.3 REFERENCES

.1 Definitions:

.1 SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined according to ASTM D698.

.2 Reference Standards:

.1 ASTM International:

.1 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.

.2 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft3 (600 kN-m/m3)].

.3 ASTM D1140 - Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-μm) Sieve.

.4 ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

.5 ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

.6 ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

.7 ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

.2 City of Winnipeg Standard Construction Specifications:

.1 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.

1.4 SEQUENCING

.1 Sequence and schedule engineered clay liner activities with work of other Sections.

.2 Perform construction of the engineered clay liner subsequent to excavation and approval of cell excavation by Contract Administrator. Excavation of base grades involves removing the existing soils to finished subgrade as shown on the Drawings.

.3 Construct the engineered clay liner in such a manner so as to facilitate placement of the HDPE liner so that no portion of the completed engineered clay liner remains exposed for greater than 72 hours.

.4 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.5 SCHEDULING

.1 Section 01 33 00 – Submittal Procedures: Detailed Work Schedule.

.2 All engineered clay liner work is to be completed by the deadline as outlined in the Contract Documents.

1.6 AMBIENT CONDITIONS

.1 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing engineered clay liner material to the requirements of this Section.

.2 After occurrence of heavy rains, do not operate equipment on previously placed material or on approved graded areas until the material has dried sufficiently to prevent the occurrence of excessive rutting.

.3 Do not place engineered clay liner material in a frozen state or against frozen ground or previously placed material.

.4 Do not place engineered clay liner material on snow, ice, water or other objectionable material or on improperly graded areas or previously placed material.

.5 Remove, replace, and compact softened, eroded, or otherwise objectionable or damaged areas or previously placed material, as determined by Contract Administrator at no additional cost to City of Winnipeg.

Part 2 Products

2.1 LOW PERMEABILITY MATERIAL SOURCE

.1 Low permeable soil for construction of the engineered clay liner is to be obtained from Cell 31 excavation, on-Site stockpiles, or supplied by Contractor.

.2 Low permeable soil material shall be excavated and temporarily stockpiled, if necessary, and hauled to Cell 31 in volumes required to construct the engineered clay liner.

.3 Use low permeable soil that is free of unsuitable materials, is of sufficient low permeability, and is stable when placed and compacted as specified.

.4 Low permeable soil must have a maximum particle size no greater than 12.5 mm.

.5 Contract Administrator will direct excavation operations in areas of unsuitable materials. Material that is unsuitable for engineered clay liner construction to be excavated and stockpiled in locations as shown on the Drawings.

2.2 UNSUITABLE MATERIALS

.1 Unsuitable materials means materials which are not approved for use as determined by Contract Administrator and include the following:

.1 Refuse, asphalt, concrete, or granular materials.

.2 Material containing loam, roots, or organic matter.

.3 Frozen material or material containing snow or ice.

.4 Clays which are classified as inorganic clays of high plasticity in accordance with applicable ASTM specifications.

.5 Soft and/or organic clays and silts of low strength.

.6 Frost susceptible silts or clays.

.7 Swelling clays.

.8 Rock and lumps of material with dimensions greater than 75 mm.

.9 Trees, stumps, branches, roots, or other wood or lumber.

.10 Wire, steel, cast iron, cans, drums, or other foreign material.

.11 Materials containing hazardous or toxic constituents at hazardous or toxic concentrations.

.2 Material generated as a result of excavation, grading, and construction activities associated with completing the Works that are deemed unsuitable for use by Contract Administrator will be loaded, hauled, and placed in an area on the Site designated by Contract Administrator. This includes water or frost impacted material as a result of Contractor negligence.

2.3 MATERIAL SPECIFICATIONS

.1 Use low permeable soil that will achieve a remoulded permeability of less than 1×10^{-7} cm/s.

Part 3 Execution

3.1 EXAMINATION

.1 Section 01 73 00 – Execution Requirements.

.2 Verify that survey bench marks and intended elevations for Works are as shown on the Drawings.

.3 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

.4 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of initial and successive lifts.

.5 Ensure areas to be backfilled are free from debris and water.

.6 Do not permit traffic in restored/repaired area without approval from Contract Administrator.

3.2 SUPPORT OF EXCAVATIONS

.1 Install and maintain sheathing, shoring, bracing and sloping necessary to support excavations to prevent any movement which may damage adjacent structures, pavements, or utilities, or delay the work, or endanger life or health. Perform the Works in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects, Ministry of Jobs, Skills, Training and Labour and any other regulations and agencies.

3.3 PREPARATION

.1 Protect excavations and trenches from contamination.

.2 Prior to placing the low permeable material for construction of the engineered clay liner, proof roll the base of Cell 31 following excavation and rough grading and obtain approval from Contract Administrator. Ensure a minimum of two passes are conducted over each area of the base with suitable compaction equipment approved by Contract Administrator.

3.4 SEGREGATION AND PROTECTION

.1 The engineered clay liner material will be subject to monitoring and testing by Contract Administrator to verify its suitability. Engineered clay liner material that fails material specifications identified in Article 2.3 shall be removed by Contractor and placed in the designated area for surplus excavated material in the stock pile area as shown on the Drawings.

.2 If required, stockpiled clay material will be covered with polyethylene sheeting and/or watered, as directed by Contract Administrator, in order to restrict moisture loss of the engineered clay liner material.

3.5 BONDING

.1 During the work, whenever the surface of the engineered clay liner material already in place becomes too dry or too smooth to bond properly with the succeeding layer, as determined by Contract Administrator, and whenever engineered clay liner material placement resumes after suspension, disc or scarify the engineered clay liner material surface in place to a depth between 100 mm and 150 mm and compact at the specified moisture content.

.2 Obtain approval from Contract Administrator of prepared surfaces prior to resumption of engineered clay liner material placement after suspension of work and prior to covering surfaces with permanent material.

3.6 PLACING

.1 Place the engineered clay liner material to a minimum thickness of 150 mm to lines and grades shown on the Drawings.

.2 Place engineered clay liner material in continuous layers of uniform thickness following the grades shown on the Drawings. Place the layers at a thickness before compaction equal to 135 percent of the length of the wedge of the sheep's foot compactor, to a maximum thickness of 150 mm.

.3 Ensure the engineered clay liner material is free from lenses, pockets, streaks and layers of pervious material.

.4 Prior to work stoppages or following completion of the final layer, the engineered clay liner surface shall be proof rolled to a smooth finish with a minimum 13.5 tonne smooth drum compactor.

3.7 MOISTURE CONTENT

.1 Maintain the moisture content throughout each layer of the engineered clay liner material as uniformly as practicable and control the moisture content to between 2 percent and 4 percent wet of optimum moisture content.

.2 In case of engineered clay liner material which is too dry or too wet, including uncompacted engineered clay liner material, adjust the moisture content by methods approved by Contract Administrator.

.3 The engineered clay liner will be watered at the completion and/or start of every work day and on hot sunny days, as directed by Contract Administrator. The engineered clay liner will be watered as required to prevent shrinkage cracks greater than 50 mm in depth.

3.8 COMPACTION

.1 Compact each layer to a minimum density of 95 percent SMDD as determined by applicable ASTM specifications.

.2 Obtain approval by Contract Administrator for the type, size, and efficiency of compaction equipment.

.3 As a minimum, compaction equipment will be a 18 tonne wedge-shape sheep's foot rollers with depth of wedge equal to three-quarters the lift thickness, minimum 180 mm length. The final lift will be back-bladed following compaction by the sheep's foot roller and compacted with a minimum 5.0 tonne smooth drum compactor.

.4 Compaction equipment must pass over the completed area a minimum number of five passes before testing.

3.9 TOLERANCES

.1 Section 01 45 00 – Quality Requirements: Tolerances.

.2 Construct the engineered base liner such that the finished compacted thickness is not less than 150 mm or as adjusted by Contract Administrator.

.3 Correct surface irregularities by loosening and adding or removing material until the surface is within the specified tolerance.

.4 Repair the engineered clay liner where disturbed by Contractor activities such that the finished compacted engineer clay liner is returned to original condition.

.5 Payment will not be made for material placed outside the tolerance limits unless directed by Contract Administrator.

.6 Survey Requirements:

.1 Engineered clay liner thickness to be confirmed by Contract Administrator prior to geomembrane installation.

.2 Engineered clay liner as-built survey data is to be made available to the Contract Administrator prior to geomembrane installation.

3.10 FIELD QUALITY CONTROL

.1 Section 01 45 00 – Quality Requirements.

.2 Testing by Contract Administrator:

.1 Contract Administrator may select samples of uncompacted fill intended for the Works and samples of compacted fill in the Works.

.2 Contractor shall provide assistance to Contract Administrator to collect samples.

.3 Contract Administrator may perform tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Testing of imported fill may include analysis for the presence of contaminants, grain size analysis, moisture content determination, bulk wet density, maximum dry density, and permeability. Testing for backfill may include moisture content determination, maximum dry density, bulk wet density, and hydraulic conductivity. Copies of test reports will be supplied to Contractor on request.

.4 Contractor shall repair all locations sampled.

.5 Testing by Contract Administrator will in no way relieve Contractor of his responsibility to test all material prior to notifying Contract Administrator of the materials' suitability for the work involved.

.3 Methods of Testing:

.1 Maximum dry density of fill containing more than 12 percent by weight passing No. 200 sieve will be determined in accordance with ASTM D698.

.2 Bulk density will be determined in the field in accordance with ASTM D1556 or with ASTM D2167 or with ASTM D6938, whichever is most suitable to obtain representative density of soil tested.

.3 Particle size analysis will be performed in accordance with ASTM D422 or ASTM D1140, whichever is appropriate to material tested.

.4 Moisture content of fill in place will be determined in accordance with ASTM D6938.

.5 Compaction testing of fill in place will be determined in accordance with ASTM D6938.

.6 Hydraulic conductivity will be determined according to ASTM D5084 on a representative sample compacted in the laboratory to the field bulk wet density and moisture.

.4 Frequency of testing:

.1 Contract Administrator may take a minimum of thirteen field density and moisture contents per lift per hectare of engineered clay liner installation.

.2 Contract Administrator may take six Shelby tube samples on the finished base engineered clay liner, and two samples from the finished sidewall engineered clay liner.

.5 Failure to Meet Specified Requirements: If tests indicate that material specifications have not been achieved or cannot be obtained with equipment in use, the procedure being followed, or the material being incorporated, remove and replace work and modify operations so that the equipment, procedures, and materials will produce the required results. Additional testing required by Contract Administrator will be paid for by Contractor.

.6 Rework and recompact areas which do not meet the specified permeability density, as directed by Contract Administrator, at no additional cost to the Contract.

3.11 ADJUSTING

.1 Section 01 73 00 – Execution Requirements: Adjusting.

.2 Finish engineered clay liner to within 30 mm of grades shown on Drawings but not uniformly high or low. Correct surface irregularities by loosening and adding or removing material until the surface is within specified grade.

.3 All sharp rocks/objects, regardless of size, shall be removed from the final surface of the clay liner to avoid damaging the HDPE geomembrane.

.4 Leave work areas in a properly graded condition sloped as required to permit proper drainage and free of depressions that will pond or collect water or debris that will restrict flow.

3.12 CLEANING

.1 Section 01 74 11 - Cleaning.

.2 Clean and reinstate work areas and areas affected by equipment outside areas specified to be excavated, to specified restoration condition.

.3 Upon completion of backfilling, remove excess material and debris from work areas and travel routes.

3.13 PROTECTION

.1 Section 01 73 00 – Execution Requirements: Protection of Installed Work.

.2 Immediately prior to temporary suspension of placement operations of engineered clay liner material, fine grade the surfaces of the engineered clay liner under construction to a uniform grade so as to leave the area free of ruts, depressions, or areas that would pond or collect water. Provide suitable equipment on Site at all times for this purpose.

.3 Do not disturb completed final graded portions of the engineered clay liner already in place when placing and compacting engineered clay liner material.

.4 Protect open excavations against damage due to surface runoff and runon. Take necessary precautions to prevent erosion of excavated or disturbed surfaces.

.5 Protect compacted clay from desiccation and erosion.

.6 Do not permit traffic or construction equipment directly on completed engineered clay liner.

END OF SECTION