

**BENTOFIX<sup>®</sup>****Thermal Lock Geosynthetic Clay Liner****• Technical Bulletin •**

# **BENTOFIX**

# **SPECIFICATION**

# **GUIDELINES**

**THE FOLLOWING SPECIFICATION GUIDELINE REFLECTS INDUSTRY ACCEPTED INSTALLATION PROCEDURES AND THE MOST CURRENT BENTOFIX QUALITY CONTROL TEST PROTOCOL. IT IS INTENDED TO BE USED AS THE GENERAL FORMAT, NOT AS A DIRECT SUBSTITUTE FOR A PROJECT SPECIFIC GEOSYNTHETIC CLAY LINER (GCL) SPECIFICATION.**

- 1.0** **GENERAL Scope** - This specification details the technical requirements for the supply and installation of a needlepunched Geosynthetic Clay Liner (GCL). The material(s) furnished and installation performed shall be in strict accordance with these requirements and the contract drawings.
- 1.1.** **Definitions** - For the purposes of this specification the following definitions shall apply:
- 1.1.1. **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 needlepunching.
  - 1.1.2. **Geotextile** - A semi-permeable woven or nonwoven fabric or scrim-reinforced nonwoven used to contain the bentonite used in a GCL.
  - 1.1.3. **Sodium Bentonite** - The high swelling clay component of GCLs consisting primarily of the mineral Montmorillonite.
  - 1.1.4. **Needlepunching** - A GCL manufacturing process whereby boards of barbed needles incorporate the staple fibers from a nonwoven geotextile, through a sodium bentonite clay layer, into the matrix of a second geotextile layer.
  - 1.1.5. **Thermal Locking** - A needlepunching enhancement process utilizing heat to bond the needlepunched fibers and more permanently lock them into the second geotextile to increase the internal shear strength characteristics and lower the bulk void ratio of the bentonite.
  - 1.1.6. **Minimum Average Roll Value (MARV)** - The minimum average value of the material in a particular lot calculated as the mean of the tested values minus two standard deviations providing a 95% confidence level.
- 1.2.** **References** - The following test methods shall be incorporated into this specification in their entirety, subject to the indicated test modifications:
- ASTM D 4632, "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles". (Note: D6496 & D6768 are now used instead of D4632).
  - ASTM D 4643, "Determination of Water (Moisture) Content of Soil by the Microwave Oven Method".
  - ASTM D 5084, "Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter".
  - ASTM D 5261, "Standard Test Method for Measuring Mass Per Unit Area of Geotextiles".
  - ASTM D 5321, "Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method".
  - ASTM D 5887, "Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter".
  - ASTM D 5888, "Standard Guide for Storage and Handling of Geosynthetic Clay Liners".

- ASTM D 5889, “Standard Practice for Quality Control of Geosynthetic Clay Liners”.
- ASTM D 5890, “Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners”.
- ASTM D 5891, “Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners”.
- ASTM D 5993, “Standard Test Method for Measuring Bentonite Mass Per Unit of Geosynthetic Clay Liners
- ASTM D 6243, “Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liners by Direct Shear Method”.
- ASTM D 6496, “Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners”.
- ASTM D 6768, “Standard Test Method for Tensile Strength of Needle-Punched Geosynthetic Clay Liners”.

**2.0** **QUALIFICATIONS** - The GCL Manufacturer, Installer and Construction Quality Assurance (CQA) inspector shall all be skilled in accordance with the following experience requirements. Any exceptions must be approved by the project engineer prior to the project bid.

**2.1.** **GCL Manufacturer** - The GCL manufacturer selected for use on this project shall have successfully produced at least 10,000,000 square meters of needlepunched GCL product.

**2.2.** **GCL Installer** - The installer shall provide to the engineer sufficient evidence of installation experience and competence with the specified geosynthetic materials.

The GCL installer shall demonstrate a minimum of 5,000 square meters of GCL installation experience **or** shall provide sufficient evidence of installation experience and competence with other Geosynthetic products (geotextiles/geogrids,geoliners) **or** shall demonstrate an acceptable level of training and supervision will be utilized in order to ensure the quality of the installation **or** shall receive initial assistance from the GCL manufacturer and/or from the GCL distributor in order to ensure a quality installation.

**2.3.** **Construction Quality Assurance (CQA) Inspector** - (if required) – The engineering consultant shall have a CQA inspector on this project. The CQA inspector shall be an employee of the engineering consultant on this project.

**2.4.** **Submittals** - Three copies of the project submittals shall be forwarded to the project engineer as designated below:

2.4.1. **Unit Prices Bid** - The square footage and associated pricing shall be based on “measured in place” quantities **or** quantity delivered to the project site as determined by the project engineer.

2.4.1.1. Measured In Place - Measured in place quantities shall be determined from the project drawings, including any allowances for waste, overlap, and anchoring. Final quantities will be payable based on the as-built drawings.

2.4.1.2. Delivered to Site - Delivered pricing quantities shall be determined from the manufacturer's shipping documents and reflect the total square footage delivered to the project site.

2.4.2. Information With Bid - The following shall be submitted with the bid:

2.4.2.1. Statement of experience from the proposed GCL supplier.

2.4.2.2. Statement of experience from the proposed GCL Installer.

2.4.3. Prior to Installation - The following information shall be supplied to the project engineer for review within 10 business days of the Contract Award to ensure that the materials and parties selected for use on the project meet the requirements of this specification:

2.4.3.1. Samples of GCL proposed for use on the project.

2.4.3.2. Reference list supplied by GCL Manufacturer indicating the appropriate experience level as required by the specification.

2.4.3.3. Reference list supplied by the GCL Installer indicating the appropriate experience level as required by the specification.

2.4.4. Prior to Deployment - The following information shall be submitted by the Lining Contractor to the Project Engineer prior to the deployment of any GCL material to ensure that the materials and subgrade preparation meet the requirements of this specification:

2.4.4.1. GCL Manufacturer's Quality Control Certifications.

2.4.4.2. Certifications of subgrade acceptance for each area covered by GCL, signed by the earthwork Contractor and CQA inspector.

**3.0 GCL MATERIALS** - The GCL product supplied to the project shall be in full accordance with the requirements of this section.

**The GCL shall be manufactured by mechanically bonding the geotextiles using a needlepunching process to enhance frictional and internal shear strength characteristics.**

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

- 3.1. **Description** - Acceptable GCLs for this project include the Bentofix Thermal Lock, or any other needlepunched GCLs which meet the requirements of this specification and the GCL Technical Data sheet listed for this project.
- 3.2. **GCL Manufacturing** - The GCL supplied in accordance with this project shall be manufactured by needlepunching as described in Section 1.2 – Definitions and the GCL Technical Data Sheet of this Project.
- 3.2.1. The needlepunched GCL shall be thermally locked. The thermal lock process must heat set the nonwoven fibers where they protrude from the second geotextile (woven or nonwoven or scrim-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 lock process.
- 3.2.2. To demonstrate the uniformity of the manufacturing process, no delamination of the geotextile components from the bentonite core shall occur when the GCL is exposed to 80 degree tap water for one hour.
- 3.3. **Alternative Materials** - Prior to considering an alternative GCL material, the Contractor shall submit certified test results and statements of quality from the proposed GCL supplier to the engineer, indicating without exception that the proposed GCL meets the requirements of this specification. Submittals shall be delivered to the engineer a minimum of five business days in advance of the bid.

No other manufacturing techniques shall be approved unless it can be suitably demonstrated that the GCL exhibits uniform shear strength characteristics across the entire width of the panel. Isolated sewn or stitched rows do not constitute uniform reinforcement for the purposes of this specification.

- 3.4. **GCL Physical Properties** - The GCL material shall be in accordance with the test methods, test frequencies and material physical properties as listed in the Appendix (GCL - Technical Data Sheet).
- 3.4.1. **Standard Conditions** - For projects where a standard nonwoven - bentonite - woven GCL will provide sufficient interface shear properties, the GCL supplied for this project shall be in accordance with the test methods, test frequencies and material physical properties as listed in the Appendix (GCL – Technical Data Sheet).
- 3.4.2. **Steep Slopes** - For slope applications where the interface shear strengths require a nonwoven - bentonite - “scrim-nonwoven” GCL, the GCL supplied for this project shall be in accordance with the test methods, test frequencies and material physical properties as listed in the Appendix (GCL – Technical Data Sheet).

- 3.5. Dimensions** - The minimum acceptable dimensions for the GCL panels shall be 15 feet wide and 150 feet long. Short rolls (rolls less than 150 feet long) may be supplied, but at a rate not to exceed 5% of the total square footage produced for this project.
- 3.6. 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 a twelve inch of panel overlap.
- 3.7. Manufacturing Quality Control** - The GCL shall be tested for compliance with this specification by the test methods and frequencies indicated on the material specification (GCL Technical Data Sheet) as appropriate. GCL materials may be tested pre-approved at the manufacturing location.
- 3.7.1. Manufacturer Quality Control Certification - Quality Control certificates shall be issued by the GCL manufacturer to the project engineer, or other designated party for each delivery of material. The certifications shall be signed by the quality control manager of the GCL manufacturer or other responsible party and shall include the following information:
- Shipment Packing List - A list indicating the rolls shipped on a particular truckload.
  - Bill of Lading - The shipping documents for the truck used for the shipment.
  - Letter of Certification - The letter indicating the material is in conformance with the physical properties specified.
  - Physical Properties Sheet - The material specification for the GCL supplied in accordance with this specification.
- 3.7.2. Manufacturer Quality Control Submittal - Quality Control submittals shall be issued by the GCL manufacturer to the project engineer, or other designated party for each lot of material if necessary. The submittals shall include the following information:
- 3.7.2.1. Bentonite Manufacturer Certification - Bentonite manufacturer quality documentation for the particular lot of clay used in the production of the rolls delivered.
- 3.7.2.2. Geotextile Manufacturer Certification - Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered.
- 3.7.2.3. GCL Manufacturer Tracking List - Cross referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered.
- 3.7.2.4. Manufacturing Quality Control Data - The manufacturing quality control test data indicating the actual test values obtained when tested at the appropriate frequencies for the properties specified in the GCL Technical Data Sheet.

- 3.8. Packaging** - All GCL rolls shall be packaged in moisture resistant plastic sleeves. The cardboard cores shall be sufficiently strong to resist collapse during transit and handling. All rolls shall have two straps to facilitate offloading on site.
- 3.9. Roll Identification and Labeling** - Prior to shipment, the manufacturer shall label each roll, both on the GCL roll and on the surface of the plastic protective sleeve. Labels shall be resistant to fading and moisture degradation to ensure legibility at the time of the installation. At a minimum the roll labels shall identify the following:
- Length and width of roll
  - Total weight of roll
  - Type of GCL material
  - Production Lot number and Individual Roll number
- 3.10. 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.
- 4.0 EXECUTION** - The following installation procedures are as specific as possible while recognizing that the specific requirements of the project may necessitate minor modifications. Significant deviations from these procedures shall be pre-approved by the project engineer or other designated party.
- 4.1. Shipping and Handling Equipment** - The party responsible for unloading the GCL shall contact the manufacturer prior to shipment to determine the correct unloading methods and equipment if different from the pre-approved and specified methods.

Bentofix Geosynthetic Clay Liner (GCL) must be supported during handling to ensure worker safety and prevent damage to the liner. Under no circumstances should the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.

The CQA inspector shall verify that proper handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the liner material itself. Suitable handling equipment is described below:

- 4.1.1. Spreader Bar Assembly** - A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the GCL core while the spreader bar beam will prevent chains or straps from chafing the roll edges.

- 4.1.2. Stinger - A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be fully inserted to its full length into the roll to prevent excessive bending of the roll when lifted.
- 4.1.3. Roller Cradles - Roller cradles consist of two large diameter rollers spaced approximately 3 inches apart which both support the GCL roll and allow it to freely unroll. The use of roller cradles shall be permitted if the rollers support the entire width of the GCL roll.
- 4.1.4. Straps - Straps may be used to support the ends of spreader .

**4.2. GCL Inspection Upon Delivery** - Each roll shall be visually inspected when unloaded to determine if any packaging or material has been damaged during transit. Repairs to damaged GCL shall be performed in accordance with Section 4.6.5 of this specification.

- 4.2.1. Rolls exhibiting damage shall be marked and set aside for closer examination during deployment.
- 4.2.2. Minor rips or tears in the plastic packaging shall be repaired with moisture resistant tape prior to being placed in storage to prevent moisture damage.
- 4.2.3. GCL rolls delivered to the project site shall be only those indicated on GCL manufacturing quality control certificates.

**4.3. Storage / Stockpiling / Staging** - Storage of the GCL rolls shall be the responsibility of the installer or other designated party. All GCL rolls shall be stock-piled and maintained dry in a flat location area away from high-traffic areas but sufficiently close to the active work area to minimize handling.

- 4.3.1. GCL should be stored no higher than three to four rolls high or limited to the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by “choking” the bottom layer of rolls.
- 4.3.2. Rolls shall not be stacked on uneven or discontinuous surfaces in order to prevent bending, deformation, damage to the GCL or cause difficulty inserting the core pipe.
- 4.3.3. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.
- 4.3.4. Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration.

- 4.4. **Manufacturing Quality Assurance Documentation** - Third party GCL MQA sampling and testing for compliance with this specification shall be coordinated by the project engineer to support the manufacturer's MQC data.
- 4.5. **Subgrade Preparation** - The surfaces upon which the GCL shall be suitable for the placement of GCL material, subject to the applicable section of this specification (Earthen - 4.5.1 or Geosynthetic - 4.5.2).
- 4.5.1. **Earthen Subgrade** - The surface upon which the GCL material will be installed shall be inspected by the CQA inspector and certified by the earthwork contractor to be in accordance with the requirements of this specification.
- 4.5.1.1. The subgrade soil shall be well graded containing less than 20% gravel two inches or larger and no sharp stones larger than 1/2 the thickness of the subgrade/foundation layer.
- 4.5.1.2. In applications where the GCL is the sole barrier and will be subjected to a hydraulic head that exceeds the confining stress, subgrade surfaces consisting of gravel or granular soils may not be appropriate due to their large void content. Where subgrade surfaces consist of gravel or granular soils, a scrim-reinforced GCL shall be used, where the bottom fabric of the GCL shall contain a scrim-nonwoven fabric. For these applications, the top six inches of the subgrade soil should possess a particle size distribution where at least 80 percent of the soil is finer than 0.2 mm (#60 sieve).
- 4.5.1.3. Site specific compaction requirements should be followed in accordance with the project drawings and specifications. At a minimum, the level of compaction should be such that no excessive rutting is caused by installation equipment or other construction vehicles which traffic the area of deployment (typically 85% of standard proctor or greater).
- 4.5.1.4. The surfaces to be lined shall be smooth and free of any debris, vegetation, roots, sticks, sharp rocks, or other deleterious materials larger than two inches as well as free of any voids, large cracks.
- 4.5.1.5. Directly prior to deployment of the GCL, the subgrade shall be final-graded to fill remaining voids or desiccation cracks, and proof-rolled to eliminate sharp irregularities or abrupt elevation changes. The surfaces to be lined shall be maintained in this smooth condition.
- 4.5.2. **Geosynthetic Subgrade** - Prior to GCL deployment the geosynthetic surface as well as other underlying geosynthetics upon which the GCL material will be installed shall be inspected and approved by the project engineer in accordance with the requirements of the project specification documents.

4.5.3. Anchor Trench - An anchor trench shall be excavated by the earthwork contractor or liner installer to the lines and grades shown on the project drawings at the top of slopes greater than 7h:1v.

4.5.3.1. The anchor trench shall be constructed free of sharp edges or corners and maintained in a dry condition. No loose soil shall be permitted beneath the GCL within the trench.

4.5.3.2. The anchor trench shall be inspected as well as approved by the project engineer prior to GCL placement, back-filling and compaction of the anchor key material.

4.5.4. Subgrade Inspection - The earthen or geosynthetic subgrade shall be continuously inspected, approved and certified by the project engineer prior to GCL placement.

Subsequent to the project engineer's approval, it shall be the installer's responsibility to indicate to the Engineer any change in the subgrade condition that could cause it to be out of compliance with any of the requirements of this section or the project specification.

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

4.6.1. GCL Orientation - In the absence of specific guidelines, GCL panels should be placed with the nonwoven side up on slopes to maximize the shear strength characteristics.

In base or flat areas, the GCL does not require any particular orientation, however, in composite liner applications, intimate contact may be facilitated by placing the woven face of the GCL against the overlying FML.

4.6.2. 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.

4.6.3. 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.

Reinforced GCL shall be used on both slopes as well as the flat areas to ensure the GCL withstands the rigors of the installation and subsequent low load hydration.

4.6.3.1. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation. For deployment of lowest to highest elevation upon approval by the project engineer.

4.6.3.2. 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.

- 4.6.3.3. 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.
- 4.6.3.4. Overlaps shall be a minimum of 12 inches and be free of wrinkles, folds or more importantly “fish-mouths”.
- 4.6.3.5. 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 unless approved the project engineer.
- 4.6.4. Anchoring- All GCL material installed on slopes greater than 7:1 shall be anchored to prevent potential GCL panel movement.
- 4.6.4.1. Standard Anchor - The GCL shall be placed into and across the base of the excavated trench, stopping at the back wall of the excavation.
- 4.6.4.2. “Run-Out” Anchor - On gentle slopes or locations where it is difficult to create an anchor trench, the GCL may alternatively be anchored by a material run-out past the crest of the slope. The length of the run-out shall be pre-approved by the project engineer prior to the use of this method.
- 4.6.5. Seaming - A 9-inch lap line and a 12-inch match line shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink.
- 4.6.5.1. Overlap seams shall be a minimum of twelve inches on panel edges and twenty four inches on panel ends.
- 4.6.5.2. Loose granular bentonite should be placed between panels at a rate of ¼ pound per lineal foot of seam if the GCL is the primary hydraulic seal.
- 4.6.5.3. The addition of bentonite to the seam area is optional when the GCL will be acting as a leak isolator for an overlying FML in composite liner applications.
- 4.6.6. Detailing - Detail work, defined as the sealing of the liner to pipe penetrations, foundation walls, drainage structures, spillways, and other appurtenances, shall be performed as per the project drawings.
- 4.6.7. Damage Repair - 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.

- 4.6.7.1. 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 12 inches 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.

- 4.6.7.2. 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.

- 4.6.7.3. Displaced Panels - Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

- 4.6.7.4. Excessive Premature Hydration - If the GCL is prematurely hydrated (excessive hydration), installer shall notify the QA/QC technician and project engineer for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design - dependent upon the degree of damage if any.

- 4.7. Cover Material - 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.

- 4.7.1. Earthen Cover Soil - If the cover material is soil or gravel, a minimum thickness of 12 inches shall be placed over the GCL. The soil cover shall be free of sharp-edged stones greater than 2 inches in size. Laboratory analysis of especially calcareous cover material shall be required to ensure compatibility with the GCL.

- 4.7.1.1. 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.

- 4.7.1.2. 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.

- 4.7.1.3. Thickness - A minimum thickness of 12 - 24 inches of cover shall be kept between heavy equipment and the GCL at all times, except when final-grading. No heavy vehicles should be driven directly on the GCL until the proper thickness of cover has been placed. A cover of 36 inches should be used in heavy equipment traffic areas.

- 4.7.1.4. 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.
- 4.7.1.5. Slope Placement - When covering GCL on sloped areas steeper than 4H:1V, cover should be pushed up-slope to minimize tension on the GCL. Cover placement from top to bottom slope shall be approved by the project engineer.
- 4.7.2. Geosynthetic Cover - Precautions shall be taken to prevent damage to the GCL by restricting the use of heavy equipment over the liner system.
- 4.7.2.1. 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) or pick up truck/all terrain forklift. This vehicle can be driven directly on the GCL, provided the ATV/truck/forklift makes no sudden stops, starts, or turns.
- 4.7.2.2. Placement - Smooth HDPE may be dragged across the GCL surface with equipment or by hand labour during positioning. Similarly, the HDPE may be unrolled with the use of low ground pressure equipment.
- 4.7.2.3. Use of Textured Liners - If a textured geomembrane is placed over the GCL, a slip sheet (such as 20-mil smooth HDPE) shall 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.
- 5.0** ACTIVATION - If the GCL will be utilized for the control of non-aqueous phase liquids, prehydration may be necessary. The GCL manufacturer shall be contacted for these cases for site specific recommendations.
- 6.0** WARRANTY - GCL material as well as installation warranties provided by the manufacturer and installer shall be made a part of the final submittal documents.
- 6.1.** Material - A five year pro-rated material and workmanship warranty shall be provided by the manufacturer of the GCL, stating that the GCL product supplied to the project was manufactured in accordance with industry accepted practices and meets the manufacturer's specified certified properties.
- 6.2.** Installation - The installer of the GCL material shall provide a one year installation workmanship warranty, repairing and or replacing any material not installed in full compliance with the requirements of the specification.