Geo-Synthetics, LLC

Waukesha, WI

Installation Services

Statement of Qualifications

2009

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***Key projects listing available on request via fax or e-mail.**

1.0 Introduction

Geo-Synthetics, LLC (GSI) is one of the nations largest independent installers of geosynthetic materials. As an independent installer, GSI has the ability to source specification compliant materials from select leading manufacturers. GSI has established solid working relationships with the industry's leading suppliers and has positioned itself to be able to procure the most technically advanced geosynthetic materials currently available. Our 25 years + installation experience, refined installation techniques and materials purchasing expertise combine to offer our clients unmatched geosynthetic product solutions on a supplied and installed basis. Project references include successfully completed projects in all of the following areas of geosynthetic application:

* Landfill Closures
* Solid Waste Landfills
* Secondary Containment
* Waste Water Containment
* Industrial Lagoons
* Decorative Ponds
* Methane Barriers

GSI is a well known and well respected installer of geosynthetics. We are involved in numerous industry associations including IAGI (the International Association of Geosynthetics Installers), in which we are instrumental in developing industry accepted specifications, including the IAGI HDPE Geomembrane Installation Specification (for high density polyethylene geomembrane liners).

GSI's client list has traditionally included general contracting firms, engineering companies, private owners and government agencies at all levels, located coast to coast in the United States operating in a wide range of industries. We have provided installation services in all of the following market areas:

* Waste Management
* Power and Energy
* Civil Construction
* Pulp and Paper
* Oil and Gas
* Aquaculture
* Agriculture
* Mining

We are confident that upon review of this document, you will feel assured of the geosynthetic construction service capabilities of GSI.

2.0 Installation Services

GSI's estimating, project management and construction operations are based in Waukesha, Wisconsin. Individual installation crews operate from locations across the country enabling GSI to provide competitive local service to markets coast to coast. As shown in our enclosed projects reference list, GSI can demonstrate installation experience coast to coast within the United States, working for private and public owners, general contractors and engineering firms.

GSI has the ability to procure and supply to site all required geosynthetic materials and to furnish all required site supervision, skilled technicians, in-house quality control technicians, site labor, deployment equipment and equipment operators, etc., related to the installation of the geosynthetic materials. Generally speaking our primary requirements of an owner or general contractor are to unload a portion of the materials prior to our mobilization to site and to provide the prepared subgrade and related earthworks on site. Scopes of work will of course vary from project to project depending on the nature of the job, resources of the owner or general contractor and site labor conditions, etc. Our basic scope of work generally provides for the following:

* Transportation of materials to site
* Unloading (once GSI fully mobilized)
* Deployment of all geosynthetic materials
* Seaming (e.g. fusion and extrusion welding, etc.)
* Quality control (per GSI in-house guidelines)

GSI has extensive installation experience with a full range of geosynthetic materials:

* HDPE and VFPE Geomembrane Liners
* PVC and Polypropylene Geomembrane Liners
* Hypalon and XR-5 Geomembrane Liners
* Geonets and Geocomposite Drainage Products
* Geotextiles (Woven and Nonwoven)
* Geosynthetic Clay Liners (GCL's)
* Erosion Control Materials
* Paving Grade Materials

Our geomembrane lining installation experience with HDPE, VFPE, PVC, Polypropylene, Hypalon and XR-5 liners now exceeds over 100,000,000 square feet gathered on literally hundreds of projects over the past 25 years.

3.0 Project Development

3.1 Sales Coverage and Sales Services

GSI is somewhat unique in its approach to sales as an independent installation company in that it maintains a highly proactive regionally based sales force charged with the responsibility of seeking out and developing new sales opportunities. Although the skills set of each individual varies our basic approach to sales is to provide technical knowledge and assistance to the owner, designer, specifying engineer or contractor as required at either the permitting, design, specification, bid or construction phase of a project's development. We wish to position ourselves to be primarily known as the recognized resource for geosynthetic installation solutions for more challenging projects where our expertise is best utilized.

In addition to fulfilling our clients Requests for Proposal (RFP's) or Requests for Quote (RFQ's), our Regional Sales Managers are capable of assisting with all of the following:

* Materials Selection
* Materials Specification
* Specification Review
* Budgetary Pricing
* Design Details
* Scheduling
* Submittals
* Credit

Responding to the need for a single point of contact for larger national scale accounts, GSI has recently created the position of National Accounts Development Manager for this purpose.

GSI's sales management is based in Waukesha, Wisconsin with Regional Sales Managers reporting to the Executive Vice President & General Manager in Waukesha. Regional sales coverage operates from Waukesha as well as other locations based in Illinois, South Dakota, North Carolina and Texas. National Accounts sales coverage is based in Waukesha.

3.2 Estimating

Estimating at GSI is a stand-alone function within the construction services group with the Chief Estimator reporting to the Executive Vice President & General Manager. Based in Waukesha, Wisconsin, the estimating group at GSI is capable of performing take-off estimates on hundreds of projects annually (GSI consistently estimates over 400 projects annually with a total bid value in excess of $100,000,000 per year).

GSI has developed its own “home grown” estimating package in an MS Excel spreadsheet format. The package allows for a large degree of flexibility in terms of respective scopes of work for GSI as well as the earth works contractor. AutoCad R14 software is used for all drafting and quantity estimating requirements. All project estimates involve the generation of a preliminary panel layout drawing and bar chart schedule detailing expected work days for project completion. Proposals are generated by the estimating department and may be communicated by e-mail if requested.

3.3 Contracts

All contracts require review by the Executive Vice President & General Manager and the review and signature of the President of the Company. Key items within any GSI construction services contract will necessarily include well defined scopes of work consistent with GSI’s proposal, clearly established methodology of payment, payment terms, insurance, bonding and warranty expectations.

GSI site Superintendents are authorized to accept signed change orders although back-charges to GSI must be authorized by the Executive Vice President & General Manager or the President in order to be duly accepted.

3.4 Procurement

Procurement of materials with associated manufacturing and shipment to site requires the establishment of an acceptable line of credit and formation of a signed contract (or accepted materials purchase order) with GSI. Purchase orders to GSI vendor firms are generally only issued by GSI when a signed contract comes into effect. Generally speaking within the geosynthetics industry vendor pricing is guaranteed for only relatively brief periods of time due to the susceptibility of geosynthetic materials to resin price fluctuations (most geosynthetics are made from polyethylene or polypropylene resins, etc.). On rare occasions Letters of Intent may be used to secure vendor pricing.

3.5 Project Management

Reporting directly to the President of the Company, the Executive Vice President & General Manager, based in Waukesha, Wisconsin, has overall responsibility for all geomembrane related installation activities conducted by GSI.

Project Managers reporting to the Executive Vice President & General Manager are responsible for the scheduling of individual projects including the coordination of material deliveries to site and timely mobilization to site of GSI installation personnel. Achievement of project milestone dates is also the responsibility of the GSI Project Manager. These individuals possess extensive practical field experience and training in project management techniques.

GSI field crews are generally comprised of a single site Superintendent, GSI trained full time welding technicians (at least one of which is qualified to operate site deployment equipment if necessary), a quality control technician (reporting to the Project Manager) and site laborers hired locally if necessary depending on the nature of the project and materials to be installed. The site Superintendent has responsibility for day to day activities on site including coordination of activity with the earthworks contractor, third party inspection firm and safety as it relates to GSI personnel on site. GSI is active on 80 to 100 projects annually across the United States.

3.6 Safety

No work or service rendered by GSI employees shall become so important as to assume priority over the safety of an employee. All GSI site Superintendents and lead technicians are OSHA trained and certified. The site Superintendent generally has the responsibility for day to day safety activities on site.

GSI has a written Safety Manual for field activities relating to geomembrane liner installation. The Manual, copies available upon request, provides guidelines not limited to all of the following:

1. Deliveries
   - unloading vehicles
   - fueling
   - lifting and carrying
   - lighting
   - loading
   - tie downs

2. Field Activities
   - vehicle safety
   - deployment
   - electrical safety

- eye protection
- fire protection
- flammable and combustible materials
- forklift and loader safety
- head protection
- heat exhaustion
- lifting and carrying
- personal protective equipment (PPE)
- tool safety

3. General Vehicle Safety
   - fueling
   - lights
   - seat belts
   - severe weather
   - tires
   - transporting employees
   - wipers

4. Record Keeping
   - accident reporting
   - accident investigation
   - OSHA 200 Log
   - disciplinary action

The following summarizes GSI response to key items common to typical contractor safety questionnaires:

*	Do you certify that all individuals assigned to the project will be drug and alcohol free?	Yes
*	Do you certify that all individuals assigned to the project will be fit for respiratory duty, if applicable?	Yes
*	Do you certify that all individuals assigned to the project will be fit to safely perform the required tasks?	Yes
*	Does your safety and health representative visit each site prior to the beginning of each project?	Yes
*	Do job descriptions for supervisory staff and management include safety and health responsibilities?	Yes
*	Does your organization have a program for reward and recognition of outstanding safety performance?	Yes

3.6 Safety (continued)

*	Does your organization have a disciplinary system for unacceptable safety performance?	Yes
*	Are workers encouraged to intervene when they observe a co-worker performing at risk?	Yes
*	Are the safety and health hazards associated with job activities / tasks identified before they begin?	Yes
*	Does your organization have a medical and first aid program?	Yes
*	Does your organization have a substance abuse program?	Yes
*	Are new employees trained in their craft prior to job placement?	Yes
*	Are new employees given a company specific safety orientation?	Yes
*	Do you provide CPR or First Aid training for your personnel?	Yes
*	Do you maintain a record of all training provided to all employees?	Yes

GSI is working diligently to continuously improve its safety programs and safety record. We are making steady annual progress in this area with the objective of becoming exemplary in our industry within the field of safety.

GSI will commit to establishing site specific safety programs with a view towards zero recordable incidents on any one specific project, including assignment of site specific safety officers if required (the GSI site Superintendent is generally responsible for all day to day safety activities on site).

GSI's current EMR rating is 0.73 (as it relates to liner installation). Documentation available upon request.

4.0 Key Personnel

President – Robert F. Groh

Bob Groh is President and majority shareholder of Geo-Synthetics, Inc. Bob has been involved with GSI since it's beginning, with the Company being founded by Bob's father in 1971. Since that time, GSI has grown from a local installer of paving grade geotextiles to a nationally recognized distributor of a full range of geosynthetics. Bob was instrumental in GSI's expansion into the geosynthetics distribution business with geomembrane installation capabilities added in 1986. He has overall responsibility for all sales and construction activities of the Company and active involvement in corporate strategic planning and corporate acquisitions. Bob has a degree in political science from UW – Whitewater.

Executive Vice President & General Manager – Steve Daniels

Steve Daniels is Executive Vice President & General Manager and a minority shareholder of Geo-Synthetics, LLC. Steve has over 20 years experience in the Construction Field. He has been involved in all aspects including field supervision, estimating, project management, sales, and executive management. He has worked in extensively in earthwork, erosion control, and geosynthetics construction. He has been involved in Geosynthetics construction for the past 12 years in various capacities. He holds a BS from Duquesne University and an MBA from Louisiana State University.

Vice President– Scott Nelson

Scott Nelson is Vice President and a minority shareholder of Geo-Synthetics, Inc. Scott has been involved in the civil engineering construction industry for over 30 years, initially in the trades with the last 20+ years in sales. He has been involved in all aspects of sales and sales management both in distribution and manufacturing, with a heavy emphasis in geosynthetics and erosion control products. Scott is also involved in numerous national organizations.

5.0 Financial Strength

GSI is a financially strong, profitable company. Geo-Synthetics, LLC is headquartered in Waukesha, Wisconsin.

GSI would be pleased to provide a Financial Statement upon request.

6.0 Insurance

GSI is a capably insured company. Typically, insurance will include General Liability Coverage for personal injury and property damage in the amount of $2,000,000 and Worker's Compensation coverage in the amount required by law. General Liability insurance is on an Occurrence Basis. Umbrella Coverage up to $8,000,000 is available.

We would be pleased to provide a sample Certificate of Insurance upon request.

7.0 Bonding & Warranties

GSI has a high capacity for bonding as evidenced by the size of projects listed herein. Performance bonding can typically be provided at an additional cost based on contract value. Warranty bonds for materials can sometimes be arranged in consultation with GSI's supplying manufacturers. Warranty bonds for installation work performed by GSI can also be arranged at additional cost if requested.

Warranties are always issued on a project specific basis. Warranties on materials will be per the warranty terms offered by GSI's supplying manufacturers (typically five years on geomembrane materials). Warranties on installation will be consistent with industry norms, likely for one or two years depending on the nature of the project. All warranties offered on a prorated basis.

8.0 Quality Control

GSI has developed its own in-house Field Quality Control Manual with the intention of offering a consistently high standard of workmanship to our clientele. The Manual, (see reference document section), provides guidelines related to all aspects of geosynthetics installation not limited to the following:

1. Material delivery
   - verification of equipment capabilities
   - identification of any damaged materials
   - verification of adequate storage provisions
   - ensure that materials are properly identified and that labeling matches manufacturers quality control documentation and shipping bills of lading

2. Geomembrane installation
   - handling and placement
   - subgrade requirements and preparation
   - anchor trench requirements
   - panel layout preparation
   - field panel placement
   - field seaming (personnel & equipment)
   - weather conditions
   - seaming
   - seam preparation
   - trial welds
   - seam sampling
   - seam testing (destructive & non-destructive)
   - defect and repair procedures

3. Geotextile installation
   - handling and placement
   - seams and overlaps
   - repairs

4. Geonets & Geocomposite installation
   - handling and placement
   - seams and overlaps
   - repairs

5. Geosynthetic Clay Liner (GCL) installation
   - handling and placement
   - seams and overlaps
   - repairs

GSI installation guidelines are consistent with industry-accepted practice and conform to most recognized industry specifications (e.g. IAGI)

GEOSYNTHETICS, INC.
FIELD QUALITY CONTROL MANUAL

1 INTRODUCTION

1.1 This manual addresses the Quality Control Program developed and utilized by Geo-Synthetics, Inc. Installation personnel are present to assure the quality of workmanship and the installation integrity of geomembranes and other Geosynthetic products.

1.2 All geosynthetic components of lining systems will be addressed in this manual, including geomembranes, geotextiles, geonets and bentonite mats. Geo-Synthetics, LLC recognizes that careful and specific documentation of the installation is required to substantiate this Quality Control Program.

2 MATERIAL DELIVERY

2.1 A QAQC Technician shall be present, whenever possible, to observe and assist in material delivery and unloading on site. The QAQC Technician shall:

- ♦ Verify the equipment used on site is adequate and does not risk damage to the geomembrane or other materials.
- ♦ Mark rolls or portions of rolls, which appear, damaged.
- ♦ Verify that storage of materials ensures adequate protections against dirt, theft, vandalism and passage of vehicles.
- ♦ Ensure that rolls are properly labeled and that labeling corresponds with Quality Control documentation and Shipping Bills of Lading.
- ♦ Assist Third Party QA Representative, if present, with material sampling or record keeping.
- ♦ Maintain Material Delivery Checklist, to include roll numbers, date, truck number, bill of lading number, roll size, storage method and any damage noted.

3 GEOMEMBRANE INSTALLATION

3.1 EARTH WORK

3.1.1 The general and/or earthwork contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of the liner unless specifically agreed otherwise.

3.1.2 In cases where no site specific earthwork quality control guidelines exist, the following guidelines shall be followed.

3.1.2.1 Surfaces to be lined shall be smooth and free of debris, roots, angular or sharp rocks, and rocks larger than one half (1/2") inch diameter. All fill shall consist of well-graded material free of organics, trash, clayballs, or other deleterious material that may cause damage to the liner. The subgrade shall be compacted in accordance with design specifications but in no event less than is required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subgrade without causing rutting or other deleterious effects. The subgrade shall have no sudden or abrupt changes in grade.

3.1.2.2 The earthwork contractor shall protect the subgrade from desiccation, flooding and freezing. Protection, if required, may consist of a thin plastic protective cover (or other material as approved by the engineer) installed over the completed subgrade.

3.2 CREST ANCHORAGE SYSTEM

3.2.1 The anchor trench shall be excavated by the general or earthwork contractor to lines and widths shown on the design drawing prior to geomembrane placement.

3.2.2 Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

3.3 PREPARATION FOR GEOMEMBRANE DEPLOYMENT

3.3.1 Panel Layout

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and approximate location of seams for the project to be approved by the project engineer.

3.3.2 Identification

Each panel used for the installation shall be given a numeric or alphanumeric identifier consistent with the layout drawing

3.4 FIELD PANEL PLACEMENT

3.4.1 Location

Geo-Synthetics, LLC will attempt to install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the drawing, the revised location shall be noted in the field as an "as-built" drawing, which will be modified at the completion of the project to reflect actual panel locations. GSI and or third party QA consultants as determined on a site-specific basis will maintain as-Built drawings.

3.4.2 Weather conditions

Geomembrane deployment will generally not be done during any precipitation, in the presence of excessive moisture (i.e. fog, dew), in an area of standing water or during high winds.

3.4.3 Documentation of Panel Placement

Information relating to geomembrane panel placement including date, time, panel number, panel dimensions and location will be maintained on the Panel Placement form.

3.4.3.1 If a portion of a roll is set back to be used at another time, the roll number will be written on the remainder of the roll in several places on the outside of the roll. And at least once on the inside to prevent numbers from being scrapped off during shipment.

3.4.4 Method of deployment

3.4.4.1 The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface.

3.4.4.2 No personnel working on the geomembrane will wear shoes that can damage the geomembrane or engage in action that could result in damage to the geomembrane.

3.4.4.3 Adequate temporary loading and / or anchoring, (i.e. sand bags, tires) which will not damage the liner, will be placed to prevent uplift of the geomembrane by wind.

3.4.5 Any damage to a panel of geomembrane will be repaired in accordance with paragraph 5.3.

3.5 GEOMEMBRANE FIELD SEAMING

3.5.1 General Requirements

3.5.1.1 Layout

In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope for any slope greater than 10 to 1. Whenever possible, horizontal seams should be located on the base of the cell, not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing. Seaming information to include seam number, welder ID, machine number, temperature setting and weather conditions will be maintained on GSI Panel Seaming form.

3.5.1.2 Personnel

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam as described in Paragraph 3.5.3. The project superintendent or master seamer will provide direct supervision of all personnel seaming to verify proper welding procedures are followed.

3.5.1.3 Equipment

Fusion Welding

Fusion welding consists of placing a heated wedge, mounted on a self-propelled vehicular unit, between two (2) overlapped sheets which are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together to form a weld. The fusion welder is equipped with a temperature readout device that continuously monitors the temperature of the wedge.

Extrusion fillet welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge if the seam overlap of the two (2) sheets to be welded. A hot air preheat and a molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

3.5.1.4 Weather Conditions

Geo-Synthetics, LLC relies on the experience of the Project Superintendent and the results of the test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc. can effect the integrity of deciding whether or not seaming should proceed. Test seams, as described Paragraph 3.5.3 are required prior to daily production seaming to determine if the weather conditions will effect GSI's ability to produce quality seams.

3.5.2 Seam Preparation

3.5.2.1 Fusion Welding

3.5.2.1.1 Overlap the panels of Geomembrane approximately four (4) to six (6) inches prior to welding.

3.5.2.1.2 Adjust the panels so those seams are aligned with the fewest possible number of wrinkles.

3.5.2.1.3 A protective layer may be used, at the discretion of the GSI Project Superintendent, directly below the overlap of geomembrane that is to be seamed.

3.5.2.1.4 Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. No grinding is required for fusion welding.

3.5.2.2 Extrusion Fillet Welding

3.5.2.2.1 Overlap the panels of geomembrane a minimum of three (3) inches.

3.5.2.2.2 Temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane.

3.5.2.2.3 Clean seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

3.5.2.2.4 Grind seam overlap prior to welding within one (1) hour of the welding operation in a manner that does not damage the membrane. Grind marks should be covered with extradite whenever possible. In all cases grinding should not extend more than one-quarter (1/4") inch past the edge of the area covered by the extrudate during welding.

3.5.2.2.5 Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel. The purged extrudate will be placed on scrap material so as to prevent contact with good liner.

3.5.2.2.6 Keep welding rods clean and dry.

3.5.3 Trial Welds

Welding technicians prior to each seaming period shall conduct trial welds, every five- (5) hours as weather conditions dictate or as requested by QAQC Technicians if welding problems are suspected. All trial welds will be conducted under the same conditions as will be encountered during actual seaming. Unless authorized, once qualified by a passing trial weld, welding technicians will not change parameters (temperature, speed, and wheel adjustment).

3.5.3.1 Trial Weld Length

The trial weld shall be at least five (5) feet long and should be made by joining two (2) pieces of geomembrane at least nine (9) inches in width.

3.5.3.2 Sample Procedure

3.5.3.2.1 Visually inspect the seam for squeeze out, footprints, pressure and general appearance.

3.5.3.2.2 Cut three (3) one-inch wide specimens, one from the middle of the seam. The specimens shall then be tested in peel using a field tensiometer and shall exhibit a film- tearing bond (FTB). If any specimen fails, the entire procedure shall be repeated. In the case of double track fusion welded seams, both welds must exhibit a FTB in order to be considered passing.

3.5.3.2.3 If repeat tests performed utilizing reasonable sets of welding parameters also fails, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved.

3.5.3.3 Trial weld documentation

3.5.3.3.1 QAQC Technician and / or assistant will be present during peel testing and will record date, time, operator, machine number, ambient and operating temperatures, speed setting, peel values and pass / repair designation.

3.5.3.3.2 All test result records shall be maintained on GSI's Trail Weld form.

3.5.3.3.3 The GSI's QAQC Technician will give final approval to proceed with welding after observing trial welds.

3.5.4 General Seaming Procedures

3.5.4.1 Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

3.5.4.2 While welding a seam, monitor and maintain the proper overlap.

3.5.4.3 Inspect seam area to assure area is clean and free of moisture, dust, dirt and debris of any kind.

3.5.4.4 Welding technicians will periodically check operating temperature and speed.

3.5.4.5 Align panels at the seam overlap to minimize wrinkles.

3.5.4.6 Fishmouths or wrinkles at seam overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkles shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.

3.5.4.7 All seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

3.5.4.8 Prior to welding seams, the top and bottom overlap of intersecting fusion welded seams will be trimmed six (6) inches. Intersecting extrusion fillet welded seams will be ground to flatten the extrusion bead prior to welding butt seams.

3.5.4.9 All “T” joints produced as a result of cross / butt seams shall be extrusion fillet welded. Overlap on each “leg” of the “T” joint will be trimmed back six (6) inches. Then grind four- (4) inches minimum on each of the three legs of the “T” and extrusion weld all of the area prepared by grinding.

3.5.4.10 Welding technicians will cut a test strip at the beginning and end of every seam. Prior to welding the next seam, the test strip will be tested for peel. These results are to be logged on the Panel Seaming form. (FTB or NFTB) The QAQC Technician will observe all test strips and may request additional test strips, based on observations.

3.5.4.11 In the event failing seam test strips are encountered, the welding machine will be taken out of service until a passing trial weld is obtained, and additional test strips will be taken to localize the flaw.

3.5.4.12 The QAQC Technician may, after consulting with GSI’s Site Superintendent, take destructive samples from any seam, if defects are suspected.

3.5.5 Seaming Documentation

3.5.5.1 The QAQC Coordinator or a designated assistant will document all seaming operations. Welding technicians will mark on the liner with "Mean Streak" permanent markers at the start and end of all seams the information regarding date, time, welder initials, machine number and set temperature. QAQC technician or assistant will record date, time, seam number welder ID, machine ID, set temperature, weather conditions and speed as determined from trial welds on the Seaming Information Form.

3.5.5.2 Welding technicians will periodically check operating temperature and speed and mark the information along the seam.

3.5.5.3 QAQC Technician will make periodic checks on welding operations to verify overlap, cleanliness, etc.

4 SEAM TESTING - GEOMEMBRANES

4.1 CONCEPT

The welded seam created by the fusion welding process is composed of a primary seam and a secondary track that creates an unwelded channel. The presence of an unwelded channel permits GSI fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure and observing the stability of the pressurized channel over time.

4.2 AIR PRESSURE TESTING

4.2.1 Equipment for Air Testing

4.2.1.1 An air pump (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi.

4.2.1.2 A rubber hose with fittings and connections.

4.2.1.3 A sharp, hollow needle or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 25 to 30 psi.

4.2.2 Procedure for Air Testing

4.2.2.1 Seal both ends of the seam to be tested.

4.2.2.2 Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld.

4.2.2.3 Inflate the test channel to a pressure of approximately 30-psi, and maintain the pressure with the range listed in Initial Pressure Schedule. Close valve, observe and record initial pressure after approximately 2 minutes.

*INITIAL PRESSURE SCHEDULE **

MATERIAL (MIL)	MIN. PSI	MAX. PSI
40	24	30
60	27	35
80	30	35
100	30	35

*Initial pressure settings are read after a two-minute "relaxing period." The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize.

4.2.2.4 Observe and record the air pressure five (5) minutes after "relaxing period" ends and initial pressure setting is recorded. If loss of pressure does not stabilize, locate faulty area and repair in accordance with section 4.2.3.

MAXIMUM PERMISSIBLE DIFFERENTIAL AFTER 5 MINUTES - HDPE

MATERIAL (MIL)	PRESSURE DIFF.
40	4 psi
60	3 psi
80	2 psi
100	2 psi

4.2.2.5 At the conclusion of the pressure test, the end of the air-channel opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated from the point of the blockage. If the point of blockage cannot be found cut the air channel In the middle of the seam and treat each half as a separate test.

4.2.3 In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

4.2.3.1 Check seam and re-test seams.

4.2.3.2 If a seam will not maintain the specified pressure, the seam should be visually inspected to localize the flaw. If this method is unsuccessful, cut one (1) inch samples from each end of the seam.

4.2.3.3 Perform destructive peel tests on the samples using the field tensiometer.

4.2.3.4 If all samples pass destructive peel testing, remove the overlap left by the wedge welder and vacuum test the entire length of seam in accordance with paragraph 4.3.

4.2.3.4.1 If a leak is located by the vacuum test, repair by extrusion fillet welding. Test the repair by vacuum testing.

4.2.3.4.2 If vacuum testing discovers no leak, the seam will be considered as passing non-destructive testing.

4.2.3.5 If one or more samples fail the destructive peel test, additional samples will be taken in accordance with Paragraph 4.4.3. or at the Site Superintendents discretion.

4.2.3.5.1 When two (2)-passing samples are located, the seam between these two (2) locations will be considered non- complying. The overlap left by the wedge welder will be heat tacked in place along the entire length of seam and the non-complying portion of seam will be extrusion fillet welded.

4.2.3.5.2 Test the entire length of the repaired seam by vacuum testing in accordance with Paragraph 4.3.

4.2.4 Air Pressure Testing Documentation

All information regarding air-pressure testing, (date, initial time and pressure, final time and pressure, pass / repair designation and technicians initials) will be written at both ends of the seam or portion of seam tested. All of the above information will also be logged on the GSI Non-Destructive Testing form.

4.3 VACUUM TESTING

This test is used when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing.

4.3.1 Equipment for Vacuum Testing

4.3.1.1 Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly and a vacuum gauge.

4.3.1.2 A rubber pressure / vacuum hose with fittings and connections.

4.3.1.3 A bucket and means to apply a soapy solution.

4.3.1.4 A soapy solution.

4.3.2 Procedure for Vacuum Testing

4.3.2.1 Trim excess overlap from the seam, if any.

4.3.2.2 Turn on the vacuum pump to reduce the vacuum box to approximately ten (10) inches of mercury, i.e., 5-psi gauge.

4.3.2.3 Apply a generous amount of a strong solution of liquid detergent and water to the area to be tested.

4.3.2.4 Place the vacuum box over the area to be tested and apply sufficient downward pressure to “seat” the seal strip against the liner.

4.3.2.5 Close the bleed valve and open the vacuum valve.

4.3.2.6 Apply a minimum of 5-psi vacuum to the area as indicated by the gauge on the vacuum box.

4.3.2.7 Ensure that a leak tight seal is created.

4.3.2.8 Observe area for leaks, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of three (3) inch overlap and repeat the process.

4.3.3 Procedure for non-complying test

4.3.3.1 Mark all areas where soap bubbles appear and repair the marked areas in accordance with Paragraph 5.3.

4.3.3.2 Re-test repaired areas.

4.3.4 General Vacuum Testing Procedures

4.3.4.1 Vacuum box testing will be performed by qualified construction personnel with frequent supervision by QAQC Technician.

4.3.4.2 Overlap must be trimmed prior to vacuum boxing all seams.

4.3.5 Vacuum testing Documentation

4.3.5.1 Vacuum testing crew will use Mean Streak permanent markers to write on liner indicating tester's initials, date and pass / repair designation on all areas tested.

4.3.5.2 The QAQC Technician or testing crew on GSI Non-destructive Testing form will maintain records of vacuum testing.

4.4 DESTRUCTIVE TESTING

4.4.1 Concept

The purpose of destructive testing is to determine and evaluate seam strength. These test require direct sampling and thus subsequent patching. Therefore, destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane.

4.4.2 Procedure for Destructive Testing

4.4.2.1 Destructive Test samples shall be marked and cut out randomly at a minimum average frequency of one test location every 1000 feet of seam length.

4.4.2.2 Location of destructive samples will be selected by QAQC Technician (or third party QA), with samples to be cut by GSI construction personnel.

4.4.2.3 Destructive samples should be taken and tested as soon as possible after the seams are welded (the same day), in order to detect possible problems in a timely manner.

4.4.2.4 QAQC Technician will observe all destructive testing and record date, time, seam number, location, and test results on GSI Destructive Testing form.

4.4.2.5 All destructive test locations with pass / repair designation will be marked on liner with permanent Mean Streak markers.

4.4.2.6 Samples Size

4.4.2.6.1 The samples should be twelve (12) inches wide with a seam eighteen (18) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner's request or by specific project specifications.

4.4.2.6.2 A one- (1) inch specimen shall be cut from each end of the test seam for field-testing.

4.4.2.6.3 The two one- (1) inches wide specimens shall be tested in the field on a tensiometer for peel. If any field specimen fails to pass, it will be assumed the sample fails destructive testing. The procedure outlined in Paragraph 4.4.3 shall be followed to locate passing samples to send to the laboratory.

4.4.3 Procedure in the event of Destructive Test Failure

4.4.3.1 Cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed seam sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

4.4.3.1.1 If the laboratory samples pass, reconstruct the seam between the two- (2) passing sample locations according to procedures detailed in Section 5.3.

4.4.3.1.2 If either of the samples fail, then additional samples are taken in accordance with the above procedure until two (2) passing samples are found to establish the zone in which the seam should be reconstructed.

4.4.3.2 All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken.

4.4.3.3 In cases of reconstructed seam exceed 150 feet, a destructive samples must be taken and pass destructive testing from within the zone in which the seam has been reconstructed.

4.4.3.4 All destructive seam samples shall be numbered and recorded on GSI's Destructive Test Record form.

4.5 Destructive samples will be tested for "Shear Strength" and "Peel Adhesion" (ASTM D638 as modified by GM-13). Five (5) specimens must exhibit FTB for each test and the average test value must meet or exceed that listed in GSI's Material specification sheet in order for the seam to pass the destructive test.

5 DEFECTS AND REPAIRS

5.1 Geo-Synthetics, LLC QAQC Technician and Project Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation.

5.2 All other Geo-Synthetics, LLC installation personnel shall, at all times, be on the lookout for damaged areas. Damaged areas shall be marked and repaired.

5.3 REPAIR PROCEDURES

Any portions of the geomembrane or geomembrane seam showing a flaw, or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and GSI Project Superintendent shall make the decision as to the appropriate repair procedure. Procedures available for repair:

5.3.1 Patching used to repair large holes, tears and destructive sample locations. All patched shall extend at least six (6) inches beyond the edges of the defect and all corners of the patches shall be rounded.

5.3.2 Grinding and welding - used to repair sections of extruded fillet seams.

5.3.3 Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws.

5.3.4 Capping - used to repair lengths of failed extrusion of fusion welded seams.

5.3.5 Extrude overlap along the length of failed fusion welded seams.

5.3.6 Removal of a bad seam and replacement with a strip of new material seamed into place.

5.4 VERIFICATION OF REPAIRS

Every repair shall be non-destructively tested using the methods set out in Paragraph 4.3. Repairs, which pass the non-destructive test, shall be deemed adequate.

Repairs in excess of 150 feet require a destructive test. Repair test results shall be logged on GSI Repair Report form. The repair location shall be recorded on an as-built drawing.

6 GEOTEXTILES

6.1 All geotextiles shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to.

6.1.1 On slopes, the geotextiles shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the Geotextile sheet in sufficient tension to preclude folds and wrinkles.

6.1.2 In presence of wind, all geotextiles shall be weighted with sand bags or an equivalent.

6.1.3 Geotextiles shall be cut using an approved cutter (i.e., hook blade, scissors, etc.). If the material is being cut in place, special care must be taken to protect other geosynthetic materials from damage.

6.1.4 Care shall be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

6.2 SEAMS AND OVERLAPS

All geotextiles shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to:

6.2.1 On slopes steeper than ten (10) horizontal to 1 vertical, it is recommended that geotextiles be continuously sewn or thermally bonded along the entire length of the seam. Geotextiles shall be overlapped a minimum of four (4) inches prior to sewing.

6.3 REPAIRS

Any holes or tears in the geotextile shall be repaired as follows:

6.3.1 On slopes - A patch made from the same geotextile shall continuously be seamed with a minimum of 12 inches overlap in all directions into place.

6.3.2 Horizontal areas - A patch made from the same Geotextile shall be spot-seamed in place with a minimum of 12 inches overlap in all directions.

7 GEONETS

7.1 HANDLING AND PLACEMENT

The geonets shall be handled in such a manner as to ensure that the geonets are not damaged in any way.

7.1.1 On slopes, the geonets shall be secured in the anchor trench and then led down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet shall be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., at the toe of slope, or where an extra layer of geonet is required). The Design Engineer in the project drawings shall identify such locations.

7.1.2 Geonets shall not be welded to geomembrane with extrusion welders. Geonets shall be cut using approved cutter (i.e., hook blade, scissors, etc.). Care should be taken to prevent damage to underlying layers.

7.1.3 Care must be taken not to entrap in the geonet anything that could cause clogging of the drainage system, and / or stones that could damage the adjacent geomembrane.

7.2 LAYERING AND TYING OF GEONET

When several layers of geonets are installed, care should be taken to prevent the strands of one layer form penetrating the channels of the next layer, thereby significantly reducing the transitivity. Layered geonets must be placed in the same directions and where laid perpendicular to the underlying geonet. Adjacent geonets shall be joined according to the following requirements.

7.2.1 Adjacent rolls shall be overlapped by at least four (4) inches and securely tied.

7.2.2 Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy inspections. Metallic devices are not allowed.

7.2.3 Tying shall be every five (5) feet on center, every two (2) feet on butt seams and every six (6) inches in the anchor trench.

7.3 REPAIRS

Any holes or tears in the geonet shall be repaired by placing a patch extending two (2) feet beyond edges of the hole or tear. The patch shall be secured to the original geonet by tying every six (6) inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area shall be cut out and the two (2) portions of the geonet shall be joined.

8 BENTONITE MAT

8.1 BENTONITE MAT

8.2 HANDLING AND PLACEMENT

8.2.1 All wrinkles shall be pulled out and overlaps shall be free of obstructions, debris and rocks.

8.2.2 Seams shall be a simple overlap unless the intended function determines the need for the addition of granular bentonite.

8.2.3 Overlap seams shall be placed so that the edge of the upper panel aligns with the matchline on the lower panel.

8.2.4 The GCL shall be secured in and anchor trench at the top of the slope as per the contract drawings.

8.2.5 Material will be deployed from the high elevation to the low elevation to protect against the adverse effect of precipitation during deployment.

8.2.6 All seams shall be parallel with the direction of the slope. Horizontal seams shall not be allowed on slopes unless approved by the engineer.

8.2.7 In general, the amount of GCL that should be deployed in a given day is the amount that can be covered during that day, either by a geomembrane or confining soil layer.

8.2.8 Placing a patch of the same material over the damaged area extending at least one foot (12 inches) beyond the damaged area in every direction will make repairs.

The procedures described herein are those in effect as of April 24, 1990. Geo-Synthetics, LLC reserves the right to deviate from these procedures in order to keep abreast of changes in technology. (Amended 2/96)(Amended 2/98)