



**Global Containment Solutions, LLC**

**2012  
CONSTRUCTION  
QUALITY CONTROL  
MANUAL**



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Global Containment Solutions, LLC

**FIELD QUALITY CONTROL MANUAL**

1. INTRODUCTION

- 1.1. This manual addresses the Quality Control Program developed and utilized by the Installation Personnel of Global Containment Solutions, LLC. (GCS) to insure 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, geocomposites, and geosynthetic clay liners. GCS recognizes that careful and specific documentation of the installation is required to substantiate this Quality Control Program.

2. MATERIAL PROCUREMENT, SUBMITTALS, & DELIVERY

- 2.1. During the bidding process, GCS will submit request for quotes to the various geosynthetic manufacturers with the appropriate specifications and required delivery dates.
- 2.2. GCS reviews each and every quote to ensure materials will meet or exceed site specifications and that the delivery dates are strictly adhered to.
- 2.3. If the proposed materials do not meet the specifications, GCS will submit a request for clarification to the client.
- 2.4. Upon award of the contract, GCS will issue purchase orders to the various manufacturers with the required delivery dates. Manufacturers are required to produce materials in accordance to their respective manufacturing quality control plans, in conjunction with the technical specifications.
- 2.5. All Geosynthetic materials produced are required to meet or exceed the contract specifications and any addenda.
- 2.6. Material technical data submittals are transmitted to the client as required clearly marked to indicate any clarifications needed for review and approval.
- 2.7. Upon receiving approval on the submittals, GCS will release the materials for production.
- 2.8. While materials are produced, the manufacture will submit the appropriate Manufacturing Quality Control documents at the required frequency to GCS.

- 2.9. GCS will review each of these documents to ensure compliance with the specifications and/or addendums issued.
- 2.10. If conformance sampling is required, GCS will make the appropriate arrangements.
- 2.11. GCS will transmit all the required submittals to the client.
- 2.12. Upon approval by the client, GCS will release the materials for delivery to the site.
- 2.13. A Third Party QA Representative should be present, whenever possible, to observe and assist in material delivery and unloading on site. The Third Part QA Representative is to note any material received in damaged state and to remove any necessary conformance samples. Upon mobilization to site, an GCS Representative shall:
  - 2.13.1. Verify the equipment used on site is adequate and does not risk damage to the geomembrane or other materials.
  - 2.13.2. Mark rolls or portions of rolls which appear damaged.
  - 2.13.3. Verify that storage of materials ensure adequate protection against dirt, theft, vandalism, and passage of vehicles.
  - 2.13.4. Ensure that rolls are properly labeled and that labeling corresponds with Quality Control documentation.
  - 2.13.5. Complete roll numbers, date, roll size and any damage will be logged on the GCS Material Delivery Checklist (See Appendix A).

### 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 to installation of the liner unless specifically agreed otherwise.
- 3.1.2. In cases where no site specific earthwork quality control guidelines exist, the following general guidelines shall be followed.
  - 3.1.2.1. Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks. All fill shall consist of well-graded material, free of organics, trash, clayballs, or other deleterious material that may cause damage to the geomembrane. Unless otherwise required by design specifications, the upper six inches (6") of the finished subgrade shall not contain stones or debris larger than one-half inch (1/2"). 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 sharp 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 until such time as the placement of geomembrane liner begins. Subgrades found to have desiccation cracks greater than one-half inch (1/2") in width or depth, or which exhibit swelling, heaving, or other similar conditions shall be replaced or reworked by the General and/or Earthwork Contractor to remove these defects.

3.1.2.3. Surface Acceptance. Upon request, GCS's Site Supervisor will provide the Owner's and/or Contractors Representatives with a written acceptance of the surface to be lined. This acceptance will be limited to an amount of area that GCS is capable of lining during a particular work shift. Subsequent repairs to the subgrade and the surface shall remain the responsibility of the Earthwork Contractor. An example of GCS's Subgrade Surface Acceptance form is included in Appendix A.

### 3.2. Crest Anchorage System

3.2.1. The anchor trench shall be excavated by the General and/or the Earthwork Contractor to lines and widths shown on the design drawings prior to geomembrane placement.

3.2.2. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that day's liner placement to minimize the potential of desiccation cracking of the clay soils.

3.2.3. 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 general location of field seams for the project.

3.3.2. Identification: Each panel used for the installation will be given a number which will be correlated with a batch or roll number. This panel identification number shall be related on the GCS Panel Placement Form, which will be used when required.

### 3.4. Field Panel Placement

- 3.4.1. Weather Conditions: Geomembrane deployment will generally not be done during any precipitation, in the presence of excessive moisture, in an area of standing water, or during high winds.
- 3.4.2. Location: GCS will attempt to install field panels as indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location will be noted in the field. These notations will be maintained and submitted by GCS and/or Third Party QA Consultants as determined on a site specific basis.
- 3.4.3. Documentation of Panel Placement: Information relating to geomembrane panel placement including date, time, panel number, and panel dimensions may be maintained on a site specific bases, on the Panel Placement Form as presented in Appendix A.
  - 3.4.3.1. If a portion of a roll is set aside to be used at another time, the roll number will be written on the remainder of the roll in several places.

#### 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 engage in actions which could result in damage to the geomembrane.
- 3.4.4.2. No personnel working on the geomembrane will wear shoes that can damage the geomembrane or engage in actions which could result in damage to the geomembrane.
- 3.4.4.3. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires) which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind.
- 3.4.4.4. The geomembrane will be deployed with slack to allow for typical thermal expansion.
- 3.4.5. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked and repaired in accordance with Paragraph 5.3 of this document.

### 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. Whenever possible, horizontal seams

should be located on the base of the cell, not less than five feet (5') from the toe of the slope. Each seam made in the field shall be numbered. Seaming information to include seam number, welder ID, machine number, temperature setting, and weather conditions may be maintained on GCS Panel Seaming Form as presented in Appendix A.

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.

#### 3.5.1.3. Equipment

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

3.5.1.3.2. Extrusion Fillet Welding: Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the overlap of the two (2) geomembrane sheets to be welded. A hot-air preheat and the addition of 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 overlapped sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and a numerical setting for the pre-heating unit.

3.5.1.3.3. Weather Conditions: GCS Relies on the experience of the Project Superintendent and the results of test seams to determine whether seaming is restricted by weather. Many factors, such as the geomembrane temperature, humidity, wind, precipitation, etc., can effect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Test seams, as described in Paragraph 3.3.5, are required prior to daily production seaming to determine if the weather conditions will effect GCS's ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the Project Superintendent to seam on any given day. Seam Preparation

#### 3.5.1.4. Fusion Welding

- 3.5.1.4.1. Overlap the panels of Geomembrane approximately four (4) to six (6) inches prior to welding.
- 3.5.1.4.2. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, or debris of any kind. No grinding is required for fusion welding.
- 3.5.1.4.3. Adjust the panels so that seams are aligned with the fewest possible number of wrinkles and “fishmouths”.
- 3.5.1.4.4. A moveable protective layer may be used, at the discretion of the GCS Project Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of dirt or moisture between the panels.

#### 3.5.1.5. Extrusion Fillet Welding

- 3.5.1.5.1. Whenever possible, the sheet will be beveled prior to heat-tacking into place.
- 3.5.1.5.2. Overlap the panels of geomembrane a minimum of three inches (3”).
- 3.5.1.5.3. Using a hot-air device, temporarily tack the panels of geomembrane to be welded, taking care not to damage the geomembrane.
- 3.5.1.5.4. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.
- 3.5.1.5.5. Grind seam overlap prior to welding within one (1) hour of the welding operation in a manner that does not damage the geomembrane. Grind marks should be covered with extrudate whenever possible. In all cases grinding should not extend more than one-quarter inch (1/4”) past the edge of the area covered by the extrudate during welding.
- 3.5.1.5.6. Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel.
- 3.5.1.5.7. Keep welding rod clean and dry.

3.5.2. Trial Welds: Trial welds shall be conducted by Welding Technicians prior to each seaming period, every five (5) hours, as weather conditions dictate or as requested by GCS CQC personnel if welding problems are suspected. All trial welds will be conducted under the same conditions as will be encountered during actual seaming. Once qualified by a passing trial weld, Welding Technicians will not change parameters without performing another trial weld.



3.5.2.1. Trial Weld Length: The trial weld shall be made by joining two (2) pieces of geomembrane, each piece at least six inches (6") in width. Trial welds for fusion welds will be approximately 15 feet long and extrusion trial welds will be a minimum of four feet (4') long.

#### 3.5.2.2. Sample Procedure

3.5.2.2.1. Visually inspect the seam for squeeze out, footprint, pressure, and general appearance.

3.5.2.2.2. Cut three (3) one inch (1") wide specimens, one (1) from the middle of the seam and one foot (1') from each end of the test seam using a one inch (1") die cutter. The specimens shall then be tested in peel using a field tensiometer.

3.5.2.2.3. In order for a trial weld to be considered acceptable, all three specimens must meet the following criteria:

3.5.2.2.3.1. Exhibit Film Tearing Bond (FTB).

3.5.2.2.3.2. If any specimen is nonconforming the entire procedure shall be repeated. In the case of double track fusion welded seams, both welds must pass in order to be considered acceptable.

3.5.2.2.3.3. If repeat tests utilizing reasonable sets of welding parameters also fail, 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.

#### 3.5.2.3. Trial Weld Documentation

3.5.2.3.1. CQC Coordinator 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/fail designation.

3.5.2.3.2. All trial weld records shall be maintained on GCS's Trial Weld Form as exhibited in Appendix A.

3.5.2.3.3. The GCS CQC Coordinator and/or Superintendent will give final approval to proceed with welding.

#### 3.5.3. General Seaming Procedures

3.5.3.1. Seaming shall extend into the anchor trench.

- 3.5.3.2. While welding a seam, monitor and maintain the proper overlap.
- 3.5.3.3. Inspect seam area to assure it is clean and free of moisture, dust, dirt, or debris of any kind.
- 3.5.3.4. Welding Technicians will periodically check machine operating temperature and speed, and mark this information on the geomembrane.
- 3.5.3.5. Align wrinkles at the seam overlap to allow welding through the wrinkle.
- 3.5.3.6. 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 wrinkle shall be heat-tacked flat and extruded or patched with an oval or round patch of the same geomembrane extending a minimum of three inches (3”) beyond the cut in all directions.
- 3.5.3.7. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day when practical, to allow for typical thermal expansion of the geomembrane.
- 3.5.3.8. Prior to welding cross/butt seams, the top and bottom overlap of intersecting fusion welded seams will be trimmed to six inches (6”). Intersecting extrusion fillet welded seams will be ground to flatten the extrusion bead prior to welding butt seams.
- 3.5.3.9. 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 inches (6”). Then grind three inches (3”) minimum on each of the three (3) legs of the “T” and extrusion weld all of the area prepared by grinding.
- 3.5.3.10. Whenever possible, Welding Technicians will cut a one inch (1”) peel specimen at the end of every seam. Prior to welding the next seam, the specimen will be tested for peel.
- 3.5.3.11. In the event non-complying seam test strips are encountered, the welding machine will be taken out of service until a passing trial weld is obtained, and additional peel specimens will be taken to localize the flaw.
- 3.5.3.12. The CQC Coordinator may, after consulting with GCS’s Site Superintendent, take destructive samples from any seam, if defects are suspected.

#### 3.5.4. Seaming Documentation

- 3.5.4.1. Welding Technicians will mark on the liner with permanent markers, such as Mean Streak, at the start of all seams information regarding date, time,

Welding Technician ID, machine number, and set temperature. CQC Coordinator or Assistant will record date, time, seam number, Technician ID, machine ID, set temperature, speed, and weather conditions on the GCS Panel Seaming Form (See Appendix A).

3.5.4.2. Welding Technicians will periodically check operating temperature and speed and mark the information along the seam.

3.5.4.3. CQC Coordinator will make periodic checks on welding operations to verify overlap, cleanliness, etc.

#### 4. Seam Testing - Geomembranes

4.1. Concept: The welded seam created by GCS's 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 GCS's 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. GCS performs non-destructive air-pressure testing in accordance with the following procedures, developed by GCS and adopted by the Geosynthetic Research Institutes Test Method GM-6.

#### 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 20 to 60 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 0 to 60 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 within the range listed in Initial Pressure Schedule. Close valve, observe and record initial pressure.

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 recorded after an optional two (2) minute stabilization period. The purpose of this “relaxation period” is to permit the air temperature and pressure to stabilize. The initial pressure reading may be recorded once stabilization has taken place.

4.2.2.4. Observe and record the air pressure five (5) minutes after the initial pressure setting is recorded. If loss of pressure exceeds the following or if the pressure does not stabilize, locate the suspect area and repair in accordance Section 4.2.3.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL AFTER 5  
MINUTES - HDPE/LLDPE

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

- 4.2.2.5. At the conclusion of all pressure tests, 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 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.
- 4.2.2.6. Remove the pressure feed needle and seal resulting hole by extrusion welding.
- 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 end seals and retest seams.
- 4.2.3.2. If a seam will not maintain the specified pressure, the seam should be visually inspected to localize the flaw.
- 4.2.3.3. If the seam passes the visual inspection remove the overlap left by the wedge welder and vacuum test the entire length of seam in accordance with Paragraph 4.3.
- 4.2.3.3.1. If a leak is located by the vacuum test, repair by extrusion fillet welding. Test the repair by vacuum testing.
- 4.2.3.3.2. If no leak is discovered by vacuum testing, the seam will be considered to have passed non-destructive testing.
- 4.2.3.4. If one or more peel specimen are in non-compliance, additional samples will be taken in accordance with Paragraph 4.4.3.
- 4.2.3.4.1. When two (2) passing samples are located, the length of seam bounded by the two (2) passing test locations will be considered non-complying. The overlap left by the wedge welder will be heat tacked in place along the entire length of seams and the non-complying portion of seam will be extrusion fillet welded.

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

#### 4.2.4. General Air Testing Procedures

4.2.4.1. The opposite end of the air channel will in all cases be pierced to assure that no blockages of the air channel have occurred.

4.2.4.2. Whenever possible, seams should be air-tested prior to completing butt seams to avoid having to cut into liner. All cuts through the liner, as a result of testing, will be repaired by extrusion welding

4.2.4.3. All needle holes in air channels, within the boundaries of the active cell, will be repaired with an extrusion bead.

4.2.5. Air Pressure Testing Documentation: All information regarding air-pressure testing, (date, initial time and pressure, final time and pressure, pass/fail designation, and Technicians number) will be written on one end of the seam, or portion of seam tested. All of the above information will also be logged on the GCS Non-Destructive Testing Form as exhibited in Appendix A.

4.3. Vacuum Testing: This test is used on extrusion welds, or when the geometry of a fusion 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 with a soft neoprene gasket attached to the open, bottom, a transparent viewing window, port hole or valve assembly, and a vacuum gauge.

4.3.1.2. Vacuum pump or Venturi assembly equipped with a pressure controller and pipe connection.

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

4.3.1.4. A bucket and means to apply a soapy solution.

4.3.1.5 A soapy solution.

#### 4.3.2. Procedure for Vacuum Testing

4.3.2.1. Trim any excess overlap from the seam, if any.

4.3.2.2. Turn on the vacuum pump. Compressor to reduce the vacuum box to approximately 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. For a period of approximately 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
- 4.3.2.9. After this period close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum three inch (3”) 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. Retest repaired areas.

#### 4.3.4. General Vacuum Testing Procedures

- 4.3.4.1. Vacuum box testing will be performed by qualified construction personnel.
- 4.3.4.2. Overlap must be trimmed prior to vacuum boxing all seams.
- 4.3.4.3. Special attention shall be exercised when vacuum testing “T” seams or patch intersections with 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 ID number, date, and pass/fail designation on all areas tested.
- 4.3.5.2. Records of vacuum testing will be maintained by the CQC Coordinator or testing crew on GCS Repair Report Form as exhibited in Appendix A.

#### 4.4. Destructive Testing

4.4.1. Concept: The purpose of destructive testing is to determine and evaluate seam strength. These tests 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 (1) test location every 500 feet of seam length, unless otherwise specified or agreed.

4.4.2.2. Location of destructive samples will be selected by CQC Coordinator (or the third party QA Representative), with samples cut by GCS 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 receive test results in a timely manner.

4.4.2.4. Qualified GCS personnel will observe all field destructive testing and record date, time, seam number, location, and test results on GCS Destructive Testing Form as contained in Appendix A.

4.4.2.5. All destructive test locations with pass/fail designation will be marked on liner with permanent markers, such as Mean Streak.

#### 4.4.2.6. Sample Size

4.4.2.6.1. The sample should be twelve inches (12") wide with a seam sixteen inches (16") long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the Owner at the Owner's request or by specific project specifications.

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

4.4.2.6.3. The two (2) one inch (1") wide specimens shall be tested on a field tensiometer for peel strength. If either field specimen does not pass, it will be assumed the sample would also not pass specified destructive testing.

4.4.2.6.4. The procedure outlined in Paragraph 4.4.3 shall be followed to locate passing samples for specified testing.



#### 4.4.3. Procedure for Non-Complying Destructive Test

4.4.3.1. Cut additional field samples for peel testing. In the case of a field production seam, the samples must lie a minimum of ten feet (10') in each direction from the location of the initial non-complying sample. Perform a field test for peel strength. If these field samples pass, then full samples can be cut for specified testing.

4.4.3.1.1. If the full samples pass, then repair 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 are still in non-compliance, 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 full samples passing specified destructive tests have been taken.

4.4.3.3. In cases of repaired seams exceeding 150 consecutive feet, a sample must be taken and pass destructive testing from within the zone in which the seam has been reconstructed. Each destructive must be considered a seam.

4.4.3.4. All destructive seam samples shall be numbered and recorded on GCS's Destructive Test Form as exhibited in Appendix A.

#### 4.5. Specified Testing of Destructive Seam Samples

4.5.1. Full Destructive Seam Testing: Full destructive samples will be tested by GCS when required by the site specific QC plan or in the event that third party destructive testing is not being performed. Full samples will be tested under appropriate conditions on site unless off site laboratory testing is required by the site supervisor.

4.5.2. Destructive samples will be tested for "shear strength" and "Peel Adhesion" (ASTM D4437 as modified by GCS). Five (5) specimens shall be tested for each test method. Four (4) out of the five (5) specimens must exhibit FTB (as defined by NSF Standard Number 54-1993) for each round of peel and shear testing.

#### 5. Defects and Repairs

5.1. GCS's CQC Coordinator and/or 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 GCS installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.
- 5.3. Repair Procedures: Any portion of the geomembrane or geomembrane seam showing a flaw, or having a destructive or non-destructive test in non-compliance shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by GCS's Project Superintendent. Procedures available for repair include the following:
  - 5.3.1. Patching - used to repair large holes, tears, and destructive sample locations. All patches shall extend at least three inches (3") beyond the edges of the defect and all corners of 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 extrusion or fusion welded seams.
  - 5.3.5. Extrude overlap along the length of fusion welded seams.
  - 5.3.6. Removal of a seam and replacement with a strip of new material seamed into place.
- 5.4. Verification of Repairs: Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed acceptable. Repairs in excess of 150 consecutive feet require a destructive test. Non-destructive testing of repair shall be logged on an GCS Repair Report Form when specified as exhibited in Appendix A.

## 6. Geotextiles

- 6.1. Handling and Placement: 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 when practical. In any event it should be deployed in such a manner as to continually keep the geotextile sheet in sufficient tension to reduce folds and wrinkles.
  - 6.1.2. In presence of wind, all geotextiles shall be weighted with sandbags or the 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: Geotextiles may be seamed by thermal bonding or by sewing.

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

6.2.2. On bottoms and slopes shallower than ten (10) horizontal to one (1) vertical, geotextiles can be either sewn as indicated above or thermally bonded. If thermally bonded the geotextile shall be overlapped a minimum of four inches (4") prior to seaming.

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 be seamed into place. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.

6.3.2. Horizontal Areas: A patch made from the same geotextile shall be spot-seamed in place with a minimum of twelve inches (12") overlap in all directions.

## 7. Geonets

7.1. Handling and Placement: The geonets shall be handled in such a manner as to ensure the geonets are not damaged in any way.

7.1.1. On slopes, the geonets shall be secured in the anchor trench and then rolled 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 (i.e., where extra layers are required or where slope is less than 10:1). Such locations shall be identified by the Design Engineer in the project drawings.

7.1.2. Geonets shall not be welded to geomembranes. Geonets shall be cut using approved cutters, (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 dirt in the geonet 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 from penetrating the channels of the next layer. Adjacent geonets shall be joined according to the following requirements.
- 7.2.1. Adjacent rolls shall be overlapped by at least four inches (4") and securely tied.
  - 7.2.2. Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
  - 7.2.3. Tying shall be five (5) to ten (10) feet along the bottom, every five (5) feet along the slope every two feet (2') across the slope and at top of berm and into anchor trench at least with one foot (1') intervals.
  - 7.2.4. In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be unrolled along the slope, on top of the previously installed geonets, from top to bottom of the slope.
  - 7.2.5. When more than one layer of geonet is installed, overlaps must be staggered and layers ties together.
- 7.3. Repairs: Any holes or tears in the geonet shall be repaired by placing a patch extending two feet (2') beyond edges of the hole or tear. The patch shall be secured to the original geonet by tying every twelve inches (12"). 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. Geocomposites

- 8.1. Handling and Placement: All Geocomposites shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to:
- 8.1.1. On slopes, the geocomposites shall be secured in the anchor trench and then rolled down the slope when practical. In any event it should be deployed in such a manner as to continually keep the geocomposite sheet in sufficient tension to reduce folds and wrinkles.
  - 8.1.2. In the presence of high wind, all geocomposites shall be weighed with sandbags or the equivalent.
  - 8.1.3. Geocomposite shall be cut using an approved cutter, i.e. hook blade. If the material is being cut in place, special care must be taken to protect other geosynthetic materials from damage.
  - 8.1.4. Care shall be taken not to entrap stones or excessive dust that could damage the geomembrane, or generate clogging of drains or filters.

8.2. Seams and Overlaps: Geocomposites may be seamed by thermal bonding or by sewing. No horizontal seams shall be allowed on side slopes greater than 4:1.

8.2.1. On slopes steeper than ten (10) horizontal to one (1) vertical, it is recommended that geocomposites be continuously sewn. The geotextile must be overlapped by at least three inches (3"), the geonet overlap by at least four inches (4").

8.2.2. On bottoms and slopes shallower than ten (10) horizontal to one (1) vertical, geocomposites can be either sewn as indicated above or thermally bonded.

8.2.3. Tying of the geonet will be with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

8.2.4. Tying shall be every five (5) to (10) feet across the bottom, every five feet (5') along the slope, at the top of the berm and into anchor trench at least with one foot (1') intervals. End to end joints on the bottom will be overlapped two feet (2') with no tying.

8.3. Repairs: The repair will be observed and if smaller than three feet (3') by three feet (3') the geocomposite will be repaired. If the tear or hole is larger, then the roll will be cut and a butt joint placed.

8.3.1. If the geonet is undamaged, and the geotextile is damaged, a patch of geotextile shall be placed. The geotextile patch shall be thermally bonded in place with a minimum of thermally bonded in place with a minimum of twelve inches (12") overlap in all directions.

8.3.2. If the geonet is damaged, the damaged geonet shall be removed. A section of geonet shall be cut to replace the removed section. The geonet shall be tied to the existing geonet using plastic fasteners placed at least every six inch (6") overlay. A geotextile patch shall be placed over the repaired geonet section. The place with a minimum of twelve inch (12") overlap in all directions.

## 9. Geosynthetic Clay Liners

### 9.1. Storage

9.1.1. Geosynthetic clay liner rolls must always be stored in a location where they will not be exposed to excessive moisture.

### 9.2. Handling and Placement

9.2.1. On slopes, geosynthetic clay liners should be placed with overlap oriented parallel to the maximum slope oriented parallel to the maximum slope (i.e. down the slope, not across the slope).

- 9.2.2. Adjoining panels of geosynthetic clay liners should be overlapped a minimum of six inches (6”).
  - 9.2.3. Geosynthetic clay liners should never be installed in standing water or while rain is falling.
  - 9.2.4. Geosynthetic clay liners should always be installed with appropriate side up.
  - 9.2.5. Rolls should be pulled tight to smooth out any creases or irregularities.
  - 9.2.6. Precautions should be taken to avoid damage to any underlying geosynthetic materials while placing the geosynthetic clay liners.
- 9.3. Cover geosynthetic clay liners with geomembrane or other cover materials after placement to avoid damage from precipitation.
- 9.4. Repairs
- 9.4.1. Repairs to cuts or tears in installed rolls should extend a minimum of six inches (6”) beyond the area in need of repair. Repair pieces should be held in place until cover material has been placed.

## 10. Geogrids

- 10.1. Geogrids will be shipped, stored and installed in accordance with the manufacturers recommended installation procedures

The procedures described herein are those in effect as of January 1, 2004. Global Containment Solutions, LLC reserves the right to deviate from these procedures in order to keep abreast of changes in technology.

## **APPENDIX A**

### **FORMS**