north country
ENVIRONMENTAL SERVICES

NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.
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September 19, 1995

Mr. Kevin Hopkins
NH Dept of Environmental Services
Solid Waste Engineering Section
6 Hazen Drive
Concord, NH 03301-6509

RE: North Country Environmental Services, Inc. (NCES)
Bethlehem, New Hampshire
Construction Approval Permit No. DES- SW-89-009
Stage II - Phase I Construction

Dear Mr. Hopkins:

This letter and enclosures is a follow-up to our discussion during your last site visit. We would like to provide you with the status of this project as required by Env-Wm 310.07(b)(5).

The liner installer will be as follows:

terrafix® Environmental Technology, Inc.
425 Attwell Drive
Rexdale, Ontario M9W 5C4
Contact: John Mooney, General Manager
Telephone: (416) 674-1159

Enclosed please find a copy of terrafix's Quality Control Manual.

The status of construction is as follows:

Site Specific

Excavation for sedimentation basin # 1 is just about complete. Work on basin # 3 will begin this week. Clearing and grubbing for the new drainage swale is complete. The swale was surveyed last week with stakes set to provide cut, fill and location information.

Stage II - Phase I

Initial Excavation - Initial excavation has been completed.

Final Grading - Final grading of the foot print will be completed within the next 10 days. This will also include the placement of the one foot layer of recompacted till.

Liner Installation - The placement of liner is scheduled to begin on September 25 with a back-up date of October 2, 1995.

Leachate Collection - All materials have been ordered with anticipated delivery of piping within the next two weeks. Pumps, controls and tankage could take between 3-6 weeks to receive and place within 4 weeks of receipt.

Enclosed please find construction summary reports for period ending August 31, 1995 and September 12, 1995 prepared by the project engineer and resident engineer.

We hope this information, along with the enclosures gives you a detailed summary of this project. Should you have any questions please don't hesitate to give me a call.

Sincerely,

NORTH COUNTRY ENVIRONMENTAL SERVICES, INC.

Larry B. Lackey /KGF

Larry B. Lackey, Vice President
Permits, Compliance and Engineering

Enclosures

cc: James N. Berg, New Hampshire Department of Environmental Services
R. Scott Shillaber, Sanborn, Head and Associates, Inc.
Doug Casella, Casella Construction
John W. Casella, New England Waste Services, Inc.
James W. Bohlig, North Country Environmental Services, Inc.
Robert A. Watts, North Country Environmental Services, Inc.

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environmental technology inc.

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QUALITY CONTROL MANUAL

1.0 Introduction

1.1 This manual defines the Quality Control Program developed and utilized by Terrafix Environmental Technology Inc. (T.E.T.), to ensure the quality of workmanship and the installation integrity of geomembranes and other geosynthetic products.

1.2 T.E.T. has recognized that careful and specific documentation of installation quality is required to substantiate this Quality Control Program.

2.0 Geomembrane Installation

2.1. Subgrades

2.1.1. The General and\or Earthworks Contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of the geomembrane unless specifically agreed otherwise.

2.1.2. Concrete surfaces to receive liner shall be smooth finished so that the installed membrane does not bear against any sharp or abrasive areas. All convex corners shall be rounded or chamfered at least 25 mm. Reinforcing bars are to be at least 100 mm below the surface in all areas where the membrane is to be anchored.

2.1.3. The General and\or Earthworks Contractor shall protect subgrade surfaces from freezing.

2.1.4. If requested T.E.T. will provide their client with written acceptance of the subgrade surfaces. Two possible formats are offered (a) daily certification of the area covered defined by panel numbers and\or construction stations, (b) certification at the end of liner deployment accepting all areas lined. Subsurface acceptance by T.E.T. will only certify that the surfaces lined where visually inspected and appeared to be suitable for geomembrane deployment.

2.2. Geomembrane Deployment

2.2.1. Prior to commencement of geomembrane deployment, layout drawings shall be produced to indicate the intended panel configuration and seam location and direction.

2.2.2. Each panel shall be assigned a numeric or alpha-numeric identifier at the time of deployment. The panel identification shall be related to the manufacturer's production roll number. Panel identification will also be shown on as-built drawings provided after the completion of the project.

2.2.3. If geomembrane panels are installed in a different arrangement than that shown on the layout drawings the difference will be reflected in the as-built drawings.

2.2.4. The methods and equipment used to deploy the geomembrane panel shall not damage the geomembrane or the subgrade.

2.2.5. No personnel working on the geomembrane shall smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane.

2.2.6. Adequate temporary ballast (sand bags) which will not damage the geomembrane, shall be used to prevent uplift or movement by wind.

2.2.7. All damage to geomembrane will be repaired in accordance with the following paragraphs. Any areas of the geomembrane seriously damaged will be marked, cut out and removed from the work area with the resulting repairs performed in accordance with the paragraphs below.

2.2.8. 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 not less the 1.5 m from the toe of all slopes. Each field seam shall be numbered in a manner which will be recorded on the as-built drawings and on the appropriate quality control documents.

2.2.9. All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by performing a test weld as described in the paragraphs below.

The project supervisor will provide direct supervision of all personnel seaming to verify proper welding procedures are followed.

2.2.10. Sufficient slack shall be installed in the geomembrane to compensate for the contraction of the material during the low temperature portion of the service life.

In most applications slack will be installed based on the discretion of the Terrafix supervisor. In cases where fixed points exist in the membrane system i.e. between structures and attachments, the following equation shall be used to calculate the minimum amount of slack required between the fixed points.

$$S = C \times (T - T_1) \times D$$

Where:

- S is the minimum amount of slack required between the fixed points.
- C is the coefficient of linear thermal expansion (or contraction) for the geomembrane material.
- T is the surface temperature of the geomembrane when the slack is measured.
- T_1 is the lowest temperature anticipated during the service life of the geomembrane.
- D is the distance between the fixed points under consideration.

2.3.1. Fusion Welding

Fusion welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two overlapped sheets such that the surface of each sheet is heated above the polyethylene's melting point. Immediately after being heated the overlap region is passed between pressure wheels which compress the molten areas together so that a continuous homogeneous weld is formed. The wedge welder is equipped with a temperature readout that continually monitors the temperature of the wedge. The wedge welder also has adjustable controls which allow the temperature, pressure and speed to be adjusted to meet specific site conditions.

2.3.2. Extrusion Welding

Extrusion fillet welding consists of introducing a bead of molten polyethylene along the edge of the seam overlap. The molten polyethylene bonds to each sheet resulting in a homogeneous bond between the bead and the surfaces of the sheets to be welded. The extrusion welder has temperature readouts which continually monitor the temperature of the extradite. The extrusion welder also has controls allow the temperature of the extradite and the pre-heat air to be adjusted to meet specific site conditions.

2.3.3. T.E.T. relies on the experience of the project Superintendent and results of test seams to determine seaming restrictions caused by weather.

Many factors such as ambient temperature, humidity, wind, sun light, etc. can effect the integrity of field seams and must be considered when deciding whether or not seaming should proceed. Test seams as described below are required prior to start of daily production seaming to determine whether or not weather conditions will effect T.E.T.'s ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the Project Superintendent to continue seaming on any given day.

2.4.1. Seam Preparation for Fusion Welding;

(a) Overlap geomembrane panels approximately 150 mm.

(b) Clean seam area thoroughly. Seam area must by free of moisture, dust, sand or any debris. No grinding is required for fusion welding.

(c) Adjust the panels to minimize any differential wrinkles.

2.4.2. Seam Preparation for Extrusion Welding;

(a) Overlap panels a minimum of 100 mm.

(b) Temporarily bond the panels. Exercise caution not to damage the adjacent areas.

(c) Clean seam area prior to seaming to assure the area is free from moisture, dust, sand or debris of any kind.

2.6.1. General Seaming Procedures

(a) Seaming shall extend as far into the anchor trenches as is feasible when the seam is welded. In any case seams must extend at least 75 mm into the anchor trench.

(b) Overlap and seam cleanliness shall be monitored continuously during fusion welding.

(c) Operating temperature and speed settings shall be monitored during all seaming.

(d) All cross-seam wrinkles (compensation) shall be aligned to facilitate welding through the wrinkles.

(e) Fishmouths or cross-seam wrinkles that cannot be welded through shall be cut along the ridge to achieve a flat overlap. The cut shall be seamed. Any portion of the cut which has in-sufficient overlap for extrusion welding shall be covered with a round or oval patch.

3.0. Non-Destructive Seam Testing

3.1. Concept

T.E.T. will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved method to verify the continuity and integrity of the seams.

3.2 Air Pressure Testing

Most fusion welded seams are composed of two distinct welded tracks separated by an un-welded channel (the air channel). Air pressure testing involves pressurizing the air channel and monitoring its ability to hold the air pressure for a fixed length of time.

3.2.1. Procedure for Air Testing

(a) Seal both ends of the air channel in the seam to be tested.

(b) Insert needle or other approved pressure feed device into the sealed air channel.

(c) Pressurize air channel to above the minimum pressure specified below. Record initial pressure after a two minute relaxation period and monitor the pressure for a period of five minutes. Pressure shall remain within the limits specified below otherwise the faulty area must be located and repaired as described elsewhere in this document.

Material Thickness mm (mil)	Minimum Initial[1] Pressure kPa (psi)	Maximum Permissible Pressure Differential kPa (psi)
1.0 (40)	172 (25)	28 (4)
1.5 (60)	186 (27)	21 (3)
2.0 (80)	207 (30)	21 (3)
2.5 (100)	207 (30)	21 (3)

(d) Release pressure by puncturing the air channel on the end opposite the pressure feed device. Remove needle or pressure feed device and repair any resultant holes.

(e) Record final results on form TET-2 (as attached).

3.2.2. Procedure for Non-Complying Air Tests

In the event of non-complying air pressure test the following procedure shall be followed until acceptable test results can be obtained;

(a) Verify the integrity of the seals at each end of the air channel, the penetration of the pressure feed and all of the attached equipment.

(b) Carefully visually inspect the seam looking for any possible leak locations. If a flaw is located in the air channel the seam will be cut at that location and two separate air tests will be recorded one on either side of the flaw location. Any necessary repairs will be as discussed elsewhere in this document.

(c) If it is impossible to achieve successful air test results over any reasonable length of seams the Terrafix supervisor will choose from the following alternatives;

Alternative 1.

The entire defective seam shall be removed and a thin strip of geomembrane shall be installed with two new fusion welds. The new welds will then be pressure tested as per the above.

Alternative 2.

The overlap shall be extrusion welded over the length of the seam. The resulting weld shall be vacuum tested as described below.

3.3. Vacuum Testing

Vacuum testing is used when the configuration of the weld makes pressure testing impossible i.e. extrusion welds and fusion welds with no air channel.

3.3.1. Equipment

The equipment used for vacuum testing consists of a vacuum box and a vacuum pump. A vacuum box is essentially a rigid housing with a transparent inspection window. The lower portion of the vacuum box is equipped with a thick soft neoprene sponge. The vacuum box is also equipped with a vacuum gage and a release valve assembly.

3.3.2. Procedure

Any excess overlap is trimmed off (for fusion welds only) and all dirt and debris are removed. A generous amount of soapy solution is then applied to the area to be tested.

The vacuum box is placed over the area to be tested and sufficient downward pressure is applied to "seat" the neoprene sponge against the liner.

The vacuum pump is engaged to and reduce the interior of the vacuum box to approximately - 34 kPa (- 10 in.Hg or - 4.9 psi), ensuring that the vacuum box is "seated" well enough that leakage around the neoprene seal is minimal.

For a period of not less than thirty (30) seconds the seam is observed through the inspection window. A non-complying test is be indicated by soap bubbles caused by air flowing from under the seam into the vacuum. If no soap bubbles are observed during the thirty (30) second inspection period the vacuum is released and the vacuum box is moved to the next test location. When seams longer than the vacuum box are tested, test locations shall be overlapped to ensure that 100 % of the seam is tested.

3.3.3. Procedure for Non-Complying Tests

All areas where flaws are indicated by vacuum testing shall be marked and repaired as described elsewhere in this document. All repairs shall be vacuum tested as per the above.

4.0 Destructive Testing

4.1. Concept

Destructive testing is utilized to evaluate seam strength and quality. Since destructive testing involves physically removing samples from the geomembrane and subsequent repairs its use should be minimized. Location of destructive samples should be strategically placed for ease of repair.

4.2. Frequency

Destructive test samples shall be marked and removed randomly with an average frequency of one sample per 150 m (500 ft) of seaming.

At the Terrafix supervisor's discretion the destructive testing frequency may be decreased to one sample per 300 m (1,000 ft.) of seam. Decreasing the frequency of destructive tests shall only be considered on installations with very long continuous welds performed in ideal weather conditions and after all samples taken at the normal frequency have been yielded acceptable results.

Extra destructive samples should be taken in potential problem areas i.e. areas of contamination, offset welds or visible defects. It is the responsibility of the Terrafix supervisor and the quality control technicians to ensure that all problem areas are located by either destructive or non-destructive testing.

4.3. Procedure

4.3.1. Sample Size

Destructive samples are normally 300 mm (12 in.) wide and 900 mm (3 ft.) in length, with the seam centered lengthwise in the sample. The 900 mm is normally divided into three sections with one section for the general contractor, one section for the owner and one section for testing by Terrafix.

Smaller samples (minimum 300 mm 12 in) may be taken if the general contractor and the owner are not interesting in having the samples independently tested.

4.3.2. Prior to removing the selected sample small coupons 25 mm in width should be removed from the seam just outside either end of the intended sample and tested in "hand-peel". If the preliminary samples indicate any type of flaw especially in peel the effort and expense of full destructive testing will be avoided and the procedures for non-complying destructive testing will be executed, if the preliminary samples shown no sign of flaws the destructive sample is removed.

4.3.3. Three 25 mm coupons shall be cut from the Terrafix portion of the sample and tested on the field tensiometer. Two of the samples are tested in peel and one in shear in the same manner as the test welds were tested. If all testing indicates a high quality weld the other samples may be given to the general contractor and the owner. The remaining portion of the Terrafix sample shall be kept and archived for a one year period. All pertinent information is then recorded on form TET-3.

4.4. Procedure for Non-Complying Destructive Tests

Attempts should be made to determine the extent of the faulty area. This may be accomplished by marking additional samples as per items 4.3. above. Samples must be taken a minimum of 3 m on either side of the failing specimen. If the failing area can be bounded by passing destructive samples on either side the Terrafix supervisor will choose from alternatives 1 and 2 below to repair the faulty seam area, otherwise the entire seam must be repaired by the same methods. If the entire seam is found to be defective destructive tests must be performed on the seams which were welded, immediately before and after the defective seam, by the same apparatus.

Alternative 1.

The entire defective area (or seam) shall be removed and a thin strip of geomembrane shall be installed with two new fusion welds. The new welds will then be pressure tested as per the above.

Alternative 2.

The overlap shall be extrusion welded over the length of the defective area (or seam). The resulting weld shall be vacuum tested as described below.

5. Defects and Repairs

The T.E.T. supervisor will conduct a detailed "walk-through" inspection to visually check all seams and panels for defects, holes, blisters and any sign of installation damage, at the end of each phase of a projects construction.

All T.E.T. personnel on site shall at all times be on the lookout for any damage or flaws. Any damage or flaws noticed by T.E.T. personnel shall be marked **and** brought tho the attention of the T.E.T. supervisor.

5.1. Repair Procedures

Any portion of the geomembrane showing a flaw, or failing either destructive or non-destructive testing shall be repaired. Several methods of repair exist and the decision as to the appropriate repair procedure shall be made by the T.E.T. supervisor. Procedures for effecting repairs are as follows;

(a) Patching - used for all through-thickness repairs. Patches shall extend a minimum of 75 mm (3 in.) beyond the edge of the defect in all directions and all corners shall be rounded.

(b) Grind and Bead - used for localized repair of extrusion welds and to repair small scraps and creases which do not penetrate the membrane.

(c) Capping - used to cover lengths of defective seam. Essentially a very long narrow patch.

(d) Faulty seams can be cut out and strips of new material can be seamed in their place.

5.2. Verification of Repairs

Every repair shall be non-destructively tested. Should the repair be large enough destructive testing may be required. Repair locations and descriptions shall be logged on form TET-4. Testing of repairs shall be logged in the same manner described above.

TERRAFIX ENVIRONMENTAL TECHNOLOGY INC.

TEST SEAM RECORDS

FORM TET-1

SUPERINTENDENT _____ PROJECT _____

DATE	TRIAL NO.	TIME	AMBIENT TEMP.	MACHINE NO.	MACHINE TEMP	PRE-HEAT TEMP	TECHNICIAN	SHEAR STRENGTH	PEEL STRENGTH	Q.C. TECH-NICIAN	PASS/ FAIL	COMMENTS

FORM TET-2

TERRAFIX ENVIRONMENTAL TECHNOLOGY INC.

SEAM TESTING

SUPERINTENDENT ______________________ PROJECT ______________________

SEAM NO.	SEAM DATE	TEST DATE AND TIME	AMBI-ENT TEMP	MACHINE NO.	TECH-NICIAN	AIR PRESSURE MAX	AIR PRESSURE AFTER 5 MIN.	PASS/FAIL	LEAK LOCATION	COMMENTS	Q.C. TECH-NICIAN	REPAIR DATE	MACHINE NO.	TECH-NICIAN	TEST OR REPAIR DATE

TERRAFIX ENVIRONMENTAL TECHNOLOGY INC.
DESTRUCTIVE TESTING

FORM TET-3

SUPERINTENDENT _____ PROJECT _____

DATE	MACHINE NO.	TECHNICIAN	SEAM NO.	SAMPLE NO.	FIELD PEEL	FIELD SHEAR	LAB PEEL	LAB SHEAR	LOCATION	COMMENTS	Q.C. TECH-NICIAN

TERRAFIX ENVIRONMENTAL TECHNOLOGY INC.

REPAIR REPORT

FORM TET-4

JPERINTENDENT _____ PROJECT _____

SEAM NO.	PANEL NO.	REPAIR DATE	MACHINE NO.	TECHNICIAN	AMBIENT TEMP	PATCH NO.	LOCATION OF REPAIRS	REPAIR VACUUM TEST DATE	VACUUM TECH-NICIAN