REPORT

Pilot Study Work Plan for Silver Lake Sediments

General Electric Company
Pittsfield, Massachusetts

Originally Submitted June 2006
Revised August 2006

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1. Introduction

1.1 General

On October 27, 2000, a Consent Decree (CD) executed in 1999 by the General Electric Company (GE), the United States Environmental Protection Agency (EPA), the Massachusetts Department of Environmental Protection (MDEP), and several other government agencies was entered by the United States District Court for the District of Massachusetts. The CD governs, among other things, the performance of response actions to address polychlorinated biphenyls (PCBs) and other constituents in soils, sediment, and groundwater in several Removal Action Areas (RAAs) located in or near Pittsfield, Massachusetts, that are included within the GE-Pittsfield/Housatonic River Site (the Site). In addition, the CD requires the performance of a number of natural resource restoration/enhancement actions for several portions of the Site.

The CD and accompanying *Statement of Work for Removal Actions Outside the River* (SOW) (Blasland, Bouck & Lee, Inc. [BBL], 1999) provide for the performance of numerous response actions at RAAs located outside the Housatonic River. For each response action, the CD and SOW establish performance standards that must be achieved, as well as specific work plans and other documents that must be prepared to support the response actions within each RAA. One such RAA is Silver Lake, which is a 26-acre lake in Pittsfield, Massachusetts and the focus of this work plan. As set forth in the SOW, and as revised in follow-up discussions with EPA and EPA's conditional approval letter dated August 17, 2004 for GE's *Pre-Design Investigation Report for Silver Lake Sediments* (Sediments PDI Report) (BBL, 2004), the Performance Standards for Silver Lake sediments are briefly summarized below:

- GE shall remove a maximum of 400 in-situ cubic yards (cy) of sediments from an area in the general vicinity of existing outfall 01A, replace the removed sediments, and restore and vegetate that portion of the affected area that is not underwater in coordination with the installation of the sediment cap and the performance of natural resource restoration/enhancement activities.

- GE shall install a cap over the entire bottom of the lake to achieve the design standards set forth in Attachment K to the SOW, including an isolation layer consisting of silty sand with a presumptive thickness of 12 inches if geotextile is placed between the sediments and the cap (or 14 inches without a geotextile), a total organic carbon (TOC) content of 0.5%, and concentrations of PCBs at non-detectable levels and other constituents at background levels (with the appropriateness of these design parameters being subject to confirmation in the pre-design investigation).

- The capping system shall include an overlaying armor layer of stone incorporated along the shoreline as necessary to prevent potential erosion of the isolation layer due to wind-induced wave action.

The work plans and other documents prescribed by the CD and SOW include a pre-design investigation (PDI) report to be completed in advance of the implementation of response actions. That report, the Sediments PDI Report, was submitted to EPA in February 2004 to summarize data collection activities and results of the pre-design sediment investigation of Silver Lake sediments.

Following the Sediments PDI Report, GE submitted the *Supplemental Pre-Design Investigations Report* (Supplemental PDI Report) (BBL, 2005) to EPA in January 2005 to summarize additional investigation results and further advance the understanding of the physical and chemical characteristics of Silver Lake sediments and their potential response to placement of an engineered cap. In addition, the Supplemental PDI Report outlined the objectives of the Bench-Scale Study for Silver Lake Sediments, which was performed in 2005 to investigate the geophysical and chemical response of lake sediments to the placement of cap materials. The activities and results of that study were summarized in the *Bench-Scale Study Report for Silver Lake Sediments* (BBL, 2006), which GE submitted to EPA in March 2006. A revised *Bench-Scale Study Report for Silver Lake Sediments* (Bench-Scale Report) was submitted to EPA in May 2006, reflecting comments on the original Bench-Scale Report set forth in EPA's conditional approval letter dated May 2, 2006.

As documented in the Sediments PDI Report, GE and EPA agreed that a field-scale pilot study is needed to further assess the behavior of Silver Lake sediments during and after cap placement, and to confirm key assumptions related to the initial cap design. This *Pilot Study Work Plan for the Silver Lake Area Removal Action* (PS Work Plan) describes the field-scale pilot study activities proposed for the sediments within Silver Lake. The PS Work Plan was initially submitted on June 14, 2006. In its conditional approval letter dated July 18, 2006, EPA requested modifications to the plan and asked for a revised submittal. As requested, GE has made a number of modifications to the PS Work Plan that are presented in this revised document.

When completed, the results of the pilot study will be combined with information from prior investigations of Silver Lake (e.g., sediments PDI, supplemental PDI, and bench-scale study) to support the subsequent evaluation and design of response actions necessary to achieve the performance standards for this RAA.

1.2 Objectives of the Pilot Study

The primary objectives of the pilot study for Silver Lake sediments are to:

- Evaluate constructability issues associated with placement of a cap comprised of multiple thin layer lifts in the lake environment;
- Assess the potential for the physical mixing of sediments with cap materials as a result of cap placement;
- Evaluate shear strength behavior and slope stability of in-situ sediments resulting from the additional stress induced by the cap to further investigate constructability, and sediment response to placement of cap materials. The pilot study will include an assessment of potential short-term behaviors (e.g., mud wave, resuspension, sediment bearing capacity) and longer-term stability issues (e.g., consolidation settlement, side-slope creep) of lake sediments;
- Evaluate the effectiveness of incorporating geotextile materials into the cap design to enhance the integrity and stability of the cap;
- Assess the potential for water quality impacts, if any, related to cap placement; and
- Confirm results of the bench-scale study related to the performance of potential cap configurations with regard to the physical and chemical isolation of PCBs present in existing lake sediments.

1.3 Format of this Work Plan

Following this section, the remainder of this PS Work Plan is presented in five sections:

- Section 2 provides a general description of the Silver Lake RAA; summarizing the relevant data from the sediments PDI, supplemental PDI, and bench-scale study activities as they relate to the pilot study.

- Section 3 discusses the pilot study approach and provides details on pilot study design and implementation such as proposed test locations, materials to be used, and construction techniques to be employed.

- Section 4 details the monitoring efforts to be performed to track conditions in Silver Lake sediments during and within a short time following implementation of the pilot study, and to assess performance of the pilot study cap in achieving physical and chemical isolation of PCBs present in lake sediments within the test area.

- Section 5 presents a proposed schedule for implementation of the pilot study activities.

- Section 6 provides a list of references.

2. Background Information

2.1 General

This section summarizes background information relevant to design and performance of the pilot study, including a general description of Silver Lake and a summary of pertinent results from previous pre-design investigation activities and the bench-scale study.

2.2 Site Location and Description

Silver Lake is located immediately west of, and across Silver Lake Boulevard from, the former 30s Complex portion of the GE Plant Area in Pittsfield, Massachusetts (Figure 1). (The former 30s Complex was conveyed to the Pittsfield Economic Development Authority (PEDA) on May 2, 2005.) The lake is bordered to the north by Silver Lake Boulevard and to the west and south by several commercial and residential properties. Silver Lake has a surface area of approximately 26 acres and a maximum water depth of approximately 30 feet. The lake receives stormwater discharges from several municipal stormwater outfalls, including PEDA's National Pollutant Discharge Elimination System (NPDES) permitted outfall that conveys stormwater from both PEDA property and GE property, that is planned to be transferred to PEDA in the future, as well as several adjacent residential and commercial/industrial properties. Silver Lake discharges to the East Branch of the Housatonic River through a 48-inch-diameter concrete pipe located in the southwest portion of the lake. This pipe conveys surface water from Silver Lake as well as stormwater runoff from Fenn and East Streets to the Housatonic River.

2.3 Summary of Relevant Pre-Design Investigation and Bench-Scale Study Results

A number of pre-design investigation activities were performed, in part, to verify assumptions made in the preliminary cap design described in the SOW. The implementation and results of these activities are summarized in the Sediments PDI Report, Supplemental PDI Report, and Bench-Scale Report. Results of these studies and other information pertinent to design and performance of the pilot study are summarized in this subsection.

2.3.1 Bathymetry

A bathymetric map of Silver Lake was prepared in 2003 using a small, vessel-mounted, global positioning system (GPS) with fathometer and laptop computer. For shoreline areas and outfalls of the lake inaccessible to the survey vessel due to shallow water, conventional topographic survey methods were employed and combined with the survey vessel data to prepare the bathymetric map provided on Figure 2.

An additional survey of the lakebed was conducted using a high-resolution side-scan sonar system. The data were processed and interpreted to generate a graphical representation of the physical characteristics of the lakebed (Figure 3). This mapping identifies specific features of the lake bottom (e.g., debris, remnant structures/obstructions) that may affect the constructability of the cap, and as such will be considered during design and implementation of the pilot study. A summary of identified physical features of the lakebed is presented in the Sediments PDI Report.

2.3.2 Sediment Characteristics

2.3.2.1 Chemical Characteristics

Numerous investigations have been performed by EPA and GE to define the nature and extent of chemical constituents in Silver Lake sediments. The majority of these activities have focused on characterizing the presence and potential mobility of PCBs, total petroleum hydrocarbons (TPH), and metals. Detailed discussion of these investigations and their conclusions are provided in the Sediments PDI Report, Supplemental PDI Report, and Bench-Scale Report.

With specific regard to PCBs, sediment sampling and analysis has been performed on several occasions in Silver Lake, as reported in reports prior to and including the Supplemental PDI and Bench-Scale Study Reports, resulting in the collection of more than 200 sediment samples. In general, these results indicate that PCB concentrations are greater in subsurface sediment, with marked decreases in PCB concentrations observed in the top 6 inches of material. Additionally, PCB concentrations in sediment appear to be generally greater in the eastern portion of the lake. The highest recorded PCB concentrations are located in the northeast portion of the lake in the area that will be subject to future sediment removal activities, as described in the SOW. A detailed discussion of these results can be found in the Sediments PDI and Supplemental PDI reports.

2.3.2.2 Physical Characteristics

Silver Lake sediments are generally characterized by the following three distinct layers:

- The surface layer (Layer 1) is characterized as soft black silt identified as having a sludge-like consistency;
- The intermediate layer (Layer 2) is characterized as soft silt and marl of an olive or brown color; and
- The bottom layer (Layer 3) is characterized as sand and silt.

Generally, the three layers have relatively low strength characteristics for their respective classifications, and Layers 1 and 2 have relatively high compressibility indices. Layer 1 generally exhibits characteristics of a low-permeability silt, Layer 2 exhibits characteristics of impervious clay, and Layer 3 generally exhibits characteristics of pervious sand. A detailed discussion of the geotechnical properties of Silver Lake sediments is available in the Sediments PDI Report.

2.3.3 Summary of Bench-Scale Study Results

The primary objective of the bench-scale study was to evaluate the physical and chemical responses of Silver Lake sediments to the placement of cap materials. Specific objectives of the bench-scale study included the evaluation of the potential for mixing and consolidation of sediments and cap materials during and after cap placement, the potential for PCB mobility during and after cap placement, and investigation of the potential for groundwater flux or gas-induced PCB transport in sediments and cap materials.

The bench-scale study was designed to be performed in three stages, with the physical and chemical results of the first stage used to select the sediment collection location for the subsequent, more detailed latter stages of the bench-scale study. In general, the study consisted of an evaluation of total consolidation of sediments following cap material placement, as well as an investigation of potential PCB transport as a result of cap placement.

During the first stage, sediment cores were collected from six locations within Silver Lake (see Figure 2). Sediment in each of the six cores were covered with the same cap configuration (i.e., approximately 12 inches of a 4:1 mixture of sand and topsoil) and were monitored for settlement consolidation. In general, the results of the first stage of the bench-scale study can be summarized as follows:

- Total consolidation of sediment, calculated as the net change in sediment surface elevation, ranged from approximately 1.1 to 3.7 inches after 45 days (total isolation layer material consolidation ranged from no consolidation to 0.38 inches). The majority of consolidation occurred within the first two weeks;
- Although there was slight mixing of sediment and cap material visually observed in one core, during and after the placement of cap materials, there were no structural failures or bearing capacity limitations observed in the sediments in any of the cores; and
- There were no observations or data indicating PCB transport.

Results of the first stage of the study (e.g., limited extent of consolidation, absence of constituent transport) indicated that the objectives of Stage 2 (i.e., further assessment of sediment consolidation and constituent transport through the cap material) had essentially been satisfied. With EPA approval, the second stage of the study was eliminated, and the study proceeded immediately to the third stage.

Stage 3 of the bench-scale study was performed on five sediment cores collected from location D which had the greatest consolidation (3.7 inches) of the six cores and the highest sediment PCB concentration (250 parts per million [ppm] in the 0- to 6-inch increment). Additional components of this stage included a simulated upward groundwater flux and the collection of gasses potentially generated and released through the cap. Stage 3 of the study also included evaluation of the potential benefits of inclusion of geotextile materials within the cap configuration. In general, the results of Stage 3 of the bench-scale study can be summarized as follows:

- Total consolidation of sediment, calculated as the net change in sediment surface elevation, ranged from approximately 1.4 to 2.3 inches after 150 days, with no observable differences related to the presence of geotextile (total isolation layer material consolidation ranged from 1.25 to 1.38 inches). The majority of consolidation occurred within the first two weeks;
- There were no observed shear or rotational failures during or after placement of cap materials, and, although there was some slight mixing visually observed in one core, the cores that included geotextile had no observable mixing of sediment and cap materials;
- Although there was a small amount of gas generated and collected in each of the cores, there was no observable relationship between gas generation and PCB mobility; and
- There was no discernable gradient, correlation, or pattern in PCB concentrations within the cores, cap material, and surface water; a further indication that there was no PCB transport.

In general, the results of the bench-scale study show no discernible indication of consolidation-based or gas-enhanced PCB mobility, which lead to the following general conclusions used in preparation of this PS Work Plan:

- The cap materials and configurations used in the bench-scale study provided an effective physical and chemical barrier in isolating sediment PCBs from the overlying cap materials;

- Study data and analyses did not show a correlation between the presence of either gas generation or TPH and PCB mobility;

- There are no indications that modifications to the conceptual cap design (as described in the SOW) or the approach to the pilot study (originally discussed in the Sediments PDI Report and ensuing discussions) are warranted.

A detailed discussion of the design, implementation, and results of the bench-scale study is presented in the Bench-Scale Report.

3. Pilot Study Approach

3.1 General

This section summarizes the pilot study approach, including the location and characteristics of the test area selected for the pilot study, why it was selected, and what cap configurations and other activities will occur during the study. This section also proposes a potential location for the construction staging area, the shoreline erosion protection measures planned for the study, how debris will be managed, and cap material placed within the test areas. As described in Section 4, a comprehensive monitoring program will be implemented before, during, and after pilot cap placement.

Implementation of the pilot study will involve creation of three contiguous test cells; two of which will include placement of geotextile layers (i.e., a non-woven geotextile and a composite geotextile), which will be covered with isolation materials in order to investigate the response of Silver Lake sediments to the placement of a cap on a field-scale level. Cap placement will be performed such that, to the extent practicable, a homogeneous layer of isolation materials is deposited over the entire test area and then monitored to assess the stability and effectiveness of the various cap configurations in isolating PCBs present in underlying sediments. Material specifications, testing methods, and frequency of material testing, for all construction materials anticipated to be used in the pilot study cap (e.g., geotextiles, sand, topsoil) have been included in Appendix A.

3.2 Pilot Study and Construction Staging Area Location

The results of previous investigative activities were used to select a location for performance of the pilot study. In keeping with the objectives established for the pilot study program, and in order to conservatively evaluate future constructability of a full-scale engineered capping system, preference was given to an area of the lake that had relatively steeper slopes and sediments that were relatively low in strength and high in PCB concentration. Based on these objectives and an assessment of all sediment data and previous investigation results, an area, approximately 1 acre in size, has been identified as suitable for performance of the study (Figure 4). Monitoring equipment is anticipated to be installed along the shore of the lake, adjacent to the proposed pilot study area. Prior to commencing any onsite pilot study activities, GE will obtain appropriate access agreements.

Assuming that the necessary access agreements can be obtained, it is currently anticipated that a staging area for construction activities will be located on the north side of the lake along Silver Lake Boulevard (Figure 4). This location will provide safe and efficient access for delivery of material, machinery, and labor. As necessary, barges and/or pipelines will be used to transport material and machinery from the staging area across the lake to the pilot study location. The staging area will be adequate for stockpiling cap material, managing construction equipment, and providing other support functions.

3.2.1 Site Preparation and Controls

Site controls and security measures will be implemented in an effort to maintain a secure study area and limit potential construction impacts to the surrounding areas. Appropriate fencing will be installed to restrict site access and protect monitoring and construction equipment. As necessary, traffic control will be provided if construction activities are anticipated to interfere with normal vehicle or pedestrian traffic in the vicinity of the study area.

During construction, to limit the potential for discharge of any suspended sediment to the Housatonic River, silt curtains will be installed at the outfall to the river located in the southwest corner of the lake. Silt curtains will be deployed such that a series of two curtains are used in succession, allowing for progressive settling of suspended materials as the water approaches the outfall to the river. Additionally, during installation of the geotextile layers and isolation layer materials, any visual observations of sheens will be noted. Appropriate measures (e.g., booms and curtains) will be available throughout the pilot study activities to contain any surface sheens and limit potential migration, if necessary.

As shown on Figures 3 and 4, within the area proposed for implementation of the pilot study, there are suspected areas of debris (i.e., tires, possible ropes, cables, and pipes). This debris is not currently anticipated to interfere with cap placement or other aspects of construction and monitoring. However, prior to initiation of placement activities, an inspection of those areas will be performed via probing or underwater cameras to positively identify the debris or obstructions. If, following inspection, it is determined that certain debris will interfere with the effective placement of the cap (i.e., objects such as pilings, logs or concrete debris that protrude more than a few inches from the sediment surface), it will be removed and transported to the proposed staging area for appropriate management (e.g., dewatering, cutting into smaller size, if necessary) and off-site disposal in a Toxic Substances Control Act (TSCA) permitted facility. It is anticipated that removed materials will be stockpiled at either the Lyman Street Parking Lot or the GE Facility. The materials will be placed on polyethylene sheeting and covered with polyethylene sheeting as well. The materials will be transported via Silver Lake Boulevard, East Street, and/or Lyman Street. Any collected water will be treated at GE's Building 64G Groundwater Treatment Facility.

3.3 Field-Scale Testing Areas and Cap Configurations

As set forth in the CD and as revised in subsequent discussions and in EPA's August 17, 2004 conditional approval letter for the Sediments PDI Report, the final cap placed over Silver Lake sediment is to consist of 12 inches of clean isolation layer material to mitigate the potential for bioturbation and address concerns related to bioturbation-driven mixing. Furthermore, these documents describe that if the cap placed over Silver Lake does not include a geotextile layer, sufficient additional isolation layer materials will be placed to provide a total cover thickness of 14 inches (12 inches plus an additional 2 inches to accommodate any potential mixing with underlying sediments).

Field-scale testing will involve placement of representative cap configurations over three sub-areas of the study area, as described below and shown in plan view on Figure 5. Cross sectional illustrations of each of the three cap configurations are displayed on Figure 6. The three test sub-areas allow for a comparative evaluation of placing isolation layer materials:

- Directly on existing sediments;
- On a non-woven geotextile placed over existing sediments; and
- On a composite geotextile placed over existing sediments.

Note that, although the SOW, as modified by GE's discussions with EPA and EPA's August 17, 2004 conditional approval letter, only requires the cap to include 12 inches of isolation layer material over geotextiles, for ease of construction, GE and EPA agreed that during the Pilot Study, a total of 14 inches of isolation layer material will be placed over the entire test area. (This is being done with the understanding that if geotextile is utilized during full-scale implementation, the isolation layer thickness will be 12 inches.) Each of the three test areas and cap configurations is further discussed below.

3.3.1 Direct Sediment Cap Test Area

The direct sediment cap test area is located in the middle of the three test areas (Figures 5 and 6). Extending from the shore, this test area will measure approximately 40 to 45 feet wide by 300 feet long. The cap design employed in this area will consist of 14 inches of isolation layer material placed directly over the top of existing Silver Lake sediments.

3.3.2 Non-Woven Geotextile Test Area

The non-woven geotextile area is located on the southern edge of the pilot test area (Figures 5 and 6). This test area will measure approximately 40 feet wide by 300 feet long. The cap design employed in the non-woven geotextile test area will consist of a single non-woven geotextile layer covered by 14 inches of isolation layer material. The non-woven geotextile to be used consists of needle-punched polypropylene fibers formed into a stable network such that the fibers retain their relative position when installed. At this stage, the use of the single layer of non-woven geotextile will be assessed for its relative ability to minimize mixing at the sediment/cap interface during cap material placement. Additionally, the benefit of including the non-woven geotextile layer will be assessed in its performance related to stabilization and distribution of the isolation layer material load.

Typically, non-woven geotextile products are available in 15-foot wide by 300-foot long rolls that weigh approximately 300 pounds. With respect to the size of this test area, it is anticipated that construction will be achieved by placement in a configuration approximately one roll long by three rolls wide. An approximate 2-foot material overlap will be used for adjacent pieces of the non-woven geotextile. Because of the relative buoyancy of the non-woven geotextile, constructability and placement of the non-woven geotextile will be assessed relative to the other test areas. Typical installation of geotextiles of this size and configuration includes placement via an on-shore crane used to load barge-mounted spindles. Once a spindle is loaded on a barge, a length of the geotextile is unrolled and anchored along the shoreline using temporary sandbags. The remaining rolled geotextile is placed in the lake as the barge advances away from the shoreline toward the center of the lake. If necessary, water-based support vessels may be used to aid in the placement of the geotextile. The support vessels and personnel may guide the placement of the geotextile to the sediment surface with poles and/or placement of sandbags on the geotextile for interim anchoring. A number of techniques, such as weighting with sandbags or the use of divers, may be evaluated in order to determine the most practical and effective means for submerging the geotextile and properly placing it and aligning it on the lake bottom.

3.3.3 Composite Geotextile Test Area

The composite geotextile area is located on the northern edge of the pilot test area and will measure approximately 40 feet wide by 300 feet long (Figures 5 And 6). The cap design employed in this area will consist of a composite geotextile layer covered by 14 inches of isolation layer material. The composite geotextile layer to be used in the composite cap will consist of two layers of a non-woven geotextile sewn together and, to facilitate cap placement, filled with a thin layer (i.e., less than 1 inch) of a sand material with TOC similar to the materials used in the isolation layer of the cap. This composite geotextile configuration will be specifically fabricated for this pilot study, and such products typically are available in rolls 15 feet wide by 75 feet long that weigh approximately 1,000 pounds per roll.

While the composite geotextile may provide additional sorptive capacity and aid in the chemical isolation of PCBs in the underlying sediments, it is being proposed at this stage primarily to assess the extent to which inclusion of geotextile minimizes mixing at the sediment/cap interface, and the extent to which it helps distribute the load of the cap to minimize the potential for differential settlement and localized bearing capacity failures of the sediment and underlying strata. Additionally, the added weight of the material between the geotextiles is expected to aid the submergence and placement of this geotextile layer as compared to the installation of the non-woven geotextile layer described above. In response to a request by EPA, GE will also perform a desktop evaluation of potential performance enhancements for the full-scale implementation that might be realized by including an activated carbon or similar activated substance in the geocomposite.

Installation methods for the composite geotextile will be similar to the methods used for the non-woven geotextile as discussed above. The composite geotextile is expected to sink under its own weight and, if necessary, divers, poles, and/or sandbags may be used to guide the placement of the geotextile to assure proper overlap and alignment.

3.4 Cap Material Composition and Placement

Following completion of geotextile placement as discussed above, isolation layer materials (i.e., sand and topsoil mixture) will be placed over the three test areas utilizing low-impact methods that broadcast cap material to the water surface. The isolation layer material will consist of a mixture of sand and topsoil, with a minimum TOC of 0.5%. During performance of the bench-scale study, an approximate 4:1 ratio of sand to topsoil was used to create isolation materials which met the minimum 0.5% TOC standard. Final Pilot Study isolation material composition (i.e. sand/soil ratios) will be determined once material suppliers have been identified.

Isolation layer materials will be mixed onsite in the construction staging area (Figure 4). Following installation of the two geotextiles, isolation layer material will be discharged to the water surface through one of the techniques specified below and allowed to settle through the water column to the sediment or geotextile surface in successive thin lifts until a minimum of 14 inches of cap material has been placed over each test area. As discussed, construction materials specifications, including type and frequency of testing, are included in Appendix A.

Potential broadcast methods of cap placement may include:

- Spray or spreader-box application of a slurry of isolation layer material and lake water;
- Jetting or washing of isolation layer materials off of barges/scows as they are slowly towed across the study area;
- Conveyor belt discharge which involves the use of one or a series of telescopic conveyor belts to discharge isolation layer materials directly to the water surface; and
- Mechanical clam-shell placement which involves repeated direct placement of isolation layer materials to the water surface via a crane-mounted clam-shell bucket.

At this time, the application of a slurry of isolation layer materials and lake water via a barge-mounted spreader box is anticipated to be the selected cap application method, allowing for the greatest control of lift thickness and distribution across the entire study area. However, final cap material placement methods will be selected in consultation with the selected contractor, drawing on their experience and expertise.

Based on soft sediment capping projects performed at other sites, placement of cap materials in thin lifts (approximately 1- to 2-inches thick) has been found beneficial in minimizing the potential for bottom disturbance. Additionally, during performance of the bench-scale study, some separation of the fine- and coarser-grained materials comprising the isolation layer material was observed. To minimize the potential for disturbance and separation during placement, the isolation layer materials will be placed in thin lifts by broadcasting materials to the water surface at a preliminary rate of 2- to 3-lifts per week. As further detailed below, sediment consolidation will be assessed in response to the placement of each successive lift, and, in addition to field observations, the consolidation data will be used to determine the schedule for placement of successive lifts.

At this time, it is anticipated that placement of each lift will begin at the deepest portion of the study area (i.e., near the mid-lake area). The barge mounted box-spreader would then be repeatedly towed across the test area in the north-south direction (i.e., perpendicular to the three test areas) placing uniform lifts of isolation materials over all three test areas with each pass. Each pass of the box-spreader would be made progressively closer to the shore such that materials placed in the up-slope region of the three test areas will be supported by those materials already placed at the toe of the slope. Should proximity to the shore line prevent the use of the barge mounted box-spreader, it is anticipated that remaining near-shore application could be performed by spraying the slurry and broadcasting the isolation materials to the water surface in the near shore area.

3.5 Shoreline Erosion Protection

As in any water body, to maintain the integrity of the cap, measures must be incorporated to protect the cap from naturally occurring erosive forces. As such, and as set forth in the CD, the cap design includes shoreline erosion protection measures. As part of the pilot study, slope protection has been designed using the United States Army Corps of Engineers (USACE) Shore Protection Manual (SPM; USACE, 1984) As described in the Sediments PDI Report, the predominant cause of erosion in Silver Lake is wind-driven wave action. Therefore, the armor system will be placed to protect the pilot study cap, above and below the mean water surface elevation, from potential erosion caused by wind driven waves (see Figure 5). The pilot study will evaluate the constructability aspects of the armor layer and its overall response to wind driven waves and also ice formation in the winter months), as well as the bearing capacity of the sediments underneath the layer. Complete material specifications for anticipated components of the armor system are included in Appendix A.

In preparation for the implementation of the pilot study, an armor system has been conservatively designed to protect the east shore adjacent to the test area from wind-driven waves associated with a 100-year wind event. A complete description of the armor system design process and related calculations is included in Appendix B. As can be seen in Appendix B, given the calculated design wave height of 1.1 feet, use of the SPM methodology indicates that armor stone with an estimated median weight (W_{50}) of 8.2 pounds and a resultant D_{50} of 5.5 inches would be sufficient. In order to be conservative, graded rip rap with a D_{50} of 6 inches will be selected for use on the east shore for protection of the pilot study cap.

The SPM provides two means of estimating armor layer thicknesses. The first method selects the maximum of two functions based on W_{50}, and W_{100} (the maximum stone weight in the graded riprap), respectively, or defaults to a conservative thickness of 1 foot if both functions result in thicknesses less than one foot. For the pilot study area, both of the stone-weight dependent functions resulted in presumed thicknesses of less than one foot, and thus, an armor layer thickness of one foot was selected. The second method, which applies strictly to graded rip rap, indicates an armor layer thickness of two times the selected D_{50}. As discussed above, the calculated D_{50} for the pilot study area is 5.5 inches, but a more conservative D_{50} of 6 inches was selected for implementation. As such, and similar to the first method, the resultant armor layer thickness is 1 foot.

Note that final design rip rap dimensions for the remainder of the lake may be different on a location-specific basis.

The main components of the armor system are as follows:

- A woven geotextile layer installed on top of the cap materials underneath the armor stone layer; and
- Graded rip rap armor layer (D_{15}: 4-inches, D_{50}: 6-inches, D_{100}: 8-inches) with a total thickness of approximately 12 inches.

The average water surface elevation (wsel) at Silver Lake is 975.93 feet. The armor layer will be constructed to extend from an elevation of 973.1 feet (2.8 feet below wsel) upward to an elevation of 978.1 feet (2.2 feet above wsel) along the shoreline of the test area. A cross-section of the proposed armoring configuration is illustrated on Figure 5.

In addition, a 3-inch thick layer of gravel and sand will be placed over the underwater extent of the armor stone to provide additional aquatic habitat in the littoral zone.

Construction of the shoreline protection will begin with preparation of the shoreline (e.g., clearing, grubbing) to accept construction of the armor system. A woven geotextile will be installed on top of the cap materials along the bank to provide added stability to the underlying shoreline materials and to act as a filter material between the armor layer and the cap materials. The armor stone and gravel layers will then be placed over the woven geotextile with placement of the armor system completed before gravel placement is initiated. At this time, it is anticipated that armor stone layer implementation will be achieved using conventional equipment (e.g., front-end loader, long-stick excavator) from a barge located within the lake. Stone placement is anticipated to proceed from the interior of the lake (i.e., in the deeper water portion of the armored area) toward the above water portion with each subsequent armor stone placed at higher elevation supported by those placed below.

Note that there are potential remedial activities required to meet the appropriate bank soil Performance Standards along the shoreline of Silver Lake. To the extent that these activities overlap with the installation of the shoreline armoring system, it is anticipated that a separate submittal will be made to EPA proposing appropriate bank soil remediation in this area. To the extent practicable, any necessary remedial activities for bank soils in this area will be completed in conjunction with implementation of this study.

4. Monitoring Program

4.1 General

The bench-scale study, with support from previous investigations, indicated that a sand cap with armor stone (with or without geotextile) could be successfully installed over Silver Lake sediments and would provide an effective isolation of the underlying sediments. The pilot study monitoring program has been designed to aid in the selection of the optimal cap configuration and placement method(s). The monitoring data will be used to assess the success of the pilot study program, confirm cap design assumptions, assess constructability issues, and assist in the development of cap installation and monitoring program for use during full-scale construction.

The overall monitoring program will involve geotechnical monitoring, sediment and isolation layer material sampling, and water column sampling before, during, and/or after construction. A schedule for the performance and duration of the various components of the monitoring program is included in Table 1. Geotechnical monitoring will be performed to assess the effects of cap placement on sediment stability and consolidation, as well as to assess the general ability to install the cap to design thicknesses. Sediment and isolation layer material sampling will be performed to assess the extent of mixing of native sediments and isolation layer materials, as well as the cap's ability to mitigate the potential advective movement of PCBs. Water column monitoring will be performed to evaluate any potential impacts to water quality as a result of construction activities. All sample collection, processing, and analyses described herein will be performed in a manner consistent with the requirements of the *Field Sampling Plan/Quality Assurance Project Plan* (FSP/QAPP; BBL, 2004b).

Note that there is some redundancy built into the proposed monitoring program to address the uncertainties in some of the advanced measurement systems being proposed (e.g., geophysical and geotechnical in-situ instrumentation), and to contribute to a weight-of-evidence approach to confirming that pilot study objectives have been met. These systems could yield valuable information in assessing the constructability questions related to cap placement over Silver Lake sediments and understanding the performance of the cap system, which will aid in further refinement of the final cap design. Based on pilot study monitoring activities and results, a focused monitoring program will be designed and implemented for full-scale construction. Although the full-scale monitoring program may include techniques used during the pilot study, alternative methods and sampling designs will also be considered, as appropriate.

As noted above, the area proposed for implementation of the Pilot Study has been selected to include an area of the lake that encompasses various conditions related to water depth and side slope conditions. It should be further noted, that to the extent practicable, monitoring device locations have, been selected to provide broad representation of the entire study area while providing data related to the sediment response to cap placement on a location specific basis. As such, monitoring programs installed within the test areas have been designed to provide information related to sediment response to cap placement in the deep-, mid-, and shallow-water depth areas, as well as from relatively steeper-, moderately-, and flatter-sloped areas.

4.2 Pre-Construction Monitoring and Site Assessment

To monitor and understand the extent to which conditions change during and after placement of the cap, existing or baseline conditions must first be established via site assessment and monitoring activities. Although extensive site characterization work has already been conducted on Silver Lake sediments, additional baseline data are needed specific to the pilot study location and objectives. Once established, baseline information will then be used for comparative purposes to track and quantify changes in the sediment or water environment. The remainder of this section presents site assessment or monitoring activities to be completed prior to the initiation of pilot study construction.

4.2.1 Sediment Surface Assessment

Bathymetric Surveys

To establish the existing general disposition and topography of the sediment surface, bathymetric surveys utilizing multi-beam sonar combined with global positioning will be completed prior to initiation of construction activities. The multi-beam bathymetric surveys will provide high-resolution images of the existing sediment surface, exploiting the differences in acoustical impedance between the water and underlying sediments to map the elevation of the sediment surface. The finished bathymetric mapping will be available for comparison to similar post-construction imagery to help confirm cap thickness and configuration, and provide insights as to post-construction stability of sediment slopes and capping components.

A typical bathymetric mapping scheme, as applied to the proposed study area is shown on Figure 7. The bathymetric survey will be referenced to a fixed onshore survey marker. In addition, one or more fixed targets will be installed in approximately 10 feet of water, in an undisturbed section of the lake near the pilot testing area. The elevation of these targets will be manually surveyed (relative to the onshore marker) prior to completion of the bathymetric surveys. At the beginning and end of the bathymetric survey, the instrument will be calibrated by imaging the surveyed target(s).

The proposed bathymetric survey will consist of a minimum of 11 transects. The primary set of transects (1 through 8) are aligned perpendicular to the bank, a configuration that provides for relatively uniform swath widths along each line. Line spacing has been chosen to achieve approximately 200% coverage for the 120-degree multi-beam swaths, and includes two transects aligned outside the edges of the study area. Three additional transects (9, 10, and 11) will be parallel to the bank in the near shore area to provide appropriate coverage in the shallow areas. These transects may be arranged as close as 10- to 15-ft apart, and would extend 10- to 15-feet beyond the edge of the study area. As necessary, conventional topographic survey methods will be used to supplement the multi-beam survey in shallow water areas.

In addition to the multi-beam bathymetric mapping, an acoustic profiler (e.g., Chirp™) will be employed using similar equipment set-ups and procedures as discussed above. The pre-construction acoustic profile survey will be utilized in association with the bathymetric survey to evaluate the pre-construction physical conditions of the sediment surface to provide baseline information for later comparison with similar surveys performed following completion of cap construction.

Information related to typical multi-beam bathymetric and acoustic profile imagery equipment and application is available in Appendix C. Note that final details of the performance of these surveys, including transect configuration, will be made in consultation with the selected contractor.

Sediment Profile Imagery

One of the means of providing an assessment of the constructability of the cap in relatively thin and uniform, homogenous lifts, will be the use of Sediment Profile Imaging (SPI) technologies, which provides the ability to capture images below the surface of sediment and/or cap. The SPI device consists of a submersible still-frame and video camera enclosed within an aluminum frame suspended from a boat. Within the aluminum frame, a window and mirror are arranged in a wedge-shape camera housing which can penetrate sediment or cap surfaces, provide an in-situ subsurface cross-sectional image of the sediment/cap materials, and be used to measure apparent lift and interim cap thicknesses.

Prior to initiating placement of isolation layer materials, SPI will be employed to capture images of subsurface sediment conditions throughout the non-geotextile study area for later comparison to similar during-construction SPI images. Subsurface images will be captured at eight locations within the non-geotextile test area as shown on Figure 7.

Information related to typical equipment and application of the SPI technology is available in Appendix C. Note that final details of the implementation of SPI technology will be made in consultation with the selected contractor.

4.2.2 Water Quality Monitoring

Beginning two weeks prior to initiation of capping activities (and continuing throughout as further discussed below), weekly water samples will be collected from three locations within the lake for analysis of PCBs and total suspended solids (TSS). As shown on Figure 8, the three collection locations are at the outfall to the river, and two locations spaced between the outfall and the proposed pilot test area. At the outfall to the river, a grab sample will be collected directly from the discharge stream passing over the outfall weir. In accordance with the FSP/QAPP, at the two locations between the outfall and the study area, water samples of equal volume will be collected from depths approximately equal to 0.2-, 0.5-, and 0.8-times the total water depth at each such location and all three depth samples will be combined into one composite sample for the given location. Analysis of these samples will provide baseline information for comparison to similar samples collected during construction and insight into any gradual changes that may be occurring in the lake water as a result of cap placement.

Additionally, beginning in June 2006, monthly water quality samples are being collected at the outfall monitoring location and analyzed for PCBs and TSS as part of GE's Housatonic River monthly water column monitoring program.

4.3 During-Construction Monitoring

Monitoring performed during construction activities will allow for the real-time assessment of changes in sediment conditions (e.g., stability, consolidation) in response to cap placement, as well as monitoring any construction related impacts to water column conditions within the lake water. Additionally, monitoring during construction will permit an ongoing evaluation of the overall interim cap thickness, and the ability of the selected placement method to meet design requirements. As further described in this section, construction monitoring will measure the following:

- Real-time consolidation of the sediment with respect to each lift;
- Ability to consistently place isolation layers in thin lifts, and reach overall isolation layer thickness standards; and
- Real-time changes in water column conditions in response to placement activities.

4.3.1 Sediment Consolidation Monitoring

Real-time sediment consolidation monitoring will provide daily measurements of the degree of sediment consolidation in response to the increasing load of cap materials as they are placed. Such information will be used to assist in the evaluation of:

- The potential for differential settling that may create an uneven sediment surface and thereby potentially affect subsequent placement of cap materials;
- Rotational or sheer failure that may threaten the integrity of the cap; and
- The appropriate timing for placement of successive lifts of isolation layer materials.

Vibrating Wire Settlement Cells
Prior to the placement of isolation layer materials, continuous sediment consolidation monitoring will be implemented utilizing vibrating wire settlement cells (VW settlement cells) attached to bearing plates placed on top of the sediment or geotextile surface. A VW transducer installed on each plate is connected to a liquid-filled tube that runs to an on-shore ventilated reservoir and data logger. As the bearing plate and transducer settle with the sediment (due to cap loads), the transducer experiences a change in hydraulic head. This change in head is relayed to an onshore data logger and converted to a vertical distance representing the total consolidation in sediments at each VW transducer location.

Settlement cells will be placed in representative near-shore, side slope, and bottom areas of the lake, including within and on the edge of geotextile areas, and on non-geotextile cap areas of the pilot study test area. Settlement cells will be placed on the edge of geotextiles to monitor possible localized bearing capacity failures due to edge effect of the geotextiles. Approximately 28 settlement cells, arranged in a grid format (see Figure 9) are proposed to monitor consolidation. The settlement cells will be connected to one of two vented reservoir/data logger utility lockers located onshore near the test area. The utility lockers will be protected from the elements, secured, and easily accessible. An additional data logger will be installed just outside the test area to provide continuous recordings of surface water elevation to augment subsurface hydraulic head data readings (see Figure 9).

During cap placement activities, VW settlement cell data will be frequently reviewed to evaluate immediate sediment behavior in response to cap placement. Time-related consolidation data will be correlated with other pertinent data such as barometric pressure and lake water levels, and used to assess stability and percent consolidation of the sediment with respect to cap loads in real-time. Additionally, anomalous VW settlement cell data can potentially be used to aid in identifying whether there are any areas of sediment instability (e.g., side-slope creep, rotational failure) that occur during cap placement activities. This information will be used to refine installation and placement methods and rates, if necessary, during full-scale implementation. Based on the results of the Bench-Scale Study, in which the maximum daily consolidation experienced in any of the cores was 1.25 inches, consolidation measurements of less than 1 inch/day will be considered sufficiently small to permit placement of the next cap lift. If consolidation measurements greater than 1 inch/day are observed, then the placement of the next lift will be delayed until the consolidation rate drops to less than 1 inch/day.

It should be noted that at present, the VW settlement cells are anticipated to be constructed of thin aluminum sheets approximately 2 x 2 feet in size that are placed on either the sediment surface, or the top of the geotextile surface. Aluminum has been specified because its light weight should minimize the potential impact of the settlement plate directly on consolidation. To the extent practicable, consolidation due to the weight of the settlement plates will be recorded during installation, either electronically (the vibrating wire settlement cells) or with conventional survey techniques (physical settlement plates).

Information related to typical VW settlement cell equipment and application is available in Appendix C. Note that final details of the implementation of VW settlement cells will be made in consultation with the selected contractor.

Physical Settlement Plates

In addition to the VW settlement cells described above, settlement will be monitored using physical settlement plates placed on top of the sediment or geotextile surface prior to isolation layer placement. Aluminum plates, approximately 2 x 2 feet in size, will be installed before the first lift of isolation layer materials in a grid-based fashion as shown on Figure 9. Following placement, the location and elevation of these plates will be surveyed and recorded to provide baseline information for comparative purposes. Similarly, at the approximate halfway point of isolation layer placement, the physical settlement plates (and the surface of the isolation layer immediately above each plate) will be surveyed again; providing interim information on sediment settlement as well as isolation layer thickness. These data will be correlated with similar information collected from other monitoring programs conducted during construction to provide a weight-of-evidence approach to consolidation monitoring.

As with the VW settlement cells, aluminum has been specified for the physical settlement plates because the light weight of the aluminum should minimize the potential impact of the plate directly on consolidation. To the extent practicable, consolidation due to the weight of the settlement plates will be recorded during installation.

4.3.2 Cap Uniformity and Thickness Monitoring

During cap placement activities, several interim assessments of the characteristics and composition of the isolation layer will be made to evaluate:

- The extent of mixing, if any, of sediment and isolation layer materials;
- The ability to place isolation layers in thin, uniformly distributed lifts; and
- Interim overall isolation layer thicknesses.

Sediment Profile Imagery

The primary means of providing an interim (during-construction) assessment of the constructability of the cap in relatively thin and uniform, homogenous lifts, will be the use of SPI technologies, which will provide the ability to capture images below the surface of cap, and images of the sediment/cap interface in the non-geotextile test area.

At the approximate half-way point of isolation layer placement activities, SPI will be employed to capture images of subsurface sediment and isolation layer conditions at 20 locations throughout the study area. Proposed locations for the SPI program are shown on Figure 7. The during-construction SPI program will be implemented once after the first four to six lifts of the isolation layer materials have been placed to assess lift thicknesses and cap placement techniques, as well as identifying any potential mixing.

Information related to typical equipment and application of the SPI technology is available in Appendix C. Note that final details of the implementation of SPI technology will be made in consultation with the selected contractor.

4.3.3 Surface Water Monitoring

As discussed above, weekly water samples will be collected from three locations within the lake for analysis of PCBs and TSS prior to placement activities (Figure 8). Such samples will continue to be collected on a weekly basis throughout the duration of cap placement activities. Analytical results from these during-construction samples will be compared to results from pre-construction samples (collected from similar locations) to provide information on changes that may be occurring in the lake water as a result of cap placement.

In addition to the weekly water quality sample monitoring described above, during capping activities, real-time measurements of lake water turbidity will be evaluated to assess immediate changes in lake conditions in response to cap placement. As part of this monitoring program, continuous turbidity measurements will be recorded at the same three locations used for the weekly water monitoring locations in the lake, as described above and shown on Figure 8.

Continuous turbidity measurements will be made and recorded using a turbidity probe and submersible battery powered data logger suspended at the approximate mid-depth elevation at each of the three locations. During cap placement activities, turbidity readings will be evaluated at least twice per day. On a daily basis, if any one turbidity reading (averaged over 15-minute intervals) exceeds 50 nephelometric turbidity units (NTU) at one of the two locations nearest the outfall (see Figure 8), water quality samples will be taken from all three locations using the same sample collection protocol as the weekly water sample collection program discussed above, for analysis of PCBs and TSS. Turbidity readings could potentially trigger the collection of one round of water quality samples per day. In addition, without respect to turbidity measurements, if in any portion of the lake significant sediment plumes or sheens are noted emanating from the pilot study area or from activities related to the pilot study (e.g., barge movement), water quality samples will be collected from the plume area and the two locations nearest the outfall, and sent for analysis of PCBs and TSS.

4.4 Post-Construction Monitoring

Following the completion of cap placement activities, the monitoring program will include the collection of field data to confirm the post-construction success of the completed pilot study construction. Specific goals of the post-construction monitoring program include collection of data representing longer-term sediment responses to the placement of the cap, confirming cap constructability and, over the longer term, evaluating:

- The ability of Silver Lake sediments to support cap placement;
- The constructability of an evenly distributed cap in relatively thin lifts while achieving stated requirements for cap thickness and TOC content; and
- The effectiveness of the cap design and placement in preventing or minimizing construction related migration of PCBs from the sediment via mixing, pore water expulsion, groundwater flux or, gas movement.

4.4.1 Sediment Consolidation and Cap Uniformity Monitoring

The objectives of the post-construction sediment stability and cap uniformity monitoring program are as follows:

- Measure and document the thickness and homogeneity with which the cap is placed over the pilot study area; and

- Evaluate the pilot test and surrounding area for indications of differential settlement, and gross rotational or sheer failure.

Bathymetric Surveys
As discussed, a primary goal of the pilot study is the comparison of pre- and post-construction sediment conditions. Bathymetric and acoustic subsurface profile surveys will be performed (similar to the methods described for the pre-construction survey) immediately and six months following completion of cap placement activities, providing information on the disposition and topography of the surface of the cap and the surrounding sediment areas.

The acoustic profiler (e.g., Chirp™) will be utilized to evaluate the topographic features of the sediment/cap interface, and provide confirmation of location specific cap thicknesses. Horizontal sediment or cap material slippage, areas of sediment upwelling or depression, or sharp differential sediment elevations (e.g., ledges) if any, could create deformations in the sediment/cap interface and/or the cap surface that could be detected and mapped by the acoustic profiler.

Together, the multi-beam bathymetric and acoustic profile surveys will also document any changes in the cap surface with respect to time and cap placement and will provide an indication of the endurance of the cap and armor layers in actual field conditions. Additionally, these post-construction surveys will be compared with the pre-construction bathymetric survey data to evaluate and create a map of the overall cap thicknesses, assess geotextile and cap material movement (if any), and assess cap stability in side-slope and flat bottom environments. Finally, post-construction bathymetric surveys will be combined with other monitoring data (e.g., sediment consolidation, physical settling) to assess cap performance and confirm the selection of a capping method and monitoring program for full-scale implementation.

Sediment Consolidation Monitoring
The VW settlement cell monitoring system, installed prior to cap construction will continue to monitor changes in sediment consolidation after the cap is installed. Immediately following construction, regular, frequent evaluations of the continuous consolidation data will be made to monitor sediment consolidation with respect to time. When it is appears that the rate of sediment consolidation has diminished, and sediment conditions have reached equilibrium, less frequent (e.g., weekly) data evaluations will be made until consolidation is considered complete.

This longer-term consolidation monitoring will help track the ability of the sediment to physically support the load of the cap. Additionally, the longer-term consolidation data will augment the post-construction bathymetric surveys in creating a record of the sediment/cap interface documented against the initial-condition geophysical survey.

Physical Settlement Plates
As in the monitoring program conducted during construction, aluminum physical settlement plates, installed prior to the placement of isolation layer materials, will be surveyed. The post-construction elevation of each of

the settlement plates, as well as the finished elevation of the cap immediately above, will be compared to similar measurements made just prior to and during construction providing an additional means of tracking sediment consolidation and confirming finished cap thicknesses. The post-construction survey of the physical settlement plates will be made immediately and six-months after placement activities have been completed to monitor short- and longer-term sediment responses to cap placement.

4.4.2 Sediment and Cap Material Coring and Chemical Analysis

To provide insight into the longer-term changes in the physical and chemical characteristics of the sediment and isolation layer materials, as well as the assessment of any short-term changes in sediment chemical characteristics in response to cap placement, the post-construction cap coring program will be performed immediately, and six months following construction completion.

Within the two study areas that include geotextile placement, cap coring will be conducted by physically pushing 4-inch Lexan tubes to the bottom of the cap strata (i.e., to the geotextile layer), and recovering isolation layer materials. Similarly, cores collected in the direct sediment test area will be pushed to the apparent bottom of the cap and just into the native sediment such that sediment and cap materials are recovered at the same time.

Care must be taken to minimize material disturbance and/or loss during sediment and cap material collection activities. Although GE has collected well over 100 sediment cores from within Silver Lake, and will continue to employ the collection methods and practices as fully described in the *Field Sampling Plan/Quality Assurance Project Plan* (BBL, revised 2002), GE recognizes that the granular, less-cohesive nature of the saturated cap materials may possibly cause difficulties with standard sediment core collection techniques. Alternative methods of core collection (e.g., core catchers, Russian peat samplers, K-B corers) that provide physical means of retaining and/or supporting materials in the bottom of the core will be made available if standard collection techniques do not provide sufficient material recovery. Should the need arise to use any of these modified collection procedures GE will discuss these modifications with EPA prior to implementation.

Sediment and isolation layer materials will be collected immediately and six-months after construction at 13 locations; four each in the three pilot-study test areas such that near-shore, side-slope, and bottom regions in each of the test areas are monitored (Figure 10), plus an additional location in the mid-slope area of the geocomposite test area. To avoid locations that may have been previously sampled, cap cores collected six months after construction will be located approximately 5-feet to the south of those collected immediately after construction. Note that all sample collection locations may be adjusted based on field conditions. In the event that significant departure from the proposed locations is necessary, GE will discuss such modifications with EPA.

Isolation layer materials within the collected cores will first be measured to document approximate cap thicknesses at each respective location. The cap thickness measurements will be used to augment bathymetric mapping and consolidation and physical settling data in preparation of a map representing overall cap thickness across the entire study area.

In each core, the sediment cap interface or the bottom of the cap material will be visually assessed for indications of mixing of sediment and cap materials. Observations of mixing, if any, will be recorded and used later in discussions related to cap material PCB analysis.

Similar to the procedures used in the bench-scale study, isolation layer material cores collected during both post-construction collection events (i.e., immediately- and six-months after construction) will be processed for analysis in the 0- to 2-inch, 2- to 4-inch, 4- to 6-inch layers (measurements relative to the sediment/cap interface, or geotextile layer), and shipped to North East Analytical Laboratories, in Schenectady, New York for analysis of PCBs, TOC and grain size using the methods described in previous sections. The remaining materials will be divided into two samples: the top two inches [nominally the 12- to 14-inch increment (measured from the cap surface)], and the remaining materials (nominally 6- to 12-inch increment) both of which will be analyzed for PCBs, TOC and grain size, as above. For those cores collected from within the direct sediment test area, a sediment sample will be collected from within the first six inches below the sediment/cap interface and analyzed for PCBs.

5. Proposed Schedule

Based on the scope and anticipated duration of the pilot study activities described in this PS Work Plan, GE proposes the following schedule:

August 2006	Bid Documents Released
September 2006	Award Contract
September 2006	Initiate Pilot Study
November 2006	Perform 1st Round of Monitoring at Conclusion of Cap Construction
May 2007	Perform 2nd Round of Monitoring 6 Months After Cap Construction
September 2007	Submit Report on Results of Pilot Scale Study

This schedule is subject to change based on the receipt of final EPA approval of this document. The pilot study construction schedule is also subject to change based on field conditions, contractor and material availability, and unanticipated seasonal variations. In the event that a change in schedule is necessary, GE will discuss such potential changes with EPA.

6. References

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BBL. 2002. *Field Sampling Plan/Quality Assurance Plan.*

BBL. 2004. *Pre-Design Investigation for Silver Lake Sediments.*

BBL. 2005. *Supplemental Pre-Design Investigation for Silver Lake Sediments.*

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U.S. Army Corps of Engineers, 1984. *Shore Protection Manual.* Washington, DC.

Tables

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TABLE 1
PROPOSED MONITORING PROGRAM SCHEDULE

PILOT STUDY WORK PLAN FOR SILVER LAKE SEDIMENTS
GENERAL ELECTRIC CORPORATION - PITTSFIELD, MASSACHUSETTS

Monitoring Event	Description	Time Relative to Pilot Study Construction			
		Before	During	Immediately After	6-Months After
Lake Bottom Imagery					
Bathymetric Survey	Pre- and Post-Construction multi-beam bathymetric survey of pilot study test area	X	--	X	X
Sub-Bottom Profiling	Pre- and Post-construction acoustic profile survey of sediment/cap interface	X	--	X	X
Sediment Profile Imaging	Pre-construction imaging of surface sediments, and during construction imaging of cross-section of first 4- to 5-lifts of isolation layer material for cap thickness and observation of physical mixing.	X	X	--	--
Geophysical/Consolidation Monitoring					
Vibrating Wire Settlement Cells	During- and post-construction continuous recording of sediment consolidation	--	X	X	X
Physical Settling Plates	During- and post-construction conventional survey of sediment elevation and cap thickness	--	X	X	X
Surface Water Quality Monitoring					
Weekly Water Sampling	Weekly sample collection from three locations with analysis for PCB and TSS	X	X	X	X
Continuous Turbidity	Continuous turbidity monitoring at three locations; readings greater than 50 NTU at either of the two locations nearest outfall triggers surface water sample collection and analysis for PCB and TSS	--	X	--	--
Sediment/Cap Material Collection					
Chemical/Physical Coring	Post-construction collection of sediment/cap material samples for assessment of total cap thickness, observations of physical mixing, and analysis for PCB and TOC	--	--	X	X

Figures

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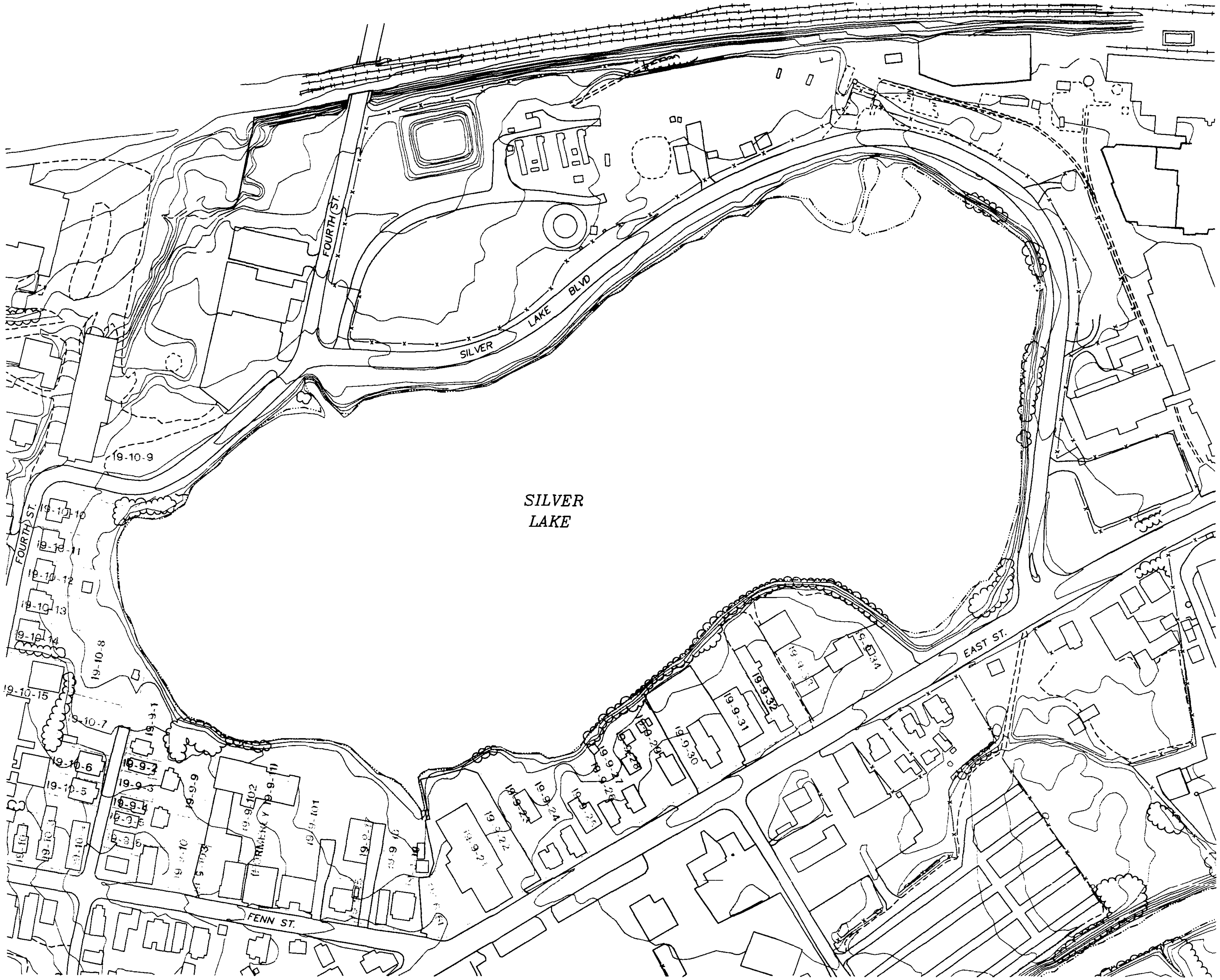

LEGEND:

EDGE OF WATER
RAILROAD
VEGETATION
PAVED ROADWAY
FENCELINE
ELEVATION CONTOUR
19-9-34 PROPERTY ID
PROPERTY BOUNDARY

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. – FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY, AND BLASLAND AND BOUCK ENGINEERS, P.C. CONSTRUCTION PLANS.
2. NOT ALL PHYSICAL FEATURES SHOWN.
3. ALL LOCATIONS ARE APPROXIMATE.

0 100' 200'
GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN – SILVER LAKE SEDIMENTS

SILVER LAKE SITE PLAN

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FIGURE
1

LEGEND:

- EDGE OF WATER
- RAILROAD
- VEGETATION
- PAVED ROADWAY
- FENCELINE
- ELEVATION CONTOUR
- SILVER LAKE ELEVATION CONTOUR
- △ A — BENCH-SCALE SEDIMENT CORE LOCATION
- 19-9-34 — PROPERTY ID
- PROPERTY BOUNDARY

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. – FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY, AND BLASLAND AND BOUCK ENGINEERS, P.C. CONSTRUCTION PLANS.
2. NOT ALL PHYSICAL FEATURES SHOWN.
3. SITE BOUNDARY IS APPROXIMATE.
4. ALL LOCATIONS ARE APPROXIMATE.
5. THE SILVER LAKE CONTOUR INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 10–13 JUNE 2003 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

0 100' 200'
GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN –
SILVER LAKE SEDIMENTS

PREVIOUS INVESTIGATION SEDIMENT CORE LOCATIONS

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FIGURE
2

SIDE SCAN SONAR TARGETS						
TARGET	EASTING (FEET)	NORTHING (FEET)	APPROXIMATE DIMENSIONS IN FEET LENGTH	WIDTH	HIEGHT	DESCRIPTION
1	187,310	2,994,599	16	13	7	SQUARE STRUCTURE WITH SUBMERGED PILINGS
2	187,280	2,994,624	3	3	1	TIRE
3	186,945	2,994,653	4	5	<1	AREA OF 3 SMALL OBJECTS
4	186,913	2,994,556	2	2	1	ROUND OBJECT
5	186,881	2,994,632	22	1	<1	LINEAR OBJECT
6	186,514	2,994,489	3	3	1	TIRE
7	186,435	2,994,408	3	3	1	TIRE
8	186,394	2,994,385	3	3	1	TIRE
9	186,337	2,994,375	3	3	1	TIRE
10	186,304	2,994,361	3	3	1	TIRE
11	186,292	2,994,359	3	3	1	TIRE
12	186,281	2,994,352	13	1	<1	PIPE OR LINEAR OBJECT
13	186,180	2,994,356	3	3	1	TIRE
14	186,304	2,994,298	16	6	5	AUTOMOBILE
15	186,435	2,994,227	6	2	1	UNKNOWN OBJECT
16	186,301	2,994,229	3	3	<1	TIRE
17	186,137	2,994,183	10	4	<1	UNKNOWN OBJECT
18	186,386	2,994,085	8	4	1	AREA OF DEBRIS
19	185,848	2,994,251	40	25	3	AREA OF PILINGS & DEBRIS
20	186,795	2,994,194	1	1	3	PILINGS
21	185,787	2,994,186	1	1	3	PILING
22	185,869	2,994,027	7	5	3	AREA OF DEBRIS
23	185,668	2,994,000	9	3	<1	RECTANGULAR OBJECT
24	185,695	2,993,940	25	8	3	PILINGS

SIDE SCAN SONAR TARGETS						
TARGET	EASTING (FEET)	NORTHING (FEET)	APPROXIMATE DIMENSIONS IN FEET LENGTH	WIDTH	HIEGHT	DESCRIPTION
25	185,705	2,993,959	1	1	3	PILING
26	185,710	2,993,926	1	1	2	PILING
27	186,050	2,993,940	2	2	1	UNKNOWN OBJECT
28	186,045	2,993,703	30	10	1	AREA OF DEBRIS
29	186,083	2,993,698	1	1	3	PILING
30	186,112	2,993,685	1	1	1	UNKNOWN OBJECT
31	186,134	2,993,641	24	12	1	AREA OF DEBRIS
32	186,243	2,993,665	63	15	1-3	AREA OF DEBRIS
33	186,249	2,993,687	15	6	5	POSSIBLE AUTOMOBILE
34	186,525	2,993,748	17	9	1	AREA OF DEBRIS - PIPES
35	186,558	2,993,773	12	8	1	AREA OF DEBRIS - 1-4' BLOCKS
36	186,607	2,993,824	13	10	1	AREA OF DEBRIS - 1-4' BLOCKS
37	186,614	2,993,989	30	10	<1	UNKNOWN OBJECT
38	186,906	2,994,049	38	22	1	2 LINEAR OBJECTS IN A 'T' FORMATION
39	186,976	2,994,027	19	9	1	LINEAR OBJECTS - POSSIBLE PIPES
40	187,303	2,994,144	50	20	1-3	AREA OF DEBRIS - TIRES, PIPES, UNKNOWNS
41	187,311	2,994,194	16	6	4	AUTOMOBILE
42	187,316	2,994,218	10	6	<1	AREA OF DEBRIS - TIRES, UNKNOWNS
43	187,318	2,994,332	15	14	1	AREA OF DEBRIS - TIRES, UNKNOWNS
44	187,296	2,994,456	2	2	2	UNKNOWN OBJECT
45	187,314	2,994,476	2	2	<1	UNKNOWN OBJECT
46	187,341	2,994,475	2	2	1	UNKNOWN OBJECT
47	187,252	2,994,465	50	25	1-3	AREA OF SUBMERGED PILINGS
48	186,665	2,994,083	1175	75	<1	AREA OF POSSIBLE ROPES OR CABLES

LEGEND:

SL-01 CONTROL POINT

FEATURES OBSERVED DURING SURVEY OPERATIONS

SUBMERGED PILING OBSERVED DURING SURVEY OPERATION

(1) SIDE SCAN SONAR TARGET

PROJECT CONTROL INFORMATION (COORDINATES & ELEVATIONS PROVIDED BY BLASLAND, BOUCK, AND LEE, INC.)			
POINT	EASTING (NAD83)	NORTHING (NAD83)	ELEVATION (NGVD 29)
SL-03	186,184.147	2,993,600.100	978.81
ES-15	187,102.536	2,993,099.601	983.98
SL-01	187,208.402	2,993,892.249	984.58

NOTES:

1. GRID SYSTEM IS IN FEET AND IS THE MASSACHUSETTS MAINLAND STATE PLANE COORDINATE SYSTEM (NAD83).
2. SHORELINE AND FEATURES ARE APPROXIMATE AND WERE TAKEN FROM DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE MASSACHUSETTS GEOGRAPHIC INFORMATION SYSTEM (MASSGIS) AND OBSERVATIONS MADE IN THE FIELD.
3. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 10-13 JUNE 2003 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

80' 0 80' 160'
SCALE: 1"=80'

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN – SILVER LAKE SEDIMENTS

SIDE SCAN SONAR OF LAKEBED

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FIGURE 3

LEGEND:

- EDGE OF WATER
- RAILROAD
- VEGETATION
- PAVED ROADWAY
- FENCELINE
- PROPOSED SILT CURTAIN
- ELEVATION CONTOUR
- SILVER LAKE ELEVATION CONTOUR
- △ A — BENCH-SCALE SEDIMENT CORE LOCATION
- 19-9-34 — PROPERTY ID
- PROPERTY BOUNDARY

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. – FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY, AND BLASLAND AND BOUCK ENGINEERS, P.C. CONSTRUCTION PLANS.
2. NOT ALL PHYSICAL FEATURES SHOWN.
3. SITE BOUNDARY IS APPROXIMATE.
4. ALL LOCATIONS ARE APPROXIMATE.
5. THE SILVER LAKE CONTOUR INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 10–13 JUNE 2003 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

0 100' 200'
GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS

PILOT STUDY WORK PLAN - SILVER LAKE SEDIMENTS

GENERAL PILOT STUDY LOCATIONS

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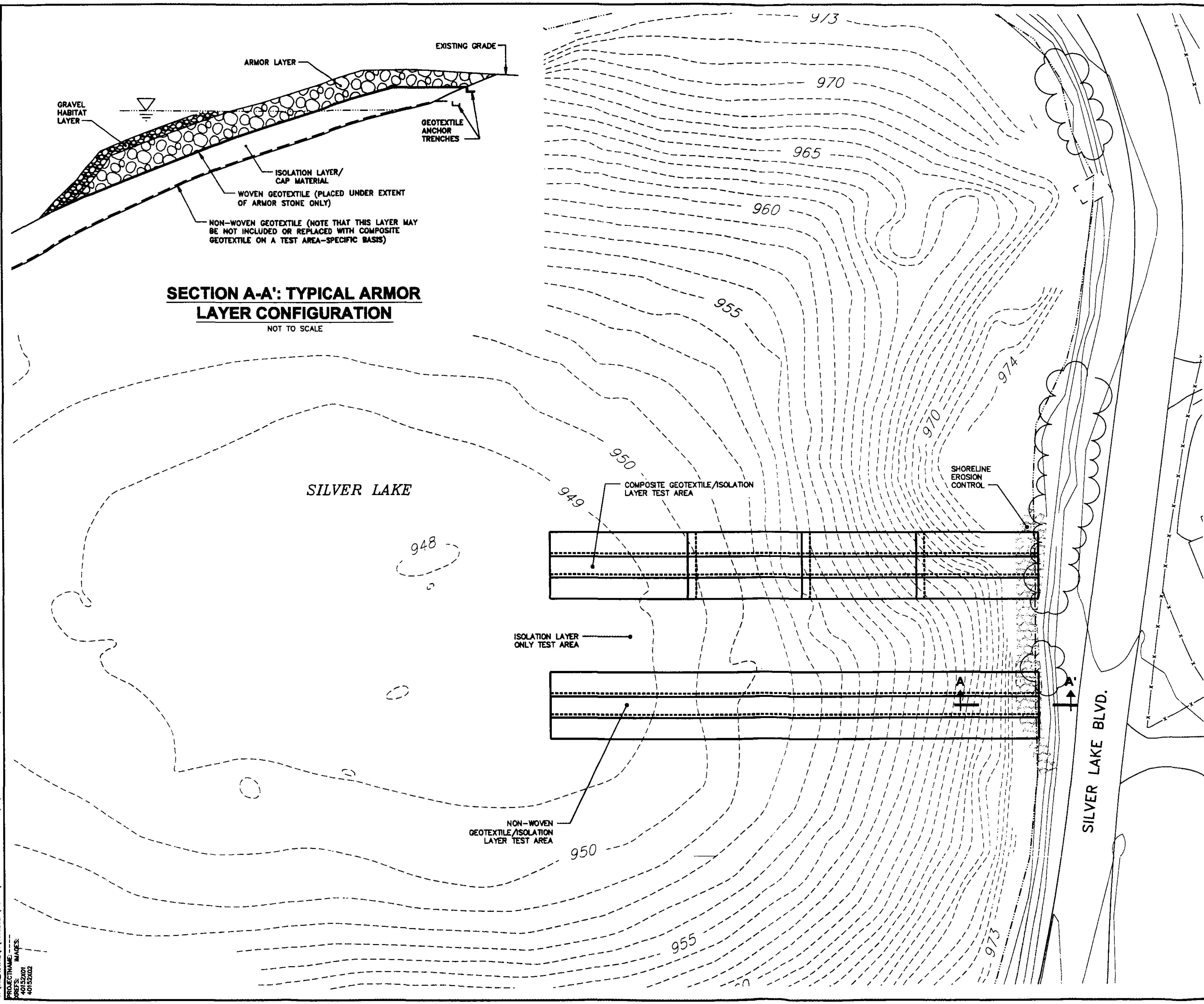
FIGURE **4**



LEGEND:

- EDGE OF WATER
- VEGETATION
- PAVED ROADWAY
- FENCELINE
- ELEVATION CONTOUR
- SILVER LAKE ELEVATION CONTOUR (—590—)
- GEOTEXTILE OVERLAP EXTENT

NOTES:

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GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHESETTS
PILOT STUDY WORK PLAN – SILVER LAKE SEDIMENTS

PROPOSED PILOT STUDY LOCATION

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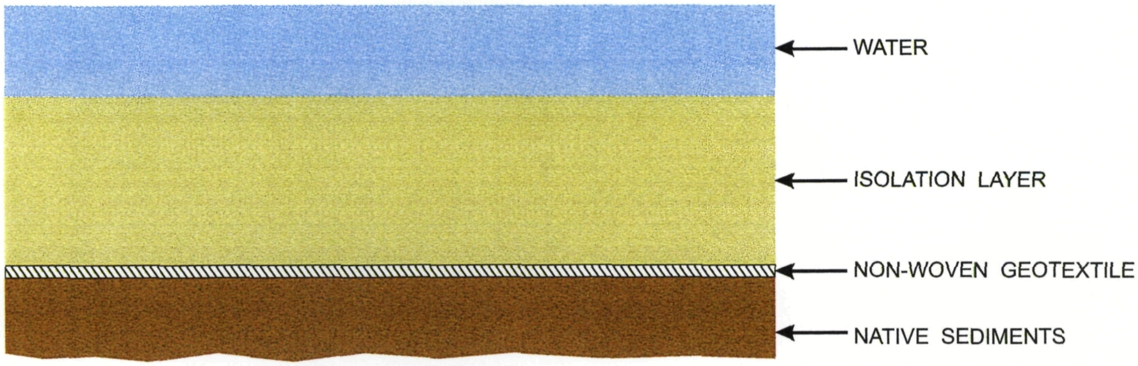
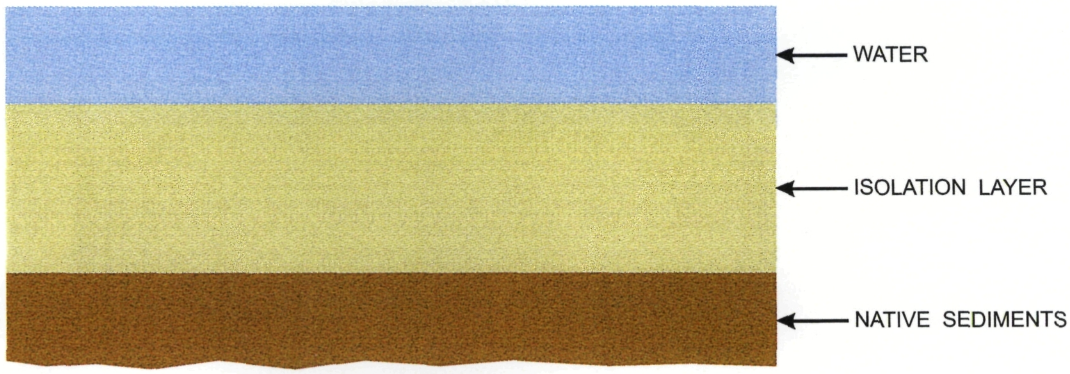
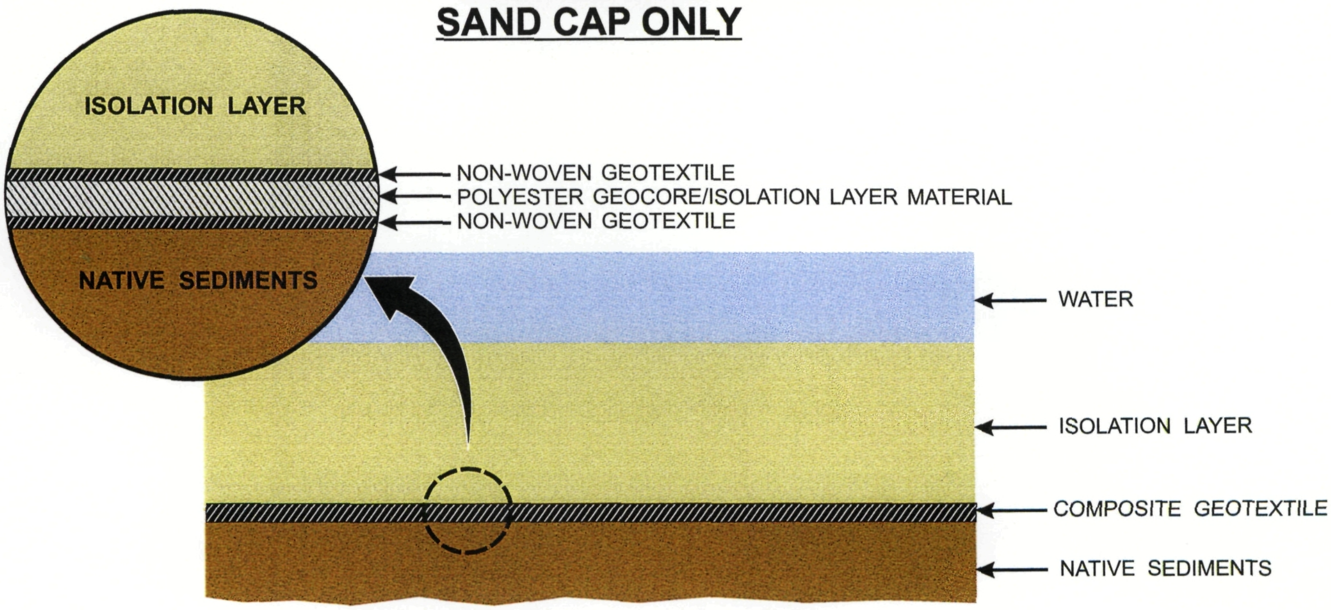
FIGURE 5



GEOTEXTILE AND SAND CAP



SAND CAP ONLY



GEOCOMPOSITE AND SAND CAP

NOT-TO-SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN - SILVER LAKE SEDIMENTS

PROPOSED TYPICAL CAP CROSS-SECTIONS

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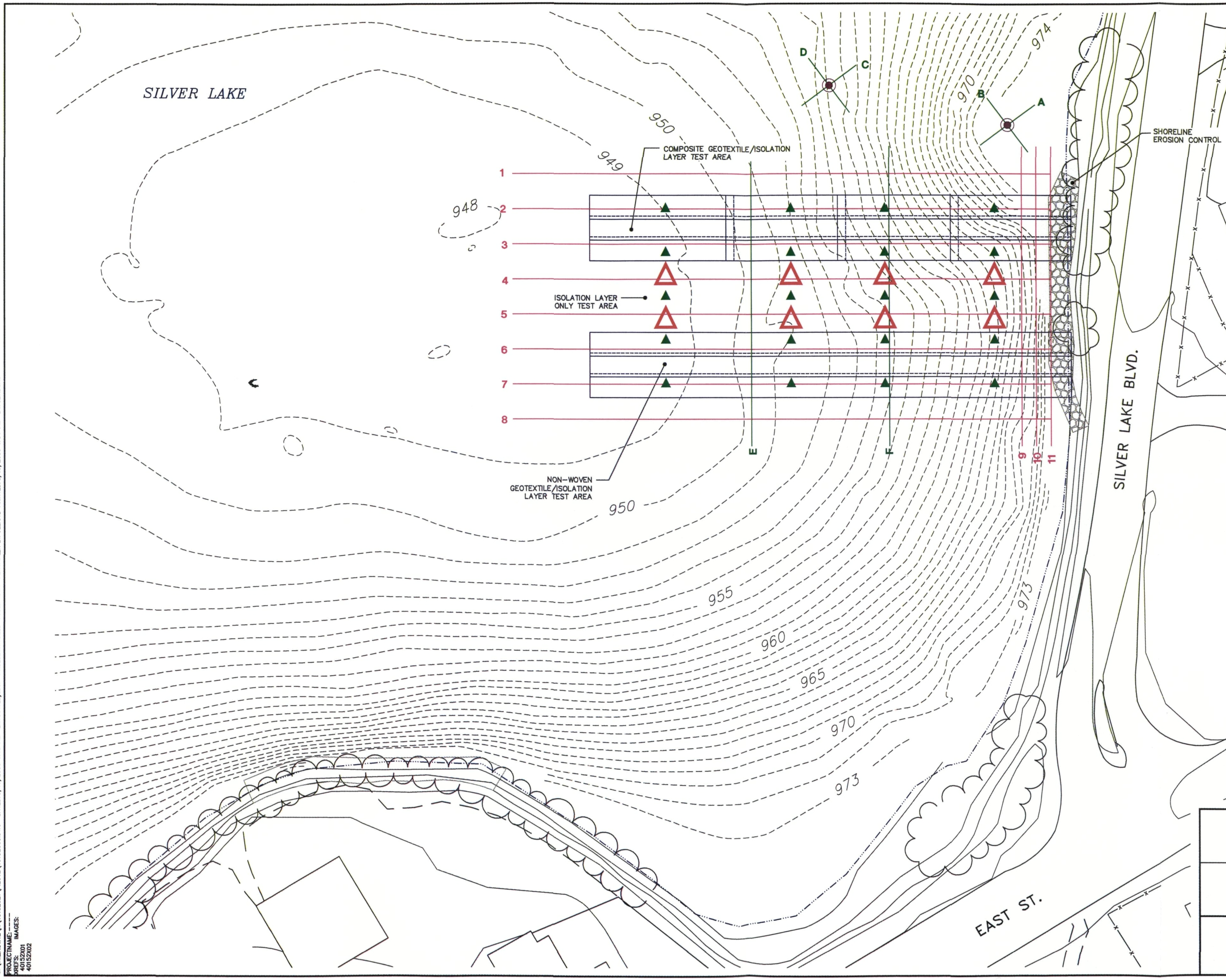
FIGURE **6**

08/15/06 SYR-D85-DJH-KLS
N:40152023\cdr\40152g01.cdr



LEGEND:

- EDGE OF WATER
- VEGETATION
- PAVED ROADWAY
- FENCELINE
- ELEVATION CONTOUR
- 590 SILVER LAKE ELEVATION CONTOUR
- GEOTEXTILE OVERLAP EXTENT
- 2 PROPOSED GEOPHYSICAL SURVEY TRANSECTS
- A PROPOSED CALIBRATION AND TIE LINES
- PROPOSED CALIBRATION TARGET
- PROPOSED PRE-CONSTRUCTION SPI MONITORING LOCATIONS
- PROPOSED DURING-CONSTRUCTION SPI MONITORING LOCATIONS

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. – FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY, AND BLASLAND AND BOUCK ENGINEERS, P.C. CONSTRUCTION PLANS.
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0 30' 60'
GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN – SILVER LAKE SEDIMENTS

PROPOSED GEOPHYSICAL SURVEY TRANSECTS

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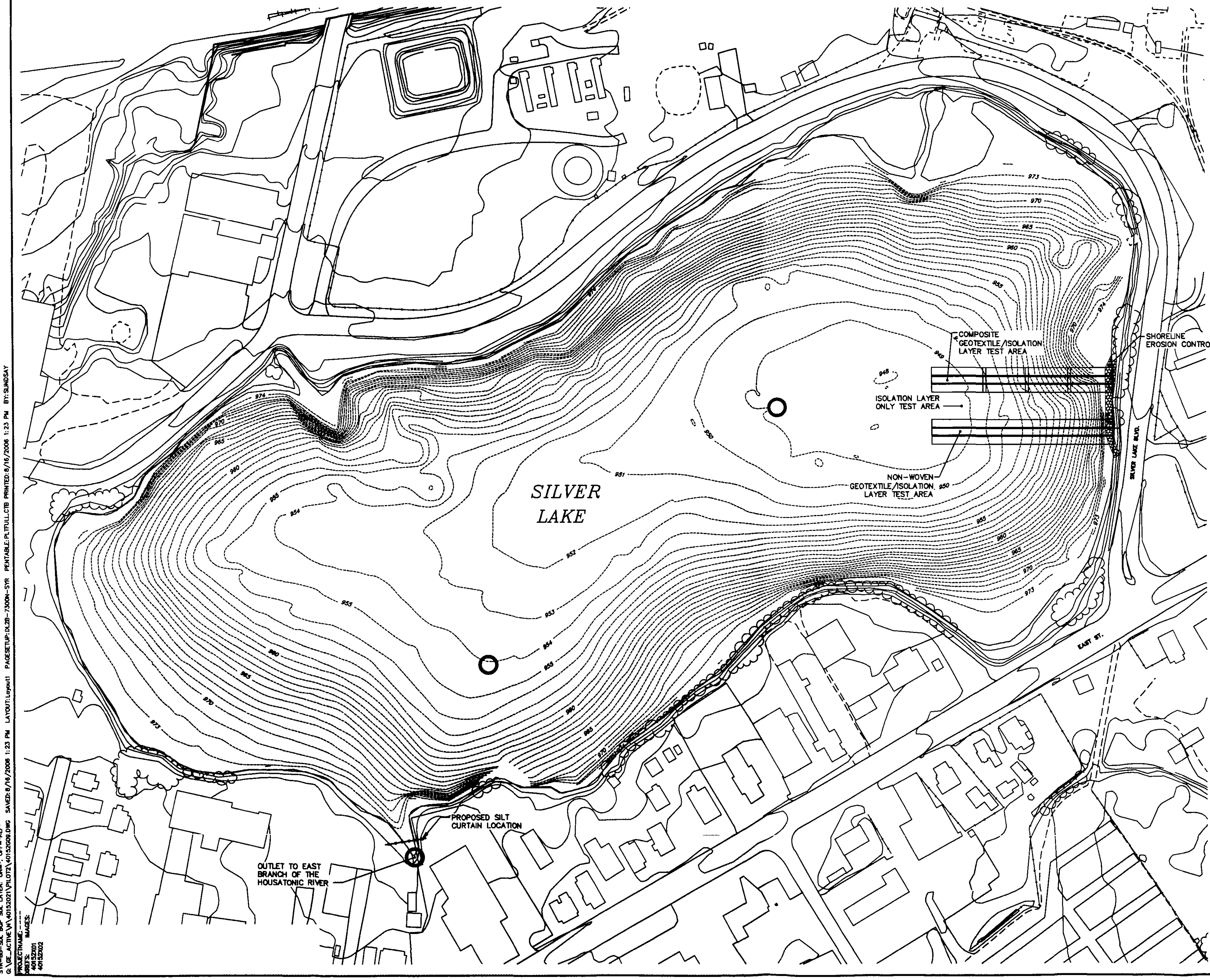
FIGURE 7

SYR-85-SDL BGP LAYER: ON=*, OFF=*REF*
G:\GE_ACTIVE\W\40152021\PILOT2\40152G08.DWG SAVED:8/16/2006 1:16 PM LAYOUT:Layout1 PAGESETUP:DL2B-7300N-SYR PENTABLE:PLTFULL.CTB PRINTED:8/16/2006 1:54 PM BY:SLINDSAY
PROJECTNAME: ----
XREFS: IMAGES:
40152X01
40152X02



LEGEND:

- EDGE OF WATER
- VEGETATION
- PAVED ROADWAY
- FENCELINE
- PROPOSED SILT CURTAIN
- ELEVATION CONTOUR
- SILVER LAKE ELEVATION CONTOUR (590)
- GEOTEXTILE OVERLAP EXTENT
- PROPOSED WATER MONITORING LOCATIONS

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. – FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY, AND BLASLAND AND BOUCK ENGINEERS, P.C. CONSTRUCTION PLANS.
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GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN –
SILVER LAKE SEDIMENTS

PROPOSED WATER MONITORING LOCATIONS

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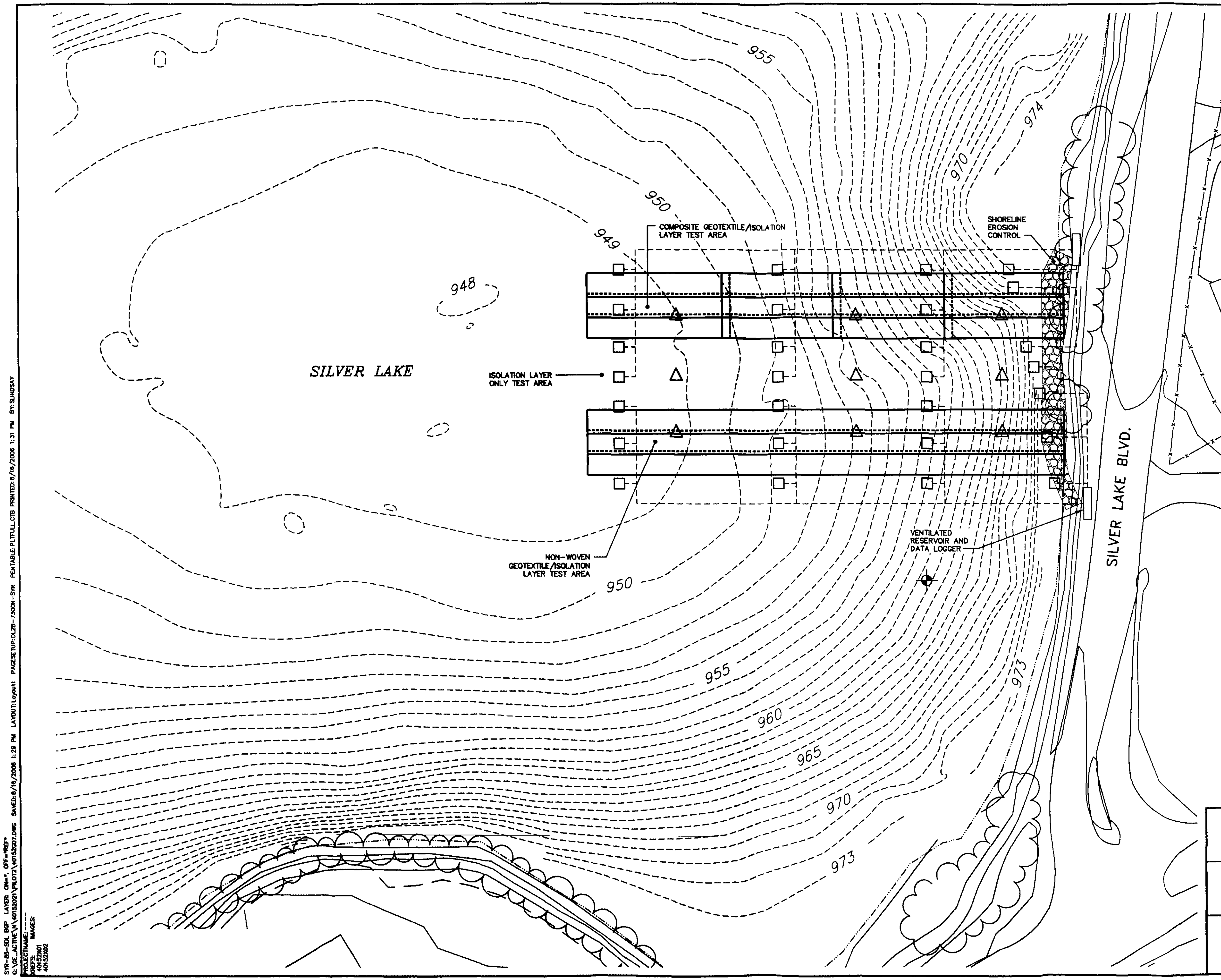
FIGURE 8



LEGEND:

- EDGE OF WATER
- VEGETATION
- PAVED ROADWAY
- FENCELINE
- ELEVATION CONTOUR
- SILVER LAKE ELEVATION CONTOUR
- GEOTEXTILE OVERLAP EXTENT
- INSTRUMENTATION WIRES, TUBES, AND CABLES
- □ PROPOSED VIBRATING WIRE SETTLEMENT CELL LOCATION
- △ PROPOSED PHYSICAL SETTLEMENT PLATE LOCATIONS
- PROPOSED SURFACE WATER ELEVATION MONITORING LOCATION

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. – FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY, AND BLASLAND AND BOUCK ENGINEERS, P.C. CONSTRUCTION PLANS.
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0 30' 60'
GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN –
SILVER LAKE SEDIMENTS

PROPOSED CONSOLIDATION MONITORING LOCATIONS

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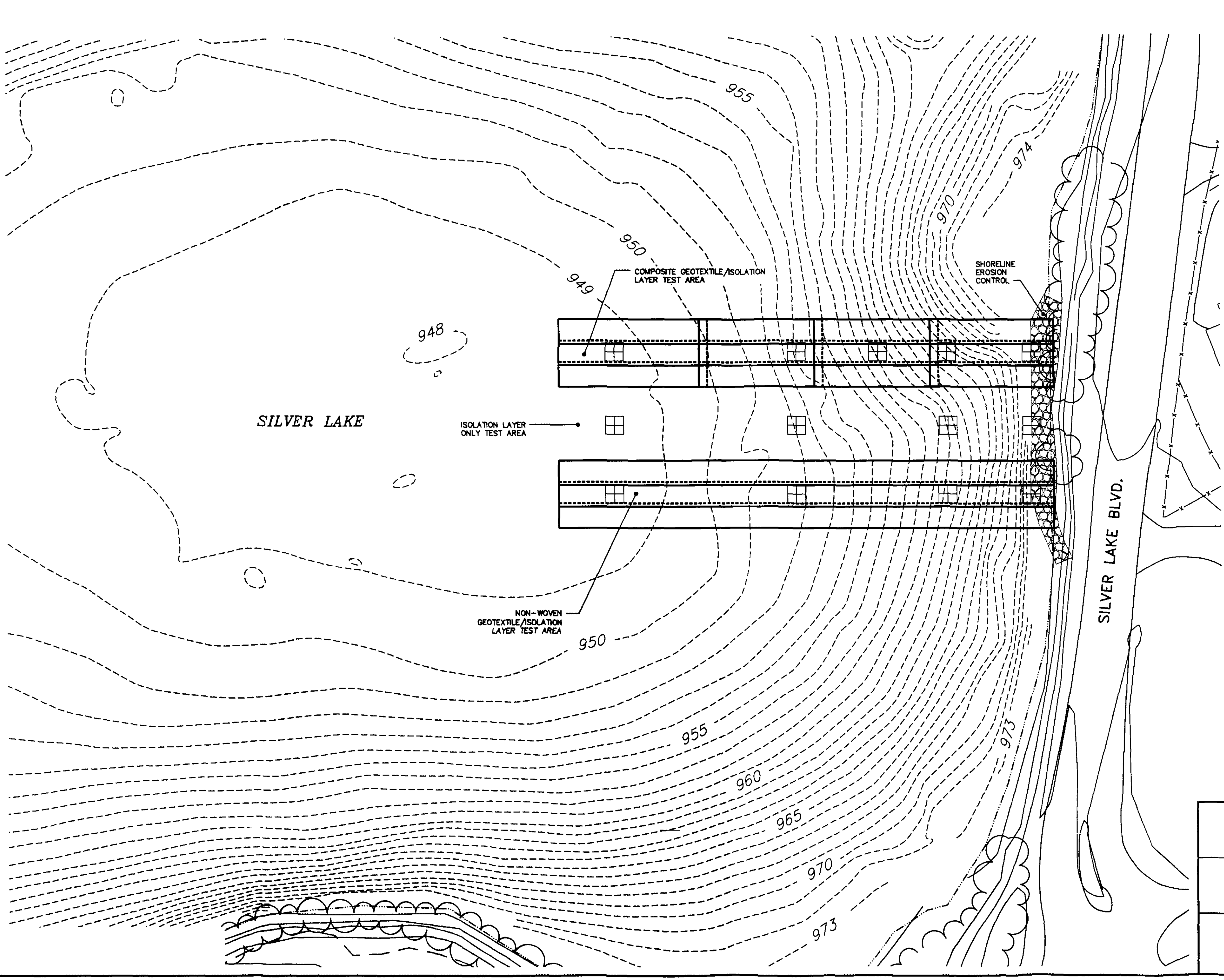
FIGURE 9



LEGEND:

- EDGE OF WATER
- VEGETATION
- PAVED ROADWAY
- FENCELINE
- ELEVATION CONTOUR
- --590-- SILVER LAKE ELEVATION CONTOUR
- GEOTEXTILE OVERLAP EXTENT
- PROPOSED SEDIMENT COLLECTION LOCATIONS

NOTES:

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0 30' 60'
GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
PILOT STUDY WORK PLAN – SILVER LAKE SEDIMENTS

PROPOSED SEDIMENT COLLECTION LOCATION

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FIGURE 10

Appendices

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Appendix A

Construction Materials and Specifications

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Construction Materials and Specifications
Silver Lake Capping Pilot Study
Pittsfield, Massachusetts

1. **Geotextile Fabrics**

A. Non-Woven Geotextile
- **Use** – Installed between sediment and isolation layer materials over approximately 1/3 of capped area.
- **Specification** – Mirafi 180-N or equivalent.
- **Testing Frequency** – None.

B. Geocomposite
- **Use** – Installed between sediment and isolation layer materials over approximately 1/3 of capped area.
- **Specification** – Mirafi 180-N or equivalent exterior layers; 12 ounce/square yard high loft polyester core.
- **Testing Frequency** – None.

C. Woven Geotextile
- **Use** – Installed between sediment/banks soils and armor layer.
- **Specification** – Mirafi 100-X or equivalent.
- **Testing Frequency** – None.

2. **Isolation Layer Materials**

A. Granular Isolation Layer Material
- **Use** – Isolation layer, composed of a mixture of sand and topsoil, placed over geotextile fabric or sediment on an area-specific basis.
- **Specification** – Approximate grain size distribution:
  - 5% Gravel; 75% Sand; 20% Silt/Clay.

  – Average Minimum Total Organic Carbon (TOC):
  - 10,000 parts per million (ppm).

- **Testing Frequency** – TOC:
    - Once every 100 cubic yards (cy) prior to placement.
  - Polychlorinated Biphenyls (PCB) and grain size:
    - Once every 500 cy prior to placement.
  - Appendix IX+3:
    - Once every 2,000 cy prior to placement.

3. Armor Layer Material

A. Armor Stone

- **Use** – Protective armor stone placed along shoreline in vicinity of water line.

- **Specification** – Angular graded rip rap:
    - D_{15}: 4-inches, D_{50}: 6-inches, D_{100}: 8-inches.

- **Testing Frequency** – Particle Size :
    - Once per 500 cy.

B. Gravel and Sand

- **Use** – Habitat layer placed over underwater extent of armor stone.

- **Specification** – Well graded gravel and sand:
    - 3-inch minus.

- **Testing Frequency** – Particle Size:
    - Once per 500 cy.

Appendix B

Armor System Design Methodology

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Armor System Design Methodology
Silver Lake Capping Pilot Study
Pittsfield, Massachusetts

As described in the Sediments PDI Report, the predominant cause of bank erosion (if any) in Silver Lake appears to be wind-driven wave action. To maintain the integrity of the Pilot Study cap, measures will be incorporated to protect the cap from such naturally occurring erosive forces. This Appendix to the Pilot Study Work Plan presents the recommended armor layer configuration for implementation and study during the Silver Lake Pilot Study Program. Note that the armoring design and calculation discussed herein are specific to the east shore of the lake in the vicinity of the pilot study location.

As part of the PDI, available wind data was acquired from several locations in the New England Region for use in designing the Silver Lake bank armoring system using standard United States Army Corps of Engineers (USACE) guidance for the protection of river and lake banks, channel bottoms, and shorelines. Specifically, the Shore Protection Manual (SPM; USACE, 1984) presents a series of calculations incorporating site-specific environmental conditions, including (but not limited to) bank slopes, prevailing winds, wind speeds and predominant fetch, and water depth; to conservatively estimate the median armor stone size and subsequent armor layer thicknesses for protection from erosion and material loss.

Wind Data Analysis

Wind speed, duration and direction all play a role during performance of the wave height analysis, which is ultimately used to specify armor stone extent, layer thickness and median stone size as part of the armor stone design. As part of the PDI, wind data was analyzed from three nearby locations:

- Albany International Airport;
- Hartford Bradley International Airport; and
- Pittsfield NOAA Wind Gauge.

All three data sets showed that the predominant winds are west/northwest with wind speed exceeding 40 miles per hour (mph). The Albany and Hartford records contained daily wind speed and direction records spanning 19 years (1965-1983) (NCDC, 2001a and 2001b). The Pittsfield record was relatively new and spanned only 4 years (1999-2003). Due to its proximity to Pittsfield and the robustness of the data set relative to the NOAA wind gauge, the Albany wind data was used to estimate design and heights.

To create a conservative armor system, wind data analysis focused on the fastest mile wind speeds from 100-year return period storms in particular the westerly wind data, thereby assuming worst case scenarios. Specifically, for design of the pilot study armor system, the maximum fastest mile westerly wind speed of 59 miles per hour (mph), as projected for the Albany airport, was selected for use in design calculations. A detailed discussion of the wind data analysis is presented in the Sediments PDI Report.

Shore Protection Manual Methodology

The methodology to determine the design wave and resultant armoring requirements considers several factors including fetch length and wind speed (as briefly discussed above), water depth, and wind duration. The SPM method includes the calculation of wind stress and wind-driven maximum wave heights, and the subsequent determination of the armor layer configuration.

Wind Stress Determination

Using fastest mile westerly wind data from the Albany Airport, as discussed, wind stresses, and resultant wave heights can be determined by applying a series of calculated adjustments to estimate maximum wind speeds for

Silver Lake. The following steps were used to develop a site-specific wind stress parameter:

1) Elevation Adjustment
2) One-Hour Wind speed Adjustment
3) Stability Adjustment
4) Location Adjustment
5) Drag Adjustment

Elevation Adjusted One-Hour Wind Speed
The purpose of this adjustment is to account for the height of the wind gauge. The standard elevation of a wind gauge (i.e., the elevation at which wind speeds should be recorded) per USACE is 10 meters (32.8 feet) To adjust the data recorded at the Albany airport to represent this suggested gauge height with respect to Silver Lake requires an approximate additional 20 feet above the surface elevation of Silver Lake (BBL, 2005). The following relationship was used to scale the wind speed relative to the elevation of the surface of Silver Lake:

$$U(10) = U(z) * \left(\frac{10}{z}\right)^{1/7} \quad \text{(USACE, 1984, Eq.3-26)}$$
$$U(10) = 63.32 \ mph$$

Where:

U(10) = elevation adjusted wind speed (mph)
U(z) = selected fastest mile westerly wind speed for the Albany airport (59 mph)
z = adjustment factor to represent Silver Lake conditions ~20 ft

Stability Adjustment
Air-water temperature differences can also affect wave growth. If the difference is zero, then the boundary layer has a neutral stability and a correction is not needed. However, if the difference is negative (i.e., the water temperature is greater than the air temperature), then the boundary layer is unstable and the wind speed is more effective in causing wave growth. However, as with the wind data, use of this adjustment factor requires an extended data record that is location specific. For Silver Lake, available meteorological data is not sufficient to estimate this factor. In the absence of sufficient data, the SMP methodology suggests the use of a conservative adjustment factor of 1.1. Therefore, the stability adjustment for the one hour wind speed is as follows:

$$U_s = R_T * U_h$$
$$U_s = 54.0 \text{ mph} \quad \text{(USACE, 1984, Eq. 3-27)}$$

Where:

U_h= one hour wind speed [U(10) ÷ 1.29 = 49.09 (mph); USACE, 1984, Figure 3.13]
R_T = Correction Factor (1.1; USACE, 1984)
U_s = stability adjusted one hour wind speed (mph)

Location Adjustment
This adjustment is to account for differences between using land based wind gauges for water applications.

$$U_L = R_L * U_s$$
$$U_L = 48.6\ mph$$

Where:

U_s = stability adjusted one hour wind speed (54.0 mph)
R_L=Ratio of Wind speed over water to wind speed over land (0.9; USACE, 1984, Figure 3-14);
U_L = location adjusted one hour wind speed (mph)

Drag Adjustment
Finally the calculated wind speed is converted to a wind stress factor (U_A):

$$U_A = 0.589 * U_L^{1.23}$$
$$U_A = 69.9 \qquad \text{(USACE, 1984, Eq. 3-28b)}$$

Where:

U_L = location adjusted one hour wind speed (48.6 mph)
U_A = calculated wind stress factor

Fetch Determination
Fetch is defined as the length of the unobstructed open water surface across which the wind can generate waves (National Oceanic and Atmospheric Administration [NOAA], 2001). As applied to the design of the pilot study cap, fetch length was determined by measuring the distance across Silver Lake that westerly and northwesterly winds may travel. The maximum fetch length determined, based on the location of the pilot study was approximately 1,540 feet.

Wave Growth
Finally, a design wave height to be carried forward in armor stone calculations can be estimated as follows:

$$\frac{gH_i}{U_A^2} = 1.6 * 10^{-3}\left(\frac{gF}{U_A^2}\right)^{1/2} \qquad \text{(USACE, 1984, Eq. 3-33)}$$
$$\rightarrow H \approx 1.1\,foot$$

Where:

g = gravitational acceleration (32.2 feet/s^2)
H_i = design wave height (feet)
U_A = wind speed/stress factor
F = fetch length (1,540 feet)

Using the above sequence of calculations and solving for *H*, a design wave height of 1.1 feet will be carried forward for use in calculation of armor stone size and layer thickness for the pilot study cap armor system.

Median Armor Stone Diameter (D_{50}) Determination

A design wave height of 1 foot was determined using methods described above. The corresponding armor stone size that is required to yield the level of protection necessary for the pilot study area was calculated using the Hudson equation:

$$W_{50} = \frac{\gamma_r H_i^3}{K_D (S_r - 1)^3 \cot\theta}$$

(USACE, 1984, Eq. 7-117)

$$W_{50} = 8.2 \ pounds$$

Where:

W_{50} = median weight of individual armor unit
γ_r = unit weight of armor material (165 lbs/ft^3)
γ_w = unit weight of water (62.4 lbs/ft^3)
H_i = design wave height (1.1 feet)
K_D = armor unit stability coefficient (2.2 – for graded angular quarry stone)
$S_r = \gamma_r / \gamma_w$ = specific gravity of armor material
Cot θ = angle between seaward structure slope and horizontal (3 for slope of 3H:1V)

From this, the median stoned diameter (D_{50}) can be calculated using the following relationship.

$$D_{50} = \left(\frac{6 * W_{50}}{\pi \gamma_r} \right)^{1/3}$$

(USACE, 1991, Eq. 3-1)

$$D_{50} = 5.5 \ inches$$

Where:

W_{50} = nominal weight of individual armor unit (8.2 pounds)
γ_r= 165 lb/ft^3
$\pi \sim 3.14$

Finally, the SPM guidance indicates that armor layer thicknesses can be calculated as the maximum of the following two functions or a default minimum thickness of one foot:

$$r = 2 * \left(\frac{W_{50}}{\gamma_s} \right)^{1/3}$$

$$r = 0.7 \ feet$$

or

$$r = 1.25 * \left(\frac{W_{100}}{\gamma_s} \right)^{1/3}$$

$$r = 0.9 \ feet$$

Where:

W_{50} = weight of individual armor unit (8.2 pounds)
$W_{100} = 2 * W_{50}$ (16.4 pounds)
γ_r= 165 lb/ft^3

As the results of both of these equations indicates an armor layer thickness of less than 1 foot, SPM defaults to a conservative armor layer thickness of 1 foot.

Summary Results for the SPM Method

To make the most conservative estimate of the stone size and armor layer thickness for the pilot study armor system, west wind speeds associated with the 100-yr storm event were selected for use. Following the steps detailed above, the following table summarizes the results of the SPM calculations and the median stone weight (W_{50}), diameter (D_{50}) and layer thickness.

Summary of SPM Calculation Results

Design Wave Height (ft)	1.1
W_{50} (lbs)	8.2
D_{50} (in)	5.5
Layer Thickness (in)	12

References

NOAA (2001). *Glossary of Coastal Terminology.* [Online]. http://www.csc.noaa.gov/text/glossary.html (last updated 2001). National Ocean and Atmospheric Administration - Coastal Services Center. Silver Spring, MD.

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National Climatic Data Center (NCDC, 2001b), Hartford Bradley International Airport, Station 063456 Daily Surface Data.

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USACE (1991). Hydraulic Design of Flood Control Channels. U.S. Army Corps of Engineers, Washington, DC.

Appendix C

Monitoring Equipment Technical Specifications

BBL®

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Multi-Beam Bathymetric Meter

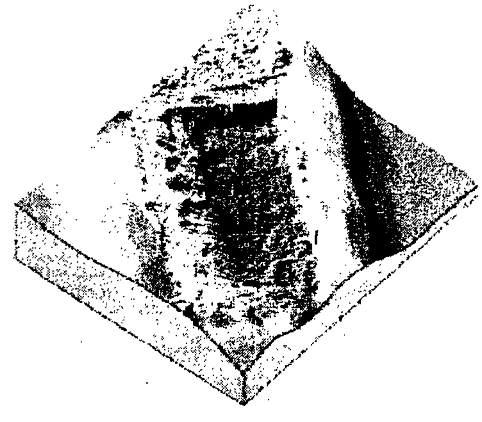
BBL®

an ARCADIS company

communications

SEA BEAM 1185 - MULTIBEAM SONAR

- 180 kHz
- 126 individual beams
- 153° swath width
- 300 m depth performance
- upgradeable to 600 m depth performance
- 1.5° resolution
- exceeding IHO standards
- integrated side scan view
- realtime motion compensation
- Windows 2000/XP or UNIX/LINUX
- dual frequency option



SEA BEAM 1185 Multibeam Echosounder collects bathymetric and sidescan data in very shallow water with beams as narrow as 1,5 x 1,5 degrees and a swathwidth in excess of 150 degrees.

The system is ideally suited for river and port authorities, research institutes and onshore survey operations. SEA BEAM 1185 offers a seafloor coverage in excess of 400 meters and a maximum depth performance of 300 meter.

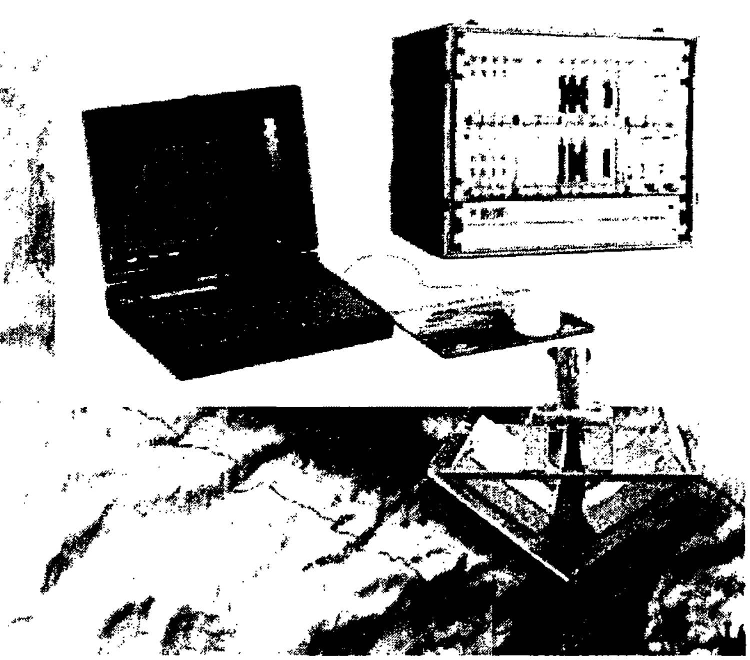
During transmission and reception SEA BEAM 1185 offers a complete roll-compensated beamforming with a very high directivity in along-track and across-track direction. Side lobe suppression of better than 36 dB with very low error rates is achieved.

The Windows based SEA BEAM 1185 is the shallow water version of the SEA BEAM 1180. An upgrade to that model can be offered at reasonable costs.

YOUR LOW COST MULTIBEAM SOLUTION

High Performance Shallow Water Solution

Professional Survey in Water Depths up to 300 m



L3 communications

TECHNICAL DATA

R/V KRABBE / WSA Bremerhaven

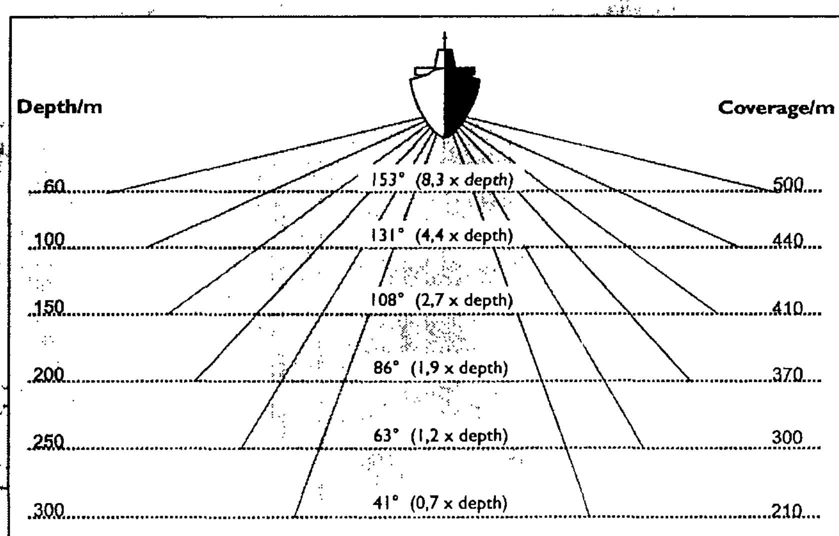
Frequency	180 kHz
Number of Beams	max. 126
Beam Width	> 153°
Power Supply	115 / 230 V AC, user selectable
Max. Pulse Power	500 W per transducer array
Max. Source Level	220 dB 1 μPa/1 m
Pulse Length	0.15 ms; 0.3 ms; 1 ms; 3 ms; selectable
Bandwidth	12 kHz, 3 kHz, 1 kHz selectable
Sidelobe Suppression	36 dB (transmission and reception)
Survey Speed	up to 16 kn for continuous seafloor coverage

DIMENSIONS

Sonar Processor Unit (SEE 30-1185)	Dimensions:	483 x 369 x 266 mm
	Weight:	approx. 33 kg
Transducer (LSE 307)	Dimensions:	390 x 280 mm each
	Weight w/o cable:	17 kg

INTERFACES AND SENSORS

Motion	DMS-2, Octans, POS M/V, MRU 5
Heading	NMEA 0183 standard, sentence HDT
Position	NMEA 0183 standard, sentence GGA or VTG
Sound Velocity	Data input via RS 232
Software	ELAC HDP 4061, CARIS, COASTAL OCEANOGRAPHCS, EIVA, QPS, ROXAR, PDS 2000, CARAIBES, TEI



L-3 Communications ELAC Nautik GmbH
Neufeldtstrasse D-24118 Kiel Germany
Phone +49 431 883 0 Fax +49 431 883 496
sound@elac-nautik.com www.elac-nautik.com

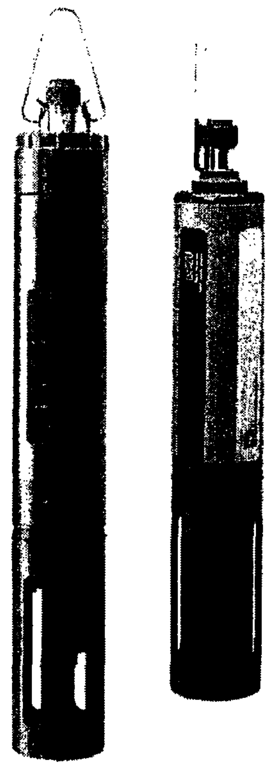
L-3 Communications Klein Associates, Inc.
11 Klein Drive Salem, New Hampshire 03079 USA
Phone +01 603 893 6131 Fax +01 603 893 8807
klein.mail@L-3com.com www.L-3Klein.com

Turbidity Meter

BBL®
an ARCADIS company

YSI

YSI 6820 and 6920 Sondes



YSI 6920 YSI 6820

Measure multiple parameters simultaneously

You can report sixteen parameters simultaneously with either sonde:

DO (% and mg/L)	ORP
Temperature	Depth or Level
Conductivity	Turbidity, Chlorophyll or Rhodamine
Specific Conductance	Total Dissolved Solids
Salinity	Nitrate
Ammonia	Chloride
Ammonium-N	pH
Resistivity	

Data Analysis with EcoWatch® for Windows®

Data analysis from any YSI sonde is easy using EcoWatch® for Windows® for data quality review, statistical analysis, and preparation for easy importation to other data analysis packages.

Connect with data collection platforms

Either sonde can easily connect to the YSI 6200 DAS Data Acquisition System, or your own data collection platform, via RS-232 or SDI-12 for remote and real-time data acquisition applications.

Self-cleaning and Stirring-independent probes

Both sondes feature YSI's self-cleaning turbidity, chlorophyll or rhodamine sensor as well as YSI's Rapid Pulse® stirring-independent oxygen sensor.

- Self-cleaning turbidity, chlorophyll or rhodamine
- Stirring-independent Rapid Pulse® dissolved oxygen system
- Field-replaceable sensors
- Easy connect to data collection platforms such as the YSI 6200 Data Acquisition System
- Compatible with YSI 650 Multiparameter Display System

In addition

The YSI 6920 is an economical logging system for long-term, *in situ* monitoring and profiling. It will log all parameters at programmable intervals, and store 150,000 data sets. At 15-minute intervals, it will log data for about 30 days.

Sensor performance verified*

Both the 6820 and 6920 use sensor technology that was verified through the US EPA's Environmental Technology Verification Program (ETV). For information on which sensors were verified, turn this sheet over and look for the ETV logo.

Pure Data for a Healthy Planet.

*Sensor Performance verified by the EPA Environmental Technology Verification Program.**

ETV

YSI

To order, or for more information, contact YSI Environmental.

800 897-4151

www.ysi.com

YSI Environmental
937 767 7241
Fax 937 767 9353
environmental@YSI.com

Endeco/YSI
508 748 0366
Fax 508 748 2543
environmental@YSI.com

SonTek/YSI
858 546 8327
Fax 858 546 8150
inquiry@sontek.com

YSI Environmental Gulf Coast
225 753 2650
Fax 225 753 8669
environmental@ysi.com

YSI Hydrodata (UK)
44 (0) 1462 673 581
Fax 44 (0) 1462 673 582
sales@hydrodata.co.uk

YSI (Hong Kong) Limited
852 2891 8154
Fax 852 2834 0034
hongkong@ysi.com

YSI (Qingdao) Limited
86 532 389 6648
Fax 86 532 389 6647
china@ysi.com

Nanotech/YSI (Japan)
81 44 222 0009
Fax 81 44 221 1102
nanotech@ysi.com

ISO 9001
ISO 14001

CE

*Sensors with listed with the ETV logo were submitted to the ETV program on the YSI 6600EDS. Sensor technology on the 6600EDS is identical to that used on the 6820/6920. Information on the performance characteristics of YSI water quality sensors can be found at www.epa.gov/etv, or call YSI at 800 897 4151 for the ETV verification report. Use of the ETV name or logo does not imply approval or certification of this product nor does it make any explicit or implied warranties or guarantees as to product performance.

YSI 6920 & 6820 Specifications

Parameter			
Dissolved Oxygen % Saturation		Range	0 to 500%
		Resolution	0.1%
6562 DO Probe	ETV✓	Accuracy	0 to 200%: ±2% of reading or 2% air saturation, whichever is greater; 200 to 500%: ±6% of reading
Dissolved Oxygen mg/L		Range	0 to 50 mg/L
		Resolution	0.01 mg/L
		Accuracy	0 to 20 mg/L: ±2% of reading or 0.2 mg/L, whichever is greater; 20 to 50 mg/L: ±6% of reading
Conductivity†		Range	0 to 100 mS/cm
		Resolution	0.001 to 0.1 mS/cm (range-dependent)
6560 Cond Probe	ETV✓	Accuracy	±0.5% of reading + 0.001 mS/cm
Temperature		Range	-5 to +70°C
		Resolution	0.01°C
6560 Temp Probe	ETV✓	Accuracy	±0.15°C
pH		Range	0 to 14 units
		Resolution	0.01 unit
6561 pH Probe	ETV✓	Accuracy	±0.2 unit
ORP		Range	-999 to +999 mV
		Resolution	0.1 mV
		Accuracy	±20 mV
Salinity		Range	0 to 70 ppt
		Resolution	0.01 ppt
		Accuracy	±1% of reading or 0.1 ppt, whichever is greater
Shallow Depth		Range	0 to 30 feet (0 to 9 m)
		Resolution	0.001 feet (0.001 m)
		Accuracy	±0.06 feet (±0.02 m)
Medium Depth		Range	0 to 200 feet (0 to 61 m)
		Resolution	0.001 feet (0.001 m)
		Accuracy	±0.4 feet (±0.12 m)
Vented Level		Range	0 to 30 feet (0 to 9 m)
		Resolution	0.001 feet (0.0003 m)
		Accuracy	±0.01 feet (0.003 m)
Turbidity		Range	0 to 1,000 NTU
		Resolution	0.1 NTU
		Accuracy	±2% of reading or 0.3 NTU, whichever is greater in YSI AMCO-AEPA Polymer Standards
6136 Turb. Probe	ETV✓	Depth	200 feet (60.96 m)
Chlorophyll		Range	0 to 400 µg/L
		Resolution	0.1 µg/L Chl; 0.1%FS
6025 Chlor. Probe	ETV✓	Depth	200 feet (60.96 m)
Rhodamine		Detection Limit	0.5 µg/L
		Resolution	0-200 µg/L as true dye; 1,000 µg/L as dye tracer
		Accuracy	±1 µg/L or ±5% reading
		Depth	200 feet (60.96 m)
Nitrate/nitrogen‡		Range	0 to 200 mg/L-N
		Resolution	0.001 to 1 mg/L-N (range dependent)
		Accuracy	±10% of reading or 2 mg/L, whichever is greater
		Depth	50 feet (15.2 m)
Ammonium/ammonia/nitrogen‡		Range	0 to 200 mg/L-N
		Resolution	0.001 to 1 mg/L-N (range dependent)
		Accuracy	±10% of reading or 2 mg/L, whichever is greater
		Depth	50 feet (15.2 m)
Chloride‡		Range	0 to 1000 mg/L
		Resolution	0.001 to 1 mg/L (range dependent)
		Accuracy	±15% of reading or 5 mg/L, whichever is greater
		Depth	50 feet (15.2 m)

† Report outputs of specific conductance (conductivity corrected to 25° C), resistivity, and total dissolved solids are also provided. These values are automatically calculated from conductivity according to algorithms found in Standard Methods for the Examination of Water and Wastewater (ed 1989).
‡ Freshwater only.

Vibrating Wire Settlement Cell

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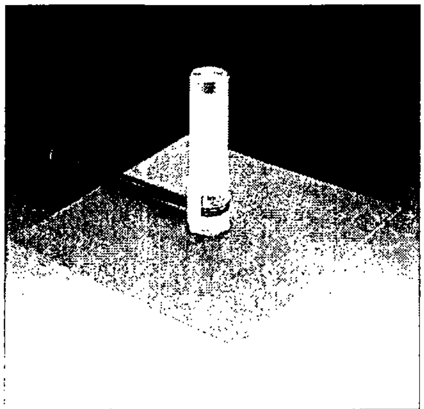
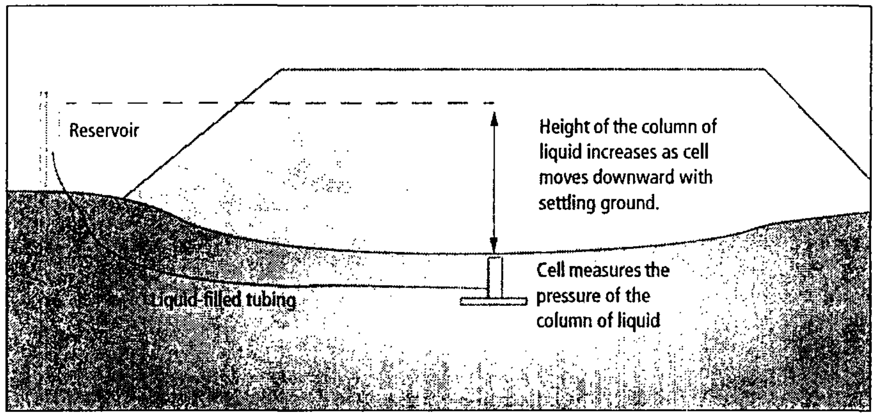
VW Settlement Cells



Vented VW settlement cell with settlement plate.

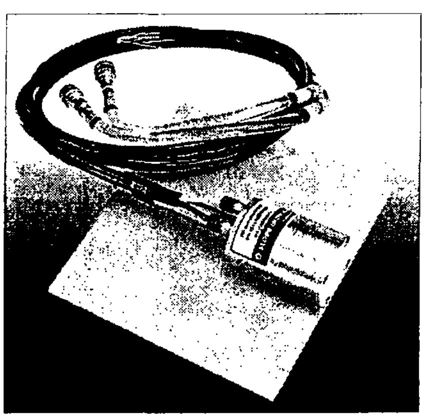


Settlement cells provide settlement measurements with no interference to construction activities.

Applications

VW settlement cells are used to monitor settlements in soil. Typical applications include:

- Monitoring settlement in fills.
- Monitoring settlement due to dewatering or preloading.
- Monitoring settlement or heave in embankments.
- Monitoring subsidence due to tunneling.
- Monitoring consolidation of soil under storage tanks.



Sealed VW Settlement Cell

Operation

The main components of a VW settlement cell are a reservoir, liquid-filled tubing, and a pressure transducer.

The reservoir is located on stable ground, away from the construction area. The liquid-filled tubing runs from the reservoir down to the pressure transducer, which is embedded in fill or installed in a borehole.

The transducer measures the pressure created by the column of liquid in the tubing. As the transducer settles with the surrounding ground, the height of the column is increased and the transducer measures higher pressure.

Settlements are calculated by converting the change in pressure to millimeters or inches of liquid head.

Advantages

Remote Readout: The reservoir and readout station can be located away from the construction area. The cell and tubing are buried and do not interfere with construction activities.

Three Ranges: Use the 22 psi vented settlement cell to monitor smaller settlements with greater precision. Use the 50 and 100 psi sealed cells to monitor larger settlements.

Manual or Automated Monitoring: The VW settlement cell can be read manually with a portable indicator, or automatically with a data logger.

SYSTEM CONFIGURATION

Vented System: A vented system consists of a vented cell, settlement plate, vented signal cable, tubing, reservoir, desiccant chamber, and readout or datalogger.

Sealed System: A non-vented system consists of a non-vented cell, settlement plate, tubing, signal cable, reservoir, readout or data logger, and a barometer.

Tubing and Signal Cable: Tubing and signal cable run from the buried cell to the reservoir at the surface. Lateral runs up to 300 m (1000') are possible if tubing is buried to minimize temperature changes and deviations from the upward slope of the tubing are kept very small.

Reservoir: The small reservoir is suitable for single-cell installation. Its liquid level must be maintained regularly. A constant level reservoir is available for long-term unattended monitoring. Both types of reservoir should be protected from the direct heat of the sun.

Barometer: Not required for vented systems. Sealed settlement cells are sensitive to atmospheric pressure, which can vary as much as 0.5 psi during the course of a day. This is equivalent to 350 mm or 14"of water head. Barometer readings are required to correct settlement readings for changes in atmospheric pressure. Barometer readings must be obtained on site at the same time as the settlement reading. Barometer readings from weather radios and airports are not adequate for this purpose. If your system will be read manually, order the field barometer. If your settlement system is automated, order the barometer for data loggers. It has an accuracy better than ±20 mm (± 0.8 inches) of water head at temperatures from -25 to 50 °C.

Readouts: The VW Data Recorder is recommended for manual readings. The CR10 data logger or VW MiniLogger can be used for automated readings. See separate data sheets for features and specifications.

Performance Specifications: Range is the maximum vertical distance between the buried cell and the reservoir. Resolution is based on readings obtained with a VW Data Recorder. Calibration accuracy is determined during calibration. Repeatability depends on proper installation of cell, tubing, and reservoir, maintenance of deaired fluid, and application of any appropriate corrections.

VENTED VW SETTLEMENT CELL

Vented VW Settlement Cell 52612420

Sensor Type: Vented vibrating wire sensor with built-in thermistor or RTD. Sensor automatically compensates for changes in barometric pressure.

Range: 14 m (47').

Resolution: 0.025% FS.

Calibration Accuracy: ± 0.1% FS.

Repeatability: ±0.25% FS to ±1% FS.

Dimensions: 64 x 280 mm (2.5 x 11")

Materials: Stainless steel and PVC plastic.

SETTLEMENT PLATE

Settlement Plate 51410100

460 x 460 mm (18 x 18") steel plate helps maintain required upright orientation of cell.

TUBING AND SIGNAL CABLE

Tubing 51416950

Twin 1/4-inch tubes inside polyethylene jacket. Tubes are filled with de-aired liquid and terminated with quick-connect sockets for connection to reservoir. Specify length.

Vented Signal Cable 50614410

Shielded cable with four 22-gauge tinned- copper conductors, 0.25" vent tube, and polyurethane jacket. For use between cell and desiccant chamber. Specify length.

Splice Kit for Vented Cable 50614415

Contains components required to splice five conductors and vent tube.

Non-Vented Signal Cable 50613524

Shielded cable with four 22-gauge tinned-copper conductors for use between dessicant chamber and readout or data logger. Specify length.

DESICCANT CHAMBER

Desiccant Chamber 52612495

Prevents moisture from entering cable and vent tubing. Desiccant can be renewed in an oven. For one cell. 108 x 108 x 64 mm (4.25 x 4.25 x 2.5").

Extra Desiccant Pack 02540003

Anhydrous calcium sulfate in moisture proof container. Sufficient for one chamber.

RESERVOIR

Small Reservoir 51419500

Accommodates one settlement cell. Includes mounting hardware, two quick-connect plugs, and small bottle of de-aired liquid.

SEALED SETTLEMENT CELLS

50 psi VW Settlement Cell. 52612020
100 psi VW Settlement Cell. 52612030

Sensor Type: Sealed vibrating wire sensor with built-in thermistor or RTD. Barometer readings are required to compensate for changes in barometric pressure.

Range: 33 m (108') with 50 psi cell; 66 m (216') with 100 psi cell.

Resolution: 0.025% FS.

Calibration Accuracy: ± 0.1% FS.

Repeatability: ±0.25% FS to ±1% FS.

Dimensions: 64 x 179 mm (2.5 x 7").

Materials: Stainless steel.

SETTLEMENT PLATE

Settlement Plate. 52630512

229 x 229 mm (9 x 9") steel plate, used in fills.

TUBING AND SIGNAL CABLE

Tubing 51416950

Twin 1/4-inch tubes inside polyethylene jacket. Tubes are filled with de-aired liquid and terminated with quick-connect sockets for connection to reservoir. Specify length.

Non-Vented Signal Cable 50613524

Shielded cable with four 22-gauge tinned-copper conductors and polyurethane jacket. Does not include connecton. Specify length.

RESERVOIR

Small Reservoir. 51419500

Accommodates one settlement cell. Includes mounting hardware, two quick-connect plugs, and small bottle of de-aired liquid.

BAROMETERS

Field Barometer 52612070
Barometer for Datalogger 52612080

INSTALLATION ACCESSORIES

De-Aired Liquid. 51419552

One quart of ethylene glycol-water 50% mixture for maintaining fluid level in reservoir. Mixture has a relative density of 1.065.

Constant-Level Reservoir 92630550
Connection Manifold 92630552

The constant-level reservoir consists of a vented reference tank, a supply tank, an overflow pump, and a weatherproof enclosure. Requires connection manifold below. Pump uses AC power. Manifold connects eight cells to the reservoir and includes a weatherproof enclosure.

Slope Indicator Head Office 12123 Harbour Reach Drive, Mukilteo, WA, 98275 USA
Tel: 425-493-6200 Tel: 800-331-0703 Fax: 425-493-6250 Email: solutions@slope.com

Sediment Profile Imaging

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Germano & Associates, Inc.

Sediment Profile Imaging (SPI)

Rapid Seafloor Reconnaissance and Assessment

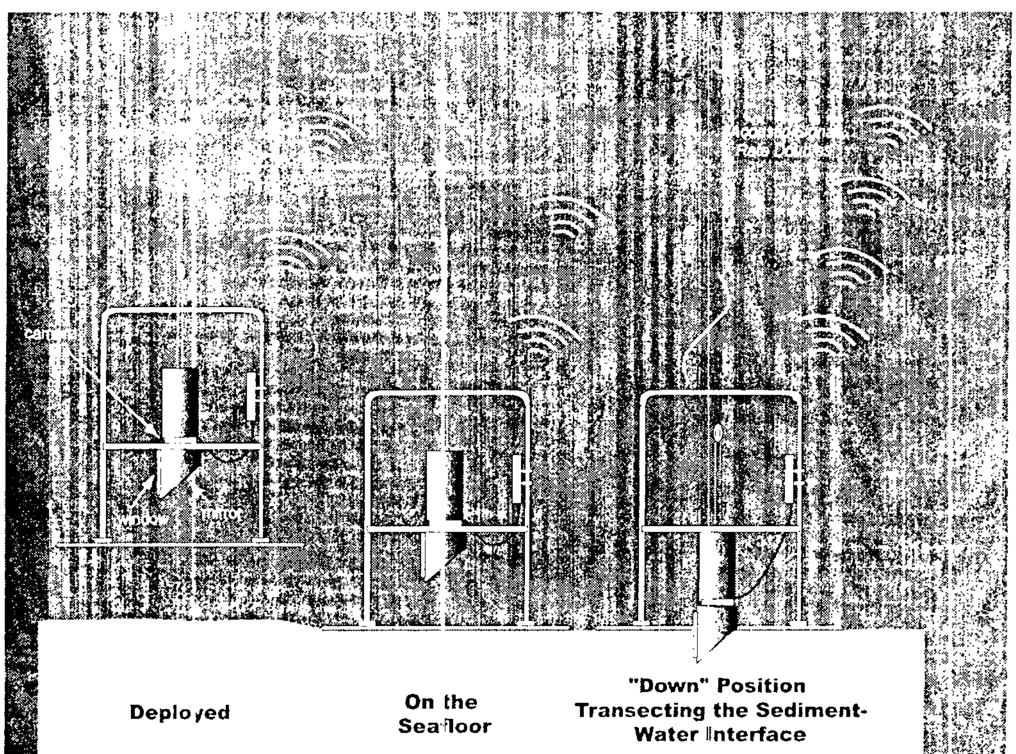
Sediment Profile Imaging - provides an alternative approach to traditional sampling technologies and is a rapid, cost effective

method for mapping changes in the surface of the seafloor. This innovative optical technique can quickly image, measure, and analyze physical, chemical, and biological parameters over large areas of the bottom of lakes, rivers, estuaries, and oceans.

What Does SPI Measure?

The digital images are rapidly analyzed by a computer image analysis system. The software allows rapid measurement and storage of a wide variety of imaged features from each photograph, including:

- *Grain size - major mode and range*
- *Small-scale surface boundary roughness*
- *Dredged-material or drilling mud thickness*
- *Depth of the apparent redox potential discontinuity (RPD)*
- *Erosional or depositional features such as ripples, mud clasts, and laminated or bedded intervals*
- *Subsurface methane gas pockets*
- *Epifauna*
- *Tube density of benthic infauna (number per linear cm)*
- *Thickness of pelletal layers*
- *Surface aggregations of bacteria*
- *Infaunal successional stage*



For more information on our SPI capabilities, please call Dr. Joseph Germano.

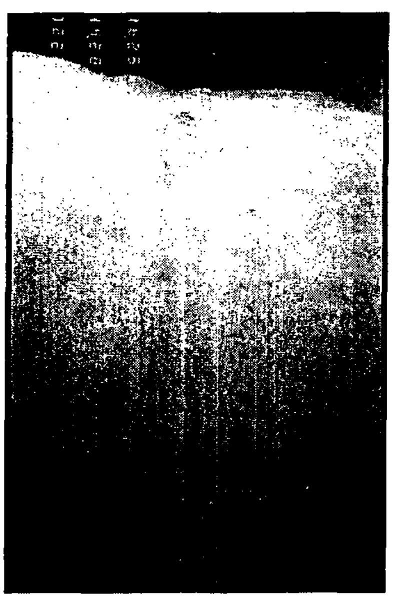
Applications:

SPI technology has a long history of successful applications for:

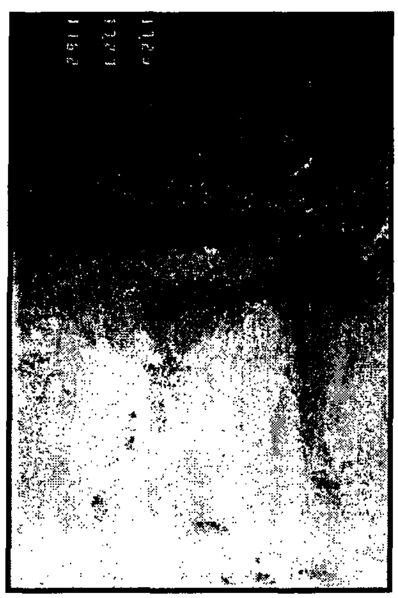
- *Reconnaissance surveys to develop the most efficient grab or box core sampling design*
- *Sediment quality surveys and identification of pollution "hot spots"*
- *Dredged material site designation studies*
- *Confined and unconfined ocean disposal site monitoring*
- *Assessment of low dissolved oxygen*
- *Aquaculture impact assessment*
- *Oil platform impact assessment*
- *Coastal municipal sewage discharge impact assessment*
- *Industrial discharge (e.g., pulp and paper mill, mine tailings) impact assessment*

SPI Technology Will Allow You To:

- *Collect and analyze data rapidly and cost effectively*
- *Develop technically defensible response materials*
- *Create economical sampling designs for expensive ground-truth samples*
- *Achieve broad area coverage (to supplement traditional chemical and biological samples)*
- *Convey ecological information in a clear, unambiguous format, that is easily understandable by the public*



An SPI photograph from a healthy mud bottom shows a sub-surface feeding void from a community of deposit-feeding marine worms.



An SPI photograph taken in the vicinity of a fish farm shows the effects of organic enrichment: a 3-cm thick layer of anoxic waste from the fish pens is covering the seafloor and preventing any oxygen from reaching the underlying sediment.

Technical Details

- High resolution digital images instantly available in the field (6.1 megapixel CCD array with 12-bit RGB color)
- Camera depth rated to 4,000m
- Rapidly shipped via air freight to any location
- Easily deployed from vessels of opportunity (only requires a winch)
- Capacity to do time-lapse imaging at 5 or 60-minute intervals
- Replicate images collected in less than a minute
- Bulk film cassette with 400-frame capacity also available for litigation cases or if client requires 35mm slides
- Image quality is never affected by water turbidity

Germano &
Associates, Inc.

Contact: Joe Germano
President

Telephone: 425.865.0199
Mobile: 425.891.2121
Fax: 425.865.0699
E-mail: joe@remots.com
Address: 12100 SE 46th Place
Bellevue, WA 98006
www.remots.com

Acoustic Sub-bottom Profiler

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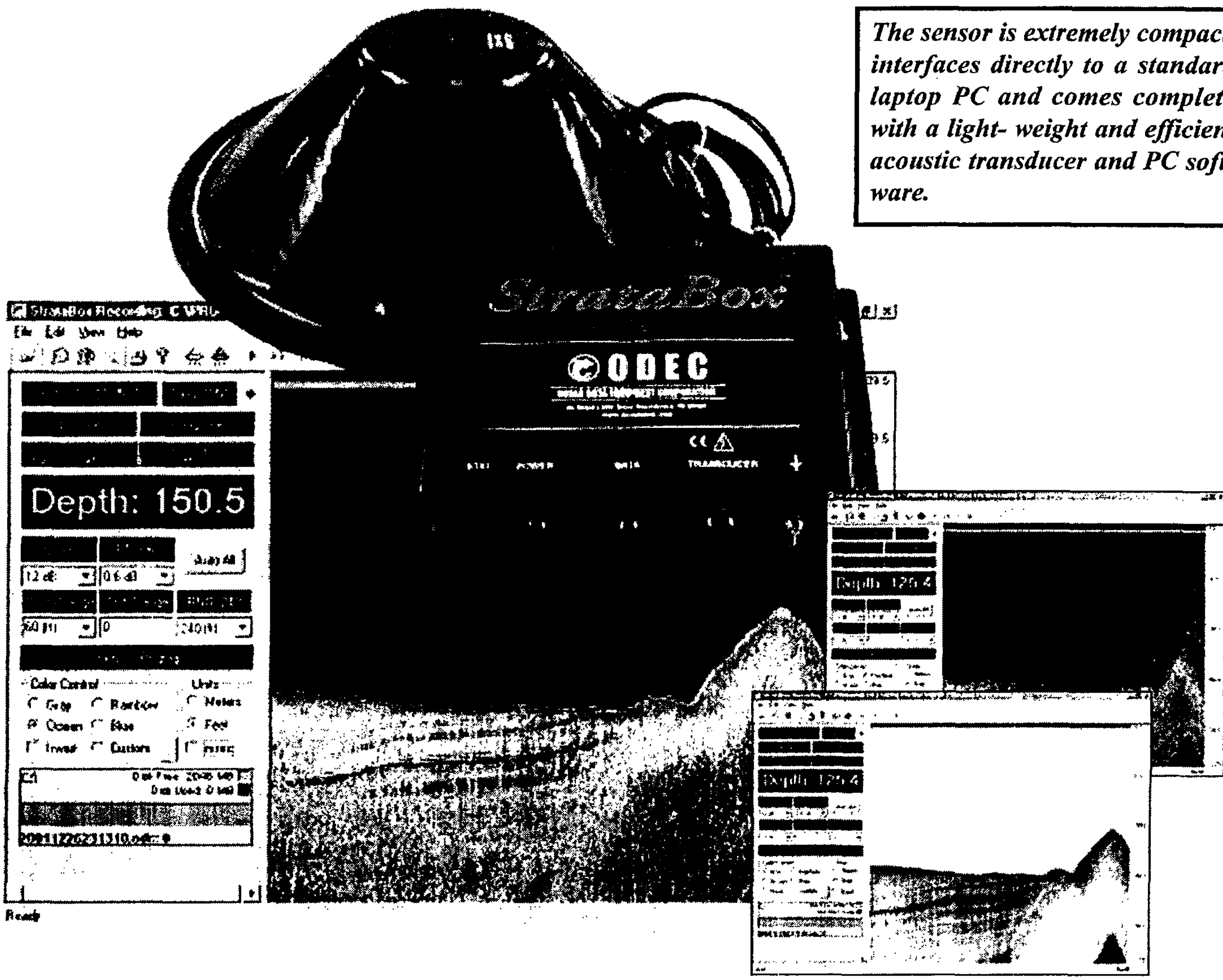
StrataBox ™

Marine Geophysical Instrument

The StrataBox ™ is a portable high- resolution marine sediment imaging instrument capable of delivering 6 cm of marine sediment strata resolution with bottom penetration of up to 40 meters. It is designed exclusively for inshore and coastal geophysical marine survey up to 150 meters of water depth.

The sensor is extremely compact, interfaces directly to a standard laptop PC and comes complete with a light- weight and efficient acoustic transducer and PC soft- ware.



Extreme ease of use, portability, and cost efficiency make this device a perfect choice for shallow water marine geophysical applications

FEATURES

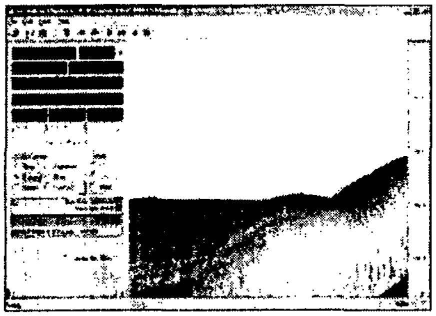
- **Strata Resolution: 6 cm with up to 40 meters bottom penetration.**
- **Depth Accuracy: ± 0.5%**
- **Geographic Position Input, NMEA Compatible**
- **Hypack & HydroPro Compatible**
- **Data Storage & Playback**
- **Zoom Modes**
- **Event Marks**
- **Low Input Power**

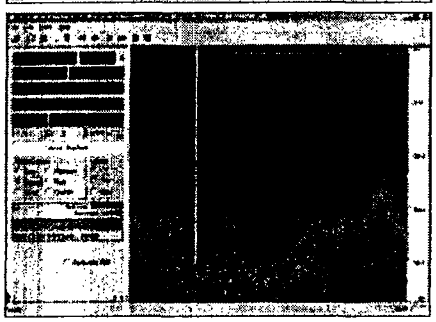
OCEAN DATA EQUIPMENT CORPORATION

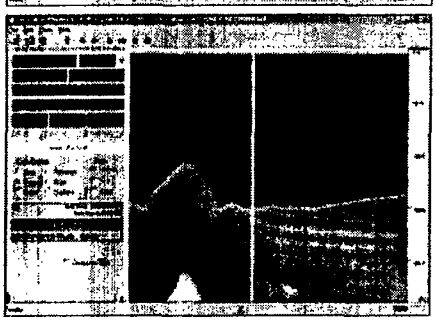
www.oceandata.com

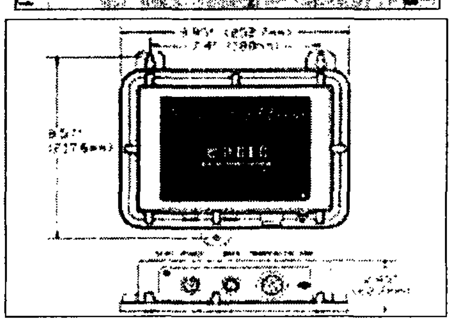
SPECIFICATIONS

StrataBox - Marine Geophysical Instrument









Units:	Feet or Meters
Depth Ranges:	0-15, 0-30, 0-60, 0-120, 0-240, 0-450 Feet. 0-5, 0-10, 0-20, 0- 40, 0- 80, 0-150 Meters. Millisecond Range-scale available in either Feet or Meters. Auto-ranging Modes in all units.
Shift Range:	0-450 feet in 1 foot increments 0-150 meters in 1 meter increments
Zoom Range:	15, 30, 60, 120, 240 feet 5, 10, 20, 40, 80 meters
Zoom Modes:	Bottom Zoom, Bottom Lock, Marker Zoom, GUI Zoom (Playback Only)
Display:	Normal Data, Zoom Data, Navigation, Depth, Command/Status Color Control for Data: 4 selections or Custom (User Input), Data Invert possible.
Strata Resolution:	6 cm with up to 40 Meters bottom penetration.
Depth Resolution:	0.1 foot, 0.1 meters.
Depth Accuracy:	±0.5%
Speed of Sound:	1500 Meters/Second or 4800 Feet/Second.
Navigation Input:	NMEA 0183, GLL, GGA, RMC, VTG, VHW, HDT. Selectable Baud Rate, RS-232 COM2.
StrataBox Interface:	Serial data, 57.6Kbaud, RS-422, COM1.
Printer Output:	Centronics (Parallel Port) interface to TDU Series Thermal Printers.
Shallow Water Operation:	< 2.5 meters; bottom type dependant
Transmit Rate:	Up to 10 Hz, depth and operator mode dependent.
Event Marks:	Manual or Periodic (selectable in 1 minute intervals)
Data File Storage:	Saves Depth, Navigation, and Graphic Data in ODEC format (Proprietary). Normal Data and Zoom Data stored is Pixel Data and can be played back and printed.
Data File Playback:	Files played back and printed at Normal or Rapid Advance Speed, with Pause and GUI Zoom available.
Frequency Output:	10 Khz.
Transmit Output Power:	300 Watts (Pulsed), 1000 Watts capable.
Input Power:	10-30 Volts DC, Nominal Power 8 watts, Reverse Polarity and Over Voltage Protected.
Dimensions:	25.4 cm (10") Length, 15.876 cm (6.25") Width, and 6.25 cm (2.5") Height.
Weight:	0.9 kg (2.0 lbs).
Environmental:	-25°C to +60°C Operating Temperature (-55°C to +90°C Storage) Water Resistant to EN60529 IP65 EMC meets EN60945 Emissions, CE Compliant

All specifications subject to change without notice.

OCEAN DATA EQUIPMENT CORPORATION
88 Royal Little Drive Providence RI 02904 USA
Tel: (401) 454-1810 Fax: (401) 454-1806
E-mail: sales@oceandata.com Web Site: http://www.oceandata.com

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