SEDIMENT DECONTAMINATION DEMONSTRATION PROJECT
RFP# 98-X-99999

PILOT STUDY WORKPLAN

Prepared for:

NEW JERSEY DEPARTMENT OF TRANSPORTATION (NJDOT)
OFFICE OF NEW JERSEY MARITIME RESOURCES (NJMR)

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EXECUTIVE SUMMARY

This Sediment Decontamination Demonstration Project Pilot Study Workplan ("Workplan") has been prepared by BEM Systems, Inc. (BEM) to set forth the procedures and methodology to be followed for the proposed sediment decontamination pilot study. The purpose of the pilot study is to demonstrate, at laboratory scale, the efficacy of an innovative sediment decontamination technology, called Georemediation™, to destroy or permanently fix contamination in the sediments to a level consistent with the proposed beneficial reuse of the decontaminated material. This work will be conducted under a Contract with New Jersey Department of Transportation (NJDOT), through the office of New Jersey Maritime Resources (NJMR). Funding for this study is from the ***Port of New Jersey Bond Act of 1996 (P.L. 1997 C.97)*** ("the Bond Act").

This workplan has been divided into several sections, the contents of which are described in general below. An introduction to the Pilot study intent and project setting is provided in Section 1.0.

Section 2.0 presents the background related to the developments leading up to the execution of the sediment decontamination demonstration project.

Section 3.0 presentes an overview of the Georemediation™ technology process, which is an advanced chemical treatment process that uses a proprietary reagent mixture to chemically degrade and convert organic contaminants to innocuous byproducts through mineralization and to precipitate metal contaminants into highly insoluble hydrated precipitates, which are, in turn, incorporated into crystalline structures.

Section 4.0 presents the specific objectives and success criteria for the proposed pilot study project. In general, the success of the pilot project will be determined by NJMR, and will be based on demonstrating at the pilot level that the Georemediation™ process produces an evironmentally and geotechnically acceptable end-product for use as soil fill at a total unit cost equal to or less than $35 per cubic yard at full-scale level.

Section 5.0 presents the anticipated beneficial reuse applications and markets for the dredged material decontaminated using Georemediation™ technology. Based on the existing and future market demands for the reuse of decontaminated sediments, BEM has identified the beneficial reuse of the decontaminated sediment product for the applications and markets:

- Structural and non-structural fill in transportation and infrastructure construction applications;
- Backfill material for non-remedial construction and for remedial capping material for the reclamation, remediation and redevelopment of abandoned brownfields sites; and,
- Daily, intermediate, or subsurface final cover material for sanitary municipal landfills.

Section 6.0 presents the chemical and geotechnical standards and criteria that will be used for the evaluation of the decontaminated material for its proposed beneficial reuse applications. The concentrations of chemical compounds present in the decontaminated sediment will be compared with NJDEP soil cleanup criteria and groundwater quality standards, in accordance with the guidelines provided in the 1997 NJDEP Guidance Manual, to evaluate human health exposure for various reuse scenarios. Geotechnical criteria for the use of sediment in various construction scenarios do not exist at the present time. Therefore, the geotechnical properties of the

decontaminated sediment will be evaluated with respect to typical construction application ranges and current industry standards and criteria.

Section 7.0 outlines the procedures for the project setup and execution in order to evaluate the Georemediation™ process against the objectives set forth in the Pilot study. A total of 500 gallons of contaminated dredged sediment will be used for the Pilot Study. This sediment will be transported to Rutgers University, where it will be screened, homogenized and characterized prior to sediment treatment.

As part of the Pilot study, BEM will conduct an initial bench-scale optimization of the Georemediation™ technology. This initial bench-scale optimization involves evaluation of the treatment efficacy for three different reagent mixes using three different mix ratios for each mix. The results of the untreated sediment characterization will be used to design the three reagent mixes.

The results of the pilot optimization stage will be evaluated to select the most suitable treatment mixture for the pilot-scale treatment. The pilot-scale treatments will be conducted to simulate mixing and curing conditions anticipated at the full-scale projects. For this purpose, bulk samples of approximately 45 gallons will be treated at one time, using rotary drum mixers. A total of five separate treatment trains will be used to study the following parameters during the Pilot study:

- Effect of dry and slurried reagent on mixing and curing process and subsequent chemical efficacy;
- Effect of severe weather conditions (high humidity, freezing temperatures) on the curing process and chemical efficacy;
- Effect of curing pile depth on the curing process and the chemical efficacy;
- Potential for air emissions exceeding regulatory levels during mixing and curing; and,
- Efficacy of mechanical dewatering equipment to reduce moisture content of the untreated and treated material and its effect on chemical efficacy of the treatment process.

Sections 8.0 and 9.0 present the specific parameters and methodologies for the chemical and geotechnical analysis of the dredged material, respectively. All chemical analyses will be performed at Accutest Laboratories, located in Dayton, New Jersey. The Pilot study and all related geotechnical testing will be conducted at the state-of-the-art Rutgers University Geotechnical and Beneficial Reuse Laboratories located in Piscataway, New Jersey. Specific quality assurance procedures will be followed during the project execution and analysis, as summarized in Section 10.0.

Sections 11.0 and 12.0 present the health and safety procedures and waste management plan, respectively. Since the pilot study is being conducted in Rutgers University Laboratory, general laboratory safety regulations with special considerations for the use of any hazardous chemicals and instrumentation will be followed. A detailed site-specific health and safety plan will be prepared by BEM prior to the pilot study to address any potential exposure of contaminated dredged material and or other chemicals to the personnel involved in the pilot study.

A summary of the project organization and project deliverables are presented in Sections 13.0 and 14.0, respectively. The total cost for conducting the work detailed in this work plan is $607,629. The itemized project budget for this pilot study is presented in Section 15.0 of this document.

Section 16.0 presents the Pilot Study project schedule. The pilot study will be initiated during April 2000 and will be concluded during the end of January 2001.

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1.0 INTRODUCTION

The purpose of this pilot study workplan (the "workplan"), prepared by BEM Systems, Inc. (BEM) of Chatham, New Jersey, is to conduct a sediment decontamination pilot study using the Georemediation™ technology, which was invented and patented by the Aleph Group (formerly IWT Corp.) of Ithaca, New York. This workplan has been prepared as a result of BEM's selection as one of the sediment decontamination technology vendors subsequent to participation in the bid solicitation (#98-X-99999) for a Sediment Decontamination Demonstration Project, issued by the State of New Jersey, office of New Jersey Maritime Resources (NJMR), in March 1998.

The pilot study is the first step of a multi-staged process under the NJMR's program designed to validate and develop new and innovative sediment decontamination technologies. The second phase of the technology demonstration process, assuming successful completion of the pilot study, involves conducting a sediment decontamination and beneficial reuse demonstration project at or near full-scale field production rates.

The source of the dredged sediments for both the pilot and demonstration projects and for future full-scale decontamination facilities originates from commercial dredging for the maintenance of the navigable channels in the NY/NJ Harbor. Both the pilot study and the sediment decontamination demonstration projects are contracted by the New Jersey Department of Transportation (NJDOT), office of New Jersey Maritime Resources (NJMR). These projects will be funded under the ***Port of New Jersey Bond Act of 1996 (P.L. 1997 C.97).***

The decontamination of dredged sediments, in general, is needed to address contamination at levels that require an actual reduction in the chemical concentrations before reuse of the dredged sediments, be it in the ocean or upland. The ultimate goal of the decontamination technologies evaluation under the NJMR's program is to reduce the contaminants in dredged sediments to levels which do not pose an unacceptable risk to human health and the environment while producing a beneficially reusable end-product.

2.0 BACKGROUND

In October 1996, the Governors of New York and New Jersey signed a Joint Dredging Plan for the Port of New York & New Jersey. The objective of this plan is to promote greater certainty and predictability in the dredging project review process, and facilitate effective long-term, environmentally sound management strategies for dredged material management. The goals of the plan, specific to New Jersey, include the development of technologies related to the decontamination, sediment control, processing, beneficial reuse, and harbor sediment contamination reduction and remediation. Some of the beneficial reuse options identified in the plan for continued development include upland beneficial uses such as landfill cover/closure, construction material and hazardous site remediation. The beneficial reuse applications in this plan may require decontamination depending upon the sediment quality and regulatory requirements prior to the use of material at the proposed locations. The plan also outlines New Jersey's commitment to develop state sponsored transportation projects (e.g. NJDOT) utilizing dredged material in an average annual volume of up to 700,000 cubic yards.

In 1997, the State of New Jersey appointed the Dredging Project Facilitation Task Force (DPFTF) under the New Jersey Commerce and Economic Growth Commission (formerly Department of Commerce and Economic Development). The purpose of the DPFTF was to assist office of New Jersey Maritime Resources (NJMR) in establishing priorities for dredging projects in accordance with their economic benefit to the Maritime Commerce in the State. The legislation implementing the Port of New Jersey Bond Act of 1996 also requires that the DPFTF review recommendations and proposals for the funding, development and construction of disposal, treatment, or processing facilities for dredged material, decontamination and treatment technologies, dredging of navigation channels in the Port District, and dredging of navigation channels statewide.

As part of their charter, the office of NJMR issued a request for proposals (RFP) in March 1998 to seek out innovative and reliable sediment decontamination technologies which produce marketable end-products at a full-scale cost of no more than $35.00 per cubic yard.

In response to this RFP, BEM developed a strategy for hosting a full-scale Central Treatment Facility (CTF) for the decontamination of sediments using the patented Georemediation™ technology and subsequent production of beneficially reusable materials. BEM presented its strategy as part of the proposal submitted in May 1998.

In November 1998 BEM was selected as one of the five vendors for the pilot study contract award. BEM was contacted to initiate contract negotiations with NJMR and DPFTF at that time.

On 22 June 1999, the office of NJMR invited BEM to a pre-contract negotiation meeting, which was also attended by personnel from USEPA and NJDEP. The purpose of this meeting was to revisit BEM's goals and approaches to the pilot study program, and to discuss any permitting and/or other regulatory requirements for the studies. At this meeting NJMR requested BEM for a revised workplan, to be developed as the first task of the revised scope of work.

A revised workplan was submitted to NJMR on 03 December, 1999. In addition, BEM submitted a letter to NJMR dated 30 December, 1999 which served as an Addendum to BEM's revised Pilot

Study Workplan. This Pilot Study Workplan Addendum was submitted in response to NJMR comments during a meeting and discussions subsequent to the submission of the revised workplan.

BEM received final comments to the revised workplan from NJMR on 17 March 2000. This document serves as BEM's Final Pilot Study Workplan, and addresses the comments received from NJMR to-date. The scope of work presented in this workplan is based on the guidance and input provided by NJMR, NJDEP and USEPA at the pre-contract negotiation meeting and through subsequent comments and discussions with NJMR.

3.0 GEOREMEDIATION™ TECHNOLOGY OVERVIEW

3.1 Introduction

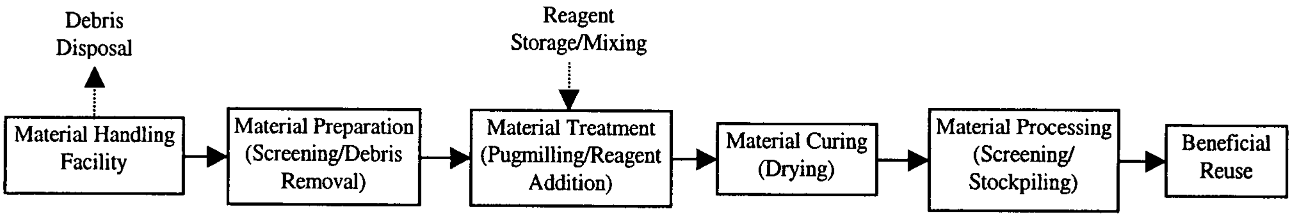
Georemediation™ is an innovative chemical treatment process, developed by the Aleph Group (formerly IWT Corp.) [US Patent #5,700,107], which has been applied successfully for the treatment of waste forms such as soils and sediments containing a wide range of organic as well as inorganic contaminants.

3.2 Decontamination and Sediment Conditioning Mechanisms

The Georemediation™ process uses a proprietary mixture of reactive, basic, inorganic substrates including fly ash, blast furnace slag, and/or cement, modified by the addition of transition metal salts, oxidants, clay pillaring agents and dispersants. The dispersants and clay pillaring agents act to separate clay particles and generate inorganic surfaces between the clay particles which act as sites for facilitating decontamination reactions. The oxidants and metal salts present in the Georemediation™ reagent facilitate electron transfer and the oxidation reactions involved in the mineralization of organic contaminants on the reactive surfaces. The Georemediation™ process precipitates the inorganic contaminants into highly insoluble hydrated precipitates, incorporating them into the crystalline structure in the end-product. This process allows the inorganics to be reduced to acceptable levels as determined by leaching tests and the total acid digestion tests. The decontamination process using Georemediation™ is rapid, taking place in matter of weeks or less as compared to similar geochemical processes occurring naturally over long periods of time. This is because these geochemical processes are accelerated and intensified by many orders of magnitude in the presence of the proprietary Georemediation™ treatment mixture. The resulting product is environmentally benign, acceptable from a human health standpoint, and beneficially reusable. The oxidized byproducts of the organic contaminants, consisting of carbonates, water, and small amounts of inorganic chlorides and sulfates, are innocuous, and commonly found in soils or are used as soil amendments. Geotechnically, the presence of pozzolanic material in the Georemediation™ mix conditions the dredged material by turning the wet, unstable "black mayonnaise" material into a soil-like end-product which is beneficially reusable.

3.3 Treatment Process

The Georemediation™ process is an innovative chemical treatment and stabilizing process that is mechanical, simple, and employs off-the-shelf equipment and reagents. For full-scale projects, Georemediation™ may be employed as an ex-situ as well as an in-situ process. Typically the contaminated material is excavated, stockpiled and screened prior to treatment. The screened material is fed into mixing equipment (e.g. pugmill), where the treatment reagent is added to the material in either slurried or dry form at a typical weight ratio of 10-20% by wet weight of the contaminated material. The decontamination process uses the natural pore-water in the sediments or additional water is added as part of the reagent slurry as a medium for the catalytic and oxidative reactions. After thorough blending of the reagent with the contaminated material, the mixture is placed into open curing beds for 14 to 28 days. During this time, the recrystallization of the matrix occurs and the material attains its desirable chemical and geotechnical properties. Once it is fully cured, the material is ready for stockpiling and transfer to its end-use applications. The Georemediation™ process also accelerates the dewatering process for material with high water content (e.g. sediments), through use of the moisture as a reagent catalyst and a combination of its flocculating properties, latent heat generated during curing process and absorptive properties of the high smectite clay content. For applications to contaminated soils, the treatment reagent is usually added in slurried form, since there is typically not adequate moisture in the soils to effectuate chemical and physical reactions. The Georemediation™ process requires no temperature and pressure controls, no excessive energy input, and no addition of oxygen or nutrients. A simplified schematic of the Georemediation™ Treatment Process for dredged sediments is shown below:



4.0 PILOT STUDY OBJECTIVES AND SUCCESS CRITERIA

The basic objective of the pilot study is to address as many of the issues as possible with respect to Georemediation™ treatment efficacy, beneficial reuse, and material processing within the scope of the workplan budget. The specific objectives for BEM's pilot study are based on the anticipated beneficial reuse applications and applicable chemical and geotechnical criteria and standards for each of these applications as discussed in Sections 5.0 and 6.0. For the purpose of clarity, BEM has categorized the objectives under the following major issues to be addressed at the pilot scale:

Sediment Decontamination Efficacy

- Optimize the Georemediation™ reagent mix ratio and reagent type to provide the most appropriate degree of decontamination efficacy during pilot scale treatment of the dredged material
- Optimize the curing period to provide the most appropriate degree of decontamination efficacy for the treated material for the applicable anticipated beneficial reuse applications
- Validate the chemical effectiveness of the selected Georemediation™ reagent mix ratio to reduce and/or stabilize the contaminants in the dredged material to levels acceptable for the anticipated reuse applications

Material Processing and Operational Issues

- Evaluate the potential for the release of unacceptable air emissions contaminant loading during decontamination treatment and curing processes
- Validate the efficacy of the decontamination technology under curing conditions similar to reasonably anticipated adverse weather conditions (cold and humid curing conditions)
- Investigate the relationship between curing bed depth and decontamination efficacy within potential full-scale design ranges (1.5' and 3' average curing bed depths)
- Investigate the efficacy of mechanical dewatering equipment to reduce the moisture content of the dredged material prior to and after the reagent mixing, and to determine its corresponding effect on the chemical efficacy of the decontamination process on the sediments
- To analyze the chemical quality of the water obtained from the mechanical dewatering study for both the untreated and treated dredged sediment and to determine the efficacy of the treatment process to decontaminated sediment pore-water. This will also provide BEM with the design parameters for the potential pore-water treatment, if deemed necessary

Anticipated Beneficial Reuse Applications

- Evaluate geotechnical properties of the decontaminated material using existing industry standards and criteria to assess its suitability for the anticipated reuse applications
- Demonstrate that reuse of the decontaminated material does not cause an unacceptable risk to human health through application of existing NJDEP Residential- and Non-Residential Direct Contact (RDC and NRDC) cleanup criteria and testing methodologies as specifically requested by NJMR and in a manner consistent with the October 1997 NJDEP technical manual, "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" (NJDEP Technical Manual)

Economic Projection and Market Analysis

- Demonstrate based on economic analysis that the projected cost ($/cubic yard) for the decontamination and beneficial reuse of sediments at demonstration project level (30,000 to 120,000 cubic yards) and full-scale levels (500,000+ cubic yards annually) using Georemediation™ will meet or exceed the $35/cubic yard goals initially established by NJDOT and NJMR.
- Demonstrate the viability of the selected beneficial reuse applications through a market analysis for both the demonstration project and full-scale implementation of the technology

The success of the pilot project will be determined by NJMR. The overall success will be based on demonstrating at the pilot level that the Georemediation™ process produces an evironmentally and geotechnically acceptable end-product for use as soil fill at a total unit cost equal to or less than $35 per cubic yard as evaluated at the full-scale level.

5.0 ANTICIPATED BENEFICIAL REUSE APPLICATIONS AND MARKETS

Based on the existing and anticipated future market demands for the reuse of decontaminated sediments, BEM has selected several beneficial reuse markets and applications which will be evaluated during the pilot study. These beneficial reuse markets include: Transportation and infrastructure construction projects; Brownfields reclamation and remediation projects; and Landfill cover. The proposed testing program for this pilot study, presented in Section 6.0, has been developed to evaluate risk to human health in each of potential beneficial reuse applications. These reuse applications are specifically called out within the context of this Pilot study workplan for the purpose of validating the geotechnical evaluation parameters and comparative geotechnical reuse ranges and the corresponding use of human health criteria.

The testing program is designed to evaluate the suitability of the sediments decontaminated using Georemediation™ process for the beneficial reuse markets without any further amendments to the end-product. Although solidification and stabilization (non-decontamination) techniques have been shown to be effective for some unique applications, depending upon the degree and type of sediment contamination and the anticipated institutional and/or engineering controls, these non-decontamination techniques will not apply in all beneficial reuse situations. For example, it is unlikely that sediments heavily contaminated with organic contaminants (with concentrations far in excess of NJDEP NRDC and IGW cleanup criteria) could be solidified/stabilized and placed as fill on brownfields or landfill sites at which there are no engineering controls geared towards protection of groundwater, such as leachate collection systems or cut off walls. In these instances, and in the absence of such engineering controls, some form of decontamination would be necessary to reduce the contaminants to levels considered protective of human health and the environment, prior to beneficial reuse on these sites.

The selected beneficial reuse applications are further discussed below, and are discussed in the context of specific standards and criteria in Section 6.0

5.1 Transportation and Infrastructure Construction Projects

Sediments decontaminated with Georemediation™ will be utilized as construction fill material for structural and non-structural applications. Specifically, BEM will evaluate the suitability of the decontaminated material for structural fill applications such as railroad/roadway subbase and subgrade material, and non-structural/structural fill applications such as embankment fill (Zone III) material, and containment dike fill material.

5.2 Brownfields Remediation and Reclamation Projects

Sediments decontaminated with Georemediation™ will be utilized as backfill material for non-remedial construction and for remedial capping material (below the top 6-inches in vegetated areas or below an asphaltic top course) for the reclamation, remediation, and redevelopment of abandoned brownfields sites under this market setting.

5.3 Landfill Cover

Under this market setting, sediments decontaminated with Georemediation™ will be utilized as daily, intermediate, or subsurface final cover material for sanitary municipal landfills. Subsurface cover on landfills consists of the material required to reach final grades under the cap, or layers beneath the final 6-inch vegetative layer.

5.4 Potential Future Reuse Applications

In addition to the reuse applications above, the treated sediments using the Georemediation™ process may be suitable for the following reuse applications:

- Admixture for topsoil
- Admixture for cement or asphalt
- Manufacture of light weight aggregate (LWA)

However, the evaluation of these potential future reuse applications is beyond the scope of work for this pilot study.

6.0 BENEFICIAL REUSE STANDARDS AND CRITERIA

Each of the beneficial reuse applications identified in Section 5.0 has a unique set of evaluation requirements based on their respective human health exposure scenarios. The exposure scenarios are key to the selection of applicable environmental standards and criteria to be used to evaluate the decontaminated sediment material's suitability for each respective beneficial reuse application. Likewise, the anticipated load bearing capacity and geotechnical performance of the decontaminated sediment under the individual reuse settings are key to the geotechnical evaluation of the decontaminated sediment. The following sections provide a detailed evaluation of the standards and criteria that will be used in the evaluation of the decontaminated sediments for the anticipated beneficial reuse applications.

6.1 Chemical Testing Criteria for All Beneficial Reuse Applications

There are two general classes of environmental standards and criteria that will be used for this project: those that evaluate human health risk from exposure to the decontaminated sediments, and those that evaluate human health risk from exposure to groundwater impacted by the decontaminated sediments. As per NJMR, ecological risk will not be evaluated under this pilot program.

6.1.1 Human Health Criteria

Human health standards and criteria have been established by the NJDEP, as summarized below.

- *Residential Direct Contact (RDC) Soil Cleanup Criteria (N.J.A.C. 7:26D, as corrected)* - The NJDEP RDC criteria generally addresses risks associated with direct dermal, incidental ingestion, or inhalation contact under chronic exposure scenarios. These criteria were developed using a maximum incremental cancer risk of one-in-one-million. Exposure is based on a seventy-kilogram person living for thirty years of a seventy-year lifetime at a residential property, with a soil ingestion rate of 100 mg/day.
- *Non-Residential Direct Contact (NRDC) Soil Cleanup Criteria (N.J.A.C. 7:26D, as corrected)* - The NJDEP NRDC criteria addresses risks associated with direct dermal, incidental ingestion, or inhalation contact under chronic exposure scenarios. These criteria were developed using a maximum incremental cancer risk of one-in-one-million. Exposure is based on a seventy-kilogram person working for twenty-five years of a seventy-year lifetime at a non-residential property, with a soil ingestion rate of 100 mg/day for a five-day workweek, forty-nine weeks each year.
- *Impact to Groundwater (IGW) Soil Cleanup Criteria (N.J.A.C. 7:26D, as corrected)* - The IGW criteria is applied to soil that may potentially impact the groundwater zone, and takes into account the varying capacity of soil to partition concentrations of individual compounds on the soil particles rather than in the surrounding pore-water. To evaluate applications in which the decontaminated material will be placed in areas with the potential to impact ground water, IGW criteria will be applied to the decontaminated sediment results. Additionally, leachate will be collected as described in the next bulleted item.

- *Groundwater Quality Standards (GWQS) (N.J.A.C. 7:9-6 as corrected)* - These criteria are based on levels of compounds in the groundwater that are acceptable for chronic human exposure. This chronic exposure is defined as consumption of two liters of water per day over a period of 70 years, and must contribute less than an incremental cancer risk of one-in-one-million. GWQS standards are applied to water that may enter or reside within the Class IIA aquifers (as defined in N.J.A.C. 7:9-6). The 1997 NJDEP Technical Manual specifies that leachate, collected from the decontaminated sediments through the USEPA Multiple Extraction Procedure (MEP) (SW846 Method 1320), as modified by NJDEP (*Analytical Testing Requirements for the Placement of Processed Dredged Material at the Koppers Seaboard Site, Kearny, NJ, January 22, 1998*), will be compared to NJDEP Class IIA GWQS to evaluate the anticipated contaminant levels in groundwater that comes in contact with the decontaminated sediments (see Section 8.4).

In accordance with the 1997 NJDEP Guidance Manual, RDC, NRDC, and IGW criteria will be used to evaluate analytical results for bulk sediment chemical analysis related to human health exposure in upland reuse applications. Leachate collected using the MEP method (see Section 8.4) will be compared to the GWQS.

6.1.2 Transportation and Infrastructure Construction Projects

The preferred reuse option for sediments decontaminated using Georemediation™ is used as structural and non-structural fill for transportation and related infrastructure construction projects.

Since the material will be used in a construction application outside the limits of residential properties and used as subbase or embankment grade material, there is limited chronic human exposure risk through either dermal (direct contact) or inhalation pathways.

There are two general categories of use that will be applicable to transportation and infrastructure construction projects. These include use as railroad/roadway subbase and subgrade material, and embankment fill material and containment dikes. These categories will have somewhat different exposure characteristics, and therefore the standards and criteria used to evaluate exposure will be different, as described below.

Although solidification and stabilization (non-decontamination) techniques have been shown to be effective for some unique applications, depending upon the degree and type of sediment contamination and the anticipated engineering and/or institutional controls, these non-decontamination techniques will not always apply in every situation. Dredged material treated using solidification/stabilization in most cases will require additional and more protective engineering controls over those needed in the beneficial reuse of decontaminated sediments.

Railroad/Roadway Subbase and Subgrade Material

Material used as railroad/roadway subbase and subgrade will have no chronic human health exposure. The material will be under railroad and roadway surfaces that will prevent exposure to human receptors. Further, this material will be placed in non-residential areas where humans will not be present for extended periods of time.

As per the October 1997 NJDEP Technical Manual, bulk sediment chemistry results will be collected. These results will be compared to the human health criteria specified above for this reuse application.

While it is not likely that water will infiltrate the materials covering the decontaminated sediment, it is possible that subbase material may be in contact with seasonally high water tables. Therefore, bulk sediment chemistry results will be compared to IGW SCC, and MEP leachate testing will be conducted to evaluate the potential for leachate to adversely impact ground water. In accordance with the 1997 NJDEP Technical Manual and conversations with NJDEP, leachate, as generated using the MEP, will be compared to GWQS criteria.

Embankment Material and Containment Dikes

Similar to the case of rail/roadway construction, material used for embankments and containment dikes (Zone II and Zone III materials as defined in Section 6.2) will also have no chronic human health exposure. Under this application, the decontaminated sediment will be used to construct the embankment or dike core, and imported topsoil will be used as surface cover. Human exposure will be prevented through the placement of this topsoil and by the fact that embankments are placed near railroads and roadways where human exposure is not chronic and the material resides in non-residential settings.

While it is not likely that water will infiltrate the materials covering the decontaminated sediment, it is possible that subbase material may be in contact with seasonally high water tables. Therefore, bulk sediment chemistry results will be compared to IGW SCC, and MEP leachate testing will be conducted to evaluate the potential for leachate to adversely impact ground water. In accordance with the 1997 NJDEP Technical Manual and conversations with NJDEP, leachate, as generated using the MEP, will be compared to GWQS criteria.

As per the October 1997 NJDEP Technical Manual, bulk sediment chemistry results will be collected. These results will be compared to the human health criteria specified above for this reuse application.

6.1.3 Brownfields Remediation and Reclamation Projects

The primary basis for use of decontaminated sediments at Brownfields Remediation and Reclamation Projects will be the geotechnical applicability of the materials. These materials will typically be placed in areas where chronic human exposures are not likely, such as under parking lots, foundations, roads, or caps. Consequently, even existing soils on brownfields remediation and reclamation sites will typically be subject to institutional and engineering controls that limit human exposure but are compatible with the redevelopment plans for the site. Similarly, human exposure to any decontaminated sediments placed on these sites as backfill or as subsurface soil cover material will equally be limited through the placement of the institutional or engineering controls that will be placed as part of the brownfields program at the site. Therefore, there will be limited chronic human exposure to these materials under this reuse application. The primary human exposure route will be via workers completing the brownfields remediation and reclamation projects. Exposure subsequent to completion of the projects will be limited due to control placement.

As per the October 1997 NJDEP Technical Manual, bulk sediment chemistry results will be collected. NRDC and IGW SCC will be used, as appropriate, to evaluate decontaminated sediments placed in the proposed reuse locations. Based on the 1997 NJDEP Technical Manual and conversations with NJDEP, GWQS standards will be used to evaluate leachate, as generated using the MEP, from the sediment. Generally, any material that is determined to be appropriate for transportation and infrastructure construction projects also will be appropriate for brownfields reclamation and remediation projects.

As previously described in Section 5.0, although solidification and stabilization (non-decontamination) techniques have been shown to be effective for some unique applications, depending upon the degree and type of sediment contamination and the anticipated engineering and/or institutional controls, these non-decontamination techniques will not always apply in every situation. For example, it is unlikely that sediments hevaily contaminated with organic contaminants (with concentrations far in excess of NJDEP NRDC and IGW cleanup criteria) could be solidified/stabilized and placed as fill on brownfields or landfill sites at which there are no engineering controls geared towards protection of groundwater, such as leachate collection systems or cut off walls. In these instances and in the absence of such engineering controls, some form of decontamination may be necessary to reduce the contaminants to levels considered protective of human health and the environment, prior to beneficial reuse on these sites.

6.1.4 Landfill Cover

Sediments decontaminated with Georemediation™ may also be used as daily or intermediate cover at landfills within New Jersey. The October 1997 NJDEP Technical Manual states that the purpose of a good intermediate landfill cover is to:

- Impede rodents and vectors from entering the waste fill
- Control malodorous emissions
- Provide a firebreak
- Have limited erosion potential
- Not be easily windblown
- Provide control of windblown litter

BEM anticipates that decontaminated sediment material will adequately meet these objectives for daily, intermediate and subsurface landfill cover as part of the final cover. This material will have limited chronic human exposure after placement in the landfill due to the non-residential areas that the landfills are in and the final surface layers of cover placement.

As per the October 1997 NJDEP Technical Manual, bulk sediment chemistry results will be collected. The results will be compared to NRDC criteria to evaluate human health risk for landfill applications, primarily with respect to exposure of workers to the decontaminated sediment at the landfill. Further, results of leachate, as generated by the MEP, will be evaluated based on concentration trends. The concentration of the final MEP leachate extract will be compared qualitatively to GWQS standards to evaluate suitability of the treated sediment for this reuse application. Based on conversations with the NJDEP regarding the MEP method, this method is intended to evaluate contaminant concentration trends in the MEP leachate after each step. A decreasing trend will be interpreted as an indication that parameters immobilized by the matrix will not be released over time. An increasing trend will indicate that the decontaminated matrix may be breaking down and releasing contaminants.

As previously described in Section 5.0, although solidification and stabilization (non-decontamination) techniques have been shown to be effective for some unique applications, depending upon the degree and type of sediment contamination and the anticipated engineering and/or institutional controls, these non-decontamination techniques will not always apply in every situation. For example, it is unlikely that sediments hevaily contaminated with organic contaminants (with concentrations far in excess of NJDEP NRDC and IGW cleanup criteria) could be solidified/stabilized and placed as fill on brownfields or landfill sites at which there are no engineering controls geared towards protection of groundwater, such as leachate collection systems or cut off walls. In these instances and in the absence of such engineering controls, some form of decontamination may be necessary to reduce the contaminants to levels considered protective of human health and the environment, prior to beneficial reuse on these sites.

6.1.5 Summary of Criteria Usage

Table 6-1 summarizes the criteria that will be used to evaluate analytical results for treated sediment with respect to suitability for reuse options during this pilot study.

Table 6-1: Summary of Criteria Usage for Decontaminated Sediment Reuse Applications

Reuse Option	Section	Test Parameter	Purpose	Criteria for Comparison
Transportation and Infrastructure Construction Projects: Railroad/Roadway Subbase and Subgrade Material	6.1.2	Leachate (MEP)	Evaluate potential ground water impact	Qualitative comparison to GWQS
		Bulk Sediment Chemistry	Identify total contaminant levels to evaluate chronic human exposure of workers during placement of decontaminated sediment materials under road surfaces	RDC/NRDC
			Evaluate potential impact of decontaminated sediments to groundwater	IGW
Transportation and Infrastructure Construction Projects: Embankment Material and Containment Dikes	6.1.2	Leachate (MEP)	Evaluate potential ground water impact	Qualitative comparison to GWQS
		Bulk Sediment Chemistry	Identify total contaminant levels to evaluate chronic human exposure	RDC/NRDC
			Evaluate potential impact of decontaminated sediments to groundwater	IGW
Brownfields Remediation and Reclamation Projects	6.1.3	Leachate (MEP)	Evaluate potential ground water impact	Qualitative comparison to GWQS
		Bulk Sediment Chemistry	Identify total contaminant levels to evaluate chronic human exposure	NRDC
			Evaluate potential impact of decontaminated sediments to groundwater	IGW
Landfill Cover	6.1.4	Leachate (MEP)	Evaluate potential ground water impact	Qualitative comparison to GWQS
		Bulk Sediment Chemistry	Identify total contaminant levels	NRDC

RDC – NJDEP Residential direct contact soil cleanup criteria
NRDC – NJDEP Non-residential direct contact soil cleanup criteria
IGW – NJDEP Impact to groundwater soil cleanup criteria
MEP – USEPA Multiple Extraction Procedure, as modified by NJDEP

6.2 Geotechnical Testing Criteria for Beneficial Reuse

Dredged sediments are considered fine-grained and are generally classified as elastic/organic silt and lean clay under the ASTM soil classification system. The grain size distribution of a majority of dredged sediments fall within a narrow range which include fines ranging from 50% to 95% by volume. These sediments typically have a mayonnaise consistency with high moisture content ranging from 50% to 70%, and are generally weak in strength. Due to high organic content in these sediments the specific gravity is significantly lower than soil-like materials. In addition, the hydraulic conductivity of the raw dredged material is usually low in comparison with upland soils due to the finer nature of sediments and the corresponding grain size distribution.

The discussions below present applicable geotechnical standards and criteria for the beneficial use applications and markets identified in Section 5.0 for dredged materials. The results of geotechnical testing performed during the pilot study will be compared to the criteria and standards described in this section. A summary of the criteria and typical values for materials generally used in beneficial reuse applications identified below is provided in Table 6-2 at the end of Section 6.2.

6.2.1 Transportation and Infrastructure Construction Projects

As outlined in the 1996 Joint Dredging Plan for the Ports of NY & NJ, the state of New Jersey has committed to the development of state sponsored transportation projects agencies such as NJDOT, that will utilize dredged material in volumes of up to 700,000 cubic yards each year. The dredged sediments will be used for structural and non-structural fill applications and this will require more elaborate testing in order to achieve performance equivalent to the soil-like material which are traditionally used for such applications.

NJDOT Criteria

To date, the traditional specifications used by NJDOT for structural and non-structural fill material were developed based on a combination of experience and major research efforts through projects sponsored by the American Association of State Highway and Testing Officials (AASHTO) in the 1950s. These approaches led to establishing simple grain size distribution requirements to predict expected performance in embankment fill (Zones 1, 2, and 3) applications. Zone 1 and Zone 2 embankment fill material designations are generally limited to sand blanket and coarser soil aggregate material placed on swamps, marshes, and other unstable grounds. Zone 3 in swamp embankments is the embankment above Zone 2 and also includes all other areas of embankment constructed on firm ground. The 1996 NJDOT Standard Specifications for Road and Bridge Construction specify the gradation designation of the material classified as Zone 3 embankment material as follows:

- The portion of the material passing the 100-millimeter sieve (4-inch sieve) shall contain not more than 35 percent by weight of material passing the 75-micrometer sieve (No. 200 sieve).

There are no other test requirements specified in the NJDOT specifications for the material used as Zone 3 embankment fill or material used as subgrade and subbase for road and bridge construction projects. These specifications were originally developed for the material composed of soil aggregate or soil aggregate and rock, and the dredged sediments almost always do not meet the above gradation-based NJDOT specifications. This is because it is assumed that material which possess suitable gradation characteristics will possess acceptable strength, bearing capacity, corrosion resistance and freeze-thaw index. Furthermore, no specific standards exist for the fill material used as subgrade or subbase, since it may vary significantly depending upon the anticipated loads and the strength characteristics of the material.

Although there are no general guidelines, criteria, or standards for the geotechnical evaluation of dredged material, the following geotechnical parameters are considered important:

- Bearing Capacity (California Bearing Ratio [CBR] and Resilient Modulus Test) [ASTM D 1883 and AASHTO T 274-82]
- Strength characteristics (Unconfined Compressive Strength, UC) [ASTM D 2166]
- Compaction characteristics for use as sub-base and sub-grade fill material for roadways (Modified Compaction Test) [ASTM D 1557/T 180]
- Deformation characteristics (Freezing and Thawing Test) [ASTM D 560]
- Corrosion characteristics (Sulfates, Chlorides and Resistivity) [ASTM D 516 and ASTM 512]
- Permeability [ASTM D 5084]

A description of each of these standard tests and their applicability with respect to reuse of dredged materials is provided in the following paragraphs.

Bearing Strength Characteristics

One of the important characteristics of structural and non-structural fill material is its strength and load bearing capacity. These characteristics are measured using Unconfined Compressive Strength testing and the California Bearing Ratio (CBR) test. The bearing strength characteristics of a material are largely dependent on the dry density and the moisture content of the material. Typically the required bearing strength of the material used for construction applications may range from a CBR value of 10 to 90 (unconfined compressive strength of 14 to 130 psi) or more depending upon the type of application (non-structural or structural fill). The following table provides some of the typical ranges of CBR values for material generally used as structural and non-structural fill in flexible pavement designs in roadway construction projects (as published by Portland Cement Association [PCA]):

good

California Bearing Ratio (CBR) (Value/Range)	Typical Roadway Construction Applications	
70 – 90	Highest quality base course material	125-170
40 – 70	~~Suitable~~ quality base course or subbase material depending on pavement design and subgrade conditions	70-125
20 – 40	Suitable quality subbase material	30-70
10 – 20	~~Subgrade~~ or select material	10-30
4-40	Subgrade	fair to low quality subbase -

During recent years, State transportation agencies have been specifying the use of resilient modulus testing for evaluation of materials to be used as road and rail subbase materials. Unlike static CBR tests, resilient modulus tests simulate cyclic loading on subgrade soils, which is important in analyzing soil performance under dynamic wheel loads. The bearing strength of a material including soils and sediments can be greatly enhanced by compacting the material and using additives such as cement and lime. The Georemediation™ decontamination process enhances the strength characteristics of the material due to the presence of cement and/or slag in the treatment reagent, in addition to oxidants, salts, and dispersants.

Compaction Characteristics

The compaction characteristics of a material are very important for evaluating its use as structural fill material since it controls the bearing strength of the material. In transportation and construction applications, typically fill is placed in 6 to 12-inch lifts and compacted with an acceptable compactive energy input based on the anticipated loads. The compaction test measures the relationship between soil density and moisture content for a standardized compactive energy input, which dictates the moisture related condition of soil materials prior to their use as structural fill. The decontaminated dredged material may be compacted to Maximum Modified Density (MMD) to evaluate its strength and ~~the CBR~~ values. The density of the soil material typically used in fill applications ranges from 130 to 160 pounds/cubic foot (pcf) at the optimum moisture content ranging from 15 to 25%. 110#/cu ft to 130#/cu ft.

6% to 30%

Deformation Characteristics

Deformation characteristics relating to the moisture and freezing temperatures are important for the material used in construction fill applications. These characteristics are measured by both swelling potential and freeze-thaw performance of the material during its reuse.

Swelling and expansion index tests may be performed to obtain values of percent swelling, swelling pressure and expansion index. These values provide insight to the performance of the material under cyclic fluctuation of ground water table. Typically the percent swelling value of greater than 4 (roughly corresponding to a plasticity index of 20) is an approximate borderline between expansive soils and those that would usually not be troublesome. Similarly, swell pressures greater than 0.6 tons/square foot (tsf), may prove to be unacceptable for certain applications. The expansion index for soil typically suitable for fill applications may range from 5 to 7, depending upon the compaction levels of the material.

Freeze-thaw testing evaluates the number of cycles or freezes and thaw sustained by a sample and its % change in volume prior to failure. The results of such testing can be used to evaluate the placement of treated material with respect to the frost line or insulating the material from adverse weather conditions in a construction setting. The number of freeze-thaw cycles sustained by soil material typically used in fill applications ranges from 2 to 5 cycles depending upon the compaction levels of the soil.

Corrosion Characteristics

The measurements of sulfates, chlorides and resistivity can be used to assess the corrosive potential of the material towards buried concrete and steel. The following presents general guidelines that will be used to evaluate corrosivity of the treated dredged material:

Constituent	Concentration (%)	Degree of Corrosion
Chlorides (Cl)	0.01-0.025	Slightly corrosive
	0.1-0.5	Very corrosive
	≥ 0.5	Extremely corrosive
Sulfates (as SO_4)	0.02-0.03	Slightly corrosive
	≥ 0.3	Severely corrosive
Resistivity (ohm-cm)	10000-6000	Little to none
	6000-4500	Mild
	4500-2000	Heavy
	2000-0	Severe

6.2.2 Brownfields Remediation and Reclamation Projects

The applicable geotechnical parameters for the reuse of decontaminated dredged sediments as general backfill material in brownfields, remedial and non-remedial construction reuse applications include the following:

- Bearing capacity (CBR, Resilient Modulus) of the material to support structures
- Strength characteristics (UC and Triaxial Test) for slope stability and shear strength, etc.
- Permeability for reuse as capping material

Bearing Capacity and Strength Characteristics

There are no existing standards or criteria relating to the bearing capacity for the reuse of dredged material as general backfill. The actual standards for a specific application depend upon the anticipated loads and expected performance. Anticipated loads can vary from close to zero (at or near the surface as cover material) to high loads (material placed on extreme slopes or under heavy structures with large loads).

Permeability Characteristics

The permeability of materials used as cover to prevent dermal exposure or as backfill is generally not specified. However, permeabilities of 10^{-5} cm/sec or lower may be required for final cover which cuts off or reduces infiltration. Both applications occur on brownfields sites, and therefore the permeability will be evaluated under this reuse option.

6.2.3 Landfill Cover

Geotechnical requirements for decontaminated sediments in landfill applications generally include the following:

- Moisture content
- Permeability
- Strength characteristics for placement on slopes and equipment loading during landfill operations

Strength Characteristics

The strength characteristics of the material in landfill cover applications are important for the purpose of slope stability and shear strength. These characteristics can be established by measuring shear strength, cohesion, and angle of internal friction of the material. Typical slopes used in landfill applications may be as steep as 3:1 (H:V). The CBR value of the material may range from 10-50 or more depending upon the amount of material placed above.

Moisture Content and Permeability Characteristics

The permeability characteristics for material for landfill cover are similar to as described in Section 6.2.2 for capping of waste units in brownfields-related applications which may require permeabilities of 10^{-5} cm/s or lower. The moisture content of the material during the compaction plays an important roles in achieving the desired in-place permeability of the material. Typically the capping material is compacted with moisture content slightly wet of the optimum thereby lubricating and allowing the particles to disperse more and creating a less flocculated and less permeable compacted soil.

The organic content, the type of treatment, pH, dry density, and the moisture content primarily control the overall performance of the dredged material. The geotechnical testing proposed as part of this workplan is designed to evaluate the suitability of the dredged material decontaminated using Georemediation™ process for the anticipated beneficial reuse applications without any further amendments. However, the results of this evaluation will indicate the types of amendments that may be needed to achieve the desired performance criteria for the beneficial reuse applications.

As previously indicated, a summary of the criteria and typical values for materials generally used in beneficial reuse applications identified in the section above is provided in Table 6-2 below.

Table 6-2: Summary of Geotechnical Tests and Typical Ranges for Materials used for Applicable Beneficial Reuse Applications

Parameter	Methodology	Purpose	Typical Values/Ranges	Applicable Beneficial Reuse Applications[a]
pH	ASTM D 4972	To assess contaminant leachability and corrosiveness of soils	7 – 7.5 10 – 11.5 (cement/lime stabilized soils)	1, 2, 3
Percent Moisture	ASTM D 2216-85	To aid in characterizing the soil and determining the degree of solidification required for placement	150 – 120% $W_{\%opt}$: 38 – 43%	1, 2, 3
Grain-size Analysis	ASTM D 421/422	To determine the particle-size distribution of material	80 – 85% Silt 10 – 15% Sand 5 – 10% Clay 0 – 5% Gravel/Shells	1, 2, 3
Specific Gravity	ASTM D 854-83	To determine the specific gravity of the sediments	2.6 – 2.7	1, 2, 3
Atterberg Limits	ASTM D 4318-84	To define the consistency of the material as a function of its water content	Liquid Limit (LL): 89 – 110 Plasticity Index (PI): 15 – 40	1, 2, 3
California Bearing Ratio (CBR) Test	ASTM D 1883	To determine thickness and value of a soil as a subgrade base or sub-base material	10 - 20 (Subgrade Material) 20 – 40 (Subbase Material) >40 (Base Course Material)	1, 3
Resilient Modulus Test	AASHTO T 274-82	To assess plastic deformation under simulated traffic conditions	Subgrades Only $K3_3\sigma_3^{k4}$ K3 = 139 –147 K4 = -0.05 to –0.11 σ_3 = deviator stress (kPa)	1
Unconfined Compressive Strength	ASTM D2166	To measure strength of an unconfined and unconsolidated material	Su = 2 – 6 tsf* (27 – 84 psi)	1, 3
Freezing and Thawing Test	ASTM D 560	To determine how materials behave or degrade after repeated freeze-thaw cycles	2 – 5 Cycles	1
Sulfates, Chlorides, and Resistivity	Sulfates (ASTM D-516); Chlorides (ASTM 512)	To assess corrosive potential of the material on buried concrete and steel structures	Resistivity: 65 – 75 ohm-cm Sulfates: 1 – 2% Chlorides: 1 – 3%	1
Modified Compaction Test	ASTM D 1557/T 180	To determine the relation between moisture content and density of a material for the purpose of compaction levels required prior to placement	γdmax = 130 – 160 pcf ($W_{\%opt}$ = 15 – 25%	1, 2, 3
Swelling Test	ASTM D4546	An index property comparable to LL and PI	Swell Pressure: 0 – 1.5 tsf	1
Expansion Index Test	ASTM D4829	To determine swelling potential of the material	Index = 5 – 7	1

[a] Beneficial Reuse Applications: 1: Transportation and Infrastructure Construction Projects; 2: Brownfields Remediation and Reclamation Projects; 3: Landfill Cover.

7.0 PROJECT EXECUTION

This section presents a detailed description of the proposed processes to achieve the objectives of the pilot study outlined in Section 4.0. The proposed pilot study objectives have been categorized as follows:

- Sediment decontamination efficacy;
- Anticipated beneficial reuse applications
- Material processing and operational issues

To address these issues and achieve the objectives of the study, BEM has broken down the pilot study execution in a series of processes starting from the storage and pretreatment of raw dredged material, material characterization, pilot optimization of the technology, demonstration of the pilot scale treatment, and disposal and/or beneficial reuse of the material.

The proposed pilot study process flow chart is presented in Figure 7-1. The major elements of the pilot study are further detailed and presented below:

7.1 Pilot Study Location

The pilot study operations and all related geotechnical testing will be conducted under the direction of Dr. Ali Maher as a consultant to BEM. Dr. Maher has an arrangement with the Rutgers University to utilize the Geotechnical and Beneficial Reuse Laboratories located in Piscataway, New Jersey for this study as a consultant to BEM. In general, the work to be performed at Rutgers as part of the Pilot study will consist of sediments storage, pretreatment, treatment (mixing), curing, sample collection and material handling, and geotechnical testing. A letter of commitment from Dr. Ali Maher, Chairman of the Department of Civil Engineering and CAIT research institute at Rutgers University is attached in Appendix A.

The pilot study was previously proposed to be conducted at New Jersey Institute of Technology (NJIT) as presented in BEM's proposal dated May 1998 for the Sediment Decontamination Demonstration Project. However, based on recent discussions with representatives from NJIT, and due to on-going renovation and construction activities at NJIT's geoenvironmental laboratories, NJIT will not be able to accommodate the space and schedule requirements for BEM's proposed pilot study. Consequently, BEM has proposed Dr. Maher as the consultant, using Rutgers laboratories as the alternative site where the pilot study will be conducted.

Based on the information from NJMR, the contaminated dredged material for the pilot study has been dredged and is currently being stored at the Sratus Petroleum site, located along the Newark Bay, north of the Elizabeth Marina. BEM has requested NJMR to provide approximately 500 gallons of dredged material required for BEM's pilot study, which will be provided by the NJMR office in 30-gallon HDPE drums after the Contract is in place. BEM will be responsible for the transportation of the material to the facilities at Rutgers University, where the pilot study will be conducted.

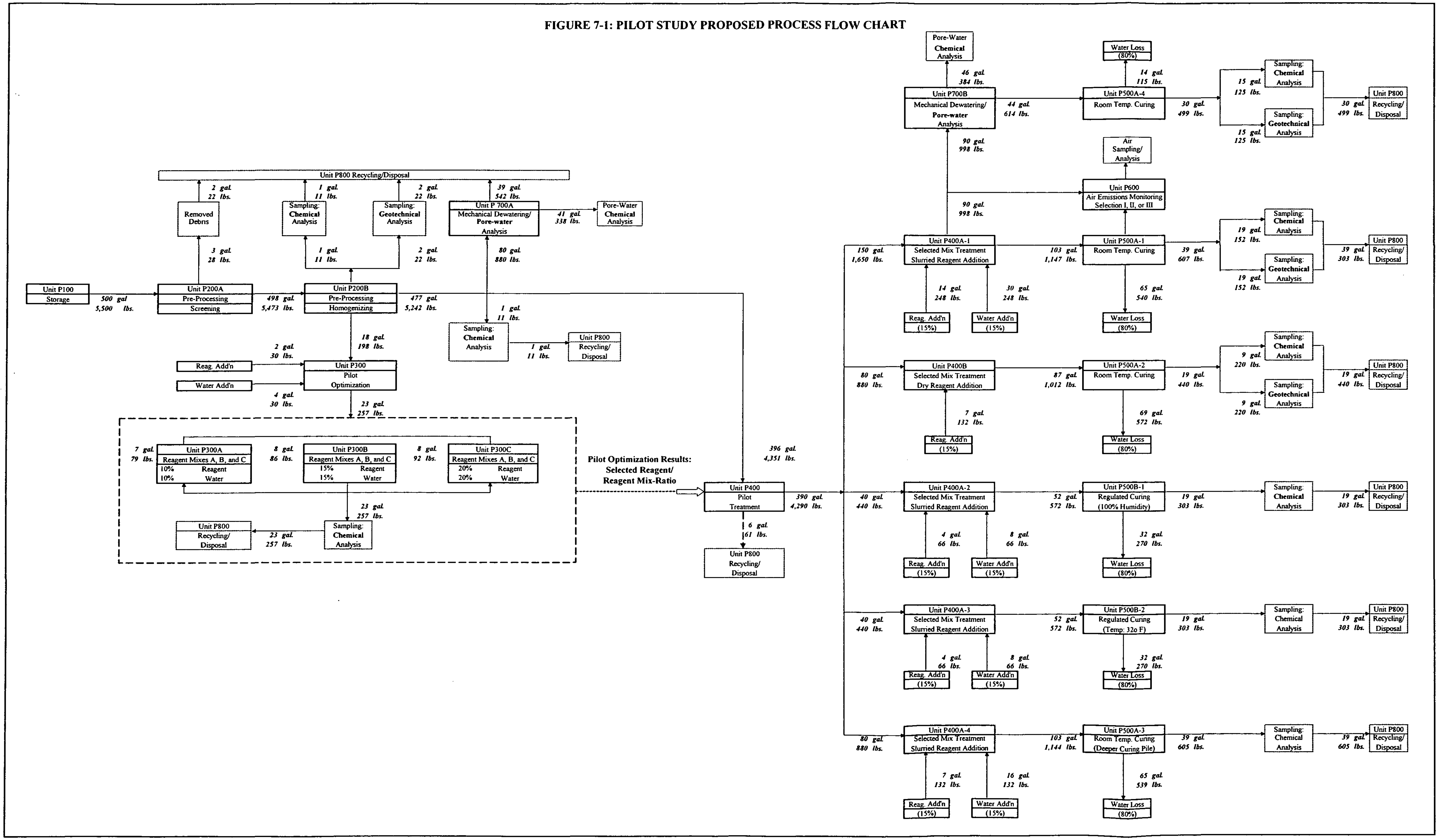


FIGURE 7-1: PILOT STUDY PROPOSED PROCESS FLOW CHART

7.2 Storage and Pre-Treatment – Unit P100 and Unit P200

The following summarizes the unit processes for the storage and pre-treatment of the raw dredged material prior to characterization and treatment.

7.2.1 Storage - Unit P100

The dredged material will be stored at room temperature at the Rutgers facilities prior to and throughout the pilot study. The drums will be tightly sealed during storage to prevent evaporation and contaminant volatilization.

7.2.2 Pretreatment - Unit P200

The purpose of pretreatment is to prepare the material to ensure better and more economical application of the Georemediation™ reagent. For the purpose of the pilot study, pretreatment will consist of removal of large debris and material homogenization. BEM has assumed that the 500 gallons of material provided for this study will consist of approximately 40% solids and will not require any dewatering for the proposed Georemediation™ treatment process. Since the chemical and physical characteristics of the sample to be provided for the pilot study are not yet definitively known, BEM assumes that as received sample will not be homogeneous and it will contain a minimal amount of debris (approximately 0.5% by wet weight). Consequently, BEM anticipates the following pretreatment for this pilot study:

Screening - Unit 200A

At Rutgers facility, the BEM team will screen the raw dredged material to remove miscellaneous debris and particle sizes larger than one inch, prior to homogenizing. For this purpose, BEM will employ a one-inch screen placed on top of a polypropylene holding tank with capacity greater than 500 gallons. BEM will pour the raw material onto the screen using a drum lifter capable of handling 30-gallon drums. The screening process will be conducted on a PVC liner to prevent accidental splashing of the dredged material. Using laboratory forks, BEM will remove and manually transfer all debris and large particles from the screen to a disposal drum. It is assumed that the amount of debris removed will represent approximately one-half percent (2.5 gallons) of the total weight of the raw dredged material. The BEM team will appropriately dispose of the debris removed from the screens.

Homogenizing - Unit 200B

After screening BEM will store the material in a clean High-Density Polyethylene (HDPE) holding tank. BEM will then homogenize the sediments using one or more gear drive, dual propeller electric mixers, mounted securely above the holding tank. Based on the physical appearance of the sample, BEM will ascertain the amount of time required for the homogeneous blending of the sediments, which may range from approximately10 to 30 minutes.

7.3 Raw Dredged Material Characterization

BEM will perform chemical and geotechnical analyses for the initial characterization of the dredged material prior to conducting the pilot optimization of the Georemediation™ technology. The sampling for the chemical and geotechnical testing will be performed immediately after the homogenization of the entire raw dredged material. For the chemical analysis, BEM will collect 3 samples, with each sample consisting of individual 5-part samples collected at random from different locations and depths within the holding tank and composited in the laboratory on an equal weight basis prior to the analysis. The geotechnical testing will be performed to evaluate only basic physical parameters of the untreated sample. Physical parameters specific to the anticipated beneficial reuse applications will be evaluated only for the treated samples. A summary of the sampling plan for the entire pilot study including the raw dredged material characterization is presented in Table 7-1.

The chemical results of the untreated sample will be used to establish three different Georemediation™ reagent design mixes (reagent mixes A, B, and C) of different strengths for the decontamination purposes. The decontamination efficacy of the three reagent mixes will be evaluated and compared during the pilot optimization stage.

TABLE 7-1: PILOT STUDY SAMPLING FREQUENCY AND TESTING REQUIREMENTS

Tests	Pilot Optimization		Pilot Treatment		Total Samples
	Untreated	Treated	Untreated	Treated	
		Chemical Testing			
% Moisture	3	18	3	44	**68**
TOC	3	18	3	44	**68**
Bulk Sediment Chemistry					
TAL Metals	3	18	3	44	**68**
BNA+20	3	18	3	44	**68**
VOC+10	3		3	44	**50**
Pesticides	3		3	44	**50**
PCBs	3		3	44	**50**
TPHCs	3	18	3	44	**68**
Dioxin/Furans	3		3	44	**50**
Sulfides	3		3	44	**50**
pH	3	18	3	44	**68**
Leaching Test (MEP)			2	2	**4**
Sulfates, Chlorides, Resistivity			3	2	**5**
Air Emissions Testing					
VOC+10				8	**8**
BNA+20				8	**8**
Pesticides				8	**8**
PCBs				8	**8**
Leachate Testing (Unfiltered and Filtered)					
TAL Metals			6	6	**12**
BNA+20			6	6	**12**
Pesticides			6	6	**12**
PCB Congeners			6	6	**12**
TPHCs			6	6	**12**
Dioxin/Furans			6	6	**12**
pH			6	6	**12**
		Geotechnical Testing			
Grain-Size			3	9	**12**
Specific Gravity			3	9	**12**
Atterberg Limits			3	9	**12**
California Bearing Ratio (CBR) Test				9	**9**
Resilient Modulus Test				9	**9**
Triaxial Compressive Test				9	**9**
Freezing and Thawing Test				9	**9**
Modified Compaction Test				9	**9**
Collapse Potential				9	**9**
Swelling Test				9	**9**
Permeability Test				9	**9**

Proctor
Density Control Testing

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7.4 Pilot Optimization Stage – Unit P300

The purpose of the pilot optimization stage is to establish the most cost-effective balance between the strength (chemical composition) of the Georemediation™ reagent mix (mix A, B, or C) and the corresponding mix-ratio (% reagent used by wet weight of sediment) in achieving the objectives of this pilot study. For this purpose, BEM proposes the following:

- Based on the initial chemical and physical characterization of the dredged material and BEM's prior testing of NY/NJ Harbor sediments, a total of three distinct Georemediation™ reagent mixes (reagent mixes A, B, and C) with distinct chemical compositions and strengths will be designed
- Three reagent mix-ratios (10%, 15%, and 20% by wet weight of sediments) will be employed to study the chemical efficacy of each of the three reagent mixes

A detailed sampling plan during the pilot optimization stage is presented in Table 7-2. A summary of the sampling plan and applicable chemical and geotechnical testing parameters at various sampling stages of the pilot study is presented in Table 7-1.

As presented in Table 7-2, a total of 9 combinations of the reagent mix and mix-ratio will be employed in the pilot optimization stage. The mixing of the sediment samples and the Georemediation™ reagent mix will be performed using a small laboratory batch mixer with a minimum of one-gallon capacity. The quantity of the reagent mix used will be measured as percent of the wet weight of the untreated sediment sample. Prior to mixing, the proprietary reagent will be slurried using a 1:1 ratio of mix to water in a separate blender. The slurried reagent will then be added to the sediment sample. BEM will base the mixing time during this treatment on visual observation in order to achieve homogeneous mixing of the proprietary mix and raw sediment sample. The mixing time may vary between 10 to 30 minute depending upon the efficacy of the mixing equipment.

After mixing, the sediment samples will be transferred to open curing pans and kept at room temperature. Following a 14-day period, all treated samples will be thoroughly homogenized and two 5-part samples will be collected from each of the 9 treated materials. The 5-part samples will be collected at random from within the homogenized treated materials and composited in the laboratory on an equal weight basis prior to analysis. The purpose of homogenizing the treated samples prior to analysis at the pilot optimization stage is to bias the results to reflect the effect of individual reagent mix and mix-ratio combinations instead of the effect of curing bed depth and location on the chemical efficacy. The effect of curing bed depth and location on the chemical efficacy of the treatment process will be studied at the pilot scale treatment using the treatment conditions identified at the pilot optimization stage.

The results of the indicator parameters for all 9 treated samples will be compared to select the Georemediation™ reagent mix (mix A, B, or C) and a corresponding mix-ratio (10%, 15%, or 20%), which will be most cost-effective in achieving the objectives of the study. The economics of the treatment process are dependent upon the design of the reagent mix as well as the amount of reagent used during treatment. However, certain desirable chemical and geotechnical properties

TABLE 7-2: PILOT OPTIMIZATION STAGE (UNIT P300) PROPOSED SAMPLING PLAN

Reagent Mix	Reagent Mix-Ratio			Total (# of Samples)
	10%	15%	20%	
	14 Day Curing Period			
A	2	2	2	6
B	2	2	2	6
C	2	2	2	6
Total (# of Samples)	6	6	6	18

NOTES:

1. Reagent mix-ratio represents the amount of dry Georemediation™ reagent mix used as percent by wet weight of the contaminated sediment.
2. The reagent will be introduced into the contaminated sediment in a slurry form using 1:1 ratio of reagent to water, prior to mixing
3. Samples will be collected at the end of the treatment curing period of 14 days to evaluate relative performance of individual Reagent mixes and mix-ratios.
4. Treated material will be homogenized at the end of the 14 day curing period prior to sampling and analysis
5. Samples will be collected as 3-part samples from different locations and depths within the homogenized curing pile and will be composited in the laboratory on an equal weight basis prior to analysis
6. Samples will be analyzed only for the following indicator parameters: pH, TOC, TPHC, PAHs, TAL, PCBs

may not be achieved using a less costly reagent mix and lower mix-ratio. Therefore, the results of the pilot optimization will be compared against the pilot objectives and beneficial reuse criteria in order to select the reagent mix and mix-ratio for the pilot scale treatment. The results will be ranked for the following parameters, in the order of importance, at the pilot stage for the selection of the appropriate reagent and reagent mix-ratio:

- Ability to degrade or reduce concentrations for greater number of contaminant groups
- Ability to achieve greater percent reductions in the contaminant concentrations
- Ability to produce material geotechnically suitable for one or more of the anticipated beneficial reuse applications
- Anticipated full-scale economics of the treatment reagent

7.5 Pilot Treatment - Unit P400

Prior to the pilot treatment, the raw dredged material will be re-homogenized and sampled for re-characterization of the material using the procedures outlined in Section 7.3. The purpose of re-characterization of the raw dredged material is to identify any changes in the contaminant concentrations during the pilot optimization period due to potential degradation of organics or loss due to volatilization. A summary of the testing parameters for the raw material characterization is presented in Table 7-1.

The treatment of contaminated sediments during the pilot stage will be performed using the reagent mix (A, B, or C) selected after the pilot optimization stage at the reagent mix ratio (e.g. 10%, 15%, or 20%) determined to be most effective. The main objective of this pilot treatment is to simulate conditions anticipated in the demonstration and full-scale projects. For this purpose, BEM will perform the pilot treatment in a staged manner with approximately 40 gallons of bulk sediment sample processed at one time, using an 8 cubic foot rotating drum mixer. The drum mixer will be used to simulate the pugmilling operation to be employed for mixing during the demonstration and full-scale projects. For the purpose of providing material balance, the selected reagent mix-ratio is assumed to be 15% by wet weight of the untreated sediments. The pilot scale treatment will be performed using proprietary reagent in both slurry and dry forms. For the treatment using slurry form, a separate 5-gallon bucket with a hand held electrical mixer will be used for blending using 1:1 reagent to water ratio.

A total of 5 treatment trains will be employed during pilot stage to achieve the objectives of the study as summarized below:

- Unit 400A-1 – Treatment using slurried reagent in order to study the chemical and geotechnical effectiveness of curing process at room temperature
- Unit 400B – Treatment using dry reagent in order to study the chemical and geotechnical effectiveness of the curing process at room temperature
- Unit 400A-2 – Treatment using slurried reagent in order to study the chemical effectiveness of curing process under regulated conditions using 100% humidity
- Unit 400A-2 – Treatment using slurried reagent in order to study the chemical effectiveness of curing process under regulated conditions using freezing temperatures

- Unit 400A-3 – Treatment using slurried reagent in order to study the chemical effectiveness as a function of the depth of the curing pile under room temperature

7.6 Curing - Unit P500

After treatment, the dredged material will be transferred to polyethylene plastic pans for the purpose of curing the material. The approximate size of the curing pans is assumed to be 2 feet wide, 2 feet long, and 1.5 feet high, with an approximate capacity of 45 gallons of material. The curing pans will be placed at room temperature as well as regulated conditions. For the purpose of this study, BEM will simulate the following two regulated conditions anticipated during demonstration and full-scale projects to study their effect on the curing process and chemical effectiveness:

- Curing at room temperature under 100% humidity
- Curing at freezing temperatures

BEM will also monitor the temperature and humidity levels for the treated material cured under room temperature conditions. In addition, BEM will also study the chemical effectiveness of the treatment at different depths of the curing pile during the curing process. For this purpose, BEM will utilize a curing pan providing at least 3 foot thickness of the treated material. At the end of each curing period, one-part duplicate samples will be collected from the center of the curing pan at three different depths within the curing pile and analyzed for the target analytes. In addition, temperature gauges will be placed at three different sampling depths in order to monitor the temperature variations during the curing process. Finally, a porous material overlain by a Geotextile will be placed at the bottom of the deep curing bed to demonstrate that at the end of the curing period, no leachate has collected at the bottom of the curing bed. A summary of the sampling plan for the material after the pilot treatment is summarized in Table 7-3. The testing requirements for these samples are presented in Table 7-1.

7.7 Air Emissions Testing - Unit P600

BEM will conduct air emissions testing during one of the pilot treatment trains to evaluate the quantities of materials that are lost to volatilization during the mixing and curing stages of the pilot test. The purpose of this testing will be to evaluate any expected air emissions that may occur during the demonstration and full-scale testing. This information will allow BEM to evaluate the need for air permits during subsequent stages of the testing program.

Air samples will be collected during the mixing stage by inserting a probe into the rotating drum mixer used for the pilot scale treatment process. Air samples will be collected during the curing process by covering the curing pans with a lid and inserting a probe into the lid.

Testing will be conducted using four sample collection media and analytical procedures. First, a six-liter Summa Canister will be used to collect a grab sample from the test unit for analysis using a modified EPA Method TO-15 procedure. This procedure uses GC/MS instrumentation, and provides a standard EPA Target Compound List (TCL) of Volatile Organic Compounds (VOCs) plus up to ten tentatively identified compounds (TICs).

TABLE 7-3: PILOT TREATMENT (UNIT P400/P500) PROPOSED SAMPLING PLAN

Treatment/Curing Conditions	Curing Period			Total
	14 Days	28 Days	60 Days	
Reagent Addition as a Slurry (1 Reagent: 1 Water)				
Room Temperature Curing	2	2	2	6
Regulated Curing (100% Humidity)	2	2	2	6
Regulated Curing (32° F)	2	2	2	6
Dry Reagent Addition				
Room Temperature Curing	2	2	2	6
Reagent Addition as a Slurry (1 Reagent: 1 Water)				
Room Temperature Curing (Curing Bed Depth Analysis)	6	6	6	18
Reagent Addition as a Slurry (1 Reagent: 1 Water)				
Mechanical Dewatering/Room Temperature Curing	2	0	0	2
Total (# of Samples)	16	14	14	44

NOTES:
1. Results of the pilot optimzation testing will be used to select the reagent mix and the associated reagent mix-ratio for the pilot treatment.
2. Reagent mix-ratio represents the amount of dry Georemediation™ reagent mix used as percent by wet weight of the untreated sediment.
3. Samples will be collected as 3-part samples from different locations and depths within the curing piles and will be composited in the laboratory on an equal weight basis
4. Samples from the deeper curing pile will be collected from three different depth intervals within the curing pile to evaluate treatment efficacy across the depth of the pile
5. Treated samples will be analyzed after curing periods of 14, 28, and 60 days for the applicable analytical parameters
6. Regulated curing will be performed to simulate certain weather conditions which may be anticipated during demonstration project
7. Mechanical dewatering will be performed immediately after the reagent mixing and prior to curing

Second, a low-volume sample pump (less than ten liters per minute) will be used to collect a sample on a polyurethane foam (PUF) sample cartridge. The total volume of air to be pumped across the sample cartridge will be determined at the time of the test, and will depend on the final size and shape of the test unit. The duration of the sample collection will be thirty minutes. The goal will be to pump the greatest possible volume of air across the sample cartridge that is consistent with the pilot testing procedures. The final detection limits will be dependent on the volume of air that is pumped. This sample cartridge will be analyzed using a modified EPA Method TO-10 procedure. This procedure uses GC/ECD instrumentation, and provides pesticide and Aroclor concentration data.

Third, a low-volume sample pump will again be used, this time to collect a sample on a PUF/XAD in a volatile organic sampling train (VOST) tube. This sample media will be analyzed using a modified EPA Method TO-13 procedure to analyze for TCL semi-volatile organic compounds (SVOCs), plus up to fifteen TICs. The duration of the sample collection will be thirty minutes.

Fourth, another low-volume sample pump will be used to collect a sample on a filter for metals analysis. Analysis will be conducted using NIOSH method 7600. The duration of the sample collection will be thirty minutes.

The sampling containers and bags used for air sampling will be utilized in accordance with the most recent regulations, including the requirements regarding dedicated, one-time usage and specified holding times. This sampling program will be conducted at eight discrete sampling times as described in Table 7-4. Results of the air emissions testing will be compared to the Reporting Thresholds and State-of-the-Art Thresholds provided in Table B of Appendix 1 to N.J.A.C. 7:27-8 to evaluate whether demonstration or full-scale implementation of Georemediation™ technology will require air emission permits and controls. Air emission testing results will also be compared to OSHA Permissible Exposure Limits (PELs) to evaluate the need for personal protective equipment during demonstration and full-scale implementation. Finally, the results of the sequential air emissions testing will be graphed to determine the approximate total emissions, on a time-weighted-average basis from mixing through curing, by calculating the area under the concentration curve.

7.8 Mechanical Dewatering Tests - Unit P700

As an aid to the process design for the demonstration project, BEM will conduct mechanical dewatering tests on the untreated and treated dredged material. The mechanical dewatering tests will be conducted using a pilot scale mechanical screw press designed to use sediment volumes ranging from 40 to 150 gallons. For the purpose of this study, BEM has assumed that screw press mechanical dewatering equipment provides a higher percent of solids as compared to belt filter press equipments. The purpose of these mechanical dewatering tests is to determine the following:

- Effectiveness of the mechanical dewatering equipment to reduce the moisture content of the dredged material prior to and after the Georemediation™ reagent mixing
- Effect of mechanical dewatering of the treated material on the curing process and chemical efficacy of the treatment
- Quality of the pore-water for the raw and treated dredged material in order to determine the need for any waste-water treatment during the demonstration project

TABLE 7-4: PILOT TREATMENT (UNIT P600) - AIR EMISSIONS TESTING PROPOSED SAMPLING PLAN

Sampling Intervals	# Of Air Samples
Reagent Addition as a Slurry (1 Reagent: 1 Water)	
At the end of mixing	1
Room Temperature Curing	
0 to 0.5 hrs (0.25 hrs)	1
0.5 to 1.0 hrs (0.75 hrs)	1
2.0 to 2.5 hrs (2.25 hrs)	1
3.75 to 4.25 hrs (4.0 hrs)	1
11.75 to 12.25 hrs (12.0 hrs)	1
23.75 to 24.25 hrs (24.0 hrs)	1
47.75 to 48.25 hrs (48 hrs)	1
Total # of Air Samples	**8**

NOTES:

1. Air samples will be collected for the following parameters: VOCs (TO-15), BNA+20 (TO-13), PCBs/Pesticides (TO-10), Metals (NIOSH 7600/6009)
2. TO-15 is a 15- to 30-second "grab" sample. The other samples will be collected over a 30 minute period.

The mechanical dewatering on the treated material will be conducted immediately after the Georemediation™ reagent mixing in order to test the pore-water quality expected from the curing pile run-offs at the demonstration and full-scale levels. The dewatered treated sample will be tested for chemical parameters at the end of a 14-day curing period. The analysis will be performed on the unfiltered and filtered samples (filtration performed during sampling) to differentiate between the dissolved and particulate-bound contaminants and whether any form of effluent treatment beyond suspended solids removal will be needed. The chemical testing results will be compared to the results for the treated material cured without mechanical dewatering, and cured for a 14-day period under room temperature conditions to determine effect of dewatering on decontamination and curing.

The dewatering test results will also help BEM identify the input energy, percent solids-in and percent solids-out expected at the demonstration levels using the proposed dewatering equipment. A summary of the proposed sampling plan for the pore-water generated during mechanical dewatering tests is presented in Table 7-5.

7.9 Disposal/Beneficial Reuse - Unit P800

In accordance with the 1997 NJDEP guidance document, the dredged material is not regulated as a solid waste. At the end of the pilot study, BEM will recycle or dispose of, in accordance with the appropriate regulations, the treated and untreated material, as well as any other waste generated during the process such as debris or contaminated water. Any treated material, which meets NJDEP NRDCSCC criteria, may be potentially used in a beneficial reuse application. For determining costs during the pilot study, BEM has assumed the untreated and treated material to be recycled or disposed as a non-hazardous contaminated material identified as ID-27 under waste disposal regulations.

A summary of the material balance for the entire pilot study process flow chart previously presented in Figure 7-1 is provided in Table 7-6 at the end of this section.

TABLE 7-5: PILOT TREATMENT (UNIT P700) - UNTREATED AND TREATED PORE-WATER PROPOSED SAMPLING PLAN

Pore-water	# of Samples
Pore-water from Untreated Sediments (Using Mechanical Dewatering)	
Unfiltered	3
Filtered	3
Pore-water from Treated Sediments (Using Mechanical Dewatering)	
Unfiltered	3
Filtered	3
Total (# of Samples)	**12**

NOTES:

1. Pore-water for analysis will be collected from the mechanical dewatering tests for both untreated and treated sediment samples
2. Pore-water from the treated sediment sample will be collected using mechanical dewatering performed immediately after the reagent mixing

Table 7-6: Pilot Study Material Balance

Process Description	Quantity	Units	Quantity	Units
Unit P100: Storage				
Material to Pre-Processing	500	gal	5,500	lbs
Unit 200A: Pre-Processing (Screening)				
Removed Debris	3	gal	28	lbs
Material to Homogenizing	498	gal	5,473	lbs
Unit 200B: Pre-Processing (Homogenizing)				
Material for Sampling: Chemical Analysis	1	gal	11	lbs
Material for Sampling: Geotechnical Analysis	2	gal	22	lbs
Material to Pilot Optimization	18	gal	198	lbs
Material to Pilot Treatment	477	gal	5,242	lbs
Unit P300: Pilot Optimization				
Reagent Addition	2	gal	30	lbs
Water Addition	4	gal	30	lbs
Material for Sampling: Chemical/Geotechnical	23	gal	257	lbs
Unit P400: Pilot Treatment				
Material to Treatment using Slurried Reagent (Room Temp. Curing)	150	gal	1,650	lbs
Material to Treatment using Dry Reagent (Room Temp. Curing)	80	gal	880	lbs
Material to Treatment using Slurried Reagent (Regulated Curing - 100% Humidity)	40	gal	440	lbs
Material to Treatment using Slurried Reagent (Regulated Curing - 32°F Temp.)	40	gal	440	lbs
Material to Treatment using Slurried Reagent (Deeper Curing Pile)	80	gal	880	lbs
Unit P400A-1: Treatment using Slurried Reagent (Room Temp. Curing)				
Reagent Addition	14	gal	248	lbs
Water Addition	30	gal	248	lbs
Material to Mechanical Dewatering/Leachate Testing	90	gal	998	lbs
Material to Curing	103	gal	1,147	lbs
Unit P400B: Treatment using Dry Reagent (Room Temp. Curing)				
Reagent Addition	7	gal	132	lbs
Material to Curing	87	gal	1,012	lbs
Unit P400A-2: Treatment using Slurried Reagent (Regulated Curing - 100% Humidity)				
Reagent Addition	4	gal	66	lbs
Water Addition	8	gal	66	lbs
Material to Curing	52	gal	572	lbs
Unit P400A-3: Treatment using Slurried Reagent (Regulated Curing - 32°F Temp.)				
Reagent Addition	4	gal	66	lbs
Water Addition	8	gal	66	lbs
Material to Curing	52	gal	572	lbs
Unit P400A-4: Treatment using Slurried Reagent (Deeper Curing Pile)				
Reagent Addition	7	gal	132	lbs
Water Addition	16	gal	132	lbs
Material to Curing	103	gal	1,144	lbs
Unit P500A-1: Room Temperature Curing				
Water Loss	65	gal	540	lbs
Material for Sampling: Chemical Analysis	19	gal	152	lbs
Material for Sampling: Geotechnical Analysis	19	gal	152	lbs
Unit P500A-2: Room Temperature Curing				
Water Loss	69	gal	572	lbs
Material for Sampling: Chemical Analysis	9	gal	220	lbs
Material for Sampling: Geotechnical Analysis	9	gal	220	lbs
Unit P500B-1: Regulated Curing (100% Humidity)				
Water Loss	32	gal	270	lbs
Material for Sampling: Chemical Analysis	19	gal	303	lbs

Table 7-6: Pilot Study Material Balance (Continued)

Process Description	Quantity	Units	Quantity	Units
Unit P500B-2: Regulated Curing (32°F Temp.)				
Water Loss	32	gal	270	lbs
Material for Sampling: Chemical Analysis	19	gal	303	lbs
Unit P500A-3: Room Temperature Curing (Deeper Curing Pile)				
Water Loss	65	gal	539	lbs
Material for Sampling: Chemical Analysis	39	gal	605	lbs
Unit P700A: Mechanical Dewatering/Pore-Water Analysis - Before Treatment				
Material to Mechanical Dewatering	80	gal	880	lbs
Pore-Water to Testing	41	gal	338	lbs
Material to Recycling/Disposal	39	gal	542	lbs
Unit P700B: Mechanical Dewatering/Pore-Water Analysis - After Treatment				
Material to Mechanical Dewatering	90	gal	998	lbs
Pore-Water to Testing	46	gal	384	lbs
Material to Curing	44	gal	614	lbs
Unit P800: Recycling/Disposal				
Debris from Pre-Processing (Screening)	2	gal	22	lbs
Material from Pre-Processing (Homogenizing)	3	gal	33	lbs
Material from Pilot Optimization	23	gal	257	lbs
Material from Pilot Treatment/Curing	135	gal	1,953	lbs

Notes:
1. Assumed 40% solids for material received
2. Assumed density of material received = 1.1 tons/cubic yard
3. Assumed density of Reagent mix = 1.8 tons/cubic yard
4. Assumed % Solids-Out from Mechanical Dewatering = 65%
5. Assumed moisture content of the treated material = 20%

8.0 CHEMICAL TESTING

Chemical testing will be conducted in accordance with the October 1997 NJDEP Technical Manual. This manual identifies five general categories of chemical testing that are described in the following sections. BEM has selected testing parameters and methodologies in accordance with NJDEP guidance as presented in the technical manual. Further guidance is provided by the November 1998 document entitled "Guidance for Sediment Quality Evaluations." These documents identify the compounds that the NJDEP has prioritized for sediment quality evaluation, and outlines expectations for detection limits and general quality control procedures. Required analyses generally fall into five categories, as detailed below.

8.1 Grain Size, TOC, and Percent Moisture

These tests provide information about the physical sizes of particles (Grain Size), and the total organic compounds (TOC) present in the sediment sample, as well as the moisture content. These tests are required for all possible end-use and reuse applications. Grain size will be analyzed using ASTM D421/D422, TOC using SW846 9060, and percent moisture using ASTM D2216.

For the grain size analysis, BEM will utilize the ASTM standard D421 for the dry ~~utilize the ASTM standard D421 for the dry~~ preparation of the sediment sample and determination of particle size distribution of particle sizes greater than 75 μm (retained on the No. 200 sieve) by sieving. ASTM D422 standard will be used to determine the distribution of particle sizes smaller than 75 μm by a sedimentation process, using a hydrometer to secure the necessary data.

8.2 Bulk Sediment Chemistry

A number of analytical procedures are used to evaluate the actual "total" concentrations within the entire sediment matrix of the bulk sediment samples as identified in Appendix B, Attachment 1 of the 1997 NJDEP Technical Manual. Following is a table that summarizes the methods that will be used, and the types of analytes that are detected by each method.

Extraction and Analysis Method	Analytes Detected
SW846 8260B	VOCs
SW846 3520C/8270C with GPC	SVOCs
SW846 3520C/8081A	Pesticides
SW846 3520C/8082	PCBs (as Aroclors)
NOAA-NOS-ORCA-71 (or equiv.)	PCB Congeners
SW846 3050B/6010B	Metals
SW846 8290	Dioxin/Furan Congeners
SW846 3545/E418.1 (Modified)	TPHC
SW846 9030B	Sulfide
SW846 9045C	pH

Some of these procedures, most notably the SVOC and Pesticide/PCB methods, allow the laboratory to select from a variety of available extraction and cleanup procedures. It has generally been recognized that the comparability between laboratories when analyzing complex sediment samples is inconsistent. BEM anticipates that specifying the extraction and cleanup procedures that are to be used for sediment analysis will improve the comparability between laboratories. While BEM will not be evaluating inter-laboratory comparability during the pilot study, BEM has explicitly specified the extraction and cleanup procedures for each of the analytical procedures that will be implemented above.

Bulk sediment chemistry analysis will be performed for all end-use and reuse applications. It is likely that some parameters, especially VOCs, will not be observed in the untreated sediment.

8.3 Modified Elutriate

The NJDEP requires a modified elutriate, or washing, to test for some sediment disposal options. The modified elutriate procedure is intended to simulate the quality of effluent from confined dredged material disposal areas after sediment has settled and the remaining water is discharged. BEM will not perform modified elutriate extraction and testing. The water this test is intended to simulate will not be generated as part of the Georemediation™ technology.

8.4 Leaching Tests

The NJDEP requires a leaching test called the Multiple Extraction Procedure (MEP), EPA SW846 1320 as modified by NJDEP (*Analytical Testing Requirements for the Placement of Processed Dredged Material at the Koppers Seaboard Site, Kearny, NJ, January 22, 1998*), for the evaluation of contaminant leaching potential of the decontaminated sediments. The procedure is similar to a TCLP extraction performed repeatedly on the same sample aliquot. The extraction is repeated seven times, and is intended to simulate repeated groundwater infiltration into the decontaminated sediment after being applied in an upland end-use application. The extracts obtained from each iteration of the extraction are analyzed for the full list of compounds and analytes listed in the 1997 NJDEP Technical Manual using methods identified in Section 6.3.2. above, with the exception that dioxins will only be analyzed in the first and seventh extracts, in accordance with the modified procedure.

The MEP results are applicable to all possible end-use and reuse applications, and will be compared to the GWQS, in accordance with the 1997 NJDEP Technical Manual.

8.5 Replicate Sample Collection

BEM will collect and analyze samples in duplicate (including MEP analysis), except the untreated sediment starting material that will be collected in triplicate, and air emissions samples that will be collected without replicates. Replicate sample collection and analysis will be performed to provide data that evaluates the precision of laboratory analysis of the complex sediment matrix.

The untreated sediment starting material will be collected and analyzed in triplicate to provide a statistically significant starting point of the pilot study. BEM will calculate the average and relative standard deviation (RSD) of these results. The average will be used for comparison to subsequent analyses. The RSD will be used to identify compounds or parameters that the laboratory has difficulty quantifying with a satisfactory degree of precision, which will be identified as 20% RSD. Results exceeding 20% RSD will be considered approximate.

Air emissions tests provide trend results that can be evaluated with respect to consistency of laboratory performance. While it would be preferable to collect and analyze replicate samples for these analyses as well, the additional benefit does not outweigh the additional costs.

The remaining analyses will be conducted in replicate. The average will be calculated and used to compare to the starting material averages. The relative percent difference will be calculated to evaluate the precision performance of the laboratory analytical methods. The RPD will be used to identify compounds or parameters that the laboratory has difficulty quantifying with a satisfactory degree of precision, which will be identified as 20% RPD. Results exceeding 20% RPD will be considered to be approximate.

8.5 Air Emissions Testing

BEM will conduct air emissions testing during one of the pilot treatment trains to evaluate the quantities of materials that are lost to volatilization during the mixing and curing stages of the pilot test. More details on the sampling and analytical testing methodologies and procedures is provided in Section 7.7 of this Workplan.

9.0 GEOTECHNICAL TESTING

This section presents the geotechnical tests and testing methodologies that will be used by BEM to evaluate the suitability of the Georemediation™ treated dredged material for the anticipated beneficial reuse applications presented in section 5.0. The geotechnical suitability of the material will be evaluated using the performance based test criteria and standards described in section 6.0.

9.1 Testing Parameters and Methodologies

BEM will evaluate the geotechnical properties of the untreated and treated sediments using standard ASTM or AASHTO testing methods. The untreated sediments will be evaluated for only basic geotechnical characteristics. However, the Georemediation™ treated material will be subject to additional geotechnical tests to evaluate its strength, deformation, corrosion, and permeability characteristics described in Section 6.2. A summary of the testing parameters and standard methodologies to be used is provided in Table 9-1. The table also presents a brief description of the purpose of each test.

The geotechnical testing for the treated material will be performed on both dry as well as slurried form Georemediation™ reagent treatments. The testing will be performed at the end of 28 days of curing period.

All geotechnical testing will be performed at the state-of-the-art Rutgers University Geotechnical and Beneficial Reuse Laboratories located in Piscataway, New Jersey. These laboratories are used by the Department of Civil and Environmental Engineering and the CAIT research institute to investigate basic soil mechanical properties and advanced soil dynamic and material reuse properties. The CAIT institute uses the Rutgers Geotechnical Laboratories in performing verification testing for soil and sediment reuse field projects for NJDOT, USDOT, and most recently for the Port Authority in the evaluation of beneficial sediment reuse under a field program conducted at the OENJ Elizabeth Metro Mall Site.

Table 9-1: Summary of Proposed Geotechnical Testing Parameters, Methodologies, and Purpose of the Testing Parameters

Parameter	Methodology	Purpose
Tests to be Conducted only for Untreated Sediments		
pH	ASTM D 4972	To assess contaminant leachability and corrosiveness of soils
Percent Moisture	ASTM D 2216-85	To aid in characterizing the soil and determining the degree of solidification required for placement
Grain-size Analysis	ASTM D 421/422	To determine the particle-size distribution of material
Specific Gravity	ASTM D 854-83	To determine the specific gravity of the sediments
Atterberg Limits	ASTM D 4318-84	To define the consistency of the material as a function of its water content
Bulk Density	ASTM D 1556-90	To determine bulk density of the sediments
Additional Tests to be Conducted only for Treated Sediments (Using Dry and Slurried Georemediation™ Reagent)		
California Bearing Ratio (CBR) Test	ASTM D 1883	To determine thickness and value of a soil as a subgrade base or sub-base material
Resilient Modulus Test	AASHTO T 274-82	To assess plastic deformation under simulated traffic conditions
Unconfined Compressive Strength	ASTM D2166	To measure strength of an unconfined and unconsolidated material
Freezing and Thawing Test	ASTM D 560	To determine how materials behave or degrade after repeated freeze-thaw cycles
Sulfates, Chlorides, and Resistivity	Sulfates (ASTM D-516); Chlorides (ASTM 512)	To assess corrosive potential of the material on buried concrete and steel structures
Modified Compaction Test	ASTM D 1557/T 180	To determine the relation between moisture content and density of a material for the purpose of compaction levels required prior to placement
Collapse Potential	ASTM D 5333	To determine collapse potential of compacted soils when unsaturated soils are inundated with water
Swelling Test	ASTM D4546	To determine swelling potential and swelling pressure of the material
Expansion Index Test	ASTM D4829	An index property comparable to LL and PI

10.0 QUALITY ASSURANCE PROCEDURES

The following section outlines the data quality and quality assurance procedures proposed to be employed by BEM during the pilot study project. The quality of the data obtained during these procedures is critical since it will be used to determine if the proposed process produces an end-product that meets all the environmental and geotechnical requirements for the anticipated beneficial reuse applications. Therefore, data quality objectives (DQO), and analytical data detection limits will be selected to achieve high integrity data that are scientifically and legally defensible.

10.1 Data Quality Objectives

The establishment of DQOs and the DQO process are necessary to provide general guidelines for making process decisions and acceptable levels of errors based on the data collected. For the pilot study project, BEM has identified the following specific DQOs:

- Obtain sufficient data to characterize contamination in the material
- Identify contaminant levels adequate to make appropriate decisions regarding the treatment process and/or beneficial reuse of the material
- Generate data of sufficient quality and integrity to withstand scientific and legal scrutiny
- Ensure that the method detection limits (MDLs) are in accordance with the October 1997 NJDEP Technical Manual

In order to achieve the DQO objectives listed above, a detailed Quality Assurance Project Plan (QAPjP) has been prepared for the pilot study and will address various issues such as analytical data quality levels, contaminants of concern, measurement objectives, and laboratory quality assurance.

10.2 Sampling Procedures

The following general sampling procedures will be followed during the pilot study in order to minimize data errors resulting from sampling events:

10.2.1 Sample Containers

The laboratory performing the analysis will provide pre-cleaned sample containers. The sample bottles will be prepared for shipment accompanied by a chain of custody, and the cooler or shuttle containing them will be custody sealed. The chain-of-custody will also accompany the bottles during transportation to the pilot study site, sample collection, transportation back to the laboratory, analysis, and identification of final disposal of the sample container. When collecting a sample, sampling personnel will record the seal number associated with each sample shuttle or cooler and record whether the seal was intact upon arrival at the pilot study location. This assures that the sample containers were not tampered with in the time between their preparation and their arrival at the site. After sample collection, the bottles again will be sealed into the shuttle or cooler and the seal number will be recorded in the pilot study logbook. Upon arrival at the laboratory, the person receiving the sample will note the number and condition of the custody seal and log the samples for analysis.

10.2.2 Decontamination of Sampling Equipment

An important aspect of quality control is the decontamination of sampling equipment. Improperly cleaned and prepared sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination. In lieu of the above, sampling equipment will be decontaminated prior to sampling using a laboratory grade alconax and de-ionized water rinse followed by a double rinse of de-ionized water. Decontaminated sampling equipment will be wrapped in aluminum foil and stored in an airtight cooler.

10.2.3 Laboratory Decontamination

In certain instances laboratory decontamination can serve as a viable alternative to decontamination during pilot study operations. Some advantages include:

- Decontamination takes place in a controlled environment
- Reduced need to transport, handle or dispose cleaning solvents, acids or wash water
- More attention can be focused upon sampling with field decontamination labor reduced or eliminated
- Reduced probability of cross-contamination due to improperly field-decontaminated equipment
- Laboratory documentation of cleaning procedures and material can be used

Disposable sampling equipment will be utilized to the greatest extent possible, thereby, minimizing the need for decontamination of sampling equipment. Non-disposable equipment used for sampling will be decontaminated prior to each use by rinsing with laboratory grade detergent and de-ionized water. The sampling equipment will be allowed to dry at room temperature and then wrapped in aluminum foil. Sampling equipments will be removed from their respective wrappers and used immediately thereafter.

10.2.4 Documentation and Data Management

Date management involves maintaining and controlling data generated during pilot study operations, laboratory analytical data, and any other data relevant to the project. Bound field logbooks will be used for recording pilot study data. This project will have dedicated logbooks, which will not be used for other projects. Entries in the logbook will be dated and the time of entry will be recorded. Sample collection data, as well as, visual observations will be documented on forms or when forms are not available, in the logbook. To the extent possible, field data will be recorded on field forms and not repeated in the logbook. Any sample collection equipment, field analytical equipment, and equipment used to make physical measurements will be identified in the logbook. Calculations, results equipment usage, maintenance, repair and calibration data for field sampling, field analytical, and field physical measurement equipment will also be recorded in logbooks. Once completed, the field forms and logbook will become part of the project file. Office data management will involve establishing and maintaining a project file. The project file will include the following:

- External and internal correspondence
- Notes/minutes of meetings and phone conversations
- Personnel organization and responsibilities

- Planning and scheduling
- QA auditing and inspection reports
- Field sampling
- Project operations
- Calculations
- Laboratory analytical data
- Field analytical data
- Contract/purchase orders
- Change orders
- Bid evaluations
- Drawings

10.2.5 Sample Custody Protocol

Sample collection and sample custody are designed so that field custody of samples is maintained and documented. These procedures provide identification and documentation of the sampling event and the sample chain-of-custody from shipment of sample bottle-ware, through sample collection, to receipt of the sample by the subcontracted laboratory. When used in conjunction with the laboratory's custody procedures and the sample bottle-ware documentation, this data fully establishes full legal custody and allows complete tracking of a sample from preparation and receipt of sample bottle-ware to sample collection, preservation, and shipping through laboratory receipt, and sample analysis.

10.3 Analytical Methodologies and Detection Limits

The samples collected during the demonstration project will be analyzed for chemical parameters by NJDEP certified Accutest Laboratories, located in Dayton, New Jersey. A list of chemical parameters and proposed methodologies is presented in Table A. The method detection limits for the chemical parameters are presented in Table B. These detection limits meet the recommended limits in the 1997 NJDEP Guidance Document.

The physical testing to determine the suitability of the end-product for the beneficial reuse options will be conducted by NJIT Geotechnical laboratories. Table C provides a list of physical tests and the proposed methodologies for the demonstration project.

10.4 Sampling and Analytical Frequency

A detailed discussion on the sampling and analytical frequency at various stages during the pilot study operation is presented in Section 7.0. Table 7-2 summarizes the proposed sampling and analytical frequency during the pilot study. The pilot study proposed process flow chart is shown in Figure 7-1.

11.0 HEALTH AND SAFETY PROCEDURES

Health and safety concerns during the pilot study are related to both the facility and the actual operation of the pilot study process. Since the pilot study will be carried out at designated laboratories at Rutgers University, all personnel involved in the pilot study will be required to follow Rutgers' general laboratory safety regulations, special considerations for the use of any hazardous chemicals, and instrumentation.

In addition, a health and safety plan (HASP) will be prepared prior to the pilot study to address any potential exposure of the contaminated dredged material and/or other chemicals to the personnel involved in the pilot study operation. The pilot study will include the following information:

- Assignment of health & safety responsibilities for personnel involved
- Medical surveillance program and employee training
- Identification of tasks and potential hazards associated with each task
- Personal protective equipment (PPE) required for various tasks
- Environmental monitoring procedures
- Emergency procedures
- Decontamination procedures

All personnel involved in the pilot study will receive a copy of the HASP and will be required to sign a document attesting that they have read and understand the HASP. Health and safety issues will be discussed prior to every task during the pilot study. A site safety officer (SSO), reporting directly to the Corporate Health and Safety Manager (CHSM), will be assigned to ensure the HASP is followed or modified, as necessary.

Air monitoring will be conducted for the tasks where the dredged material is agitated, transferred, or treated during the pilot study process. Air monitoring will consist of either a photoionization detector (PID) or flame ionization detector (FID) to characterize the presence of any organic vapors.

The CHSM will conduct health and safety audits on a periodic basis during the pilot study to ensure compliance with the HASP. These audits may be scheduled or unscheduled. At the conclusion of the audit, the CHSM will debrief the involved personnel and results of the audit will be provided to the applicable personnel and their immediate supervisors.

12.0 WASTE MANAGEMENT PLAN

This section describes the procedures BEM will implement to control the disposal of chemicals, wastewater, debris, and any other potentially harmful materials generated during the pilot study. Applicable federal, NJ State, county, and municipal laws will be complied with, and special measures will be taken to prevent the above-mentioned substances from being disposed of uncontrolled.

Proactive waste minimization measures will be undertaken during the pilot study in order to reduce the total volume of waste generated. The wastes that do not require off-site disposal will be separated from the waste that can be appropriately managed within the Rutgers laboratories. During the handling of all wastes, precautions will be taken to prevent any human health and environment exposure to the waste.

12.1 Material Safety and Data Sheets

BEM will have available at all times MSDSs for all chemicals and products used during the pilot study in compliance with New Jersey "Right-To-Know" laws.

12.2 Disposal Control

Off-site disposal will be conducted as needed for accumulated materials. For the purpose of this proposal, BEM assumes that all these material are to be considered as non-hazardous, and therefore, we will not perform any sampling and analytical activities. The material will be packaged in the disposal drums or containers and properly disposed of or recycled at a permitted disposal and/or recycling facility. Estimated volume of total material to be disposed is approximately 120 gallons (2,000 lbs.).

Non-hazardous waste such as laboratory by-products and PPEs will be disposed of in accordance with federal, state, and local regulations.

13.0 PROJECT PLANNING

13.1 Project Organization

BEM's overall project organization approach for the pilot study is specifically designed to address the needs of the pilot study, followed by the potential need for demonstration project and full-scale CTF facility. The organizational structure is intended to provide clear lines of communication between the program personnel and a single point of accountability to the client for the program. The pilot study organization chart and the project team is presented in Figure 13-1 and Table 13-1, respectively. The following presents an outline of the key personnels along with their roles and responsibilities:

Principal Program Director, Mr. Mark Nardolillo. All senior level program personnel report to Mr. Nardolillo. The specific responsibilities include, but are not limited to, the following:

- Overall contracting and financial responsibilities for the project
- Overall risk management, and health and safety
- Public relations
- Coordinating/interfacing with the client and regulatory agencies to resolve potential conflicts

Lead Pilot Project Manager, Mr. John Butziger, P.E. All project functions and assigned staff level program personnel report to Mr. Butziger. The specific responsibilities include, but are not limited to, the following:

- Primary Point-of-Contact
- Coordination, direction, and integration of operating and business functions
- Contract reporting and monitoring
- Coordination and management of all subcontractors
- Regulatory liaison
- Design, implementation, and coordination of the geotechnical testing program for the pilot study

Mr. John Butziger will coordinate most of the geotechnical testing at the Rutgers facility and will work closely with other project team members for the beneficial reuse evaluation of the end-product.

Principal Process Engineer, Mr. John Ferrante, P.E. All operational functions of the pilot study and staff level program personnel working on the process engineering phases of the study will report to Mr. Ferrante. The specific responsibilities include, but are not limited to, the following:

- Providing technical oversight for the pilot study
- Coordination, direction, and integration of the operational project team including facility and equipment setup, and process engineering

Project Engineer, Mr. Ajay Kathuria, E.I.T. Mr. Kathuria will be responsible for execution and coordination of all operational functions, working closely with Principal Process Engineer and will report directly to Lead Pilot Project Manager. The specific responsibilities include, but are not limited to, the following:

- Day-to-day implementation, execution, and task management of the operational aspects of the pilot study
- Scheduling and coordination of sample collection for various analyses
- Assistance in the data evaluation and management during the pilot study

QA/QC Manager, Mr. Andrew Crabb. QA/QC manager will coordinate all aspects of the chemical testing during the pilot study. The specific responsibilities include, but are not limited to, the following:

- Laboratory subcontractor coordination for the sampling and analytical testing
- Coordination of analytical data management
- Provide general Quality Assurance/Quality Control (QA/QC) during the analytical testing

Peer Reviewer (Process Engineering), Dr. Olu Songonuga, Ph.D., P.E. Dr. Songonuga will provide secondary quality assurance and peer review or the operational and engineering process aspects of the study. The specific responsibilities include, but are not limited to, the following:

- Review engineering and operational aspects of the pilot study
- Peer review of the monthly progress and final reports

Technology Manager, Mr. Jeff Newton (Aleph Group). All technology applications and testing shall be performed under the direction of the Technology Manager. The specific responsibilities include, but are not limited to, the following:

- Reagent mix development and technology optimization
- Pilot study data review and interpretation
- Coordinating/interfacing with the peer review team

Geotechnical Testing Coordinator, Dr. Ali Maher, Ph.D. (Rutgers). All geotechnical testing during the pilot study will be conducted at Rutgers University in close coordination with Dr. Ali Maher. The specific responsibilities include, but are not limited to, the following:

- Assistance in facility setup for the pilot study operations and geotechnical testing
- Scheduling of geotechnical tests and identification and testing equipments
- Coordination of laboratory support for the geotechnical testing
- Review and interpretation of the geotechnical test results.

Project Peer Reviewers, Mr. James R. Payne, Ph.D., P.E. (Payne Environmental); Dr. Raj Khera, Ph.D. (NJIT); Dr. Issa Oweis, Ph.D. (Converse). BEM has assembled a team of well-respected and experienced peer reviewers to oversee the pilot study. Each of them have published numerous technical articles and/or references in their respective technical areas of expertise.

Figure 13-1: Pilot Project Organization Chart

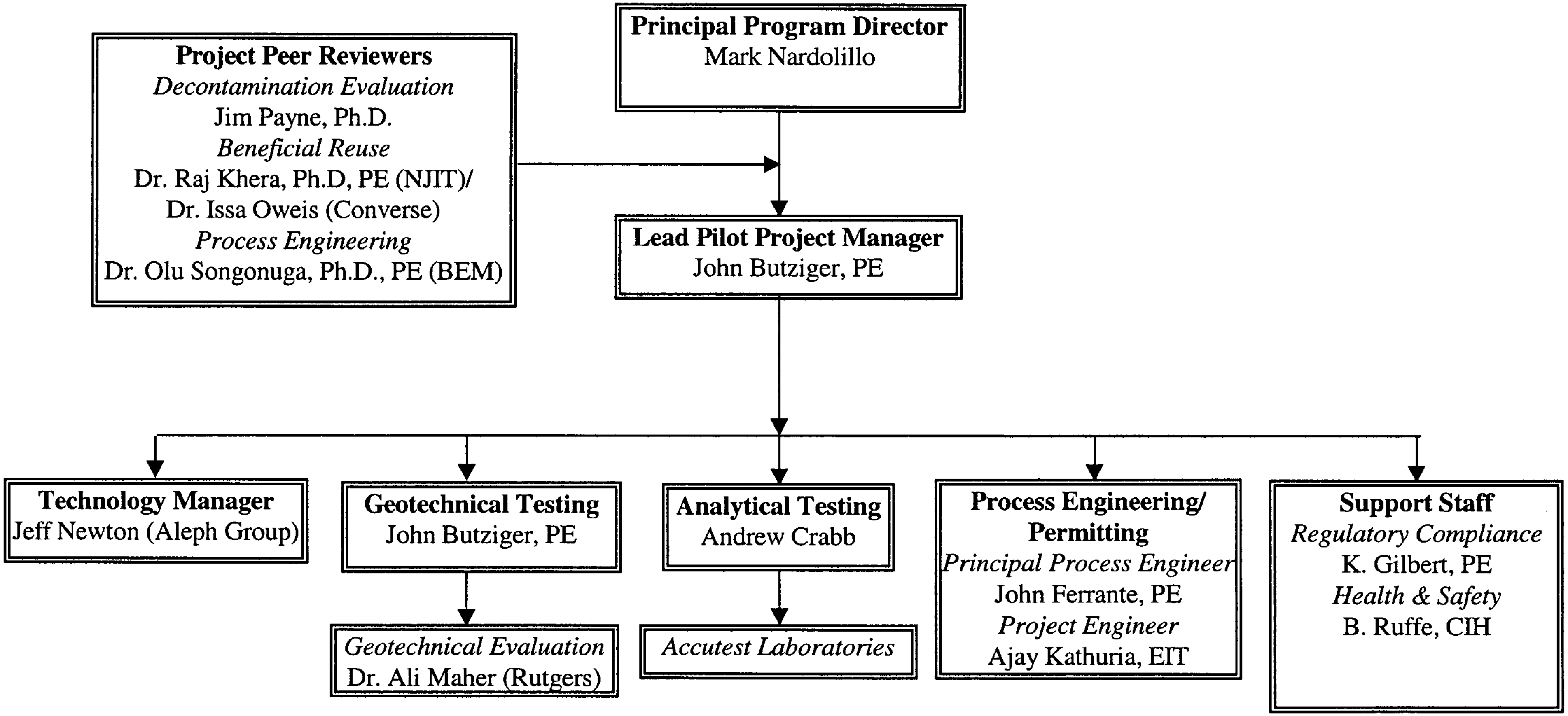

Table 13-2: Project Team Members

Team Member	Name	Project Title	Phone #	Email
BEM Systems, Inc. (BEM)	Mark Nardolillo	Principal Program Director	(908) 598-2600, Ext.111	Mnardolillo@bemsys.com
	John Butziger, PE	Lead Pilot Project Manager	(908) 598-2600, Ext. 152	Jbutziger@bemsys.com
	John Ferrante, PE	Principal Process Engineer	(908) 598-2600, Ext. 133	Jferrant@bemsys.com
	Olu Songonuga, Ph.D., PE	Peer Reviewer (Process Engineering)	(908) 598-2600, Ext. 125	Osongonuga@bemsys.com
	Ajay Kathuria, EIT	Project Engineer	(908) 598-2600, Ext. 137	Akathuria@bemsys.com
	Kathleen Gilbert, PE	Regulatory Compliance Engineer	(908) 598-2600, Ext. 131	Kgilbert@bemsys.com
	Brian Ruffe, CIH	Health and Safety Manager	(908) 598-2600, Ext. 147	Bruffe@bemsys.com
	Randy Youngman	Senior Scientist	(407) 894-9900, Ext. 106	Ryoungman@bemsys.com
	Andrew Crabb	QA/QC Manager	(908) 598-2600, Ext. 164	Acrabb@bemsys.com
	Denise Barnette	Data Validator	(908) 598-2600, Ext. 158	Dbarnette@bemsys.com
	Sebastien Farhi	Accountant/Administrator	(908) 598-2600, Ext. 127	Sfarhi@bemsys.com
	Ada Chan	Secretary/Clerk	(908) 598-2600, Ext. 124	Achan@bemsys.com
Aleph Group	Jeff Newton	Technology Manager	(607) 279-3297	AlephNTN@AOL.com
Payne Environmental	James R. Payne, Ph.D.	Decontamination Evaluation	(760) 942-1015	Jamesrpayne@comuserve.com
Dr. Ali Maher, Ph.D	Dr. Ali Maher, Ph.D	Geotechnical Testing and Consulting	(732) 445-2485	
New Jersey Institute of Technology (NJIT)	Dr. Raj Khera, Ph.D., P.E.	Beneficial Reuse Evaluation	(201) 596-2475	Raj@iop.com
Converse Consultants	Dr. Issa Oweis, Ph.D.	Beneficial Reuse Evaluation	(973) 605-5200	Convers@mail.idt.net

14.0 PROJECT DELIVERABLES

After the review and approval of the proposed pilot study workplan by the client, the regulatory agencies, and the contract execution, BEM will provide feedback on the progress of the pilot study with the following major deliverables, in accordance with the NJMR's recommendations outlined in the March 1998 bid document (#98-X-99999):

14.1 Monthly Progress Reports

BEM will submit monthly progress reports from the contract execution date to provide the status and progress of the pilot study, including results of the study to-date. The progress reports will be submitted within a week after each month from the start of the pilot study. BEM will submit ten copies of the monthly progress reports to NJMR for distribution purposes. The monthly progress reports will address all aspects of the pilot study including, but not limited to the following:

- Facility and project set up
- Regulatory compliance
- Health and Safety procedures
- Work performed during the reporting period
- Status of current work
- Updated project budget and schedule
- Problems or delays experienced during the reporting period
- Actions being taken to rectify problems
- Proposed action plan and for the next reporting period

14.2 Draft/Final Report

A draft report will be submitted to NJMR and regulatory agencies within three weeks after the completion of the pilot study. This report will detail all aspects of the pilot study, including, but not limited to, the following:

- Pilot study objectives
- Decontamination technology overview
- Process description, operational and health and safety procedures used
- Quality control objectives and procedures used
- Analytical results of pre- and post-treatment samples
- Interpretation of pilot study results and evaluation of decontamination efficacy
- Final budget and schedule summary
- Recommended future testing

BEM will submit ten copies of the draft report to NJMR for distribution and review. BEM will submit ten copies of the final report within two weeks from the receipt of all the comments from NJMR to the draft report.

14.3 Meetings

At a minimum, BEM will schedule meetings with NJMR and appropriate regulatory agencies at the pilot study kickoff, mid-term, and at the end of the study. BEM will schedule additional meetings as deemed necessary by NJMR during the pilot study.

15.0 PROJECT BUDGET

BEM's pilot study will be executed at the Rutgers/CAIT facilities in New Brunswick, New Jersey. The proposed pilot study is not a capital intensive project requiring no infrastructure improvements. The Rutgers/CAIT facility have much of the needed infrastructure and equipment for the project. The Rutgers/CAIT facility will be used by BEM at a zero cost to the client as part of BEM's cost sharing plan. Any additional non-disposable equipments need for the Pilot Study and as listed in Table 15-2 will be leased for the anticipated duration (6 to 9 months) of the project.

Most of the project costs for the pilot study are associated with the chemical and geotechnical testing and analysis. In addition, significant effort will be spent on the data evaluation, interpretation and technology optimization during the pilot study.

The following estimate data sheets are provided to support the Lump Sum Price of **$607,629** to conduct the pilot study:

Table 15-1: Pilot Study Cost Proposal Summary
Table 15-2: Equipment, Material, and Disposal Cost
Table 15-3: Chemical Analysis Cost – Sediment Matrix
Table 15-4: Chemical Analysis Cost – Pore-water
Table 15-5: Chemical Analysis Cost – Air Emissions
Table 15-6: Geotechnical Analysis Cost – Sediment Matrix
Table 15-7: Mechanical Dewatering Test Cost – Sediment Matrix
Table 15-8: Labor Cost
Table 15-9: Cost Sharing Plan

PILOT STUDY COST PROPOSAL
Table 15-1: SUMMARY

ITEM	TOTAL COST		REFERENCE
DIRECT COST			
A. BEM Labor	$	153,315	Table 15-8
B. Equipment	$	28,283	Table 15-2
C. Material	$	125	Table 15-2
D. Miscellaneous			
(i) Permits	$	500	N/A
(ii) Vehicle Rental Cost	$	1,000	N/A
(iii) Air Monitoring Equipment (PID) Rental Cost	$	500	N/A
TOTAL DIRECT COST =	**$**	**183,723**	
SUBCONTRACTOR COST			
A. Accutest (Analytical Services - Sediments)	$	204,142	Table 15-3
B. Accutest (Analytical Services - Pore-water)	$	27,099	Table 15-4
C. Air Toxics (Analytical Services - Air Sampling)	$	9,000	Table 15-5
E. Jeff Newton (Technology)	$	18,360	Table 15-8
F. James R. Payne (Decontamination Evaluation)	$	7,600	Table 15-8
G. Dr. Ali Maher (Soil Tech.) [Geotechnical Testing and Consulting]			
Geotechnical Testing	$	37,470	Table 15-6
Geotechnical Evaluation	$	4,000	Table 15-8
H. Dr. Raj Khera (Beneficial Reuse Evaluation)	$	4,800	Table 15-8
I. Dr. Issa Oweis (Converse) [Beneficial Reuse Evaluation]	$	6,240	Table 15-8
J. Julie Smith (Independent Data Validation)	$	31,500	Table 15-8
K. Mechanical Dewatering Test	$	6,000	Table 15-7
L. EISCO-NJ (Transportation/Disposal of Waste Material/Water)	$	2,500	Table 15-2
TOTAL SUBCONTRACTOR COST =	**$**	**356,211**	
SUBTOTAL COST =	**$**	**539,934**	
G&A (15%)	$	80,990	
Profit (5%)	$	26,997	
TOTAL PILOT STUDY COST =	**$**	**647,920**	
COST SHARING			
BEM (Labor/Chemical Analysis)	$	38,456	Table 15-9
Jeff Newton (Labor)	$	1,836	Table 15-9
TOTAL COST SHARING =	**$**	**40,292**	
PILOT STUDY LUMP SUM PRICE =	**$**	**607,629**	

PILOT STUDY COST PROPOSAL
Table 15-2: EQUIPMENTS, MATERIAL, AND DISPOSAL COST

ITEM	DESCRIPTION	SPECIFICATIONS	UNIT	UNIT COST	QUANTITY	TOTAL COST
1. EQUIPMENT						
A. TRANSFER & STORAGE						
Drum Lifter	Winch-Operated Lift, Stack and Tilt	1,000 lbs Cap., 55 Gal drums 57" Stack, 64" Pour	Each	$ 1,420.42	2	$ 2,840.84
Holding Tank	High-Density Polyethylene Cylindrical Tank (with Covers)	600 Gal.	Each	$ 872.55	2	$ 1,745.10
B. SCREENING						
Screen	Stainless Steel Space Cloth	Type 304, 1" opening, 48" wide	Sq. Ft.	$ 15.29	80	$ 1,223.20
Debris Handling Tool	Stone Fork	Tine spacing 1", 30" handle	Each	$ 87.41	2	$ 174.82
Debris Disposal Drum	Hazardous-Material Steel Drum	20 Gal., with overpack	Each	$ 55.15	1	$ 55.15
C. HOMOGENIZING						
Electric Mixer	Gear Drive, Clamp Mount, Dual Propeller	1.5 hp, 230/430 VAC 60 Hz, 3ph., 420 rpm	Each	$ 1,845.29	2	$ 3,690.58
Sewage Ejector Pump	Type 316 Stainless Steel	1/2 hp	Each	$ 404.75	1	$ 404.75
D. PILOT OPTIMIZATION STAGE						
Weighing Scale (small)	Electronic Bench Scale (Legal-for-Trade)	4,000 g Cap., 1.0 g Grad.	Each	$ 319.80	1	$ 319.80
Bench-Scale Mixer (for treatment/reagent slurry)	Electric (with attachments)	1 Gal. mixing bowl, variable speed	Each	$ 80.00	2	$ 160.00
Lab Supplies	beakers, jars, spatulas, water, etc.	variable sizes	Lump Sum	$ 200.00	1	$ 200.00
E. PILOT TREATMENT						
Rotating Drum Mixer	Trailer-Towable Mixer	6 Cu Ft., 1.5 hp, Electric	Each	$ 3,164.38	2	$ 6,328.76
Reagent Storage Tank	Polypropylene Cylindrical Tank (with Covers)	55 Gal., 22"X36"	Each	$ 156.86	2	$ 313.72
Reagent Slurry Mixer	Direct Drive, Electric	1.5 hp, 115/230 VAC, 12" propeller (for 5 gallon pails)	Each	$ 398.14	2	$ 796.28
Weighing Scale (large)	Electric Bench Scale (Tilting-Head Display)	400 lbs. Cap., 0.2 lbs. Grad. 18"X18" base, 33" high	Each	$ 661.22	1	$ 661.22
F. MATERIAL TRANSFER						
Scoops	Deep-Dish Scoop	10" wide X 15.25" high, 48" long	Each	$ 40.74	4	$ 162.96
G. CURING			Lump Sum			$ 5,000.00
Rectangular Tanks	Polypropylene rectangular tanks (with covers)	24"X18"X24" (45 gal.)	Each	$ 210.21	10	$ 2,102.10
Polycarbonate Pans	Rectangular Polycarbonate Pans	20 4/5"X12 4/5"X6"	Each	$ 15.31	12	$ 183.72
Covers (Polycarbonate Pans)	Covers	For 20 4/5" pans	Each	$ 8.93	12	$ 107.16
H. HEALTH & SAFETY						
Gloves	Nitrile Gloves	9 mil, L	Pair	$ 1.60	12	$ 19.20
	Rubber Gloves	20 mil, L	Pkg.	$ 7.76	2	$ 15.52
	Latex Gloves (Disposable)	7 mil, L, M	Box of 100	$ 11.64	2	$ 23.28
Protective Wear	Steel Toe Boots	Leather	Pair	$ 110.33	4	$ 441.32
	Replacement Liners (for Boots)		Pair	$ 14.88	12	$ 178.56
	Safety Glasses	Forsight Single lens	Each	$ 3.85	6	$ 23.10
	Safety Glasses	Forsight Single lens (over the glasses)	Each	$ 4.81	6	$ 28.86
	Tyvek	Fastzip (White Coveralls)	Case (25)	$ 122.50	1	$ 122.50
	Saranex Tyvek	Fastzip (Coveralls)	Case (12)	$ 155.16	1	$ 155.16
	Respirator Masks	Disposable Dust Mask	Pkg. (50)	$ 7.28	1	$ 7.28
	Respirator Masks	Cartridge Respirator (Full-Face)	Each	$ 199.48	4	$ 797.92
TOTAL EQUIPMENT COST =						$ 28,283
2. MATERIAL						
Georemediation Mix	Proprietary Reagent	As Designed by Tech. Developer	lb	$ 0.10	1000	$ 100.00
Polymer	Organic Polymer for W/W Treatment		Lump Sum	$ 25.00	1	$ 25.00
TOTAL MATERIAL COST =						$ 125
3. WASTE DISPOSAL (EISCO-NJ)						
Treated/Untreated Sediment Material Recycling; Contaminated Water Disposal	Includes volume for sampling etc. From waste/water related tests	Approximate total weight = 2.5 tons Approximate Volume = 10 gal	Lump Sum Lump Sum	$ 2,500.00	1	$ 2,500.00
TOTAL WASTE DISPOSAL (ESICO-NJ) COST =						$ 2,500
TOTAL COST =						$ 30,908

PILOT STUDY COST PROPOSAL

Table 15-3: CHEMICAL ANALYSIS COST - SEDIMENT MATRIX

(ACCUTEST LABORATORIES)

PARAMETER	METHODOLOGY	# OF SAMPLES	TAT	UNIT COST[1]	TOTAL COST
UNTREATED SAMPLES PRIOR TO PILOT OPTIMIZATION STAGE (UNIT P300)					
TAL Metals	SW846 6010B	3	14 d-fax	$ 203.50	$ 610.50
BNA+20	SW846 8270C	3	14 d-fax	$ 363.00	$ 1,089.00
VOC+10	SW846 8260B	3	14 d-fax	$ 220.00	$ 660.00
Pesticides	SW846 8081A	3	14 d-fax	$ 137.50	$ 412.50
PCBs	SW846 8082	3	14 d-fax	$ 137.50	$ 412.50
TPHC	SW846 3545/EPA 418.1	3	14 d-fax	$ 61.88	$ 185.63
Dioxin/Furans	SW846 8290	3	21 d	$ 1,425.00	$ 4,275.00
Sulfides	EPA 9030M	3	14 d-fax	$ 165.00	$ 495.00
pH	SW846 9045	3	14 d-fax	$ 13.20	$ 39.60
TOC	EPA 1986	3	14 d-fax	$ 66.00	$ 198.00
Sulfates, Chlorides, and Resistivity		3	14d-fax	$ 100.00	$ 300.00
Subtotal Cost =					**$ 8,677.73**
TREATED SAMPLES FOR PILOT OPTIMIZATION STAGE (UNIT P300)					
TAL Metals	SW846 6010B	18	7 d-fax	$ 277.50	$ 4,995.00
BNA+20	SW846 8270C	18	7 d-fax	$ 495.00	$ 8,910.00
TPHC	SW846 3545/EPA 418.1	18	7 d-fax	$ 84.38	$ 1,518.75
pH	SW846 9045	18	7 d-fax	$ 18.00	$ 324.00
TOC	EPA 1986	18	7 d-fax	$ 90.00	$ 1,620.00
Subtotal Cost =					**$ 17,367.75**
UNTREATED SAMPLES PRIOR TO PILOT TREATMENT (UNIT P400)					
TAL Metals	SW846 6010B	3	14 d-fax	$ 203.50	$ 610.50
BNA+20	SW846 8270C	3	14 d-fax	$ 363.00	$ 1,089.00
VOC+10	SW846 8260B	3	14 d-fax	$ 220.00	$ 660.00
Pesticides	SW846 8081A	3	14 d-fax	$ 137.50	$ 412.50
PCBs	SW846 8082	3	14 d-fax	$ 137.50	$ 412.50
TPHC	SW846 3545/EPA 418.1	3	14 d-fax	$ 61.88	$ 185.63
Dioxin/Furans	SW846 8290	3	21 d	$ 1,425.00	$ 4,275.00
Sulfides	EPA 9030M	3	14 d-fax	$ 165.00	$ 495.00
pH	SW846 9045	3	14 d-fax	$ 13.20	$ 39.60
TOC	EPA 1986	3	14 d-fax	$ 66.00	$ 198.00
Sulfates, Chlorides, and Resistivity	SW846	3	14d-fax	$ 100.00	$ 300.00
Multiple Extraction Procedure (MEP)	EPA 1320	2	21 d	$ 9,395.00	$ 18,790.00
Subtotal Cost =					**$ 27,467.73**
TREATED SAMPLES DURING PILOT TREATMENT (UNIT P400)					
14 day Cure - 7-day TAT					
TAL Metals	SW846 6010B	16	7 d-fax	$ 277.50	$ 4,440.00
BNA+20	SW846 8270C	16	7 d-fax	$ 495.00	$ 7,920.00
VOC+10	SW846 8260B	16	7 d-fax	$ 300.00	$ 4,800.00
Pesticides	SW846 8081A	16	7 d-fax	$ 187.50	$ 3,000.00
PCBs	SW846 8082	16	7 d-fax	$ 187.50	$ 3,000.00
TPHC	SW846 3545/EPA 418.1	16	7 d-fax	$ 84.38	$ 1,350.00
Dioxin/Furans	SW846 8290	16	21 d	$ 1,425.00	$ 22,800.00
Sulfides	EPA 9030M	16	7 d-fax	$ 225.00	$ 3,600.00
pH	SW846 9045	16	7 d-fax	$ 18.00	$ 288.00
TOC	EPA 1986	16	7 d-fax	$ 90.00	$ 1,440.00
Subtotal Cost =					**$ 52,638.00**
28 day Cure - 14-day TAT					
TAL Metals	SW846 6010B	14	14 d-fax	$ 203.50	$ 2,849.00
BNA+20	SW846 8270C	14	14 d-fax	$ 363.00	$ 5,082.00
VOC+10	SW846 8260B	14	14 d-fax	$ 220.00	$ 3,080.00
Pesticides	SW846 8081A	14	14 d-fax	$ 137.50	$ 1,925.00
PCBs	SW846 8082	14	14 d-fax	$ 137.50	$ 1,925.00
TPHC	SW846 3545/EPA 418.1	14	14 d-fax	$ 61.88	$ 866.25
Dioxin/Furans	SW846 8290	14	21 d	$ 1,425.00	$ 19,950.00
Sulfides	EPA 9030M	14	14 d-fax	$ 165.00	$ 2,310.00
pH	SW846 9045	14	14 d-fax	$ 13.20	$ 184.80
TOC	EPA 1986	14	14 d-fax	$ 66.00	$ 924.00
Sulfates, Chlorides, and Resistivity	SW846	2	14d-fax	$ 100.00	$ 200.00
Multiple Extraction Procedure (MEP)	EPA 1320	2	21 d	$ 9,395.00	$ 18,790.00
Subtotal Cost =					**$ 58,086.05**
60 day Cure - 21-day TAT					
TAL Metals	SW846 6010B	8	21 d	$ 185.00	$ 1,480.00
BNA+20	SW846 8270C	8	21 d	$ 330.00	$ 2,640.00
VOC+10	SW846 8260B	8	21 d	$ 200.00	$ 1,600.00
Pesticides	SW846 8081A	8	21 d	$ 125.00	$ 1,000.00
PCBs	SW846 8082	8	21 d	$ 125.00	$ 1,000.00
TPHC	SW846 3545/EPA 418.1	8	21 d	$ 56.25	$ 450.00
Dioxin/Furans	SW846 8290	8	21 d	$ 1,425.00	$ 11,400.00
Sulfides	EPA 9030M	8	21 d	$ 150.00	$ 1,200.00
pH	SW846 9045	8	21 d	$ 12.00	$ 96.00
TOC	EPA 1986	8	21 d	$ 60.00	$ 480.00
Subtotal Cost =					**$ 21,346.00**
Sediment Analytical Subtotal					*$ 185,583.25*
QA/QC (10%)					*$ 18,558.33*
TOTAL ANALYTICAL COST (ACCUTEST) =					**$ 204,141.58**

NOTES

1. The Unit Cost of each analysis is based on the Turn-Around-Time (TAT) specified
2. DEP List outlined in DADM - VOCs, SVOCs, Pest, Metals, Cyanide, Dioxins, PCB Congeners

PCB Congeners are only analyzed when aquatic environments are potentially affected. In other cases, Aroclors will be reported

PILOT STUDY COST PROPOSAL
Table 15-4: CHEMICAL ANALYSIS COST - PORE-WATER
(ACCUTEST LABORATORIES)

PARAMETER	METHODOLOGY	# OF SAMPLES	TAT	UNIT COST[1]	TOTAL COST
PORE WATER FROM UNTREATED SAMPLES - UNFILTERED (UNIT P700A)					
TAL Metals	SW846 6010B	3	21-d	$ 185.00	$ 555.00
BNA+20	SW846 8270C	3	21-d	$ 330.00	$ 990.00
Pesticides	SW846 8081A	3	21-d	$ 125.00	$ 375.00
PCBs	SW846 8082	3	21-d	$ 125.00	$ 375.00
Dioxins/Furans	SW846 8290	3	21-d	$ 1,425.00	$ 4,275.00
TPHC	SW846 3545/EPA 418.1	3	21-d	$ 56.25	$ 168.75
pH	SW846 9045	3	21-d	$ 12.00	$ 36.00
Subtotal Cost =					**$ 6,774.75**
PORE WATER FROM UNTREATED SAMPLES - FILTERED (UNIT P700A)					
TAL Metals	SW846 6010B	3	21-d	$ 185.00	$ 555.00
BNA+20	SW846 8270C	3	21-d	$ 330.00	$ 990.00
Pesticides	SW846 8081A	3	21-d	$ 125.00	$ 375.00
PCBs	SW846 8082	3	21-d	$ 125.00	$ 375.00
Dioxins/Furans	SW846 8290	3	21-d	$ 1,425.00	$ 4,275.00
TPHC	SW846 3545/EPA 418.1	3	21-d	$ 56.25	$ 168.75
pH	SW846 9045	3	21-d	$ 12.00	$ 36.00
Subtotal Cost =					**$ 6,774.75**
PORE WATER FROM TREATED SAMPLES - UNFILTERED (UNIT P700B)					
TAL Metals	SW846 6010B	3	21-d	$ 185.00	$ 555.00
BNA+20	SW846 8270C	3	21-d	$ 330.00	$ 990.00
Pesticides	SW846 8081A	3	21-d	$ 125.00	$ 375.00
PCBs	SW846 8082	3	21-d	$ 125.00	$ 375.00
Dioxins/Furans	SW846 8290	3	21-d	$ 1,425.00	$ 4,275.00
TPHC	SW846 3545/EPA 418.1	3	21-d	$ 56.25	$ 168.75
pH	SW846 9045	3	21-d	$ 12.00	$ 36.00
Subtotal Cost =					**$ 6,774.75**
PORE WATER FROM TREATED SAMPLES - FILTERED (UNIT P700B)					
TAL Metals	SW846 6010B	3	21-d	$ 185.00	$ 555.00
BNA+20	SW846 8270C	3	21-d	$ 330.00	$ 990.00
Pesticides	SW846 8081A	3	21-d	$ 125.00	$ 375.00
PCBs	SW846 8082	3	21-d	$ 125.00	$ 375.00
Dioxins/Furans	SW846 8290	3	21-d	$ 1,425.00	$ 4,275.00
TPHC	SW846 3545/EPA 418.1	3	21-d	$ 56.25	$ 168.75
pH	SW846 9045	3	21-d	$ 12.00	$ 36.00
Subtotal Cost =					**$ 6,774.75**
TOTAL ANALYTICAL COST =					**$ 27,099**

NOTES
1. The Unit Cost of each analysis is based on the Turn-Around-Time (TAT) specified

PILOT STUDY COST PROPOSAL
Table 15-5: CHEMICAL ANALYSIS COST - AIR EMISSIONS
(AIR TOXICS LABORATORIES)

PARAMETER	METHODOLOGY	# OF SAMPLES	TAT	UNIT COST[1]	TOTAL COST
AIR EMISSIONS MONITORING SAMPLES (UNIT P600)					
PCBs/Pesticides	TO-10	8	14 d-fax	$ 220.00	$ 1,760.00
TCL+ SVOCs	TO-13	8	14 d-fax	$ 420.00	$ 3,360.00
TCL+ VOCs	TO-15	8	14 d-fax	$ 280.00	$ 2,240.00
Metals	NIOSH 7600	8	14 d-fax	$ 160.00	$ 1,280.00
Mercury	NIOSH 6009	8	14 d-fax	$ 45.00	$ 360.00
Subtotal Cost=					**$ 9,000.00**
TOTAL ANALYTICAL COST (AIR EMISSIONS)=					**$ 9,000.00**

NOTES

1. The Unit Cost of each analysis is based on the Turn-Around-Time (TAT) specified

PILOT STUDY COST PROPOSAL
Table 15-6: PHYSICAL ANALYSIS COST - SEDIMENT MATRIX
(RUTGERS GEOTECHNICAL LABORATORIES)

PARAMETER	METHODOLOGY	# OF SAMPLES	UNIT COST[1]	TOTAL COST
UNTREATED SEDIMENT SAMPLES (UNIT P200)				
Percent Moisture	ASTM D2216	3	$ 20.00	$ 60.00
Grain-Size Analysis	ASTM D422	3	$ 250.00	$ 750.00
Specific Gravity	ASTM D854	3	$ 100.00	$ 300.00
Atterberg Limits	ASTM D4318	3	$ 150.00	$ 450.00
TREATED SEDIMENT SAMPLES (SLURRIED REAGENT MIX) [UNIT P400A-1/P500A-1]				
Percent Moisture	ASTM D2216	3	$ 20.00	$ 60.00
Grain-Size Analysis	ASTM D422	3	$ 250.00	$ 750.00
Specific Gravity	ASTM D854	3	$ 100.00	$ 300.00
Atterberg Limits	ASTM D4318	3	$ 150.00	$ 450.00
California Bearing Ratio (CBR Test)	ASTM D1883	3	$ 320.00	$ 960.00
Resilient Modulus Test	AASHTO T274	3	$ 700.00	$ 2,100.00
Triaxial Compressive Strength	ASTM D4767	3	$ 450.00	$ 1,350.00
Freezing and Thawing Test	ASTM D560	3	$ 350.00	$ 1,050.00
Modified Compaction Test	ASTM D1557	3	$ 300.00	$ 900.00
Collapse Potential	ASTM D5333	3	$ 400.00	$ 1,200.00
Swelling Test	ASTM D-4546	3	$ 500.00	$ 1,500.00
Permeability Test	ASTM D5084	3	$ 450.00	$ 1,350.00
TREATED SEDIMENT SAMPLES (DRY REAGENT MIX) [[UNIT P400B/P500A-1]				
Percent Moisture	ASTM D2216	3	$ 20.00	$ 60.00
Grain-Size Analysis	ASTM D422	3	$ 250.00	$ 750.00
Specific Gravity	ASTM D854	3	$ 100.00	$ 300.00
Atterberg Limits	ASTM D4318	3	$ 150.00	$ 450.00
California Bearing Ratio (CBR Test)	ASTM D1883	3	$ 320.00	$ 960.00
Resilient Modulus Test	AASHTO T274	3	$ 700.00	$ 2,100.00
Triaxial Compressive Strength	ASTM D4767	3	$ 450.00	$ 1,350.00
Freeze/Thaw Test	ASTM D560	3	$ 350.00	$ 1,050.00
Modified Compaction Test	ASTM D1557	3	$ 300.00	$ 900.00
Collapse Potential	ASTM D5333	3	$ 400.00	$ 1,200.00
Swelling Test	ASTM D-4546	3	$ 500.00	$ 1,500.00
Permeability Test	ASTM D5084	3	$ 450.00	$ 1,350.00
TREATED SEDIMENT SAMPLES (AFTER MECHANICAL DEWATERING/CURING[UNIT P400A-1/P700/P500A-4]				
Percent Moisture	ASTM D2216	3	$ 20.00	$ 60.00
Grain-Size Analysis	ASTM D422	3	$ 250.00	$ 750.00
Specific Gravity	ASTM D854	3	$ 100.00	$ 300.00
Atterberg Limits	ASTM D4318	3	$ 150.00	$ 450.00
California Bearing Ratio (CBR Test)	ASTM D1883	3	$ 320.00	$ 960.00
Resilient Modulus Test	AASHTO T274	3	$ 700.00	$ 2,100.00
Triaxial Compressive Strength	ASTM D4767	3	$ 450.00	$ 1,350.00
Freezing and Thawing Test	ASTM D560	3	$ 350.00	$ 1,050.00
Modified Compaction Test	ASTM D1557	3	$ 300.00	$ 900.00
Collapse Potential	ASTM D5333	3	$ 400.00	$ 1,200.00
Swelling Test	ASTM D-4546	3	$ 500.00	$ 1,500.00
Permeability Test	ASTM D5084	3	$ 450.00	$ 1,350.00
TOTAL GEOTECHNICAL COST =				**$ 37,470**

PILOT STUDY COST PROPOSAL
Table 15-7: MECHANICAL DEWATERING TEST - SEDIMENT MATRIX (SUBCONTRACOTRS)

TEST	# OF TESTS	UNIT COST	TOTAL COST
Mechanical Dewatering Test (Unit P700)	2	$ 3,000.00	$ 6,000.00
TOTAL SUBCONTRACTOR COST =			**$ 6,000.00**

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PILOT STUDY COST PROPOSAL
Table 15-8: LABOR COST

Personnel Title	Personnel Name	UNIT	Rate	Task						Total mhrs	TOTAL COST
				Work Plan	Operations	Sampling	Data Analysis	Reports Preparation	Admin. Support		
BEM Labor											
Principal Project Director	Mark Nardolillo	mhrs	$ 192.07	20	30		30	30		110	$ 21,127.70
Lead Pilot Project Manager	John Butziger	mhrs	$ 79.08	90	80	20	60	80		330	$ 26,096.40
Principal Process Engineer	John Ferrante	mhrs	$ 136.70	10	40		30	30		110	$ 15,037.00
Peer Reviewer (Process Engineering)	Olu Songonuga	mhrs	$ 100.55	8	10		40	40		98	$ 9,853.90
Project Engineer	Ajay Kathuria	mhrs	$ 51.97	120	176	40	50	120		506	$ 26,296.82
Regulatory Compliance Engineer	Brian Pederson	mhrs	$ 66.66		20		10	20		50	$ 3,333.00
Health and Safety Manager	Brian Ruffe	mhrs	$ 73.44		60	16	16	16		108	$ 7,931.52
Senior Scientist	Randy Youngman	mhrs	$ 61.08	20	10	40	40	30		140	$ 8,551.20
Staff Scientist	Sandra Gaurin	mhrs	$ 36.72		80	20	20	40		160	$ 5,875.20
QA/QC Manager	Andy Crabb	mhrs	$ 70.03	65	40	80	80	60		325	$ 22,759.75
Accountant/Administrator	Sebastien Farhi	mhrs	$ 51.29						80	80	$ 4,103.20
Secretary/Clerk	Ada Chan	mhrs	$ 29.37						80	80	$ 2,349.60
Total BEM Labor Hours =		mhrs		333	546	216	376	466	160	2,097	
Total BEM Labor Cost =				$ 25,140	$ 39,798	$ 13,615	$ 31,850	$ 36,459	$ 6,453		$ 153,315.29
Jeff Newton											
Technology Manager	Jeff Newton	mhrs	$ 85.00	8	60	8	80	60		216	$ 18,360.00
Total Jeff Newton Labor Hours =		mhrs		8	60	8	80	60	-	216	
Total Jeff Newton Labor Cost =				$ 680	$ 5,100		$ 6,800	$ 5,100			$ 18,360.00
James R. Payne											
Decontamination Evaluation	James R. Payne	mhrs	$ 100.00		16		40	20		76	$ 7,600.00
Total James R. Payne Labor Hours =		mhrs		-	16	-	40	20	-	76	
Total James R. Payne Labor Cost =					$ 1,600			$ 2,000			$ 7,600.00
Dr. Ali Maher Labor											
Geotechnical Testing and Consulting	Dr. Ali Maher	mhrs	$ 100.00				20	20		40	$ 4,000.00
Total Dr. Maher Labor Hours =		mhrs		-	-	-	20	20	-	40	
Total Dr. Maher Labor Cost =								$ 2,000			$ 4,000.00
Dr. Raj Khera											
Beneficial Reuse Evaluation	Dr. Raj Khera	mhrs	$ 100.00		8		20	20		48	$ 4,800.00
Total Dr. Raj Khera Labor Hours =		mhrs		-	8		20	20	-	48	
Total Dr. Raj Khera Labor Cost =					$ 800			$ 2,000			$ 4,800.00
Converse Labor											
Beneficial Reuse Evaluation	Dr. Issa Oweis	mhrs	$ 130.00		8		20	20		48	$ 6,240.00
Total Converse Labor Hours =		mhrs		-	8	-	20	20	-	48	
Total Converse Labor Cost =					$ 1,040			$ 2,600			$ 6,240.00
Julie Smith											
Independent Data Validation	TBD	mhrs	$ 70.00				400	50		450	$ 31,500.00
Total Julie Smith Labor Hours =		mhrs		-	-	-	400	50	-	450	
Total Julie Smith Labor Cost =					$ -			$ 3,500			$ 31,500.00
Total mhrs/Task		mhrs		341	638	224	956	606	160	2,525	
TOTAL COST =				$ 25,820	$ 48,338	$ 13,615	$ 38,650	$ 53,659	$ 6,453		$ 225,815

PILOT STUDY COST PROPOSAL
Table 15-9: COST SHARING PLAN

TEAM MEMBER	MECHANISM	SHARED COST
BEM		
Labor	10% of Total BEM Labor Cost	$ 15,332
Analytical (Chemical)	10% of Analytical Cost by Accutest to be Shared by BEM	$ 23,124
JEFF NEWTON		
Labor	10% to Total Jeff Newton Labor	$ 1,836
TOTAL COST SHARING =		**$ 40,292**

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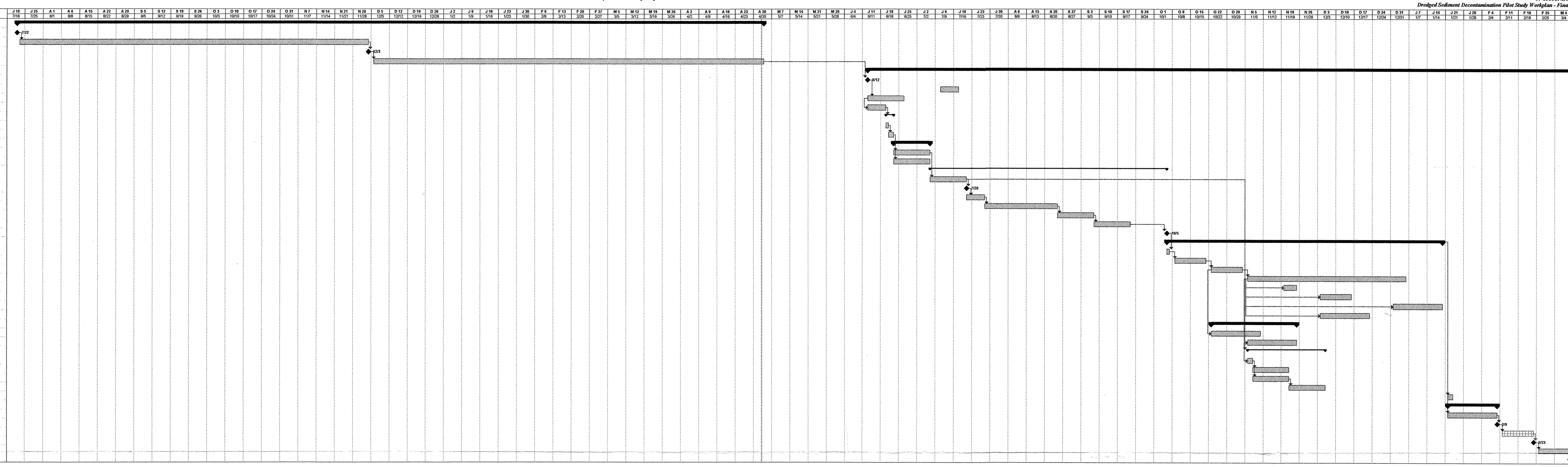
16.0 PROJECT SCHEDULE

A detailed schedule for the proposed BEMs pilot study is presented in Figure 16-1. The total duration of the pilot study is estimated to be approximately 9 months (June 2000 1999 to March 2001). The major operational milestones at various stages of the pilot study along with the submission of monthly progress and final report are included in Figure 16-1.

Figure 16-1
Proposed Pilot Study Project Schedule

BEM Systems, Inc.
99-1518CNEO
Dredged Sediment Decontamination Pilot Study Workplan - Final

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Pre-Pilot Study Schedule**	**205 days**	**Thu 7/22/99**	**Wed 5/3/00**	
2	Pre-Contract Negotiation Meeting	1 day	Thu 7/22/99	Thu 7/22/99	
3	Workplan Preparation, NJMR Review, and Revisions by BEM	96 days	Fri 7/23/99	Fri 12/3/99	2
4	Revised Workplan Submission to NJMR	0 days	Fri 12/3/99	Fri 12/3/99	3
5	NJMR/NJDEP Review, and Revisions (#2) by BEM	108 days	Mon 12/6/99	Wed 5/3/00	4
6	**Pilot Study Schedule**	**194 days**	**Mon 6/12/00**	**Fri 3/9/01**	
7	**Notice To Proceed**	0 days	Mon 6/12/00	Mon 6/12/00	5FS+28 days
8	**Monthly Progress Reports**	**5 days**	**Tue 7/11/00**	**Mon 7/17/00**	**7FS+4 wks**
16	**Pilot Setup**	10 days	Tue 6/13/00	Mon 6/26/00	7
17	**Material Procurement and Storage (Unit P100)**	5 days	Tue 6/13/00	Mon 6/19/00	16SS
18	**Pretreatment (Unit P200)**	**3 days**	**Tue 6/20/00**	**Thu 6/22/00**	17
19	Screening (Unit P200A)	1 day	Tue 6/20/00	Tue 6/20/00	
20	Homogenization (Unit P200B)	2 days	Wed 6/21/00	Thu 6/22/00	19
21	**Raw Dredged Material Characterization**	**10 days**	**Fri 6/23/00**	**Thu 7/6/00**	
22	Chemical Testing	10 days	Fri 6/23/00	Thu 7/6/00	20
23	Physical Testing	10 days	Fri 6/23/00	Thu 7/6/00	20
24	**Pilot Optimization (Unit P300)**	**65 days**	**Fri 7/7/00**	**Thu 10/5/00**	
25	Untreated Data Analysis/Reagent Mix Design	10 days	Fri 7/7/00	Thu 7/20/00	22
26	Reagent Mix Selections	0 days	Thu 7/20/00	Thu 7/20/00	25
27	Pilot Optimization Treatments	5 days	Fri 7/21/00	Thu 7/27/00	26
28	Curing Period	20 days	Fri 7/28/00	Thu 8/24/00	27
29	Treated Samples Chemical Characterization	10 days	Fri 8/25/00	Thu 9/7/00	28
30	Chemical Data Analysis	10 days	Fri 9/8/00	Thu 9/21/00	29
31	Reagent Type and Mix-Ratio Selection	0 days	Thu 10/5/00	Thu 10/5/00	30FS+10 days
32	**Pilot Treatment (Unit P400)**	**76 days**	**Fri 10/6/00**	**Fri 1/19/01**	
33	Re-Homogenizing of Raw Material (Unit P200B)	1 day	Fri 10/6/00	Fri 10/6/00	31
34	Raw Material Re-Characterization	10 days	Mon 10/9/00	Fri 10/20/00	33
35	Treatments (Unit P400A-1 to P400A-4/P400B)	10 days	Mon 10/23/00	Fri 11/3/00	34
36	Curing (Unit P500A-1 to P500A-3/P500B-1 to P500B-2)	9 wks	Mon 11/6/00	Fri 1/5/01	35
37	Chemical Testing (14 Days)	5 days	Mon 11/20/00	Fri 11/24/00	36SS+2 wks
38	Chemical Testing (28 Days)	10 days	Mon 12/4/00	Fri 12/15/00	36SS+4 wks
39	Chemical Testing (60 Days)	15 days	Mon 1/1/01	Fri 1/19/01	36SS+8 wks
40	Geotechnical Testing	15 days	Mon 12/4/00	Fri 12/22/00	36SS+4 wks
41	**Air Emissions Testing**	**25 days**	**Mon 10/23/00**	**Fri 11/24/00**	
42	Air Sampling (During Treatment)/Analysis	15 days	Mon 10/23/00	Fri 11/10/00	35SS
43	Air Sampling (During Curing)/Analysis	15 days	Mon 11/6/00	Fri 11/24/00	36SS
44	**Mechanical Dewatering/Pore-water Analysis**	**22 days**	**Mon 11/6/00**	**Tue 12/5/00**	25
45	Mechanical Dewatering (Untreated/Treated Sediments)	2 days	Mon 11/6/00	Tue 11/7/00	36SS
46	Pore-water Analysis	10 days	Wed 11/8/00	Tue 11/21/00	45
47	Curing (Treated/Dewatered Sediment)	10 days	Wed 11/8/00	Tue 11/21/00	45
48	Chemical Testing	10 days	Wed 11/22/00	Tue 12/5/00	47
49	**Disposal (P700)**	2 days	Mon 1/22/01	Tue 1/23/01	32
50	**Draft Report Preparation/Submittal to NJMR**	**15 days**	**Mon 1/22/01**	**Fri 2/9/01**	
51	Data Analysis/Report Preparation	15 days	Mon 1/22/01	Fri 2/9/01	32
52	Submit Draft Report to NJMR	0 days	Fri 2/9/01	Fri 2/9/01	51
53	Draft Report Review by NJMR	2 wks	Mon 2/12/01	Fri 2/23/01	52
54	**Review Comments by NJMR**	**0 days**	**Fri 2/23/01**	**Fri 2/23/01**	53
55	Final Report Preparation	2 wks	Mon 2/26/01	Fri 3/9/01	54
56	**Submit Final Report to NJMR**	**0 days**	**Fri 3/9/01**	**Fri 3/9/01**	55



Project: pltsch2.mpp
Date: Wed 5/3/00

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress | External Tasks | Project Summary | Split | Rolled Up Split

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amended at 56 FR 43702, September 4, 1991; 56 FR 50759, October 8, 1991; 57 FR 41833, September 11, 1992.

U.S. Environmental Protection Agency (USEPA) SW-846, Test Methods for Evaluating Solid Waste, 3rd. Ed. (and revisions), November 1986.

U.S. Environmental Protection Agency (USEPA) Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, 3rd Ed., March 1983

Portland Cement Association (PCA), Concrete Information, Properties and Uses of Cement-Modified Soil, 1992.

W.S. Adaska, Portland Cement Association (PCA), Soil Cement – A Material with Many Applications, authorized reprint from: January 1991 issue of ACI Concrete International.

APPENDIX A

Letter of Commitment from Dr. Ali Maher, Ph.D.
(Rutgers University – Department of Civil and EnvironmentalEngineering)

27 December 1999

Mr. John M. Butziger, P.E.
BEM Systems, Inc.
100 Passaic Avenue
Chatham, NJ 07928

Re: Sediment Decontamination Demonstration Project
Proposed Pilot Study by BEM Systems, Inc. (BEM)

Dear Mr. Butziger:

This letter is in reference to BEM Systems, Inc.'s (BEM's) proposed Pilot study project as part of the Sediments Decontamination Demonstration Project undertaken by the office of New Jersey Maritime Resources (NJMR). BEM has retained my services as a consultant to oversee the Pilot study operations. As a consultant to BEM, I have made arrangements with the Civil Engineering Department at Rutgers University to utilize the available equipment and laboratory space to conduct these operations (testing arrangement). The Pilot study operations will be conducted in a portion of the Civil Engineering Laboratories from which access will be restricted to any persons not involved in this project. Those personnel involved in this project will be required to have read and be familiar with the BEM Health and Safety Plan for this project and the applicable laboratory procedures and regulations for laboratory safety relating to the sediments tested, the reagents used, and the laboratory equipment. Moreover, the work will be conducted under direct BEM supervision.

A detailed description of the project execution, material handling, and geotechnical testing procedures is provided in BEM's Pilot Study Workplan. The following summarizes the Pilot Study operations which will be conducted at the Rutgers laboratories:

- Storage of the dredged material at room temperature in tightly sealed storage containers;
- Pretreatment of the dredged material, which will include the homogenizing and screening of the material using equipment capable of handling 30 to 55 gallon drums of dredged material;
- Dredged material sampling for the purpose of chemical and geotechnical characterization. The samples for the chemical analysis will be sent to Accutest Laboratories and will be handled in accordance with their protocols;
- Laboratory scale optimization of the Georemediation™ technology, which will include several combinations of bench scale mixing and curing of dredged material samples (one gallon each) using Georemediation™ reagent. The curing of the treated material will be conducted in open pans for a minimum of a two week period;
- Pilot scale treatment of the dredged material based on the results of the optimization stage. This will consist of mixing of approximately 40 gallons of bulk sediment samples with the Georemediation™ reagent mix using an 8 cubic foot rotating drum mixer or similar

equipment. A total of five separate treatment trains will be employed for the purpose of testing various parameters.

- Air emissions testing which will require inserting a probe into the rotating drum mixers and curing pans (covered with lids) to collect air samples during treatment process. Air sampling will be conducted using standard EPA testing procedures (to be conducted by BEM);
- Sample collection and material handling for any other tests to be performed outside the Rutgers laboratories (e.g. mechanical dewatering, filter, porewater analysis tests) (responsibility of BEM);
- Sampling and geotechnical testing to investigate basic soil mechanical properties and advanced. A detailed summary of the testing parameters and standard methodologies is provided in BEM's Pilot Study Workplan.

All quality assurance procedures outlined in BEM's Pilot Study Workplan will be followed during the project execution and material handling at the Rutgers laboratories. These include, but are not limited to proper use of sample containers, decontamination of sampling equipment, laboratory decontamination procedures, documentation and data management, and sample custody procedures. Disposal of the dredged material and any waste generated during the study will be handled by BEM through permitted disposal and/or recycling facilities within the state of New Jersey.

Should you have any questions or require additional information, please do not hesitate to call me at (732) 445-2485.

Very truly yours,

Dr. Ali Maher, Ph.D.
Geotechnical Consultant

cc: M. Nardolillo (BEM)

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