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Remediation of the Black Lagoon Trenton, Michigan

Great Lakes Legacy Program

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EXECUTIVE SUMMARY

This report describes a joint effort between the U.S. Environmental Protection Agency (EPA) Great Lakes National Program Office (GLNPO) and the Michigan Department of Environmental Quality (MDEQ) to remediate contaminated sediments in the Black Lagoon. The Black Lagoon lies in the Trenton Channel of the Detroit River, outside the City of Trenton, Michigan. The Detroit River is a 32-mile international connecting channel linking Lake St. Clair and the upper Great Lakes to Lake Erie. The lagoon is within the Detroit River International Wildlife Refuge, the first international refuge so designated in North America. The lagoon also is adjacent to a public park that contains picnic and playground areas.

The Detroit River Area of Concern (AOC) is a binational AOC which drains approximately 700 square miles of land in Michigan and Ontario, including the city of Detroit. Eleven beneficial use impairments have been identified in the Detroit River (see: http://www.epa.gov/glnpo/aoc/detroit.html). The known causes of impairments include bacteria, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), metals, and oil and grease from urban and industrial development in the watershed. Combined sewer overflows (CSOs) and municipal and industrial discharges are major sources of contaminants within the AOC. Stormwater runoff and tributaries in Michigan are also major sources of contaminants. Additional environmental concerns include invasive species, changes in the fish community structure, and reductions in fish and wildlife habitat.

The Black Lagoon proposal was the first project to be accepted and funded under the Great Lakes Legacy Act (GLLA) of 2002. This legislation was specifically developed to address the contaminated sediment problem in Great Lakes AOCs. The primary objective of the project was to remove the polluted sediments in the lagoon, and improve the environment by mitigating beneficial use impairments (BUIs) that impacted the lagoon, its inhabitants, and the surrounding community.

Two specific goals were targeted with this objective:

1) Reduce relative risk to humans, wildlife, and aquatic life, and

2) Restore the aquatic habitat within the Black Lagoon.

GLLA Project activities at the site began in late September 2004 and continued through November 2005. Prior to dredging, a silt curtain was installed to enclose the entire lagoon and protect the adjacent river from releases of suspended sediments during dredging operations. Water quality and air monitoring strategies also were employed throughout the project to ensure that the remediation activities were not adversely affecting the health of the ecosystem, surrounding environment, or the remediation staff.

Dredging operations were undertaken with the goal to dredge to hardpan across the lagoon. Using a clamshell dredge device, approximately 103,500 cubic yards of contaminated sediments were removed. After completion of this first round of dredging, the remaining residual sediments were sampled and analyzed to verify that the dredging activities reduced contamination to acceptable levels. Results of these analyses suggested that high concentrations of the contaminants of concern still remained in some areas, so a second phase of dredging was conducted to remove an additional one to three feet of sediment. Sampling after Phase II of dredging indicated that, although contaminants were still present in some areas above originally targeted levels, the second round of dredging successfully reduced both the overall concentration and the distribution of those contaminants. In all, approximately 115,000 cubic yards of contaminated sediments containing approximately 478,000 pounds of PCBs, mercury, oil and grease, lead, and zinc were removed from the lagoon.

After removing the contaminated sediments, a sand and stone cover was installed. The cover consisted of at least 6 inches of clean sand that was further covered by 4 to 6 inches of stone. The primary purpose of the cover was to provide a barrier between the benthic community and any residual contaminated sediment. This cover will enhance natural attenuation, add habitat for regrowth of healthy organisms on the lagoon floor, and reduce exposure of fish to contamination through consumption of bottom dwelling organisms.

Following dredging and the placement of a sand cover in the lagoon, the City of Trenton was awarded $151,000 from the Great Lakes Basin Program for Soil Erosion and Sediment Control for shoreline habitat restoration (2006). In June 2007, the City of Trenton received a $582,000 boating/infrastructure grant from the U.S. Fish and Wildlife Service for marina construction/boating access and is matching that grant with $200,000 to construct floating docks and boat access at the site, as well as move forward on redevelopment of its downtown area. The lagoon was informally named the Black Lagoon after aerial surveys depicted the lagoon as literally black from oil and grease contamination. On Monday June 18, 2007, the City of Trenton and its many partners celebrated the restoration and revitalization of the Black Lagoon in a ceremony renaming Black Lagoon as “Ellias Cove” in honor of the family who donated the adjacent land to the City of Trenton that became Meyer-Ellias Park.

1.0 PROJECT DESCRIPTION

This report describes remediation of the Black Lagoon, located in the Trenton Channel of the Detroit River, near Trenton, Michigan. The Black Lagoon is part of the Detroit River Area of Concern (AOC). The Detroit River is a 32-mile international connecting channel linking Lake St. Clair and the upper Great Lakes to Lake Erie. The Detroit River AOC is a binational AOC which drains approximately 700 square miles of land in Michigan and Ontario, as well as the 107 square mile City of Detroit "sewershed." Approximately 75 percent of the total land area of the watershed is in Michigan (607.7 square miles). Eleven beneficial use impairments (BUIs) have been identified in the Detroit River and most of these are impairing the Black Lagoon. The known causes of impairments include urban and industrial development in the watershed, bacteria, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), metals, and oils and greases. Combined sewer overflows (CSOs) and municipal and industrial discharges are major sources of contaminants within the AOC. Stormwater runoff and tributaries in Michigan are also major sources of contaminants. Additional environmental concerns include invasive species, changes in the fish community structure, and reductions in fish and wildlife habitat. Detroit River priorities include: control of combined sewer overflows (CSOs), control of sanitary sewer overflows (SSOs), point/nonpoint source pollution controls, remediation of contaminated sediments, habitat restoration, and pollution prevention.

The Black Lagoon had been severely impacted by historical contamination from upstream industries. These impacts included the lagoon's reduced capacity to support recreational activities such as swimming, fishing, and boating, as well as impairment of lagoon aesthetics by oil floating on the water surface. The health of the aquatic life in the water and sediments of the Black Lagoon, as well as wildlife along the shoreline, also were adversely affected by the pollution.

One of the greatest pollution concerns was contaminants in the sediment underlying the lagoon. Contaminated sediments are ingested by bottom-dwelling benthic organisms as they feed and can be toxic to many of the invertebrates inhabiting the sediment. Additionally, the chemical toxins can be concentrated up the food chain as larger organisms eat the smaller organisms. Contaminated sediments also have the potential to be resuspended by storms and ship propellers, potentially contaminating other areas downstream. Removal of the contaminated sediments was deemed necessary to lessen or eliminate these pollution-associated risks.

The remediation of the Black Lagoon was a joint effort between the U.S. Environmental Protection Agency (EPA) Great Lakes National Program Office (GLNPO) and the Michigan Department of Environmental Quality (MDEQ). This project was performed under the authority of the Great Lakes Legacy Act of 2002, with support from the Clean Michigan Initiative (CMI) of 1998. Additional support for the project was provided by the Detroit District of the U.S. Army Corps of Engineers (USACE), the City of Trenton, the American Heritage Rivers program, and several private firms operating under contract to U.S. EPA and MDEQ.

1.1 GENERAL SITE DESCRIPTION

The Black Lagoon lies within the U.S. Fish and Wildlife Service's Detroit River International Wildlife Refuge, the first international refuge so designated in North America. The lagoon is a 3.5-acre cove of relatively still water in the Trenton Channel of the Detroit River at the end of Helen Street in the City of Trenton, Michigan (see Figure 1-1).

The city's Meyer Ellias Memorial Park, which contains picnic and playground areas, is immediately adjacent to the west side of the lagoon. Residential homes, private boat slips, and a sea wall are located immediately to the south and southwest of the lagoon. An open, flat area of private property (the E. C. Levy property) is located immediately north of the lagoon area, and the defunct McLouth steel mill is approximately 0.5 miles to the north. The mill closed in 1995 and is considered the primary source of sediment contamination in the Black Lagoon.

The shoreline consisted of exposed sand and gravel, with broken concrete placed below the water level to provide erosion and ice flow protection (prior to remedial activities). Water depths vary from approximately 1 to 6 feet below Low Water Depth (LWD). The lagoon is partially separated from the Trenton Channel by a sand/silt bar, which has water depths of 0.2 to 1.8 feet below LWD.

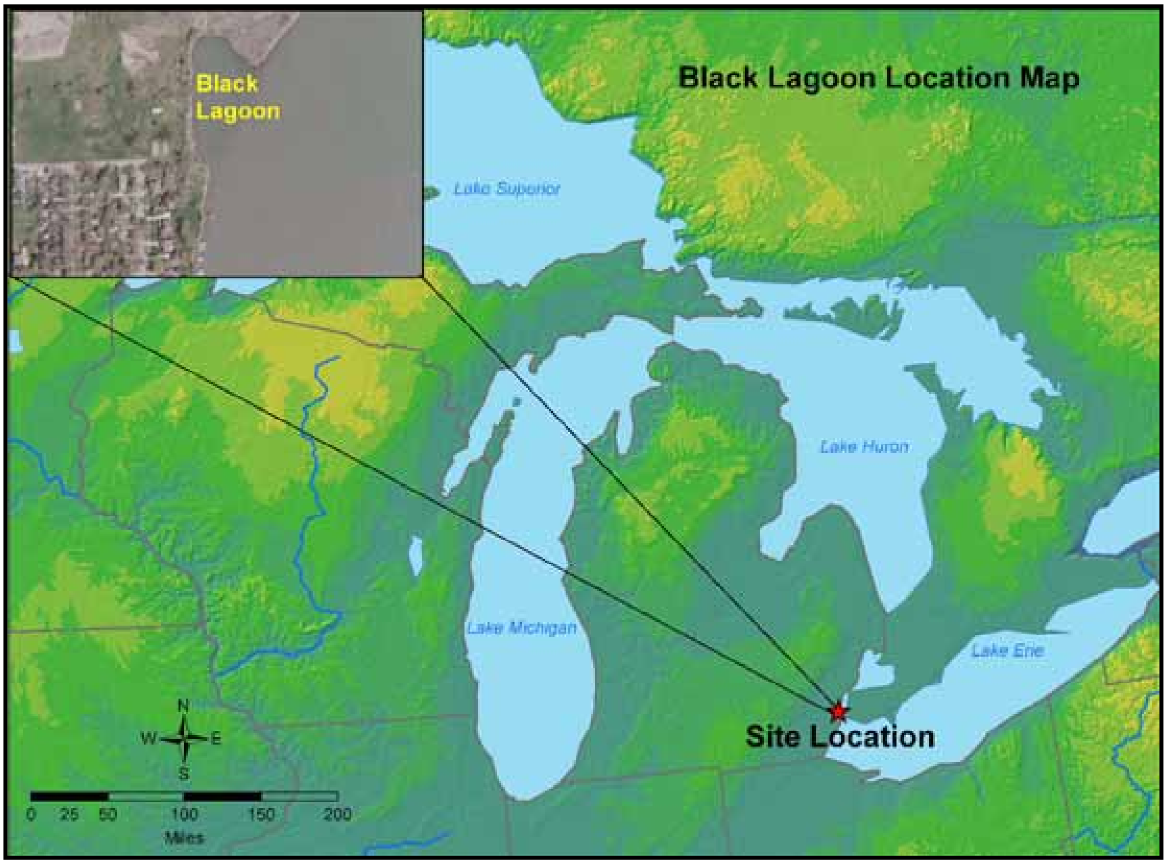

Figure 1-1 Black Lagoon Remediation Site Location Map

1.2 SITE HISTORY

Numerous environmental studies were conducted from 1993 to 2003 by U.S. EPA, MDEQ, and the USACE-Detroit District to investigate the extent of contamination in Black Lagoon waters and sediments. (Floating oil and grease and the effects of pollution on the Black Lagoon wildlife were readily observable by the neighborhood residents and by the City of Trenton.) Results from these studies indicated elevated levels of several contaminants, including concentrations of up to 11 mg/kg of mercury, 6.5 mg/kg of PCBs, and 30,000 mg/kg (dry weight) of oil and grease. Such levels exceed the Consensus-based Sediment Quality Guidelines (CBSQG) probable effect concentrations (PEC) found in MacDonald *et al.* (2000). Table 1-1 provides a comparison of CBSQGs to average concentrations of contaminants reported in the lagoon (see Appendix B for surficial sediment concentrations for these and additional contaminants). Based on these data and consideration of the most likely impacts to the AOC, mercury, PCBs, and oil and grease were identified as the contaminants of concern (COC) for this site.

Table 1-1 Site Sediment Concentrations From 1999 Sediment Survey

Contaminant	Average Sediment Concentration[1] (mg/kg, dw)	Sediment Quality Guideline (mg/kg, dw)	Ratio of Average Sediment Concentration to SQG
Mercury[2]	4.24	1.06	4.0
Oil & Grease[3]	6,039	2,000	3.01
Total PCBs[2]	2.6	0.68	3.85

Notes:

(1) Site mean determined as the mean of the weighted mean concentrations for each sediment core

(2) SQGs are based on the Probable Effects Concentrations found in MacDonald, *et al.* (2000), "Development and Evaluation of Sediment Quality Guidelines for Freshwater Ecosystems"

(3) SQG is based on the "heavily polluted" designation found in U.S. EPA (1977), "Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments"

PCBs – Polychlorinated biphenyls (as Aroclors)

dw – Dry weight

Contamination of the sediments was observed at depths of 0.5 to 12 feet below the surface of the sediment. Mercury concentrations were found to increase with depth in some locations within the lagoon (Figure 1-2).

To address these challenges, U.S. EPA's Great Lakes National Program Office (GLNPO) facilitated a workgroup comprised of MDEQ, U.S. EPA, the USACE, the City of Trenton, and American Heritage Rivers, that would undertake dredging of the Black Lagoon. This project was identified in the 1996 Detroit River Remedial Action Plan as one of the priority contaminated sediment cleanup sites in the river.

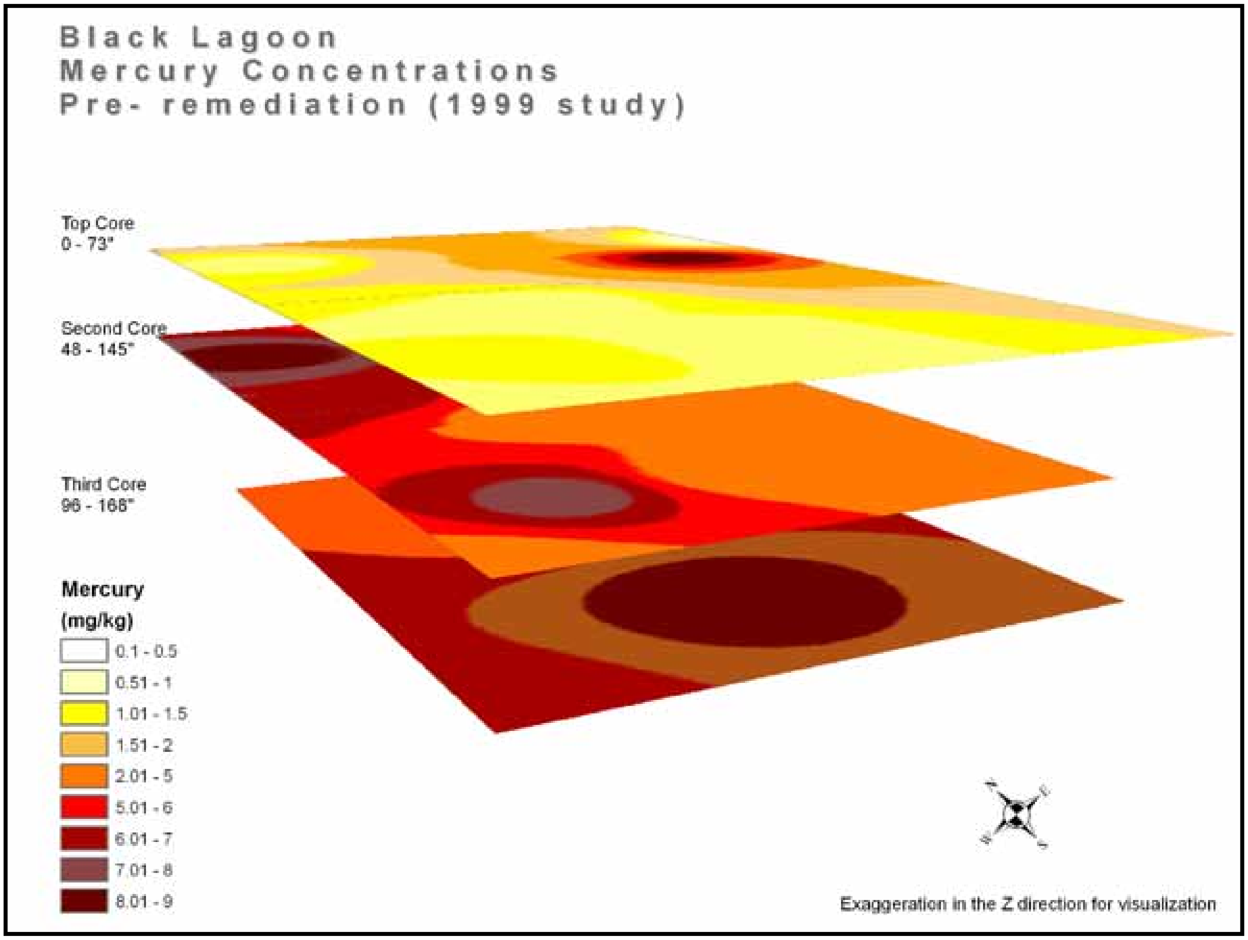

Figure 1-2 Pre-remediation Sediment Mercury Concentrations at Depth in Black Lagoon

In March 2004, MDEQ submitted a proposal to GLNPO for GLLA funding to remediate the Black Lagoon. USACE-Detroit District developed the remediation specifications and related drawings with input from MDEQ and GLNPO.

Briefly, the project design consisted of four major components:

1) Dredge the contaminated sediments.
2) Convey the removed sediments by barge down the Detroit River to the Pointe Mouillee Confined Disposal Facility (the facility is operated by the USACE).
3) Cover the remaining sediment with clean sand and gravel.
4) Monitor the dredging process with appropriate testing protocols to ensure that remediation activities did not cause further environmental contamination, and sample the remaining sediments to verify that contaminants were removed as planned before placing the clean sand and gravel cover over the dredged area.

1.3 PROJECT OBJECTIVES

The primary objective of this project was to remove the polluted sediments in the lagoon, and improve the environment by mitigating impacts that affected the lagoon, its inhabitants, and the surrounding community. The remediation of Black Lagoon sediments was identified in the Remedial Action Plan (RAP) as one of many necessary actions to move toward the de-listing of this AOC.

Two specific objectives were targeted with the following strategies:

1. **Reduce relative risk to humans, wildlife, and aquatic life –** Dredging and removal of the contaminated sediments were planned to permanently reduce the amount of heavy metals, PCBs, and oil and grease entering the lagoon food web. To further protect the lagoon ecosystem from any remaining contaminants, the dredged areas were to be covered with sand and gravel.

2. **Restore the aquatic habitat within the Black Lagoon –** Once contaminated sediments are removed and covered with the protective cover, the food web and the entire aquatic ecosystem will have a stable, non-toxic environment. Benthic organisms, in particular, will benefit, along with the native fish and wildlife that feed on them. In conjunction with the remediation project, the City of Trenton planned to use a grant for habitat restoration to further encourage the return of native fish and wildlife species.

This remediation project along with many other actions recommended in the RAP has the potential to directly impact the following Beneficial Use Impairments (BUIs): Restrictions on fish and wildlife consumption, degradation of benthos, restriction on dredging activities, and loss of fish and wildlife habitat

A side benefit of this project was the revitalization of the economic and recreational resources. Removal of the contaminated sediment would improve the aesthetic value of the area and allow development projects to proceed safely. In order to meet these project objectives, the Project Team established target levels for post-dredging sediment concentrations for the three COCs as: 1 mg/kg for total PCBs (as Aroclors), 1 mg/kg for mercury, and 2,000 mg/kg for oil and grease. The technical approach used to accomplish these activities is discussed in detail in Sections 2 – 7 of this report.

1.4 PROJECT FUNDING

The Black Lagoon proposal was the first project to be accepted and funded under the Great Lakes Legacy Act of 2002. This legislation was specifically developed to address the contaminated sediment problem in Great Lakes AOCs. Together, the Great Lakes make up one fifth of the fresh water on the earth's surface, providing water, food, recreation, and transportation to more than 35 million Americans. The quality of this resource is of great importance and, although the discharge of toxic and persistent chemicals from industrial and municipal wastes into the Great Lakes has been substantially reduced over the past 20 years, contaminated sediments remain at certain sites, affecting water quality. Among other things, the Act provides for the remediation of contaminated sediment in 31 U.S. Great Lakes Areas of Concern (AOCs).

The Act is divided into three components: projects; research and development; and public information. Projects may be classified as either remediation (cleanup of sediments) or non-remediation (monitoring or prevention of further contamination).

The $8.7 million Black Lagoon remediation project was funded with $5.6 million from GLNPO under the GLLA and $3.1 million in non-federal matching funds from the MDEQ.

1.5 PROJECT MANAGEMENT

Because the Black Lagoon project was a collaborative effort involving multiple partners, a project management team was established to ensure effective communication, clear understanding of responsibilities, and adherence to project requirements by all parties. These project management strategies are summarized below.

1.5.1 Project Planning, Permits and Notifications

The U.S. EPA and MDEQ entered into a written Project Agreement for the Black Lagoon remediation project. This Project Agreement documented the financial, technical, and logistical obligations and responsibilities of the U.S. EPA and the non-Federal sponsor, MDEQ, and included the financial coordination process that would be used to jointly fund the project. Through this agreement, GLNPO and MDEQ developed a formal strategy of commitment and communication to facilitate successful completion of the project.

Project participants also reviewed all specifications and drawings developed by the USACE-Detroit District. Project planning meetings were held at offices in Chicago and at the project site to discuss and finalize key project activities (e.g., plans, permits, technical methods, quality control requirements and procedures).

The prime contractor, Environmental Quality Management (EQ), developed a written Project Work Plan (EQ, 2004) that documented the project goals, strategies, and implementation plans. This work plan was approved by U.S. EPA and was supplemented by a Quality Assurance Project Plan (QAPP) that documented the management and quality systems implemented to achieve the objectives for the project. Together, these documents provided a mechanism for ensuring that all project objectives and strategies were clearly understood by all involved parties and that these strategies included a project design and quality control procedures that would ensure that data collected during the project would be reliable and of sufficient quantity and quality to support U.S. EPA decisions regarding project.

EQ was responsible for securing all required permits, licenses, access agreements, and making all notifications (e.g., the dredging permit, the MDEQ Environmental permit, and access agreements with the City of Trenton and Meyer Ellias Park). Copies of all permits, licenses, access agreements, and notifications were maintained at the project site at all times.

1.5.2 Project Communication, Roles and Responsibilities

Communication procedures were defined in the QAPP (available as part of the Project Record), and included regularly scheduled conference calls, progress meetings, daily activity reports, and project management teams. GLNPO also assembled a Project Team comprised of representatives from all parties involved in major project activities. The role of the Project Team was to ensure communication among all staff involved in the project, address technical and logistical issues as they arose, and communicate problem resolution to all involved parties. Although GLNPO was responsible for serving as U.S.

EPA's lead office on the project, EQ's support to GLNPO was provided through an existing U.S. EPA Region 5 contract. Therefore, representatives from both EPA offices (GLNPO and Region 5 Superfund) participated in project management and project team activities. The roles and responsibilities of key project management personnel are identified in Table 1.2. All of the individuals shown in Table 1.2 served on the Project Team.

Table 1-2 Project Team Roles and Responsibilities

Key Person	Organization/ Role	Responsibility
Marc Tuchman	U.S. EPA GLNPO Project Lead	• Primary GLNPO contact • Financial and contractual monitoring • Ensure that decision objectives are met at project completion
Michael Alexander	MDEQ Project Manager	• Primary MDEQ contact for EQ • Coordinate with GLNPO on project requirements • Financial and contractual monitoring • Ensure that decision objectives are met at project completion
Michelle Jaster	U.S. EPA Region 5 Federal On-scene Coordinator (FOSC)	• Primary U.S. EPA FOSC contact for GLNPO, MDEQ, and EQ Project Team • Oversee site activities • Approve modifications to project plans relating to site activities
Rosanne Ellison	U.S. EPA GLNPO Remedial Action Plan (RAP) Liaison for the Detroit River AOC	• Point of contact for local issues • Area of Concern (AOC) liaison
Louis Blume	U.S. EPA GLNPO QA Manager	• Assist in the development of quality documentation and identification of project quality objectives • Ensure that all environmental collection activities achieve appropriate quality documentation
David Bowman	U.S. Army Corps of Engineers (U.S. ACE) point of contact	• U.S. ACE point of contact • Coordinate activities associated with confined disposal facility (CDF) and other technical issues
Susan Boehme	Illinois/Indiana Sea Grant Liaison to U.S. EPA	• Outreach to community • Prepare fact sheets and provide updated content for U.S. EPA website
Jack Greber	EQ Project Director	• EQ primary point of contact with the U.S. EPA FOSC, GLNPO, U.S. ACE, and MDEQ

Table 1-2 Project Team Roles and Responsibilities

Key Person	Organization/ Role	Responsibility
John Mullane	EQ Project Manager	• EQ point of contact with the U.S. EPA FOSC • Identify resource requirements and assign staff to project teams • Develop and monitor project budgets and costs • Develop and implement field-related work plans; ensure compliance with schedules and project requirements • Participate in preparation of EQ's final project report
Robert Armstrong	EQ Site Manager	• Report to the EQ Project Manager and perform on-site, daily communications with EPA, and subcontractor foremen and supervisors • Coordinate on-site work and inspections

Weekly conference calls were conducted during the course of the project to provide progress updates and status reports to all involved parties. These meetings also were used as a forum to communicate new issues and challenges that required resolution or decisions. Urgent issues and challenges were communicated through ad-hoc conference calls, meetings, or on-site discussions. Decisions resulting from on-site discussions were documented by EQ in Daily Activity Reports. These reports were used to log all decisions made in the field and are available in EQ's project files. Decisions resulting from meetings and conference calls were documented through meetings minutes and group emails.

Use of these carefully considered communication strategies and pre-arranged roles and responsibilities enabled U.S. EPA to keep the project on track, despite the logistical challenges at the remediation site. For example, after the project started, it was discovered that the original pre-hydrographic survey of the lagoon had some errors that were propagated through to the calculations of the sediment volume that needed to be removed. The project managers held several on-site meetings to find an equitable method of using the valid survey data and calculating sediment quantities to ensure that this unforeseen problem would not delay remediation activities. Final resolutions of this and other challenges were documented in the Daily Activity Reports and updates to the work plan.

1.5.3 Public Outreach and Community Involvement

A variety of outreach activities were used to communicate information concerning this remediation project to the community surrounding the Black Lagoon. These included community meetings, public announcements, and ceremonies. One such ceremony in September 2005 was jointly hosted by U.S. EPA Administrator Mike Leavitt and Larry Arreguin, representing Governor Jennifer Granholm, to announce the initiation of the Black Lagoon remediation project as the first project funded by the GLLA. Two public meetings regarding the Black Lagoon project were held in 2004 to present detailed information to the public and provide them with an opportunity to voice concerns.

EPA also maintains a Web site with links to Black Lagoon remediation information topics and press releases. The site, http://www.epa.gov/greatlakes/sediment/legacy/blklagoon.index.html, includes:

- Information about Black Lagoon cleanup site visits,
- Fact Sheets about the Black Lagoon project,
- New releases,
- Maps and aerial photographs of the Black Lagoon project region,
- This project report: Remediation of the Black Lagoon Trenton, Michigan, Great Lakes Legacy Program, January 2008, and
- A Black Lagoon photo gallery with pictures of the different stages of the remediation process, such as site preparation, installation of silt curtains, and transportation of contaminated sediments on barges down the Detroit Channel.

Additionally, as a part of the outreach program, U.S. EPA maintains a Great Lakes Legacy Act Web site with links to various topics, located at: http://www.epa.gov/greatlakes/sediment/legacy/index.html.

1.6 DATA MANAGEMENT

Data collected during the Black Lagoon project were managed using procedures outlined in the project planning documents. These procedures included using standard protocols for recording field data and remedial activities, defined electronic data deliverables

(EDDs) for laboratory data, chain-of-custody forms for transferred samples, and a data logging system to track all field and laboratory data submitted for independent data verification.

1.6.1 Data Management

EQ was assigned responsibility for managing most of the field data, laboratory data, and other project information gathered during preparation and implementation of the project. This included:

- Original planning documents developed for the project.
- Laboratory data generated during analysis of excavated material stockpile samples (used to determine disposal specifications).
- Field records and a Daily Activity Quality Control (QC) Report that described dredging work performed, areas dredged, estimated volume of material removed and conveyed to the confined disposal facility (CDF), activities planned for the next day, and environmental monitoring results. These environmental monitoring results included the water quality and air monitoring data generated by on-site direct read instruments and by Clayton Laboratory Services to confirm that the remediation activities were not adversely affecting the health of the ecosystem, surrounding environment, or the remediation staff.
- A Construction Documentation Report developed by EQ upon completion of the project that includes an overview of the remediation.

To ensure effective handling of such data, EQ developed and implemented field-related work plans and QC procedures for technical data generated by field staff.

GLNPO’s QA contractor, CSC, was responsible for managing data associated with the sediment confirmation sampling conducted after completion of each phase of dredging. This sampling was conducted by MacTech, who reported the data to MDEQ and GLNPO. GLNPO, in turn, forwarded their copy of the data to CSC. Data management strategies for these activities are described below.

Sediment Confirmation Sampling Records. Logbooks and chain-of-custody forms were used to document sediment confirmation sampling activities. Daily logbooks were used to record field information, including weather conditions, personnel present, field measurements and observations, and any deviations from original sampling plan. Calibrations of any field equipment, including any calibration results, also were documented in the logbooks. Instrument readings taken during the remediation were documented in boring logs, in the field logbook, or both. Daily logbooks were stored at the project site and were turned over to GLNPO for inclusion in the project file at the completion of field activities. Upon collection, each sediment sample location, sediment thickness and physical properties were recorded. Once samples were collected, a chain-of-custody record was created for each sample. This record then accompanied the sample until the analytical data had been accepted. After data quality was deemed acceptable, all chain-of-custody forms were archived in the project file maintained by EQ.

Laboratory Records for Sediment Confirmation Samples. Sediment confirmation samples collected by MacTech were analyzed by TriMatrix Laboratories. Because results from these samples would be used to decide whether or not dredging activities must be resumed, activities at the site were delayed pending receipt of the laboratory data. In order to minimize costs associated with the delay of field activities, TriMatrix was required to provide summary level data on a quick-turnaround basis and supplement the data with a full data package. These summary level data included a subset of data qualifiers for the sediment confirmation results. Following submission of these quick turnaround summary level results, all laboratory data and records associated with the sediment confirmation sampling were included in final analytical reports submitted to the MDEQ Project Manager. Final data were delivered in the form of EDDs (electronic data deliverables), as well as hard-copy data packages that included the analytical results, quality control sample results, data narratives from the analytical laboratory, and the chain-of-custody forms.

Results of the Independent Data Verification. GLNPO forwarded the TriMatrix data to CSC for independent data verification. CSC followed standard procedures to receive and manage all incoming sediment confirmation data. Data quality assessments were used to evaluate the quality of the Black Lagoon sediment confirmation data. CSC followed standard procedures for verifying the sediment data (see the Black Lagoon Project Record for CSC's data verification SOP). The purpose of the data quality assessment was to verify that the data were of a sufficient quality to support their intended use. The data verification process focused on evaluating the sediment confirmation data relative to pre-determined measurement quality objectives (MQOs) specified in the QAPP to ensure that only data of acceptable quality would be used for decision making. A data review narrative was drafted to document results of the review (see the Black Lagoon Project Record for the data review narratives). The narratives also included quantitative data quality assessments which are an evaluation of the sensitivity, precision, and bias associated with the data. No sediment confirmation sample results generated during this project were invalidated for use based on the data verification.

1.6.2 Database

GLNPO developed a sediment confirmation database used to maintain and archive GLLA project sediment contamination data from various projects. This database is referred to as the Great Lakes Sediment Database (GLSED). This database contains sediment confirmation data for project contaminants of concern and their respective location information. Field observations and all relevant collection information also are stored in the database. The database is compatible with the Query Manager Data Management System administered by the National Oceanic and Atmospheric Administration.

1.6.3 Public Access

Upon request, GLNPO provides data generated for the Black Lagoon remediation project to stakeholders and other interested parties. To facilitate distribution, a comprehensive Project Record has been compiled and components are available to requestors. The record contains all relevant documentation concerning the project, including project planning and operational documents, fact sheets, analytical data, and all project reports. Interested parties may contact GLNPO's Sediment Assessment and Remediation Team to submit a request. In addition, and as discussed in the previous section, GLNPO expects to provide public access through written request.

2.0 MONITORING IMPACTS OF DREDGING OPERATIONS

As part of the project design, an environmental monitoring program was conducted to ensure that the remediation activities themselves were not adversely affecting the health of the ecosystem, the surrounding environment, or the remediation staff, and were not causing exceedances of applicable federal, state, and local standards. Air quality was monitored prior to and throughout the project, as described in Section 2.1. Water quality was monitored during the project as described in Section 2.2.

2.1 AIR MONITORING

A two-stage approach to air monitoring was implemented to ensure that release of airborne contaminants was minimized and that air emissions from project construction activities did not adversely affect air quality in the surrounding community. The first stage involved assessment of background contaminant levels prior to project construction activities. Collection of these pre-construction data provided a baseline for comparing the emissions produced during the dredging process, as well as information on the quality of the air entering the work zone. The second stage consisted of daily air quality monitoring once dredging started and throughout the project duration.

Fixed sampling sites were established around the perimeter of the lagoon area. The locations were established so that at least one sampling location would be downwind of site operations, and at least one other station would be upwind and represent background conditions (see Figure 3-1). Global positioning system (GPS) units were used to physically locate each site, and personal sampling pumps were used to collect the air samples. Samples were taken at each of these three perimeter locations on two separate occasions prior to dredging operations to establish background levels of PCBs, lead, and mercury. These samples are collected as 8-hour composites. Air concentrations were determined using methods published by the National Institute for Occupational Health and Safety (NIOSH), as shown in Table 2.1. All air samples collected during the project were picked up from the site by a local laboratory (Clayton Laboratory Services) and results were received within 48 hours. EQ evaluated the data and verified the usability of the results by reviewing the associated method QC reported by the laboratory.

Once the project began, air samples were collected from the same three perimeter locations on each of the first six days of dredging and then biweekly thereafter, until the end of dredging operations. As with the background samples, these air samples were analyzed for PCBs, lead, and mercury using NIOSH Methods 5503, 7300, and 6009. Any results at or above the reporting limit were evaluated against background results and applicable permissible exposure limits (PELs). During a single day, PCBs were not to exceed of 0.5 mg/m^3 air, lead was not to exceed 0.05 mg/m^3 air, and mercury was not to exceed 0.5 mg/m^3 air. Monitoring results indicated that there were no adverse effects on air quality resulting from the construction activities, and all results recorded were less than the applicable PEL.

During dredging, real-time air monitoring for volatile organic compounds (VOCs) and particulate emissions also was conducted using direct-read instruments at each of the perimeter locations. All air monitoring equipment was calibrated daily, and calibration data were noted on the Daily Activity Report. These real-time samples were collected and analyzed at the beginning and end of each shift and every two hours throughout the work day on each day that dredging operations were conducted and recorded on the Daily Activity Report. For total VOCs, the action level was considered to be 5 ppm sustained for 15 minutes, and no exceedances of these levels occurred during the project. For particulate emissions, a visible dust plume was an action level requiring notification and corrective action. Additional air monitoring (beyond the fixed perimeter locations) was performed at various locations at the request of the Federal on-scene coordinator (FOSC) or designated representative. The locations and results of this additional air monitoring were reported on each day's report. Any results above background also were accounted for and noted on the daily report.

Table 2-1 Air Monitoring/Sampling Activity, Parameters, and Frequency

Air Monitoring/ Sampling Activity	Parameter/ Method	Number of Locations/ Identified Task	Frequency	Results
Perimeter Air Sampling – Background	PCBs/NIOSH 5503 Pb/NIOSH 7300 Hg/NIOSH 6009	3 locations – lagoon	All locations were sampled in 2 separate events prior to any dredging operations.	PCBs: All results non-detect Pb: All detected results < PEL Hg: All detected results < PEL
Perimeter Air Sampling – Definitive	PCBs/NIOSH 5503 Pb/NIOSH 7300 Hg/NIOSH 6009	3 locations – lagoon	All locations were sampled the first 6 days of dredging operations and biweekly thereafter.	PCBs: All results non-detect Pb: All detected results < PEL Hg: All detected results < PEL
Perimeter Air Monitoring – Real Time	VOCs and Particulates via direct read instruments	3 locations – lagoon	All locations were monitored every 2 hours throughout the work day on any day that dredging operations were conducted.	VOCs: All results non-detect Particulates: All results < project action levels
Personnel Air Monitoring	**Lagoon:** PCBs/NIOSH 5503 Pb/NIOSH 7300 Hg/NIOSH 6009 **CDF:** PCBs/NIOSH 5503 Pb & Cr/NIOSH 7300 Hg/NIOSH 6009	1 location – lagoon (dredge operator) 3 locations – CDF (truck driver, excavator operator, bulldozer)	Each task was sampled the first 6 days of dredging operations and biweekly thereafter.	PCBs: All results non-detect Pb: All detected results < PEL Hg: All detected results < PEL

Finally, air samples were collected in the proximity of personnel associated with different tasks at both the lagoon and the confined disposal facility (CDF). At the lagoon, air samples were collected in the cab of the dredging excavator. At the CDF, air samples were collected in the excavator, bulldozer, and dump truck. As with the perimeter samples, these samples were collected as 8-hour composites once per day for each of the first six days of dredging operations and biweekly thereafter, and were analyzed for PCBs, lead, and mercury using the same NIOSH methods used to analyze the perimeter samples.

All sampling and analysis activities were conducted in accordance with the approved Quality Assurance Project Plan (QAPP). Data were formatted to facilitate QC review by EQ's Corporate QC Director or her designee. During this QC check, the reviewer identified any out-of-control data points and omissions and interacted with the laboratory to correct data deficiencies. QC reviews were reported in the Daily Activity Reports on the same day that results were received, along with any results above the reporting limit. In addition to the QC review of all data reported, a complete data validation was performed on 10% of the data collected, as described in the project QAPP.

2.2 WATER QUALITY MONITORING

Water quality monitoring was conducted on a daily basis during dredging activities to ensure that contaminants from the dredged sediments were contained. Turbidity was used for evaluating the water quality.

Water quality samples were collected at three locations relative to the silt curtain: 300 feet upstream; 300 feet downstream; and 600 feet downstream. The criteria for evaluating turbidity for the project were established as follows: if turbidity measurements taken at the sample point 300 feet and/or 600 feet downstream are greater than 150% of the measurement taken 300 feet upstream during dredging activities, dredging was discontinued, results were evaluated with the regulators, and potential engineering controls were implemented.

Turbidity measurements were taken at mid-depth within the water column every 2 hours when dredging operations were underway. Turbidity was initially monitored using *in-situ* monitoring stations capable of taking turbidity measurements at any time, and the data were transmitted via radio telemetry to a data logging receiver onshore. These data were recorded on a laptop for evaluation purposes and reported in the Daily Activity Report. During the winter months, the monitoring stations were removed to avoid potential damage from ice flows. The 6-inch pilings used to support the telemetry equipment were left in the river to mark the turbidity monitoring locations, and a 2-person crew working from a small boat collected turbidity measurements from these locations every 2 hours using a hand-held *in-situ* turbidity meter.

Turbidity samples were always collected at the upstream location prior to the downstream location, and downstream results were evaluated against upstream results. In addition to these pre-planned upstream and downstream locations, turbidity readings also were taken along the silt curtain, both inside and outside the dredge area, to verify that there was no release of suspended sediment into the river system. The locations of these additional sampling sites were coordinated by EQ and the FOSC or designated representative; these locations and associated turbidity readings were documented in the Daily Activity Report.

Twice-daily visual observations were made of the silt curtain and the area downstream from the lagoon. If a water quality problem was observed, such as an oil sheen on the water, additional inspections were performed. As with other exceedances, the information was immediately provided to the on-site government representative and documented in the Daily Activity Report. In all situations, the exceedances were confirmed to be either weather-related, or the result of physical activity in the proximity of the monitoring stations (i.e., boat traffic).

Early in the project, all turbidity exceedances could be correlated with tugboat and barge movement near the remote turbidity stations. On several occasions, as the project progressed and the turbidity curtain began to show signs of wear, however, there were visual observations of turbidity outside of the project area. In these instances, all work was ceased and hand-held turbidity readings were taken in the visually turbid area. Although there were no exceedances of the limits in the dredging permit, work was not resumed until the apparent cause of the turbidity was located and corrected.

3.0 SITE PREPARATION AND SET UP

Before remediation activities began, several site preparation and set up activities were necessary at both the Black Lagoon and at the Pointe Mouillee confined disposal facility (CDF). The CDF is a 700-acre crescent-shaped dike designed to contain contaminated dredged materials from the Detroit and Rouge Rivers. It is located in Lake Erie at Pointe Mouillee, Michigan, and is operated by the USACE. As part of the project design, contaminated sediments removed from the Black Lagoon were transported to the Pointe Mouillee CDF. Site preparation and set up activities at the Black Lagoon and the CDF included establishing work zones, conducting site surveys, establishing site security controls, and preparing the CDF for receipt of Black Lagoon sediments. Site setup began on Monday, September 27, 2004. These activities are described in Sections 3.1 – 3.4, below.

3.1 SITE SURVEY

Both the lagoon and CDF work areas were surveyed prior to mobilizing activities at these sites. The lagoon area was surveyed to delineate property lines and to provide proper placement of the perimeter security fence. The CDF was surveyed to define the limits of the sub-cell disposal area in Cell 5, prior to placement of dredged materials, and for positioning of a cross-dike that was to be constructed along the southern end of the sub-cell between existing perimeter dikes.

Prior to initiating the project, access agreements were established with the City of Trenton and private property owners. Existing limits of all property to be accessed and utilized under the project were located and properly identified. This property included the areas to be remediated as well as the supporting areas used for staging operations and access. Property for which rights had been obtained was surveyed and property lines identified with semi-permanent markers, except where there were existing approved markers. Prior to beginning the removal operation, a pre-dredge hydrographic survey was conducted to establish baseline conditions. This survey is discussed in Section 4.2.1.

3.2 SITE SECURITY

A perimeter fence was erected that encompassed the land utilized under access agreements with the City of Trenton and private property owners. This fence provided security for equipment and materials, and restricted access by the general public. To further enhance security and ensure the safety of site personnel and the public, a uniformed security guard was stationed at the lagoon area during non-working hours, and around the clock at the CDF. Figure 3-1 provides general schematic drawing of the lagoon work area.

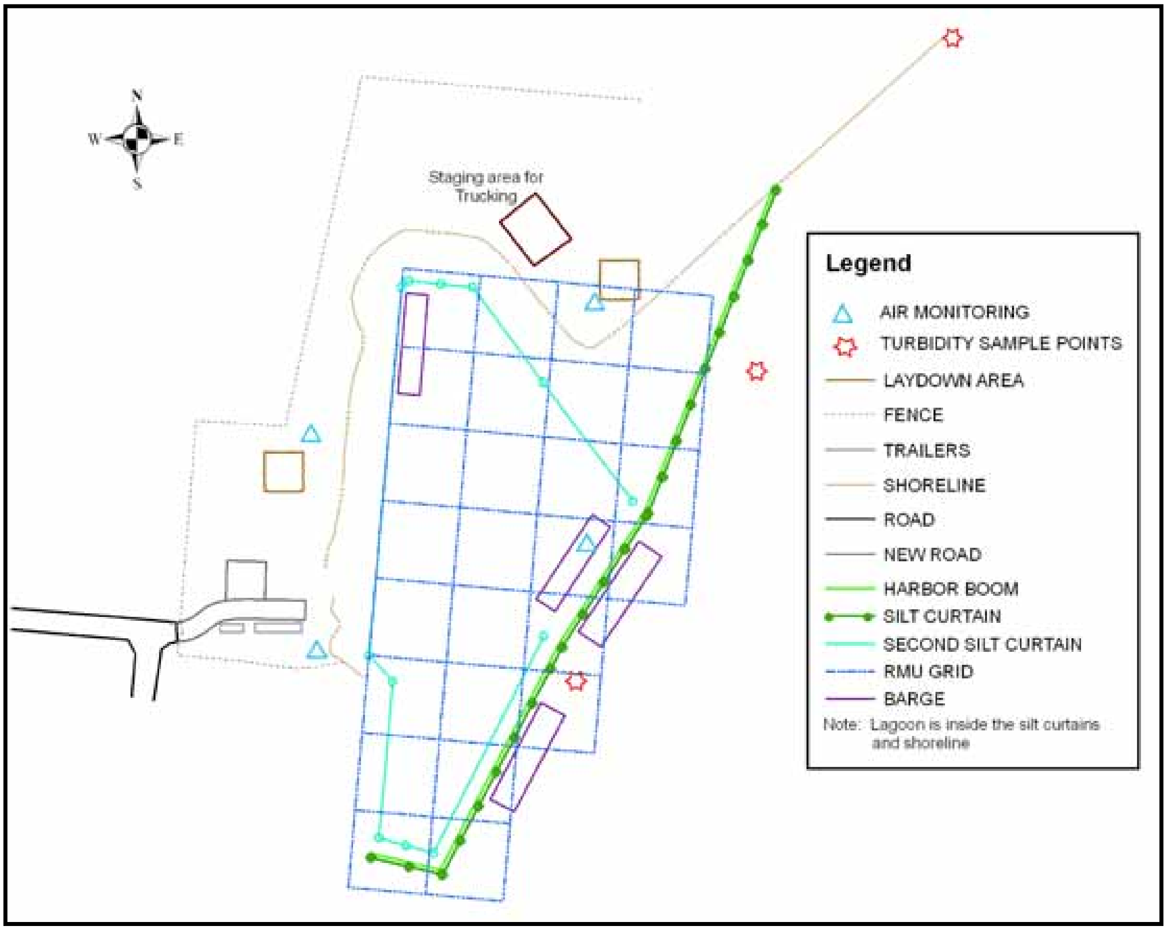

Figure 3-1 Schematic Drawing of Black Lagoon Remediation Site

3.3 CDF SITE CONSTRUCTION AND PLACEMENT

3.3.1 CDF Preparation

Setup, preparation, and construction work was necessary to prepare Cell 5 of the facility for acceptance of the excavated sediments. Figure 3-2 provides a map of the barge route from the Black Lagoon to the Pointe Mouillee CDF. Cell 5 is located in the northwest corner of the CDF. These CDF preparation activities involved:

1) Making required enhancements at the transfer station and offloading area for transferring the dredged material from barges to haul trucks and/or to the temporary storage area;
2) Constructing a temporary sediment storage cell near the transfer station;
3) Clearing and grubbing (removing vegetation from the roots) Cell 5;
4) Construction and enhancement of haul roads; and
5) Construction of the sub-cell area within Cell 5 that received the dredged contaminated sediment.

Figure 3-2 Map of Detroit Area with Barge Route from Black Lagoon to the Pointe Mouillee CDF

3.3.2 Construction of Transfer Station/Offloading Area

A temporary transfer facility was constructed in the south interior channel of the CDF, next to the existing pump-out platform. The existing structures in this area were removed and replaced upon completion of offloading activities. Six large H-piles were installed to provide moorings for the working deck barge and sediment transfer barges during offloading operations. The storage pad area and roadway north of the transfer site were cleared, grubbed, and leveled to accommodate equipment and offloading operations. Additional gravel/stone was added to improve the stability of the area and enhance work operations. This work and storage area was used as the general construction support site and consisted of a small office trailer, tool shed, and portable toilets; heavy equipment fueling and parking; and material lay down.

A shallow depression was constructed in the storage pad area to accommodate temporary storage of sediment. This structure was 6 feet deep and approximately 75 feet x 100 feet, and was lined with 30-mil PVC with 24 inches of overlap at every chemically welded seam. A dike was constructed around the storage area to prevent releases into the channel.

Soundings were taken across the full width and length of the transfer site prior to start-up and immediately after completion of all transfer operations. Accumulated material that fed into the channel around the transfer facility during off-loading operations was removed after the final soundings were taken, and all data were provided to USACE.

Clearing and Grubbing. The cell and borrow pit areas were cleared and grubbed of existing vegetation (e.g., *Phragmites*) and small trees (cottonwood, willows, etc.). The interior slopes and floor of the cell were cleared using a dozer and excavator. All vegetation refuse was disposed of within Cell 5.

Haul/Dump Road Construction. A temporary haul road was constructed within the containment cell to facilitate offloading of dredged material. This road bisected the cell from east to west and included a temporary ramp at both ends. Due to extreme moisture conditions of the cell floor and heavy rains early in the project, it became necessary to deviate from the original work plan and utilize the cross dike as a road. Sediment was dumped from the cross dike and from other strategic locations around the perimeter of the cell. These sediment piles were spread from the outer edges of the cell toward the center and compacted in 2-foot lifts. Eventually, the entire cell was graded to drain to the center of the cross dike, where a weir was installed to prevent stagnant water from accumulating. (See Section 4.3.6 for additional details concerning placement of the dredged materials.)

Cross Dike Construction. A new interior cross dike was installed along the southern end of the sub-cell between the existing perimeter dikes. The interior dike segregated and confined the dredge materials from existing and future materials in Cell 5. The dike was constructed in accordance with USACE drawings and specifications.

Dike construction material was originally to be obtained from within Cell 5, in the borrow area shown on the USACE drawings. This material was inappropriate, due to its water content and composition, therefore, material was conveyed from the offloading area to the cross dike location via 35-ton off-road articulated dump trucks.

Placed borrow materials were shaped, graded, and compacted using a D6 LPG dozer. Soil material was placed in layers not more than 12 inches in loose thickness. Each layer was compacted by a minimum of 3 passes of the D6 LPG. Dike construction tolerances adhered to the required engineering specification of plus 0 and minus 6 inches.

Existing Dike Liner. A 2-foot soil layer was placed over the interior of the existing dike to cover the riprap and to prepare the surface for placement of the synthetic liner. The soil materials were obtained from areas directly adjacent to the interior of the existing dike (i.e., the soil/dredge spoil material that is in the floor of Cell 5).

The soil was placed in layers not more than 12 inches in loose thickness, and each layer was compacted by a minimum of 3 passes of the D6 LPG dozer. Woven fabric liner of polyethylene geotextile was installed along the interior slope of the existing perimeter dike to confine the solidified dredged material and to prevent any seepage through the dike wall into Lake Erie or the Pointe Mouillee Wildlife Refuge. Inspections were made prior to liner placement to ensure no protruding objects existed that could cause damage to the liner. The geotextile was placed with the long dimension parallel to the existing dike and laid smooth and free of tension, stress, folds, wrinkles, or creases. The strips were placed to provide a minimum 24 inches of overlap for each joint and each joint was sealed per the manufacturer's specifications. Geotextile installation did not exceed the placement of dredged material by more than 100 linear feet, per the USACE specifications.

Overflow Weir Construction. An overflow weir was installed in the interior dike in accordance with USACE drawings and specifications. The weir helped properly manage and control free water in the sub-cell, and mitigate any oil sheen formation.

4.0 DREDGING OPERATIONS AND DREDGE MATERIAL DISPOSAL

4.1 CONTAINMENT OF THE DREDGE AREA

A silt curtain was installed to enclose the entire lagoon and protect the adjacent river from releases of suspended sediment during dredging operations. Dredging was not allowed within 10 feet of the silt curtain. The curtain measured 1,500 feet long by 25 feet deep and consisted of an 18-ounce laminated vinyl polyester fabric; heat-sealed seams; 5/8-inch polypropylene twisted rope edge reinforcement; 8-inch by 8-inch by 8-inch EPS foam blocks for buoyancy; aluminum stress plates at the corners; 5/16-inch galvanized ballast chain; and 5/16-inch galvanized steel top-load cable.

The original work plan called for anchoring the turbidity curtain every 50 feet to a pipe piling at the water surface and to the river bottom using H-beams attached to the ballast chain. Due to strong and erratic currents, the initial placement failed. The project team explored several options with USACE and decided to decrease the spacing between anchor pilings to 10 feet.

This method proved to be successful for a short period of time (approximately 60 days). However, sporadic tears in the fabric eventually appeared. The tears were addressed by adding additional layers of turbidity curtain at the tear locations. This method eventually failed when the river current scoured a hole under the turbidity curtain. Ultimately, an inner curtain made from a permeable material was deployed along the entire length of the project. This curtain performed very well and proved successful for the remainder of the project (Figure 3-1).

To reduce the need for mechanically handling ice inside of the turbidity curtain, eight to ten bubblers were strategically placed within the lagoon to circulate the water and prevent ice formation. As described in Section 2.2, ice flows in the river made it necessary to remove the existing fixed turbidity stations from within the Trenton Channel; the turbidity readings continued as per the permit requirements utilizing a handheld turbidity monitor and work boat or harbor tugboat. These readings were documented and reported in the same manner as previously required.

A 12-inch harbor boom was placed along the inner perimeter of the turbidity curtain to provide added containment of any potential oil sheen. Sorbent boom was also maintained directly inside the harbor boom to provide a secondary level of containment for potential oil sheen. Emergency oil spill containment equipment and materials were maintained on-site at all times in the event of oil releases during dredging operations.

All turbidity curtain and boom containment structures were kept in place during active dredging operations within the contaminated lagoon areas, and these safeguards remained in place until the water quality within the dredge area met the water quality standards specified by MDEQ and USACE. At a minimum, the curtain and boom were inspected daily to ensure that they were intact and in good working condition. Any damage or performance problems discovered with these structures were documented and immediately reported to on-site government representatives. Necessary repairs or adjustment were made immediately, and dredging did not proceed until these modifications were completed.

4.2 MECHANICAL DREDGING

Dredging occurred in two phases. Phase I of the dredging operations was accomplished using a long-reach excavator and a CAT excavator with an environmental clamshell. The excavators were mounted on two deck barges, and dredged material was placed into a steel hopper on the back of the barge. The sediments were allowed to drain through weep holes in the hopper that were equipped with filters to prevent resuspension of sediment in the lagoon. The CAT excavator was used to remove the lighter density material first and the long-reach excavator was used subsequently to remove the remaining sediment to a depth of between 13 and 15 feet below LWD, or until hardpan or clay was reached. These activities are detailed below in Section 4.2.1.

After completing the first phase of dredging, the remaining sediments were sampled and analyzed to verify that the dredging activities reduced contamination to acceptable levels. However, results of these analyses indicated that high concentrations of the contaminants of concern still remained, so a second phase of dredging was conducted to remove an additional 1 to 3 feet of sediment. Unlike the sediments removed during the first phase, the layer of sediments targeted during Phase II consisted of fine-grained material that was difficult to remove using the excavation methods implemented in Phase I. The management team looked for an alternative method that could remove the light sediments and decided to use a mechanical dredge plant equipped with an environmental clamshell. New technology was employed to carefully track the excavation process; survey equipment and software (Hypack's Dredgepack® system) allowed the location data to be recorded during the process. Material from the excavator was offloaded directly into the hopper barges on the dredge plant. In addition to the change in dredging operations for Phase II, additional environmental controls were implemented. A second turbidity curtain was installed perpendicular to the inner permeable curtain to completely enclose the dredge area. Four additional curtains were installed to create 5 separate cells. Single cells ranged from 150 to 200 feet wide. Three to seven pieces of pipe were used to prevent sediment migration along the bottom. Phase II dredging procedures are detailed in Section 4.2.2.

4.2.1 Initial Dredging Operations (Phase I)

Prior to beginning the removal operation, a pre-dredge hydrographic survey was conducted to establish baseline conditions. These soundings were performed with hydrographic sounding equipment and software. The original intent was to conduct the survey jointly with USACE, but due to scheduling conflicts, EQ's marine subcontractor and a technician from the software manufacturer conducted the survey. The pre-dredge survey results were presented to the on-site USACE representative, who approved the survey prior to dredging. As the actual dredging effort progressed, it was discovered that several measurement errors in the pre-dredge survey had gone unnoticed. These errors caused the calculation of material dredged to be incorrect, and as progress surveys were conducted, the error in quantities increased in frequency. When the problem was discovered, the survey data were reviewed by USACE and EQ engineers to determine an equitable way to effectively utilize the large amount of valid survey data that was available. This resulted in several on-site meetings during which parameters were agreed upon for using the pre-dredge survey data and for making sediment quantity calculations (see Daily Activity Report dated 2/9/05). Mechanical dredging began with the side slope stabilization area (SSSA) , specifically the sandbar, at the far northeast portion of the project area (Figure 4 -1).

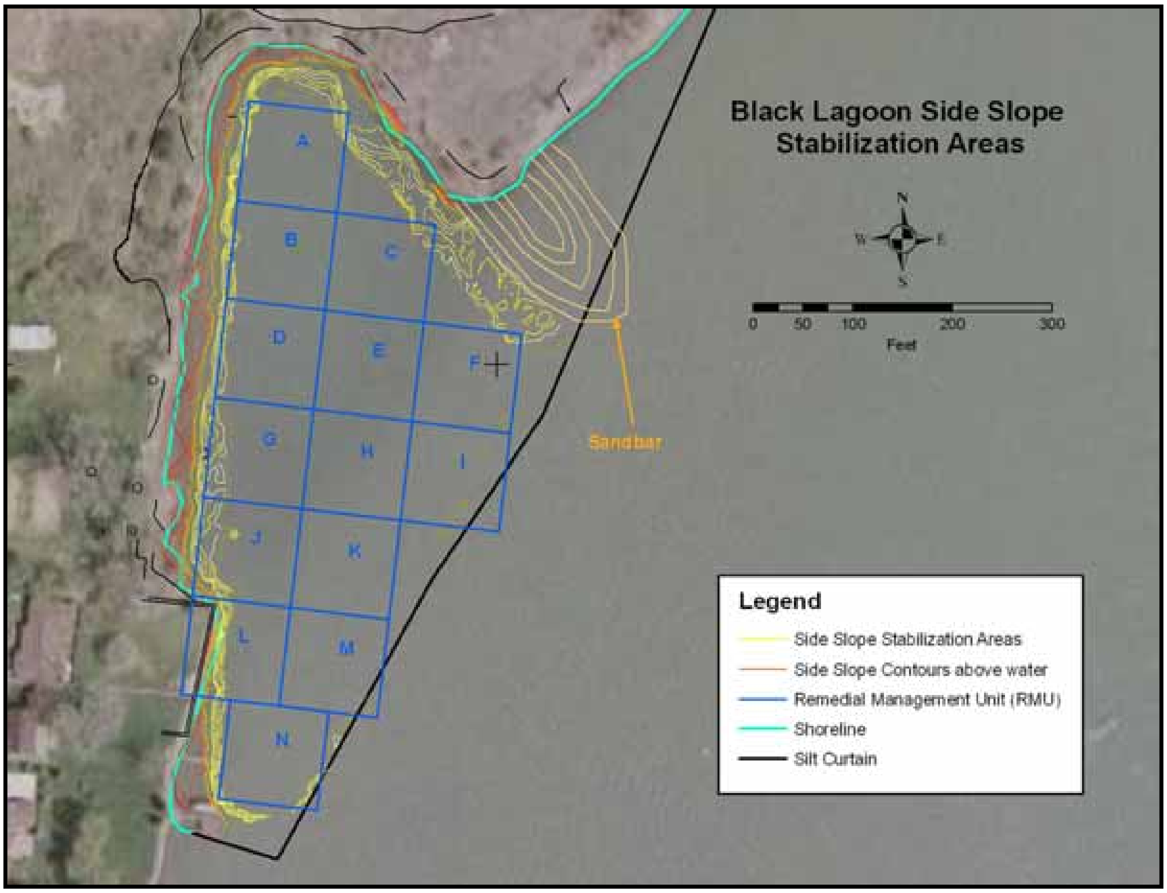

Figure 4-1 Map Showing Side Slope Stabilization Areas (SSSA)

Upon completion of removal of the sandbar, a survey was conducted and EQ was informed by the USACE on-site representative that the area was over-dredged and not in accordance with the specifications set forth in the engineer's drawings. This resulted in a meeting with all involved parties, during which it was determined that the available drawings were inadequate and the intent not clear. All parties agreed that the existing material would be shaped to conform as best as possible to the intent of the riprap structure that was to be placed in this area. Once the SSSA was shaped to the new specifications issued by the USACE, a lead line was used for sounding measurements for this area. Riprap was laid over the entire SSSA to the depths specified by the USACE.

Following removal of the sandbar, dredging progressed from the northeastern end (upstream) of the lagoon toward the southern end of the project limits (downstream). Dredging continued from the channel area towards the shoreline. This pattern was maintained throughout the first phase of dredging.

Phase I dredging was accomplished by mechanical means with a 320L long-reach excavator and a CAT 235DL excavator equipped with an environmental clam-shell. The excavators were mounted on two deck barges, 28’x111’ (#744) and 33’x138’ (#102), equipped with spuds. Dredged material was placed into a steel hopper located on the back of each dredge barge (dredge plant). The hoppers contained weep holes, which allowed necessary bulk dewatering of the sediment. Absorbent pads or sausage boom were placed on and around the hoppers to contain any oil. A silt fence and filter fabric panels were attached on the inside of the hoppers in front of the weep holes. This allowed the material to shed water, yet prevented as much re-suspension of the sediments as possible.

Dredging began by removing the top “light weight sediment” utilizing a closed hydraulic clamshell bucket on the CAT 235DL excavator to reduce the amount of sediment re-suspension. After the light layer of sediment was removed and a stiffer silty clay layer was reached, the CAT 330 long-reach excavator followed behind and removed the remaining contaminated sediments. Sediment was removed to a minimum depth of 13 to 15 feet from LWD, based on IGLD 85 Datum, or until hardpan was reached anywhere in between these depths. After the hoppers on the dredge plants were loaded to capacity, the operation transitioned to the loading of the transport barges.

Check soundings were conducted during dredging operations using a lead line and hydrographic survey equipment.

4.2.2 Modified Dredging Operations (Phase II)

Alternative dredging methods were necessary to remove the 1 to 3 feet of fine grained, unconsolidated sediments targeted during the second round of dredging. These sediments were difficult to remove due to the material density, which was only slightly above that of the water, allowing the sediment to shift along the bottom of the lagoon. It was the opinion of all parties involved that even the simple action of moving a barge or penetrating the sediment with an open bucket or clamshell was sufficient to cause sediment shifting. To overcome this problem, several bench-top experiments were conducted to evaluate the efficiency of alternative operational procedures and methods, including increasing the density of the sediment. Methods tested included: the use of mulch and bentonite to compress the sediment, thereby increasing its density; a slow rate of descent and ascent of a clamshell; and the addition of a polymer to control re-suspension. Upon completion of these investigations and lengthy discussions with all involved parties, the following changes in operational procedures were implemented.

Dredging Equipment. One mechanical dredge plant equipped with an 8-ton crane and a 4-cubic yard environmental clamshell replaced the two dredge plants equipped with hydraulic excavators. This dredge plant was also outfitted with real-time positioning software, which monitored the horizontal position of the dredge plant as well as the horizontal and vertical position of the clamshell. The dredge plant offloaded directly into the hopper barges, which were shuttled to the solidification and offloading area on the northern shore of the lagoon, using the 35-ft harbor tug. There were no changes in solidification or transportation procedures other than the amount of solidification agent used. A 15% increase was required because bulk shedding of water was eliminated from the operation.

Additional Environmental Controls. An additional turbidity curtain was strategically placed perpendicular to the inner permeable curtain (i.e., east to west). The curtains were bolted together from surface to sediment and prevented recontamination as each cell was completed. In addition to the turbidity curtains, a barrier consisting of 3 to 7 pieces of 4-foot by 50-foot HDPE pipe was also used to prevent sediment migration along the bottom of the lagoon. Each section of barrier pipe was floated into position prior to dredging a cell and located approximately 25 feet beyond each curtain placement location. The pipe was flooded and weighted with pipe saddles to overcome neutral buoyancy and each end was marked with buoys.

Operational Procedures. Phase II dredging began in the far south end of the lagoon and proceeded to the north. The lagoon was divided into isolated cells by installing turbidity curtains that ran from the main curtain to the shore. The isolation curtains extended from the surface of the water to the bottom of the lagoon. The curtains were held in place by steel pipe pilings and weights attached to the bottom of the curtain. Individual cells ranged from 150 to 200 feet wide (north to south). Length of the isolation turbidity curtains varied depending on location in the lagoon, but generally ranged between 250 and 350 feet.

Four isolation curtains were installed, creating five cells. All isolation curtains were attached to a new inner perimeter curtain before any dredging began, but isolation curtains were not positioned or pulled into place until a cell had been dredged. Dredging along the northern edge of each cell extended approximately 25 feet beyond the limits of the cell, up to the barrier pipe, and then the isolation curtain was pulled into place. Survey data for the entire lagoon were updated and recorded throughout the dredging process by the onboard equipment and software prior to designating an area as completed and before placing the isolation curtain. After the isolation curtain for an individual cell was placed, the barrier pipe was pumped out, floated into its next position, flooded again, weighted, and sunk into place. This allowed the operator to overlap dredging areas to ensure that the best possible coverage was achieved. In conjunction with the above procedures, careful operation of the clamshell was crucial to the overall success of the project. For this reason, Hypack's Dredgepack® system was employed and individual training conducted on-site, prior to, and during, dredging activities. Training was provided directly by Hypack. In addition to technology and training, clamshell descent and ascent through the water column was restricted to a maximum of 1 foot per second, minimizing resuspension in the water column.

Procedural Steps/Order for Silt Curtain and Barrier Pipe Placement. Placement of the segregation structures and dredging progressed from south to north (Cell 1 to Cell 5). Specific work activity proceeded as follows:

1. Barrier pipe was placed from east to west, approximately 25 feet north of the location of the curtain to be placed perpendicular to the shoreline.
2. Dredging proceeded up to the barrier pipe.
3. After dredging was completed up to the barrier pipe, the curtain was placed inside, isolating that cell from the remainder of the lagoon.
4. Barrier pipe was evacuated and floated into position approximately 25 feet north of the next cell to be dredged and flooded again.

This process was repeated until the project was completed, at which time, the pipe and curtains were removed from the lagoon and disposed of appropriately.

Daily Activity Quality Control (QC) Report. A Daily Activity QC Report addressing dredging activities was presented to the on-scene coordinator or their designee. This report described dredging work performed, areas dredged, and environmental monitoring results (e.g., water quality and air monitoring). The estimated amount of material removed daily and conveyed to the CDF was documented, and planned work for the next day was described. Other remarks or clarifications pertinent to the dredging operation were documented, as needed, in the appropriate section of the report. When trucking became the primary mode for the transport of dredge material to the CDF, these activities were described in the daily report in a similar manner. Corporate QC (CQC) inspection data and photo-documentation records were maintained throughout the sediment removal, transfer, and placement operations. CQC inspection procedures and reports were attached to the daily activity reports when applicable and maintained on-site throughout the duration of the project.

4.3 DISPOSAL OF DREDGED MATERIAL

During Phase I of the dredging operations, transport barges were used to transport the sediment to the CDF until January 2005, when ice in the river prevented travel up the channel. A contingency in the work plan allowed for trucking the sediment, so this method was implemented for the remainder of Phase I and for Phase II. These activities are detailed below in Sections 4.3.1 through 4.3.7.

4.3.1 Loading of Transport Barges During Phase I Dredging Operations

Transport barges were loaded outside of the silt curtain. This was accomplished by locating the transport barges immediately adjacent to the outside perimeter of the curtain, and then loading them by extending the excavator boom over the curtain from the dredge plant and dumping the material into the transport barges. Various engineering controls and careful operator practices were used to prevent removed sediment from being released into the river channel. The primary control was a “spill prevention plate,” which consisted of a steel plate that overlapped the transport barge and the silt curtain and lead back to the dredge plant. This plate was welded to 6 of the steel pipe pilings that anchored the turbidity curtain and was hinged to allow it to adjust to the varying height of the transport barge as it was loaded.

4.3.2 Transporting Dredged Materials to the CDF

Three transport barges were used to convey the dredged materials to the government-provided CDF on Pointe Mouillee. The barges were moved using the *Robin Lynn*, a 90-foot, 1,800-horsepower tugboat, up the Trenton Channel to the north, under the Grosse Ile toll bridge, and into the Detroit River Channel.

4.3.3 Stabilizing Barged Dredge Materials at the CDF

Dredged material was mixed with Calciment to solidify the material. Solidification greatly reduced the risk of releasing sediment back into the environment during handling and conveyance operations. The Calciment was stored at the CDF offloading site described in Section 3.4.1. The stabilizing agent was mixed with dredge material in the transport barges prior to offloading at the CDF. The temporary storage pit was intended to be used in the case of a rain event to prevent shutdown of dredging activities. Due to the composition of dredge material and the amount of water separation that occurred during transportation to the CDF, material was solidified on the barge and transferred to the storage pit for further solidification prior to placement in the cell.

Given the inherent nature of the mixing and transfer operations, some sediment re-entered the adjacent water surrounding the offloading area. Engineering controls were employed to isolate the spillage to that area and consisted of surface-to-bottom impermeable curtains and harbor and absorbent booms. Upon completion of offloading operations, the adjacent waters were dredged and the engineering controls were removed.

With the onset of winter, ice in the channel prevented barge transportation to the CDF. Beginning in January 2005, transportation via truck to the CDF was implemented with much success, as described in Section 4.3.5 of this report.

4.3.4 Offloading and Conveying Barged Dredge Materials

Dredged sediment from the Black Lagoon was received at the transfer/offloading area of the CDF. The tug and barges entered the CDF through the Southeast Interior Channel, where a smaller harbor tugboat (e.g., 35-foot, 300-horsepower) was used to maneuver the barges and place them at the transfer site. The barges were moored next to the H piles and the working deck barge at the temporary, contractor-installed, transfer site.

After the full barges were moored, the previously unloaded barges were transported back to the lagoon by the 90-foot tugboat, *Robin Lynn*. Sediments were removed from the barges with a CAT 330 long-reach excavator positioned on shore and an 85-ton Manitowoc crane positioned on the adjacent working deck barge. The sediments were offloaded from the barges directly into the storage/solidification pit and then into 35-ton off-road articulated dump trucks. Sediment was transported from the offloading area to the Cell 5 placement area using four articulated dump trucks.

4.3.5 Trucking and Contingency Plan Operations During Phases I and II

In late December 2004, severe winter weather and hard freezing occurred. The river channel became clogged with ice and impassable at the toll bridge and at the entrance to the CDF. These weather conditions required implementation of the trucking contingency plan. Implementing the trucking contingency plan included moving the GTB2 barge into the lagoon and positioning it along the north shore.

This barge was used to solidify the sediment, which was then directly loaded into trucks. To accomplish this, a small area of the shoreline (i.e., the bank of the lagoon) was excavated to bring the barge as close to the shore as possible. The excavated material was solidified with Calciment and transported to the CDF. The area that was excavated along the north shoreline was approximately 150 feet x 40 feet x 4 feet. The amount of Calciment required to solidify the excavated material averaged approximately 17% over the course of the project.

A loading platform was constructed to offload the barge into trucks, using approximately 60 linear feet of sheet piling to create a wall at the shoreline. Limestone aggregate was used to raise the grade behind the sheet piling wall from the existing grade of 576.5 feet to an elevation of 583.5 feet. Placement of the GTB2 barge immediately adjacent to the shoreline/sheet piling prevented inadvertent spillage of dredged material into the lagoon during the offloading process. Once all dredging operations were complete, the sheet piling was removed and the area restored.

The solidification agent (Calciment) was staged directly west of, and adjacent to, the raised aggregate landing. Calciment was added into the barge and mixed in place prior to direct loading into trucks. Mixing operations were closely monitored to ensure that no free liquid existed prior to loading the dredged material into trucks for transportation over the road. Calciment was stored in a secure area surrounded on 3 sides, to protect it from prevailing winds and minimize dust migration (see Figure 4-2). This same equipment also was used to load the transport trucks. The existing air/dust monitoring methods and frequency proved to be adequate to ensure compliance with the original work plan. However, 2 to 3 additional monitoring points were added to encompass the area of new operations.

Any solids dropped while loading trucks were collected and placed back into the barge, using a CAT 966 loader. Vehicle decontamination pads were constructed at the lagoon and at the CDF. All trucks were washed prior to leaving both the lagoon and the areas of operation in the CDF. All water generated from the vehicle washes at the lagoon was collected in a sump at the southwest end of the wash pad and pumped back into the barge GTB2 and solidified.

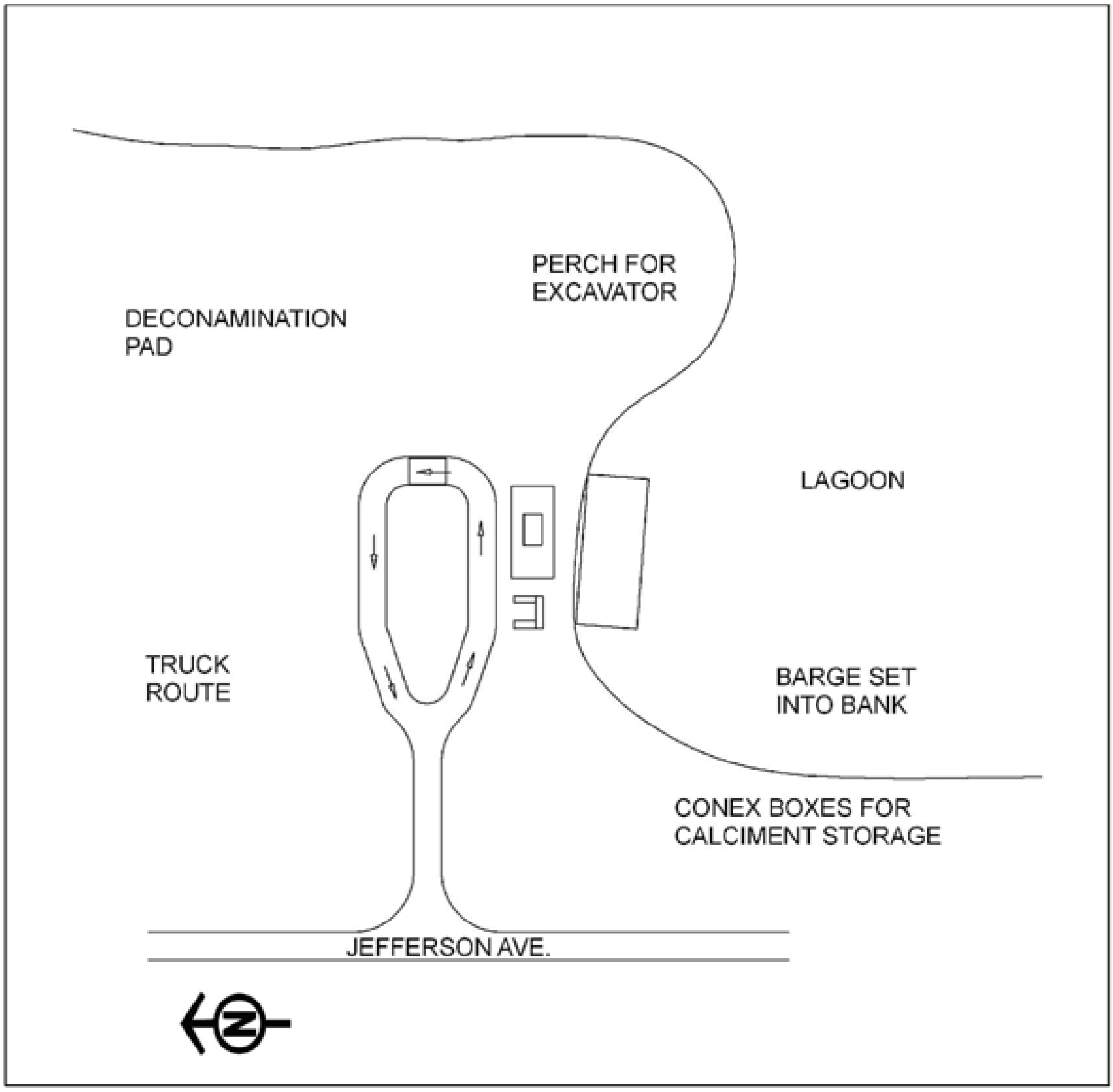

Figure 4-2 Schematic Drawing of Contingency Trucking Operations

Transport trucks were scheduled to facilitate truck traffic, and typically traveled in groups of two or three. Several groups of trucks were utilized concurrently to maintain production rates. A bill of lading was prepared for each load, and a copy was retained in the site file. Trucks were covered prior to leaving the lagoon area. Upon arriving at the CDF, trucks backed up to the temporary storage pit and offloaded. All transport trucks were washed prior to leaving the CDF area. Water collected at the CDF wash pad was pumped into the temporary storage pit. Off-road dump trucks were used within the confines of the CDF to convey the dredged material to the placement area in Cell 5.

4.3.6 Placement of Dredged Material

Dredge material was placed in the CDF at an elevation of 579.0 feet. Sediment was dumped off the cross dike and other strategic locations around the perimeter of the cell. These sediment piles were then spread from the outer edges of the cell toward the center and compacted in 2-foot lifts, using an excavator and D6 LGP wide-track bulldozer. The material was distributed evenly throughout the cell and to a consistent depth to eventually form a relatively flat surface with a gradual slope that allowed drainage to be directed to the weir. The placed materials were compacted in 12-inch layers by making a minimum of 3 passes with the dozer.

4.3.7 Capping the CDF Cell

A minimum of a 2-foot cap was placed on top of the dredged materials. Cap material was obtained from areas adjacent to the offloading site within Cell 5. The material was excavated with a CAT 330 excavator and spread in 1-foot lifts, then compacted with a D6 LGP dozer. At least 3 passes were made with the D6 LGP dozer over all placed cap material. The top of the cap did not exceed an elevation of 581.0 feet.

5.0 SEDIMENT CONFIRMATION SAMPLING AND ANALYSIS

After each of the dredging phases, the remaining sediments were sampled at pre-determined locations and analyzed to confirm that the remediation activities achieved the project objectives. The locations for these post-dredging sediment samples were randomly selected according to a statistical plan designed to provide a specified level of power and confidence in achievement of project objectives. The basis of the design is described below in Section 5.1. Additional details concerning its execution, including the location of sampling points, sample collection procedures, analytical procedures, and quality control strategies are provided in Sections 5.2 and 5.3.

5.1 SEDIMENT CONFIRMATION SAMPLING DESIGN

The sampling design and residuals analysis were developed in accordance with U.S. EPA's seven-step, systematic planning process known as the Data Quality Objective (DQO) process. The technical approach detailing development of the sampling design is documented in Appendix D of the project QAPP and is summarized below.

In order to determine if concentrations in the remediated area were lower than target levels, a 100 x 100-foot grid system was established within the Black Lagoon area cordoned off behind the silt curtain. Each 100 x 100-foot grid was considered a remedial management unit (RMU), for a total of 14 RMUs. The RMUs were identified by the capital letters A through N and served as the basis for evaluating the achievement of target levels.

As part of the DQO process, a decision statement was developed for the sediment confirmation sampling in the lagoon. This statement was based on achieving study objectives, namely: *"Has the dredging removed the contaminated sediment sufficiently to proceed with placement of the aggregate residual cover?"* It was agreed that additional excavation might be warranted in an RMU if the average concentrations of contaminants of concern in that RMU exceeded certain target levels. These target levels were 1 mg/kg for total PCBs (as Aroclors, hereafter total PCBs), 1 mg/kg for mercury, and 2,000 mg/kg for oil and grease.

U.S. EPA's *Guidance for the Data Quality Objective Process* (EPA G-4) was used to develop a power curve for optimizing the sampling design. In developing the power curve, existing sediment confirmation data were needed to estimate the variability that might be expected in the sediment confirmation samples for this project. Therefore, case study data from several sediment remediation projects were obtained and evaluated for use in planning the remedial activities, sampling design, and residuals analysis for the Black Lagoon project. A series of case studies were evaluated against the site criteria of the Black Lagoon (U.S. EPA 2004). Of these, one project, the Fox River SMUs 56/57, was found to be most similar to the Black Lagoon, based on pre-determined criteria, and was used to develop parameters for the residuals analysis. Total PCBs were chosen as the proxy contaminant for all of the COCs because the observed concentrations showed the highest variability in the earlier studies. In addition, average total PCB concentrations in the Black Lagoon prior to remediation were closest to the target level and would, therefore, require the largest number of samples to demonstrate successful remediation.

Based on the power curve, four samples per RMU were determined to be necessary for evaluating the post dredging site conditions against the project target levels with the specified decision error. Therefore, each of the 14 RMUs was further sectioned into four 50 x 50-foot cells, for a total of 56 cells. Sampling stations were randomly located within each of the 50 x 50-foot cells (Figure 5-1), in accordance with a stratified random sampling design (i.e., a combination of grid and random sampling). Due to the shape of the lagoon, a few small areas were outside the grid system. Adjacent RMU sediment sample results were used to determine management of those areas.

As part of developing the power curve, the limits of the decision error also were specified. A false positive (F+) decision (i.e., an incorrect determination that a COC was still present above the target level) could result in unnecessary additional remediation and dredging. A false negative (F-) decision (i.e., an incorrect determination that the COCs were no longer present at the target levels) could result in unwanted increased risk to human health and to the environment. The sediment confirmation sampling strategy used in this study was designed to achieve a 95% power in detecting an exceedance of the target level when the true concentration of total PCBs across the RMU was 5 mg/kg.

This allowed for decisions to be made with false positives rates of 15% (confidence of 85%) and false negatives rates of less than 5% (power of 95%).

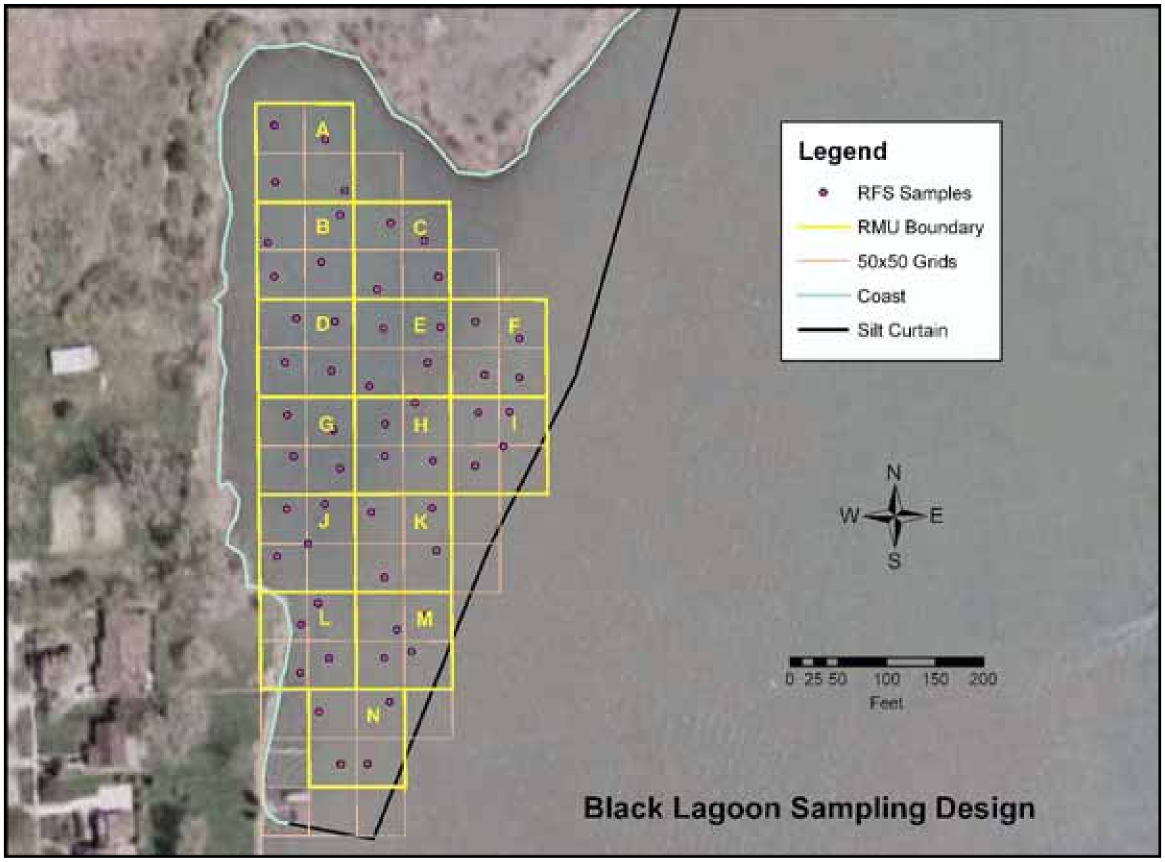

Figure 5-1 Black Lagoon Sediment Confirmation Sampling Design

The sampling design called for one homogenized composite sample to be collected from each 50 x 50-foot cell, yielding four routine field samples *(RFS)* per RMU, or a total of 56 routine field samples. Individual samples were collected and homogenized as described in Section 5.2.1 and analyzed for each contaminant of concern as described in Section 5.2.2. The thickness of the sediment was measured prior to collecting each sample. These thickness measurements were taken within 3 to 5 feet of each sampling location, but not so close that the sediment would be disturbed prior to sampling at the pre-defined site.

Statistical tests were developed to evaluate whether remediation activities achieved project goals. These tests were based on null hypotheses that total concentrations of the contaminants of concern were less than the project-specified target levels. The project target levels were 1 mg/kg for total PCBs, 1 mg/kg for mercury, and 2000 mg/kg for oil and grease.

The specific statistical tests were:

1. Total PCBs concentration less than the target level of 1 mg/kg
   - H_0: Total PCBs <1 mg/kg
   - H_1: Total PCBs ≥ 1 mg/kg
2. Mercury concentration less than the target level of 1 mg/kg
   - H_0: Total Mercury < 1 mg/kg
   - H_1: Total Mercury ≥ 1 mg/kg
3. Oil and grease concentration less than target level of 2000 mg/kg
   - H_0: Total Oil and Grease < 2000 mg/kg
   - H_1: Total Oil and Grease ≥ 2000 mg/kg

The average concentration of each COC was calculated for each of the 100 x 100-foot RMUs and compared to the respective target levels. If the statistical evaluation was inconclusive, additional sampling could be considered. Results for this comparison are presented and discussed in Section 6.

Additional information concerning the sediment confirmation sampling design can be found in *Appendix D, Post-dredging Sediment Sampling and Residuals Analysis*, of the project QAPP.

5.2 SAMPLING AND ANALYSIS

Sediment confirmation sampling was conducted in the Black Lagoon following each excavation phase. Samples were collected after Phase I according to the sampling design set forth in the QAPP (Figure 5-2, Samples May 05). After the second phase of excavation, a sampling design was developed to evaluate achievement of target levels that specified collecting samples at the center of each RMU. In some cases, logistics in the field, such as a stuck barge, prevented collecting all of the samples at the prescribed locations. For these cases, samplers and project leads determined alternative locations that provided sufficient coverage of the site to evaluate achievement of project objectives. Final sample locations are provided in Figure 5-2. Analytical results from sediment confirmation samples collected after the first dredge and second dredge are provided in Tables 6-1 and 6-2, respectively.

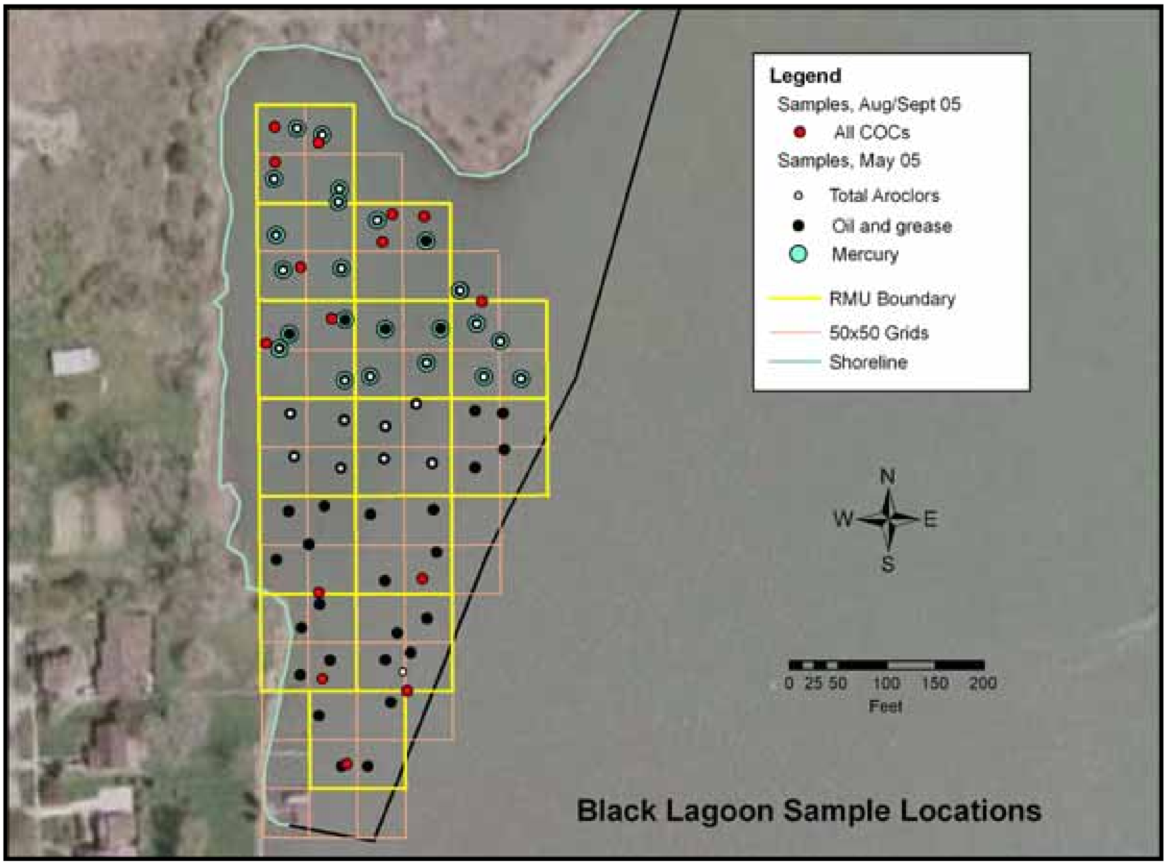

Figure 5-2 Actual Black Lagoon Sampling Locations for May, August, and September 2005 (Note: Two samples are located so close together that they cannot be differentiated in this figure)

5.2.1 Sampling Methods

As noted above, the sampling design called for one homogenized composite sample to be collected from each 50 x 50-foot cell, yielding four routine field samples (RFS) per RMU, or a total of 56 samples collected in May 2005. To maximize RFS representativeness, three Ponar grab samples were collected at the randomly located station within each 50x50-foot cell, homogenized separately, then combined, and homogenized again. Figure 5-2 illustrates the Black Lagoon sampling locations for the 56 samples collected in May 2005 and the 15 samples collected in August/September 2005. These pre-selected sampling sites were located in the field using a GPS receiver.

Samples were collected by MDEQ's contractor. Sampling methods are described in detail in Appendix D, Attachment 2 of the project QAPP and are summarized briefly here. Routine field samples were collected from 0 to 6-inches below the surface as a composite of three grab samples for each sampling location shown in Figure 5-2. At each station, a mini-Ponar dredge sampling device was used to collect three grab samples: one off the bow of the sampling vessel, one off the stern, and one off the port site. These three grab samples were composited in a clean stainless steel bowl and thoroughly homogenized using clean stainless steel spoons and spatulas. Because thorough homogenization of the samples prior to filling the sample containers was critical for creation of representative composite samples, unrepresentative materials such as stones and wood chips were removed, and the sample was mixed until uniform texture and color were obtained. The Ponar sampler and mixing utensils were cleaned and decontaminated with river water and a steam cleaner after collection of every three samples, or whenever oil or grease was visible on the sampling equipment.

Samplers recorded sample location, sediment thickness, and sediment physical observations in a field log book. Sediment depth measurements were determined to the nearest half foot, at locations a minimum of three feet away from the sampling locations, in order to avoid disturbing or contaminating the sediment to be sampled for chemical analysis. Observations included the gross physical characteristics of the surficial sediment, such as obvious odor, oily sheen, texture, color, and the presence of debris.

Due to the importance of the sediment confirmation samples in determining whether dredging activities had achieved project objectives, they were supplemented by a suite of samples gathered for quality control purposes. These QC samples included:

- *Field Sample Splits (FSS)*: Field sample splits were prepared by using extra volume from each composite created when preparing the RFSs. Six of these splits were prepared (i.e., a 10% frequency) at randomly selected locations provided to the sampling team along with the locations of the RFSs. These FSSs were placed in the same type of jars that were used for the RFSs and were labeled so that they appeared to be routine samples to the laboratory staff that received and analyzed them.

- *Matrix Spikes/Matrix Spike Duplicates (MS/MSD):* Matrix spike and matrix spike duplicate samples also were prepared by using extra volume of the final homogenized composite obtained for six of the RFSs (i.e., a 10% frequency). Unlike the FSSs, which were sent as "blind" QC samples (i.e., the laboratory did not know they were splits), the MS/MSD samples were clearly designated as QC samples for the laboratory. Locations of the MS/MSDs were selected at random by the samplers.

5.2.2 Analytical Methods

Sediment sample analyses were performed by TriMatrix Laboratories, under contract to MacTec. EPA Method 8082 was used to determine Total PCBs (as Aroclors). EPA Method 7471A was used to determine mercury. EPA Method 9071B was used to determine oil and grease. EPA Method 3550B was used to determine solids.

5.3 QUALITY OF SEDIMENT CONFIRMATION DATA

Due to the importance of the sediment confirmation samples in determining whether dredging activities had achieved project objectives, all data were reviewed as described in the project QAPP. In addition, the data were evaluated to verify that they provided the sensitivity, precision, accuracy, representativeness, completeness, and comparability required to support these decisions. Details of that assessment are provided in Appendix A of this report. Briefly, this assessment concluded that:

- *Sensitivity*: Reporting thresholds were sufficient to meet project objectives for this study, but this was due, in part, to the relatively high concentrations of mercury and oil and grease present in the samples. If the sample concentrations had been lower for these analytes, it may not have been possible to verify that non-detects were due to the true absence of contamination at the target level or to limitations of the analytical procedure. This issue should be considered in future studies.

- *Precision*: Precision was examined in two ways: (1) by comparing results of RFSs with their FSSs to assess precision of the entire sampling and laboratory system, and (2) by comparing results from MS samples with their MSDs to determine laboratory precision. As was expected, laboratory precision was better than system precision (which includes laboratory variability plus sampling variability), and variability in the sampling activities accounted for most of the system variability. Precision estimates were within acceptable ranges for mercury, oil and grease, and most PCB components. However, the system precision for one of the PCB components (Aroclor 1260) exceeded the measurement quality objective of 50% RPD, with an observed precision of 75% (still within what is typically observed with sediment sampling and analysis).

- *Bias*: Although slight measurement bias was observed for each COC, these biases were within acceptable ranges of measurement error.
- *Completeness and Representativeness*: The sediment confirmation sampling strategy reflected a stratified random design intended to generate a data set representative of the entire lagoon. This strategy was followed completely after the first phase of dredging (which accounted for approximately 90% of the total sediment removal activities), thereby yielding a fully representative and complete data set for this stage of the project. Sediment confirmation sampling after subsequent dredging passes was to be conducted as deemed necessary and if resources allowed. A sampling design was developed after Phase II dredging operations were completed (which accounted for approximately 10% of the total sediment removal activities). Although the confirmation sampling was not as extensive, the design was based on the same grid pattern used for the Phase I sampling.
- *Comparability*: Comparability is the confidence with which one data set can be compared to other data sets. Sediment confirmation data were generated using standard analytical methods. All sampling and analytical procedures used in evaluating sediment conditions in this project are well-documented and available in the project QAPP, facilitating comparability of the sediment confirmation results. These procedures should be reviewed and considered when evaluating these data for other uses. In regards to the sediment volume data, as is discussed in Chapter 6 of this report, the survey data originally used to design the project work plan reflected the International Great Lakes Datum (IGLD) 55 instead of the newer IGLD 85 system. This difference in specification accounted for some of the unexpected challenges encountered with respect to sediment depths and volumes. Physical changes to the lagoon floor also may have accounted for some of these challenges.

6.0 PROJECT RESULTS

Three sets of sediment confirmation samples were collected using the statistically based sampling designs described in Section 5. The first set was collected immediately after the first phase of dredging operations. Results from this set indicated that high levels of contamination were still present in the remaining sediments across the lagoon. Based on these results, a second round of dredging (Phase II) was performed to remove approximately 12,000 cubic yards of additional sediments. After completing the second round of dredging, a second round of sediment confirmation samples were collected. As is typical for dredging projects, these data indicated that a residual layer of contaminated sediment still existed, even though a significant reduction in contaminant levels in the remaining sediments was observed. The remaining sediments were then covered with a protective layer of clean sand and gravel to provide a clean substrate for the benthic community. A third set of sediment confirmation samples was collected after application of the clean sand and gravel to confirm the absence of contamination at levels of concern in the new lagoon substrate.

Results from all three sets of sediment confirmation samples are discussed in Section 6.1. Results of the final hydrographic survey and final calculations of the contaminated sediment removed from the site are presented in Section 6.2. A discussion of the quality of sediment confirmation data used to determine achievement of project objectives is presented in Section 6.3. Chapter 7 of this report describes the process for installing the clean sand and gravel cover over the dredged site, demobilizing equipment and staff, and restoring the site to pre-existing conditions.

6.1 POST-DREDGING SEDIMENT CONFIRMATION SAMPLE RESULTS

Initial dredging activities were completed in May 2005. To determine if dredging had restored the lagoon sediments to acceptable levels, 62 sediment confirmation samples were collected as described in Sections 5.1 and 5.2.1 of this report (i.e., 56 RFS and 6 FSS samples). In addition, 19 sediment core samples also were collected to confirm the depth of the sediment after the survey. Samples were analyzed by TriMatrix Laboratories as described in Section 5.2.2, and results were reported to the Project Team. All 56 RFS samples were analyzed for oil and grease, 24 of the samples were analyzed for mercury, and 27 were analyzed for PCBs. The 19 core samples were analyzed for oil and grease only. Because all results exceeded the target levels of 2000 mg/kg for oil and grease, 1 mg/kg for mercury, and 1 mg/kg for total PCBs, the laboratory was instructed to discontinue further analysis of the remaining samples. The minimum, maximum, and mean COC concentrations for the samples that were analyzed are shown in Table 6-1. A summary of all sediment confirmation data is provided in Appendix A.

Table 6-1 Results From Sediment Confirmation Samples Collected After the First Dredge

Contaminant	Target Level for Project (mg/kg)	Concentrations Reported (mg/kg)				
		Minimum	Maximum	Mean	Standard Deviation	Number of samples
Oil and Grease	2,000	12,000	28,500	20,242	3612	56
Mercury	1	1.1	3.1	2.45	0.42	24
Total PCBs	1	0.54	2.28	1.47	0.45	27

The original plan was based on the assumption that dredging activities would remove all or most of the sediments, and along with them, all or most of the contaminants of concern. As shown in Table 6-1, however, the contaminants of concern were still present at high levels after the first round of dredging operations. These higher than expected concentrations, along with deeper than expected post-dredge sediment depth measurements, confirmed suspicions that the original sediment depth estimates were incorrect. In order to better understand the magnitude of additional work required to reach hardpan and remove the contaminated sediments, a distribution map showing the remaining sediment floor was created by kriging the post-dredge sediment depth measurements. Kriging is a spatial and variance interpolation method used to predict values across the site in areas where samples were not collected (Cressie, 1990). The map, presented in Figure 6-1, indicated that two to six foot depths of sediment still covered large areas of the lagoon.

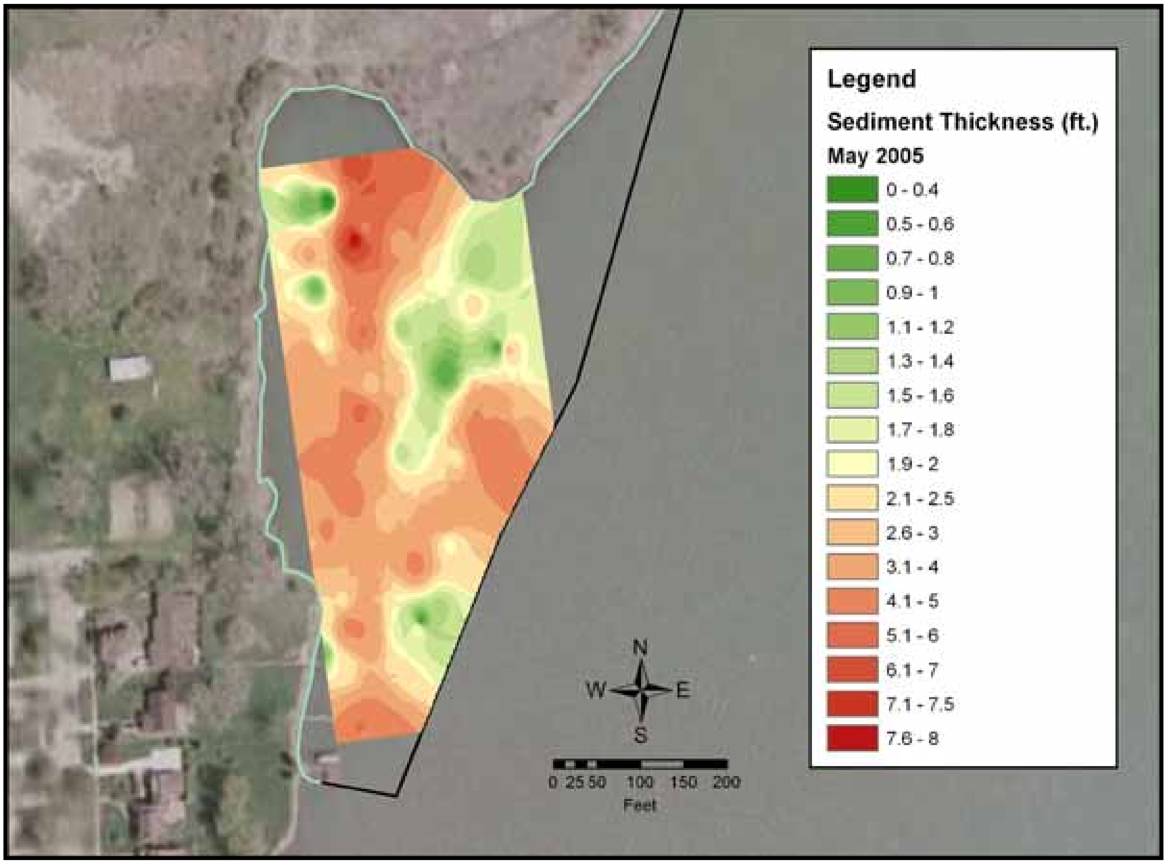

Figure 6-1 Black Lagoon Sediment Thickness After Completion of Phase I Dredging (based on data collected in May 2005)

After reviewing the new sediment depth and contaminant data, a second phase of dredging was deemed necessary and samples were collected based on new criteria. The area to be dredged and the sample frequency were reduced. The change in scope for the project was documented in a revised DQO table. The Phase II criteria were to dredge to the clay layer. The minimum, maximum, and mean concentrations of the sediment samples collected after the second phase of dredging in August and September 2005 are presented in Table 6-2.

Table 6-2 Results From Sediment Confirmation Samples Collected After the Second Dredge

Contaminant	Target Level for Project (mg/kg)	Concentrations Reported (mg/kg)				
		Minimum	Maximum	Mean	Standard Deviation	Number of samples
Oil and Grease	2,000	2,050	16,500	10,724	4,154.00	15
Mercury	1	0.24	4.7	2.78	1.42	15
Total PCBs	1	0.13	1.91	1.12	0.56	15

A new map of the sediment thickness after the second phase of dredging is presented in Figure 6-2.

Figure 6-2 Black Lagoon Sediment Thickness After Completion of Phase II Dredging (based on data collected in August and September 2005)

Results suggest that, although the Phase II dredging activities did not completely reduce contaminant concentrations to the levels targeted, the second round of dredging was successful in reducing both the overall concentration and the distribution of those contaminants. Figures 6-3 and 6-4 illustrate this by showing the estimated concentration and distribution of oil and grease before and after contaminated sediments were removed in Phase II. Figures 6-5 and 6-6 present similar information for total PCB distributions. A similar pair of figures could not be presented for mercury due to the lack of confirmation samples in the southern half of the lagoon because of the decision to halt the sample analysis when results reported for oil and grease showed all samples exceeded the target levels (see Table 6-1). As can be seen from these figures, dredging efforts in the Black Lagoon dramatically reduced the levels of contamination across the site. See Section 6.3 for final sediment confirmation results after placement of the residual cover.

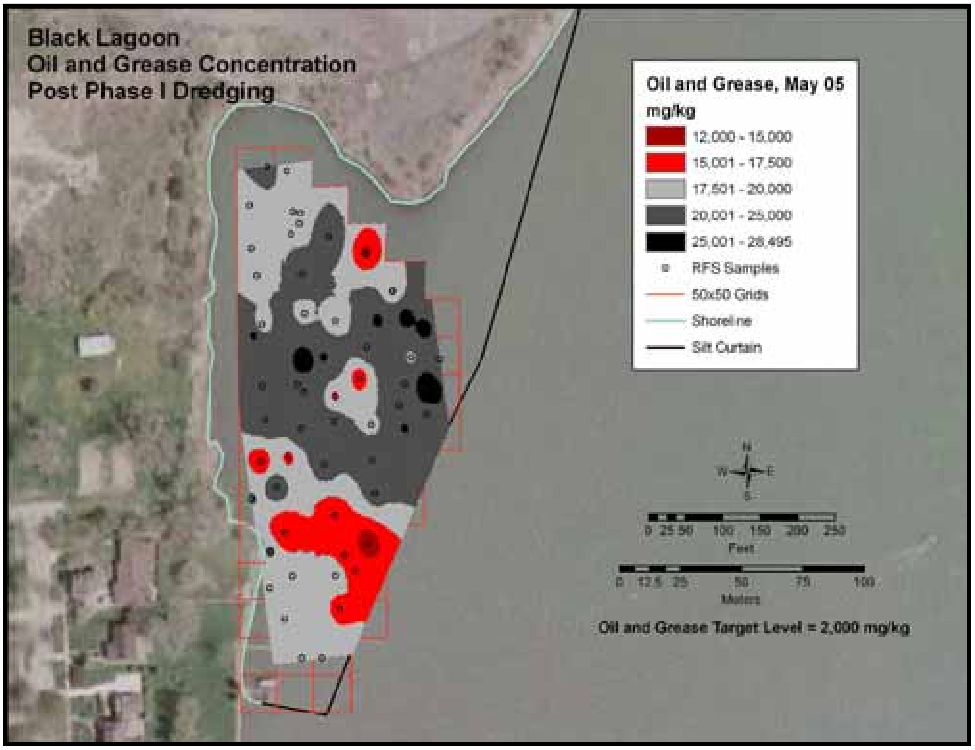

Figure 6-3 Estimated Oil and Grease Concentrations Prior to Phase II Dredging

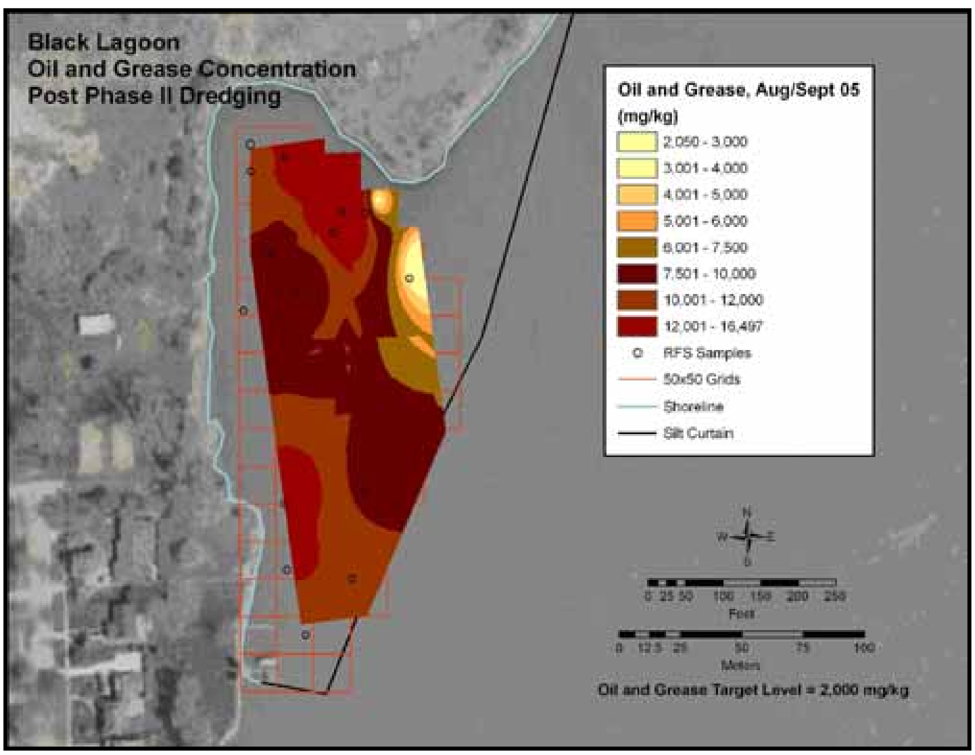

Figure 6-4 Estimated Oil and Grease Concentrations After Phase II Dredging

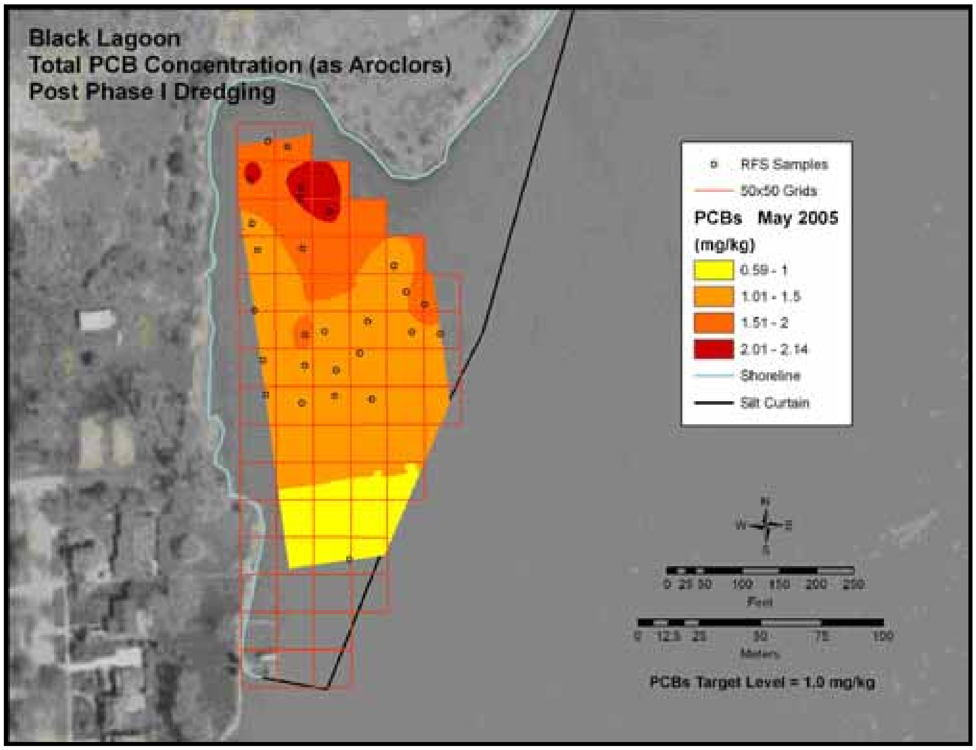

Figure 6-5 Estimated Total PCB Concentrations Prior to Phase II Dredging

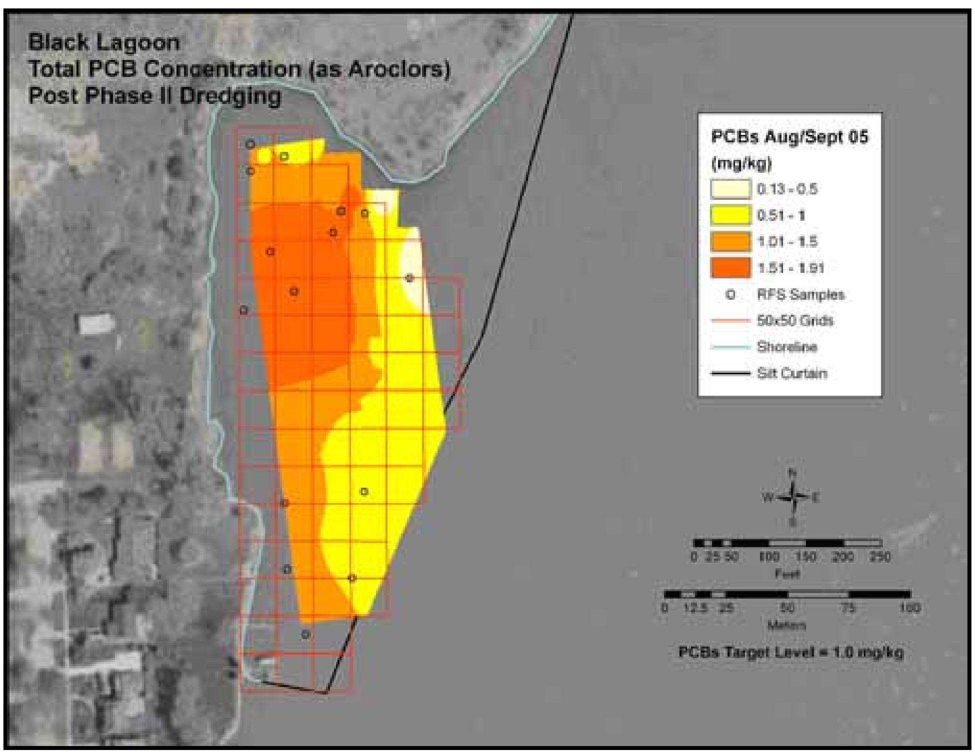

Figure 6-6 Estimated Total PCB Concentrations After Phase II Dredging

6.2 VOLUME OF CONTAMINATED SEDIMENTS REMOVED

Upon completion of all dredging activities, a final hydrographic survey was performed to calculate the exact amount of dredge material removed from the lagoon. A hydrographic survey was conducted by both EQ's survey crew and a crew from the USACE Detroit District. The data from both surveys were compared and deemed accurate.

Due to inherent problems with the pre-dredge survey discussed previously, certain data and quantity adjustments were made to accurately calculate sediment volumes. These adjustments or accommodations included: adding pole soundings taken by hand into a surface model of the survey (water depth was too shallow for hydrographic equipment); adjusting the surveys to International Great Lakes Datum (IGLD) 85 elevations (the original specifications were in IGLD 55)[1]; and encompassing a greater survey area that extended outside of the specified dredge limits to account for side slope failure. Once all of these accommodations were made and individual calculations completed, the total volume removed from the lagoon was determined. The total amount of sediment removed from Black Lagoon was determined to be 115,671 cubic yards. Figure 6-7 presents cumulative dredge volume data by month, based on these calculations.

As can be seen from this figure, 103,549 cubic yards were removed during Phase I (October 2004 through May 2005), and an additional 12,122 cubic yards were removed in Phase II (September 2005).

[1] The IGLD is an international elevation reference system. Because of movement of the earth's crust, the "datum" must be adjusted every 25-35 years.

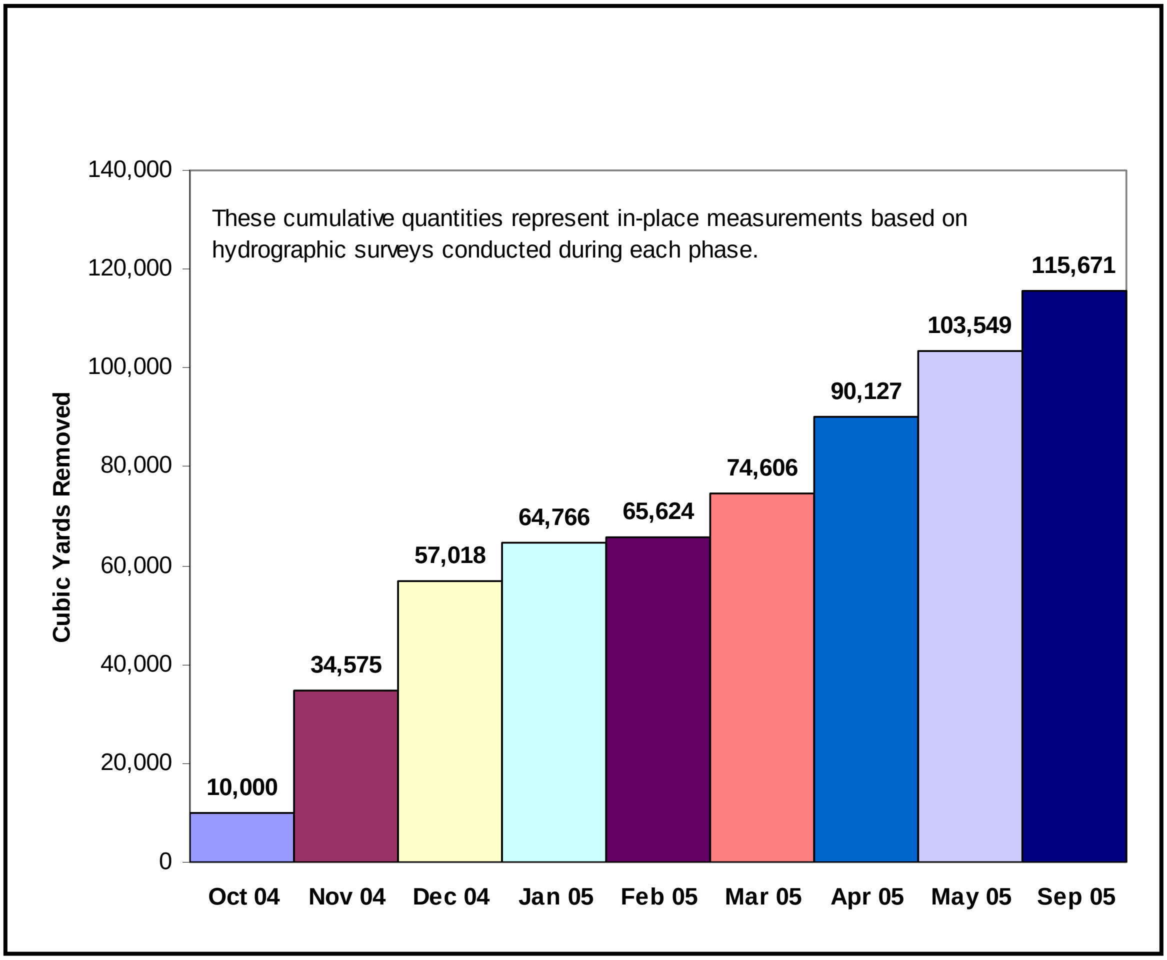

Figure 6-7 Cumulative Summary of Sediment Quantities Dredged from the Black Lagoon

The accuracy of the revised calculations was substantiated by the estimates obtained from the kriging maps presented in Figures 6-1 and 6-2. A three-dimensional view of both surfaces is provided in Figure 6-8 to show the difference in the estimated sediment thickness before and after Phase II dredging activities.

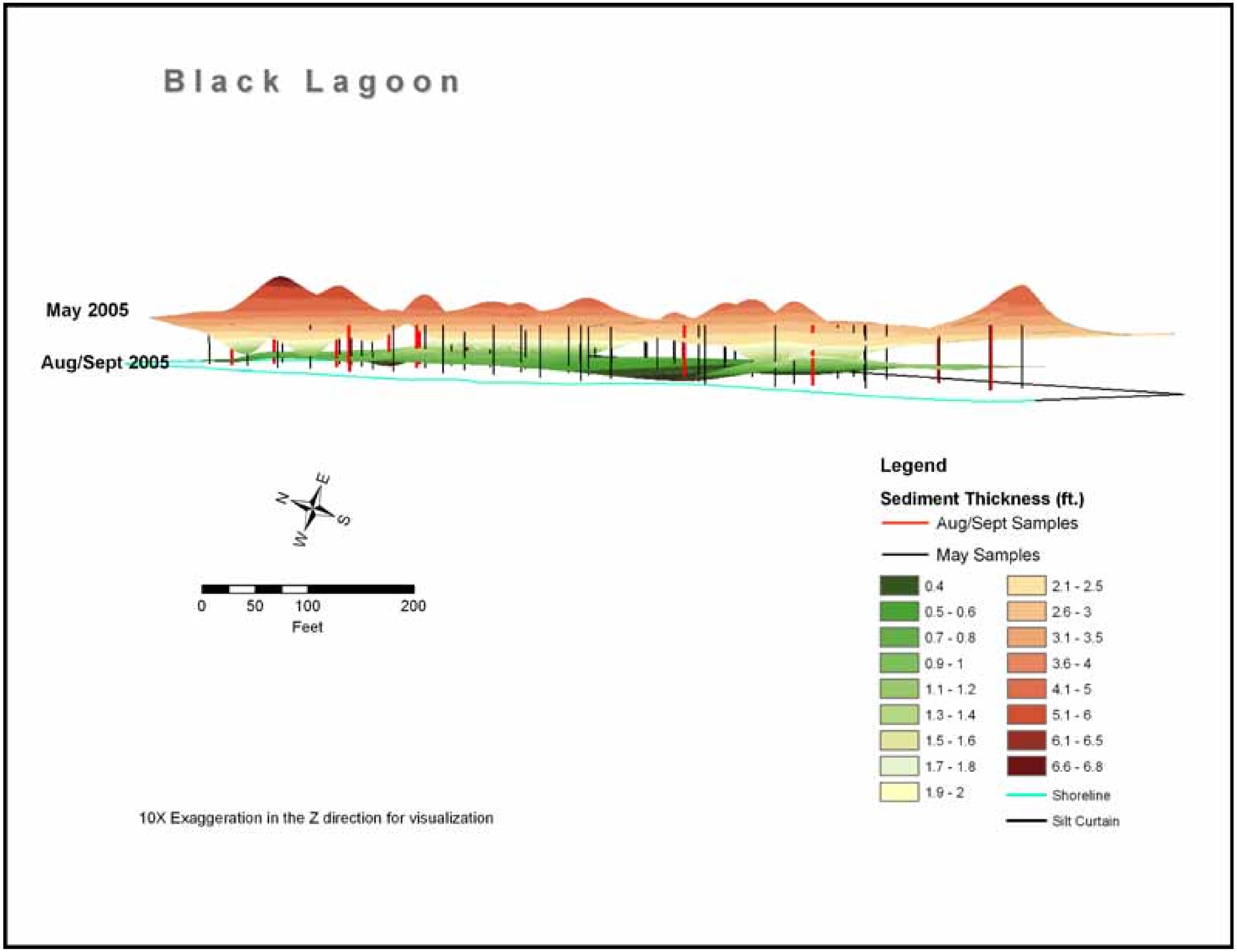

Figure 6-8 Three-dimensional View of Estimated Sediment Surfaces, Before Phase II Dredging (May 2005) and After Phase II Dredging (September 2005) (Sediment thickness in the Z dimension includes a 10X exaggeration factor for visualization.)

Figure 6-9 provides a cut-and-fill report to show the three-dimensional surface of the estimated sediment removed from the site during Phase II. The cut-and-fill surface, calculated area, and volume were developed by subtracting the estimated sediment thickness surface of August/September 2005 from the May 2005 surface (Figure 6.8). Even though all estimates are based on sediment thickness ± 0.5 feet, the cut-and-fill report provides fairly accurate account of the sediment removed from the site (approximately 11,000 cubic yards, which agrees within 10% with the calculated figure of 12,122 cubic yards).

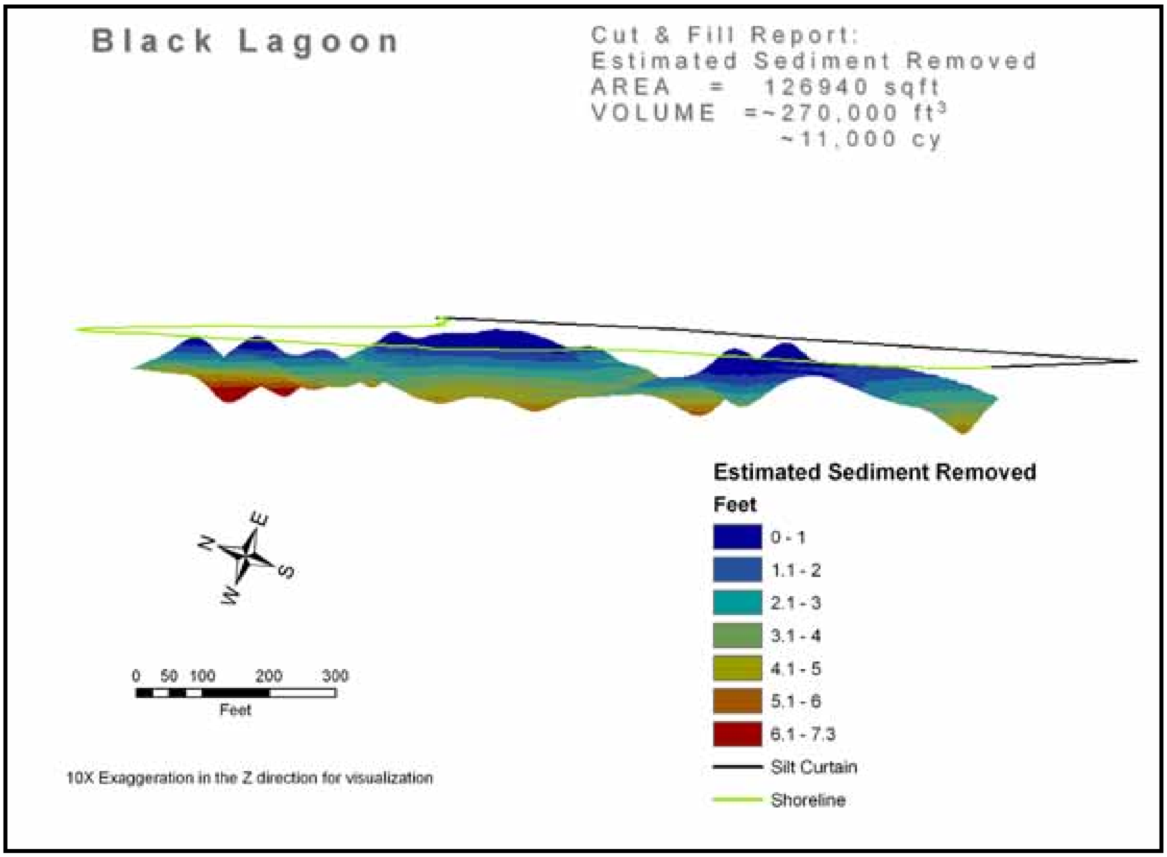

Figure 6-9 Three-dimensional View of the Estimated Volume of Sediment Removed During Phase II. (Calculated cut-and-fill report for volume and area of the three-dimensional surface derived by subtracting September 2005 estimated surface from the May 2005 estimated surface.)

6.3 FINAL SEDIMENT CONFIRMATION RESULTS

Dredging efforts in the Black Lagoon dramatically reduced the levels of contamination across the site. Approximately 95% of the contaminated sediment inventory was successfully removed from the site (based on the total sediment volume removed as presented in Figure 6-7 and the estimated volume remaining calculated from the post dredge sediment thickness data). However, the target levels for the COCs set forth in the QAPP were not achievable under the project sediment volume constrictions, schedule, and budget.

Estimated Amount of Contaminants of Concern Removed from the Black Lagoon

Contaminant	Pounds Removed
Total PCBs	160
Mercury	360
Oil & Grease	300,000
Lead	38,000
Zinc	140,000

Practical limits to the dredging attempts are based on both engineering and case study findings. Two dredging attempts were made to remove the contaminated sediments from Black Lagoon. The original plan specified that if additional dredging was deemed necessary for a specific RMU, additional dredging would be limited to one additional pass per RMU. This limit on the number of redredging attempts was due to project resources, as well as the diminishing returns reported in environmental dredging case studies. For example, at the GM Massena site, the greatest reduction of PCB residuals concentrations was experienced through the second dredging attempt (U.S. EPA 2004). Therefore, in the event that sediment removal operations are unsuccessful in achieving the mean residual concentrations for the contaminants of concern, engineering contingencies such as an isolation cover are implemented. The best professional judgment of GLNPO, MDEQ, USACE, and their supporting contractors concluded that the correct course of action was to install the residual cover to isolate any remaining contaminated sediments.

The residual cover consisted of at least 6 inches of sand and 6 inches of gravel installed to trap the underlying sediment and provide a clean habitat for benthic communities. After the deposition of the sand layer, 18 additional sediment confirmation samples were collected. Sampling in the sand cover is an environmental verification technique that is kept to a minimum, to maintain the residual cover's integrity and prevent mixing the underlying sediment with the clean cover. Results of the residual cover sampling and analyses showed that the mean concentrations of oil and grease, mercury, and total PCBs were all below target levels (Table 6-3).

Table 6-3 Results From Sediment Confirmation Samples After Placement of Residual Cover

Contaminant	Target Level for Project (mg/kg)	Concentrations Reported (mg/kg)				
		Minimum	Maximum	Mean	Standard Deviation	Number of samples
Oil and Grease	2,000	180	1,830	457	456	18
Mercury	1	0.03	2.1	0.19	0.48	18
Total PCBs	1	Not detected	0.27	0.14	0.1	18

Figures 6-10, 6-11, and 6-12 illustrate the distribution of contaminants of concern in the new sediment floor. Note that two samples, BL-05-10 and BL-05-12, are located so close together that they cannot be differentiated in Figures 6-10, 6-11, and 6-12.

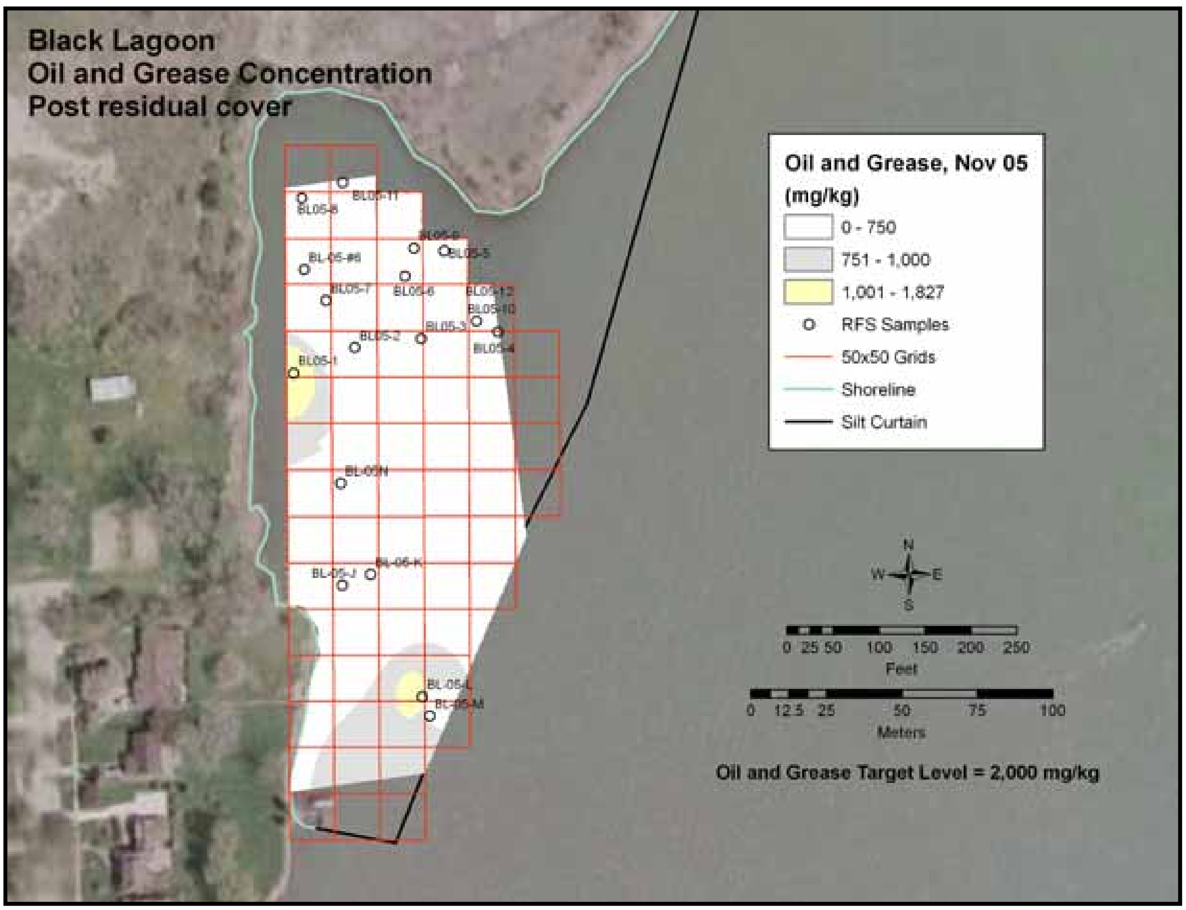

Figure 6-10 Oil and Grease Concentrations in Black Lagoon Sediment Floor After Remediation

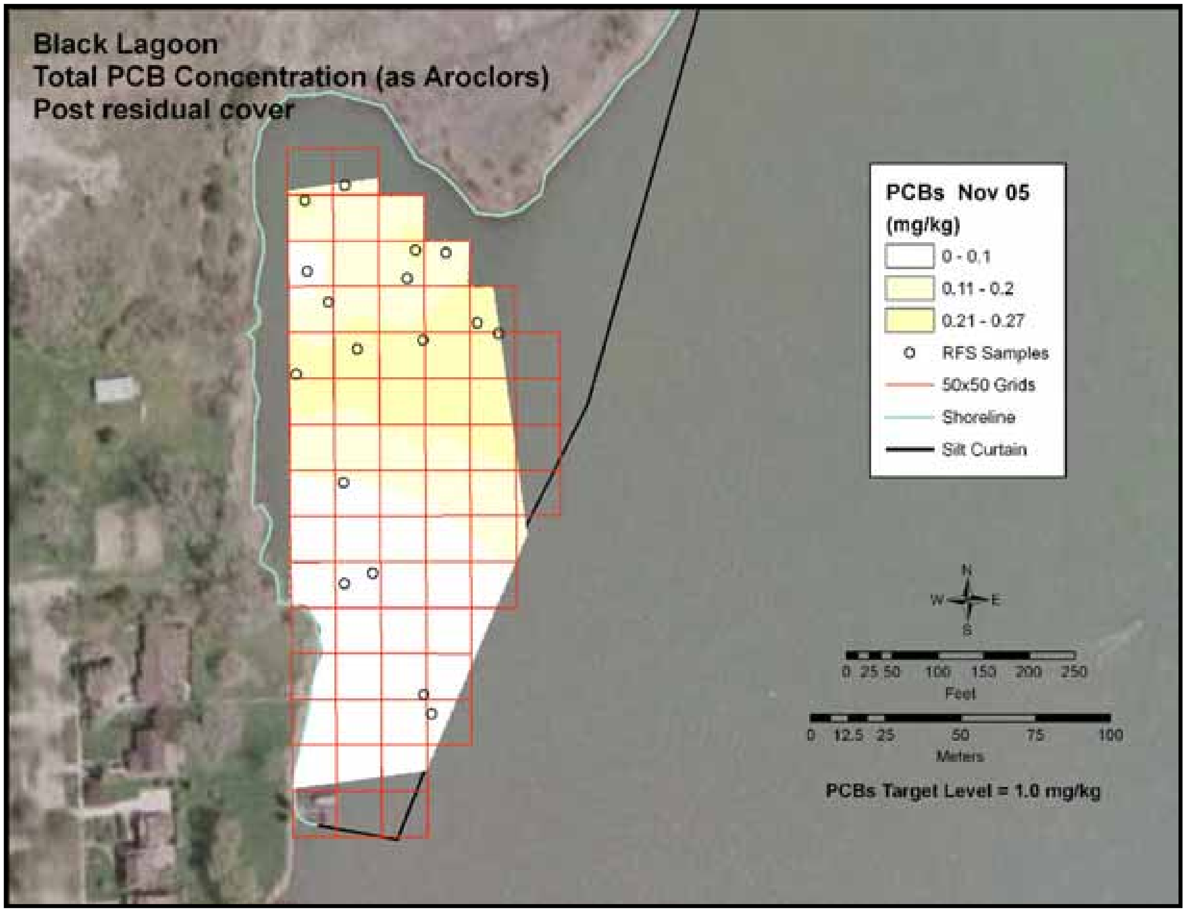

Figure 6-11 Total PCB Concentrations in Black Lagoon Sediment Floor After Remediation

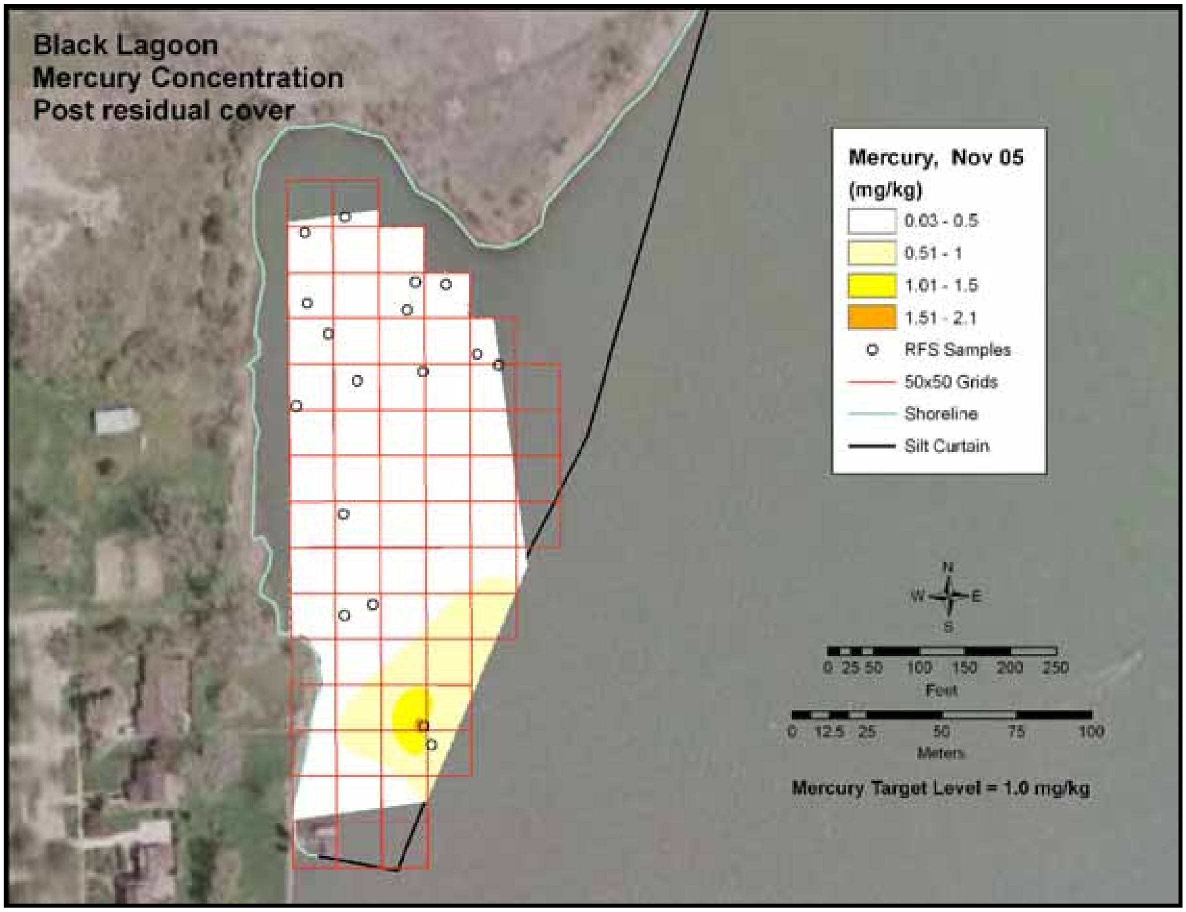

Figure 6-12 Mercury Concentrations in Black Lagoon Sediment Floor After Remediation

Total PCB concentrations were significantly reduced throughout the lagoon, from a mean of 2.6 mg/kg prior to remediation to 0.14 mg/kg post remediation and application of the sand cover (Figure 6-13).

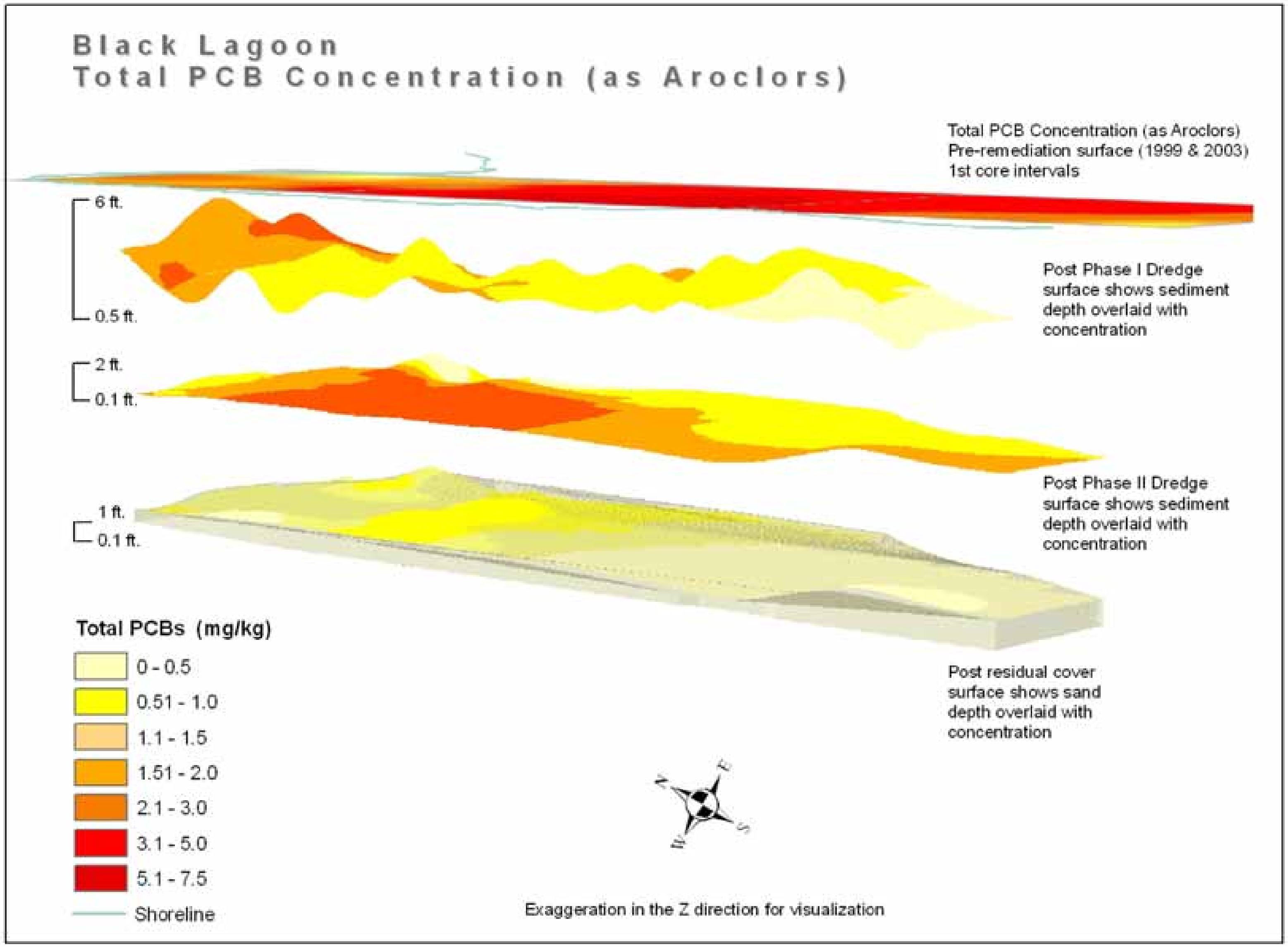

Figure 6-13 Black Lagoon Sediment Surfaces Overlain with Total PCB Concentrations through the Remediation Project

7.0 RESIDUAL COVER PLACEMENT, DEMOBILIZATION, AND SITE RESTORATION

7.1 PLACEMENT OF THE RESIDUAL COVER

Following completion and approval of all dredging operations, residual cover placement began over the dredge area with the goal of enhancing natural attenuation and adding habitat for aquatic life within the lagoon. The cover consisted of a minimum 6-inch lower layer of clean sand and a 6-inch upper layer of stone covering the sand. The sand and stone aggregate material characteristics complied with USACE-approved quarry and gradation curves.

The sand cover was spread using an 85-ton crane with a 3-cubic yard bucket, utilizing Dredge Pack to log the exact GPS location where each bucket was released. Each bucket was released by progressively opening the bucket wider as the material was released. Materials were released from a height of approximately 2 feet above the surface of the water to achieve a greater rate of dispersion and to reduce mounding. The cover materials were shuttled from the north end of the lagoon by hopper barge and tugboat, and the progression of cover material was from south to north.

An additional 1,500 cubic yards of sand were approved for placement in the northern half of the lagoon to increase cover thickness. Because of variables outside the control of the operator, such as the topography of the bottom of the lagoon and the strength of the current within the lagoon that could have affected the rate of descent and dispersion of material, the sand layer of some areas varied in thickness by up to 20%. Prior to stone placement, the sand layer thickness was tested and verified by taking a predetermined number of core samples.

The stone cover was applied in the same manner as the sand layer and provided a cover of approximately 4 to 6 inches over the sand. Again, the exact depth of this layer varied due to the bottom topography, but was less affected by any current within the lagoon because of the weight of the stone.

7.2 DEMOBILIZATION AND SITE RESTORATION

Following completion and acceptance of all work (i.e., dredging, aggregate placement, and CDF capping), site demobilization activities were conducted. This consisted of site restoration at both the lagoon and the CDF; removal of all work-related facilities, equipment, and materials; and final inspection of all restored areas.

Restoration at the lagoon work site consisted of removing boardwalks; grading work areas; seeding of the Ellias Property; and removal of the field office, utilities, and temporary security fence. All refuse or waste construction materials in the park area and around the shoreline area were removed and properly disposed.

The temporary transfer station at the CDF and all other temporary structures were removed. Disturbed areas (such as the offloading storage pad, temporary storage pit, and borrow areas) were graded and returned to their pre-existing conditions. Because of excessive truck traffic during transportation activities, all dike roads were re-graded and gravel added as necessary.

Upon completion of site restoration work, a final site inspection was conducted with project partners and other interested parties (e.g., park and City officials) to ensure that all work and restoration activities were satisfactorily completed.

8.0 CONCLUSIONS AND PROJECT ACCOMPLISHMENTS

The Black Lagoon remediation proposal was the first project to be accepted and implemented as a result of the Great Lakes Legacy Act. As the initial undertaking in a series of projected clean-up projects under the GLLA, the Black Lagoon project experienced challenges that will provide valuable lessons for future projects. These challenges included sediment volumes that were greater than anticipated based on historical data, low sediment densities encountered in the second phase of the project, and a barge that ran aground in the northern part of the lagoon (see Section 4.2.1 for details). These issues illustrated the importance of establishing accurate baseline conditions through comprehensive hydrographic surveys prior to initiation of the project.

Many of these challenges led to the development of new approaches or techniques that may be applied to future remediation efforts. For example, a series of bench tests was performed to identify operational procedures that ultimately allowed for successful removal of the low-density sediments encountered in Phase II. These operational procedures are discussed in Section 4.2.2 and may be of use should similar situations be encountered elsewhere. Likewise, kriging techniques were employed by GLNPO and MDEQ for the first time as a means of estimating sediment volumes and provided a means for confirming the revised volume calculations that were necessary to account for unforeseen problems with the original hydrographic survey data. Kriging also provided a new way to estimate and visualize contaminant distributions in GLLA projects.

Despite these challenges, the Black Lagoon project also was a story with many successes, including the environmentally safe removal of 115,000 cubic yards of contaminated sediment from the small bay (Figure 8-1). Several techniques were effective in preventing accidental contamination of the environment during the remediation process. Oil spill booms put in place prevented surface contaminants such as oil and grease from spreading to the surrounding water. A combination of various types of silt curtains kept sediments resuspended by dredging from traveling outside of the dredging area. Careful monitoring of turbidity and chemical measurements in the water and air around the lagoon reassured the neighborhood residents that neither their health nor the environment was endangered by the remediation project.

Testing of the sediments barged to the Pointe Mouille CDF showed that large amounts of oil and grease (300,000 pounds), mercury (360 pounds), and PCBs (160 pounds) were successfully removed, along with lead (38,000 pounds) and zinc (140,000 pounds). These are contaminants that will no longer endanger the aquatic and shoreline wildlife. The addition of a sand and gravel cover will allow the regrowth of healthy organisms on the lagoon bottom, and fish will no longer become contaminated from feeding on the bottom dwellers.

Black Lagoon Remediation Project Accomplishments

- 115,000 cubic yards of contaminated sediments were removed
- Approximately 478,000 pounds of PCBs, mercury, oil and grease, lead, and zinc were removed
  - 160 pounds of PCBs
  - 360 pounds of mercury
  - 300,000 pounds of oil and grease
  - 38,000 pounds of lead
  - 140,000 pounds of zinc
- Contaminant concentrations measured in the sediment floor after removal of contaminated sediments and placement of a new cover were all below target concentrations
  - PCB concentrations in the lagoon sediment were reduced from an average of 1.12 mg/kg to 0.135 mg/kg in the new sediment floor—an 8-fold reduction
  - Mercury concentrations in the lagoon sediment were reduced from an average of 1.40 mg/kg to 0.205 mg/kg in the new sediment floor—a nearly 7-fold reduction
  - Oil and grease concentrations in the lagoon sediment were reduced from an average of 6,280 mg/kg to 473.3 mg/kg in the new sediment floor—a 13-fold reduction
- First cleanup project under the Great Lakes Legacy Act, a special initiative designed to clean up contaminated Great Lakes sediment hot spots
- First use of kriging techniques in a GLNPO or MDEQ sediment remediation project

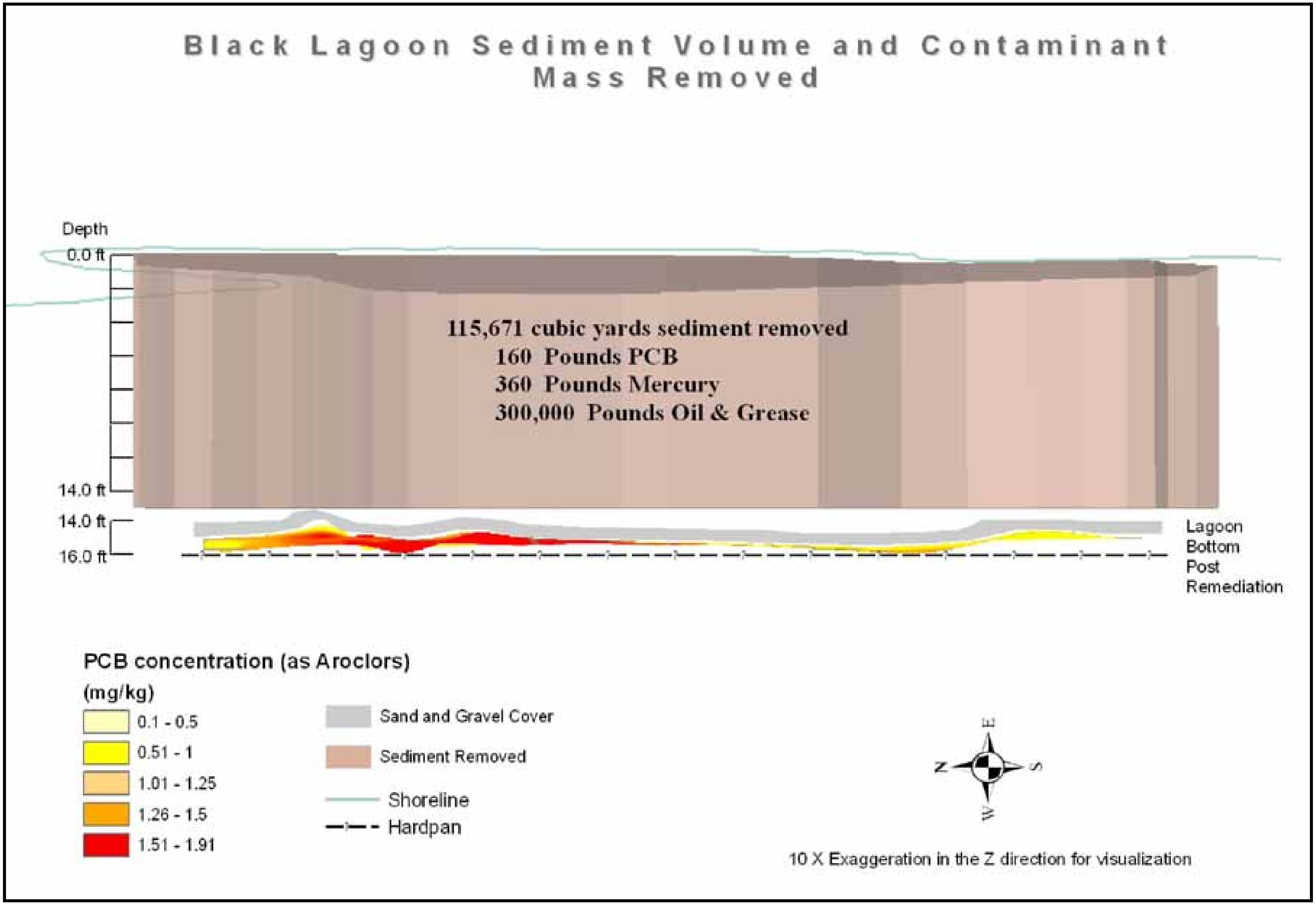

Figure 8-1 Black Lagoon Sediment Volume and Contaminant Mass Removed, with Residual Layer of Sediment and Residual Cover Overlain with Total PCB Concentrations

9.0 FUTURE OF THE SITE

The remediation project is expected to serve as a catalyst for redeveloping not only the lagoon, but also the city's entire 240-acre shoreline and waterfront district. Adjacent areas of the city are also experiencing a rebirth as a result of the redevelopment. The City of Trenton has completed a downtown streetscape with decorative streetlamps, new landscaping and curbs just south of the lagoon. The adjacent site of the former McLouth Steel plant is also undergoing redevelopment.

The lagoon was informally named the Black Lagoon after aerial surveys depicted it as literally black from oil and grease contamination. Subsequent to the $8.7 million remediation of the Black Lagoon's contaminated sediment in 2004-2005 through the U.S. Great Lakes Legacy Act and the Clean Michigan Initiative, a $151,000 shoreline habitat restoration was completed in 2006. In 2007, a $582,000 Boating Infrastructure Grant was awarded from the U.S. Fish and Wildlife Service to build a marina and further economic revitalization of downtown Trenton ($200,000 will also be provided as a local match from Trenton). On Monday June 18, 2007, the City of Trenton and its many partners celebrated the restoration and revitalization of the Black Lagoon in a ceremony renaming of the Black Lagoon as "Ellias Cove," in honor of the family who donated the adjacent land to Trenton that became Meyer-Ellias Park.

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APPENDIX A SUMMARY SEDIMENT CONFIRMATION DATA

Sample	Phase	Lab Sample ID	Sampling Date	Results in mg/kg		
				Oil & Grease	Total PCBs	Mercury
BL05-01	Post 1° Dredge	389434	5/9/2005	22300	1.870	2.4
BL05-05	Post 1° Dredge	389436	5/9/2005	18100	1.690	2.3
BL05-02	Post 1° Dredge	389437	5/9/2005	18500	2.270	2.5
BL05-04	Post 1° Dredge	389438	5/9/2005	18900	2.280	2.7
BL05-07	Post 1° Dredge	389439	5/9/2005	19100	2.020	2.7
BL05-14	Post 1° Dredge	389440	5/9/2005	22900	2.200	2.6
BL05-06	Post 1° Dredge	389473	5/10/2005	18500	1.210	2.7
BL05-08	Post 1° Dredge	389474	5/10/2005	18700	1.010	2.4
BL05-09	Post 1° Dredge	389475	5/10/2005	21800	1.700	3.1
BL05-10	Post 1° Dredge	389476	5/10/2005	15800	0.950	2.3
BL05-13	Post 1° Dredge	389478	5/10/2005	14400		2
BL05-11	Post 1° Dredge	389479	5/10/2005	20700		2.5
BL05-15	Post 1° Dredge	389480	5/10/2005	17800		2.5
BL05-18	Post 1° Dredge	389481	5/10/2005	18900		2.2
BL05-22	Post 1° Dredge	389482	5/10/2005	17500		2.1
BL05-20	Post 1° Dredge	389483	5/10/2005	25800		2.6
BL05-27	Post 1° Dredge	389484	5/10/2005	26700	1.380	2.9
BL05-24	Post 1° Dredge	389485	5/10/2005	25900	2.180	2.7
BL05-25	Post 1° Dredge	389486	5/10/2005	22300	1.260	2.2
BL05-26	Post 1° Dredge	389487	5/10/2005	19100	1.180	2.2
BL05-19	Post 1° Dredge	389488	5/10/2005	21700	1.060	2.9
BL05-17	Post 1° Dredge	389490	5/10/2005	25500	0.960	2.2
BL05-16	Post 1° Dredge	389491	5/10/2005	27300	1.790	3.1
BL05-21	Post 1° Dredge	389492	5/10/2005	25300	1.210	1.1
BL05-30	Post 1° Dredge	389565	5/11/2005	20900	1.410	
BL05-28	Post 1° Dredge	389566	5/11/2005	24200	1.430	
BL05-29	Post 1° Dredge	389567	5/11/2005	26500	1.360	
BL05-33	Post 1° Dredge	389568	5/11/2005	17100	1.210	
BL05-34	Post 1° Dredge	389569	5/11/2005	16100	1.430	
BL05-40	Post 1° Dredge	389570	5/11/2005	21200		
BL05-38	Post 1° Dredge	389571	5/11/2005	28500		
BL05-37	Post 1° Dredge	389572	5/11/2005	24500		
BL05-39	Post 1° Dredge	389573	5/11/2005	25200		
BL05-35	Post 1° Dredge	389574	5/11/2005	19200	1.250	
BL05-36	Post 1° Dredge	389575	5/11/2005	20800	1.650	
BL05-31	Post 1° Dredge	389576	5/11/2005	22400	1.170	
BL05-32	Post 1° Dredge	389577	5/11/2005	22400	1.430	
BL05-41	Post 1° Dredge	389578	5/11/2005	15500		
BL05-42	Post 1° Dredge	389579	5/11/2005	16900		
BL05-46	Post 1° Dredge	389580	5/11/2005	21300		
BL05-47	Post 1° Dredge	389735	5/12/2005	22800		
BL05-48	Post 1° Dredge	389736	5/12/2005	20900		
BL05-56	Post 1° Dredge	389737	5/12/2005	12900		

Sample	Phase	Lab Sample ID	Sampling Date	Results in mg/kg		
				Oil & Grease	Total PCBs	Mercury
BL05-55	Post 1° Dredge	389738	5/12/2005	16900		
BL05-45	Post 1° Dredge	389739	5/12/2005	15800		
BL05-54	Post 1° Dredge	389740	5/12/2005	16600		
BL05-57	Post 1° Dredge	389741	5/12/2005	19600		
BL05-60	Post 1° Dredge	389742	5/12/2005	16900		
BL05-59	Post 1° Dredge	389743	5/12/2005	18800		
BL05-58	Post 1° Dredge	389744	5/12/2005	21700		
BL05-43	Post 1° Dredge	389746	5/12/2005	22400		
BL05-44	Post 1° Dredge	389747	5/12/2005	20200		
BL05-51	Post 1° Dredge	389748	5/12/2005	12000		
BL05-53	Post 1° Dredge	389750	5/12/2005	19600		
BL05-49	Post 1° Dredge	389751	5/12/2005	18300		
BL05-50	Post 1° Dredge	389752	5/12/2005	20500		
BL05-R	Post 1° Dredge	389753	5/12/2005		0.540	
BL05-61	Post 1° Dredge	389754	5/12/2005	18000		
BL05-04COR	Post 1° Dredge	390300	5/19/2005	25500		
BL05-04COR	Post 1° Dredge	390301	5/19/2005	29400		
BL05-59COR	Post 1° Dredge	390302	5/19/2005	18800		
BL05-59COR	Post 1° Dredge	390303	5/19/2005	11500		
BL05-39COR	Post 1° Dredge	390304	5/19/2005	24900		
BL05-39COR	Post 1° Dredge	390305	5/19/2005	18400		
BL05-39COR	Post 1° Dredge	390306	5/19/2005	14300		
BL05-28COR	Post 1° Dredge	390307	5/19/2005	23500		
BL05-28COR	Post 1° Dredge	390308	5/19/2005	27200		
BL05-41COR	Post 1° Dredge	390309	5/19/2005	23900		
BL05-41COR	Post 1° Dredge	390310	5/19/2005	19700		
BL05-53COR	Post 1° Dredge	390311	5/19/2005	19000		
BL05-53COR	Post 1° Dredge	390312	5/19/2005	19100		
BL05-07COR	Post 1° Dredge	390313	5/19/2005	26000		
BL05-07COR	Post 1° Dredge	390314	5/19/2005	24100		
BL05-07COR	Post 1° Dredge	390315	5/19/2005	28300		
BL05-01COR	Post 1° Dredge	390316	5/19/2005	27700		
BL05-01COR	Post 1° Dredge	390317	5/19/2005	23100		
BL05-04COR	Post 1° Dredge	390318	5/19/2005	26900		
BL-05-N	Post 2° Dredge	394379	8/18/2005	10300	1.380	4.7
BL-05-M	Post 2° Dredge	394380	8/18/2005	10400	0.690	4.1
BL-05-L	Post 2° Dredge	394381	8/18/2005	12600	1.010	4.4
BL-05-K	Post 2° Dredge	394382	8/18/2005	8590	0.770	2.3
BL-05-J	Post 2° Dredge	394383	8/18/2005	12800	1.100	4
BL05-01	Post 2° Dredge	395404	9/19/2005	8820	1.690	3.04
BL05-02	Post 2° Dredge	395405	9/19/2005	8450	1.890	4.12
BL05-03	Post 2° Dredge	395406	9/19/2005	13700	1.040	2.17
BL05-04	Post 2° Dredge	395407	9/19/2005	2050	0.130	0.24
BL05-05	Post 2° Dredge	395408	9/19/2005	3790	0.200	0.69
BL05-06	Post 2° Dredge	395409	9/19/2005	16500	1.540	2.78
BL05-07	Post 2° Dredge	395410	9/19/2005	9780	1.910	3.55

Sample	Phase	Lab Sample ID	Sampling Date	Results in mg/kg		
				Oil & Grease	Total PCBs	Mercury
BL05-08	Post 2° Dredge	395411	9/19/2005	11400	0.990	2.22
BL05-09	Post 2° Dredge	395412	9/19/2005	16500	1.660	2.92
BL05-10	Post 2° Dredge	395413	9/19/2005	15190	0.810	0.67
BL-05N	Post Sand Cover	396253	10/11/2005	477 U	0.013	0.17
BL-05-L	Post Sand Cover	396254	10/11/2005	1830	0.075	2.1
BL-05-M	Post Sand Cover	396255	10/11/2005	460 U	0.000	0.085
BL-05-J	Post Sand Cover	396256	10/11/2005	465 U	0.000	0.13
BL-05-K	Post Sand Cover	396257	10/11/2005	471 U	0.000	0.051
BL-05-#6	Post Sand Cover	396258	10/11/2005	500 U	0.000	0.048
BL05-11	Post Sand Cover	396759	11/2/2005	572 U	0.185	0.056
BL05-12	Post Sand Cover	396760	11/2/2005	520 U	0.273	0.053
BL05-10	Post Sand Cover	396761	11/2/2005	488 U	0.161	0.027
BL05-8	Post Sand Cover	396762	11/2/2005	507 U	0.207	0.028
BL05-9	Post Sand Cover	396763	11/2/2005	520 U	0.230	0.031
BL05-7	Post Sand Cover	396764	11/2/2005	507 U	0.150	0.045
BL05-6	Post Sand Cover	396765	11/2/2005	493	0.129	0.04
BL05-5	Post Sand Cover	396766	11/2/2005	709	0.157	0.091
BL05-4	Post Sand Cover	396767	11/2/2005	732	0.234	0.044
BL05-3	Post Sand Cover	396768	11/2/2005	579	0.212	0.029
BL05-2	Post Sand Cover	396769	11/2/2005	663	0.266	0.066
BL05-1	Post Sand Cover	396770	11/2/2005	1240	0.270	0.44

U = not detected at the reporting limit shown
Post 1° Dredge = Samples collected after the primary phase of dredging
Post 2° Dredge = Samples collected after the secondary phase of dredging

APPENDIX B SUMMARY SEDIMENT CONCENTRATION DATA, 1999

Surficial Sediment Concentrations from 1999 Sediment Survey			
Contaminant	Average Sediment Concentration (mg/kg, dw)	Sediment Quality Guideline (mg/kg, dw)	Ratio of Average Sediment Concentration to SQG
Arsenic[1]	8	33	0.25
Cadmium[1]	5.6	4.98	1.12
Chromium[1]	99	111	0.89
Copper[1]	90	149	0.60
Mercury[1]	1.40	1.06	1.32
Nickel[1]	52	48.6	1.07
Lead[1]	146	128	1.14
Zinc[1]	1380	459	3.01
Oil & Grease[2]	6,280	2,000	3.14
Total PAHs[1]	10.5	22.8	0.46
Total PCBs[1]	1.12	0.68	1.66

[1] SQGs for these contaminants are based on the Probable Effects Concentrations found in MacDonald, *et al.* (2000), "Development and Evaluation of Sediment Quality Guidelines for Freshwater Ecosystems."

[2] SQG for this contaminant is based on the "heavily polluted" designation found in U.S. EPA (1977), "Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments."

PAHs – Polynuclear aromatic hydrocarbons
PCBs – Polychlorinated biphenyls
dw – Dry weight

Data taken from Environmental Quality Management, Inc., October 2004, *Quality Assurance Project Plan, Remediation of the Black Lagoon, Trenton Channel, Detroit River, Trenton Michigan.*