Report

Summary Report

Fox River Deposit N

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Division Project No. 97746

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Wisconsin Department of Natural Resources

April 2000

Foth & Van Dyke
consultants · engineers · scientists

Executive Summary

The Wisconsin Department of Natural Resources and the U.S. Environmental Protection Agency sponsored a PCB contaminated sediment removal demonstration project from the Fox River at sediment Deposit N in 1998 and 1999. This project, described in greater detail in the report, was successful in meeting the primary objective of the demonstration that environmental dredging of PCB contaminated sediment can be performed in an environmentally safe manner. Other benefits of the project were public outreach and education on environmental dredging.

Deposit N, located near Little Chute and Kimberly, Wisconsin, covered an area of approximately 3 acres and contained about 11,000 cubic yards (cu yd) of sediment. PCB concentrations were as high as 186 ppm. The sediment deposit average 2-3 ft thick, laying over fractured bedrock, in water depths of about 8 ft.

Of the 11,000 cu yd in Deposit N about 65% of the volume was designed and targeted for removal due to bedrock conditions at the site. Approximately 8,200 cu yd of sediment was removed generating 6,500 tons of dewatered sediment, containing 112 total pounds of PCBs. Of the total sediment volume removed during the entire project, about 1,000 cu yd was obtained from Deposit O, another contaminated sediment deposit adjacent to Deposit N. Monitoring data showed that the river was protected during the dredging and that wastewater discharged back to the river complied with all permit conditions. The project met the design removal specifications, e.g., sediment volume, tonnage, allowed residual sediment thickness.

The total cost of the project was $4.3 million, with an overall average cost of $525 per cu yd of sediment removal. A cost analysis of this project indicates that a significant portion of the funds were incurred for pioneering efforts associated with the first PCB cleanup project on the Fox River and for winter construction expenses associated with an accelerated schedule and late season work in 1998. This analysis indicates that a more representative cost for work for a Deposit N type project may be on the order of $250 per cu yd. Similarly, future large-scale projects (e.g., 100,000 cu yd or more) could be implemented for less than $200 per cu yd.

Principal contractors for the project were: Foth & Van Dyke of Green Bay, Wisconsin for permitting, community relations, design and oversight; Koester Environmental Services of Evansville, Indiana for remediation construction; and Winnebago County Solid Waste Management Board, Wisconsin and Wayne Disposal of Michigan as the landfill disposal contractors. Local property owners provided real estate and access to the river for the remediation work.

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1 Introduction

The Wisconsin Department of Natural Resources (WDNR) and the U.S. Environmental Protection Agency (USEPA) sponsored a PCB contaminated sediment removal project from the Fox River at sediment Deposit N (Figure 1). Deposit N, located near Little Chute and Kimberly, Wisconsin, was selected to demonstrate that environmental dredging technologies could remove sediment to project specifications while being protective to human health and the environment. Thirty-nine miles of the Fox River and hundreds of square miles of Green Bay have significant levels of PCB contamination in the bed sediment as a result of industrial discharges of PCBs in the 1950s, 1960s and 1970s.

Deposit N was located upstream of the Cedars Dam as shown in Figure 1. Deposit N covered an area of 3 acres and contained about 11,000 cubic yards of sediment with a maximum concentration of 186 ppm (1994 data). The sediment deposit averaged 2-3 feet thick, above fractured bedrock, in water depths of about 8 feet. A site Remedial Investigation (RI) was completed for Deposit N in November 1996 and a Feasibility Study (FS) was completed in April 1997. The RI/FS forwarded the remediation alternatives of dredging and containment to the WDNR. Subsequently, the WDNR selected removal of sediments by dredging as the technology for this demonstration project. In 1997 Foth & Van Dyke of Green Bay, Wisconsin was hired as the project design and construction oversight contractor to guide the implementation of this sediment removal project.

Specific Deposit N design objectives are presented in Section 6.3. The general project objectives were:

- Environmental dredging to remove contaminated sediment to specifications.
- Protection of the river, local properties, and residents during the sediment removal work.
- Safe transport and disposal of the sediment.
- Maintenance of good local relations while performing the project.

The project met these overall objectives and successfully met the project construction specification requirements placed on the remediation contractors. This summary report provides a chronology of major project events, construction elements, environmental data collected during the project and an evaluation of project costs.

Following site mobilization activities, actual sediment removal work at Deposit N occurred in November/December 1998, and again from August to October, 1999. Following the completion of work to project specifications, additional work was performed in October and November 1999 at Deposit O, an adjacent contaminated sediment deposit.

This report should be viewed as a Summary Report. A companion document, *Appendix to Summary Report*, contains data and technical support information for the sediment removal work at Deposit N. A Construction Documentation Report will also be developed for this project which will include daily construction observation reports and contractor logs.

2 Approval and Permits

Local, state and federal approval permits were necessary to obtain in order to implement this project. Public input was also received as part of this permitting process. Many of the permitting activities involved extensive material performance and treatability testing analyses to demonstrate compliance with regulations and environmental protectiveness of the project. Results of the permitting process for this project should help to streamline future sediment cleanup projects. Overall, the project efforts demonstrated that permits and approvals are attainable for complex PCB contaminated sediment remediation projects.

Permits and approvals obtained to implement the Deposit N cleanup included:

- Approved Environmental Assessment (EA)

- Chapter 30 Permit (regulates dredging, shore land and in-river activities)
  - project design projected no adverse effects

- Army Corps of Engineers Nationwide Permit

- WDNR Wisconsin Pollutant Discharge Elimination System (WPDES) Permit
  - pre-design testing and analysis, public review hearing, and use of net environmental benefit approach (NR 106)

- WDNR Plan Modification Approval for acceptance of non-TSCA PCB contaminated sediment (<50 ppm) at Winnebago County Sunnyview Landfill

- Local Access Agreements with Inter Lake Papers, Altergott Family Corporation, Friends of the Fox, Corps of Engineers, and Bellin Family

- Local Government Approvals/Input
  - Little Chute Administrators and Department Heads
    - addressed traffic, schedule, noise and communication needs
  - Kimberly Administrators and Department Heads
    - addressed traffic, schedule, noise and communication needs
  - Little Chute Public Meetings
    - Project Informational Meeting
    - WPDES permit hearing
    - Project VIP Day
    - Project Open House Day

3 Public Outreach and Community Acceptance

Public participation and input was actively pursued throughout the project. Major project activities which shared information, responded to public concerns, and made the project accessible to the public included:

- Public information meetings.
- Regulatory permit hearings.
- Development of brochures and fact sheets with distribution to 13 local libraries and village halls.
- Internet web site information outreach. WDNR Fox River web site; www.dnr.state.wi.us/org/water/wm/lowerfox
- Distribution of brochures and fact sheets to local residents.
- Construction of an on-site public observation area.
- Interpretative signage at the public observation area.
- Regular visits and contact with local government officials and adjacent property owners.
- Frequent media interviews.
- Project open houses and visitor tours.

A number of activities were implemented with the objective of including the community in the Deposit N project. Public announcements and meetings were held in 1997 and 1998 to share information and gather public input. During initial work on the project in the Spring of 1998, the engineering design team visited community representatives from Kimberly and Little Chute, Wisconsin to present project design information and gather local input on the Deposit N project. In June 1998 a public outreach meeting was held at the Little Chute Civic Center to present project design information and gather input. In August 1998 a WPDES permit hearing was convened to share information on the proposed wastewater discharge permit and measure to protect the Fox River during the cleanup.

In December 1998 an open house was held at Deposit N where the public was invited to tour a controlled area of the project site and discuss the project with the State and contractors. Over 170 visitors toured the project site on the December 5, 1998 project open house day.

In addition, local TV, radio and print media were continuously allowed access to view and discuss the project with the on-site personnel. Throughout the entire project, a public observation deck, complete with interpretative signage, was in-place to allow the public to view site operations. Approximately 150 local residences were visited on a regular basis by state and project staff to deliver project update letters, to solicit input, and address any questions or concerns from neighbors to the cleanup work.

4 Access Agreements

Shoreland real estate and access to shoreland areas was necessary to implement the Deposit N sediment removal project. Therefore, there was a need to identify key land areas and associated property owners to enter into an agreement for use of their property during project activities. Separate access agreements were successfully negotiated with various property owners. Good relations with property owners and neighbors greatly facilitated the property access agreement negotiations.

The purpose of the access agreements was to provide an understanding between the property owners and the state as to allowable activities to be undertaken on the property, identify restoration activities to be performed by the State, and describe any specific requirements the property owners deemed necessary for use of their property for project activities.

Access agreements with the local property owners were negotiated as follows:

- The 5 acre on-shore treatment site area on the north shore of the river, owned by the Altergott Family Corporation.

- The shore-line property adjacent to the on-shore treatment site, owned by the U.S. Army Corps of Engineers and leased by the Friends of the Fox (an access agreement was obtained from both parties).

- The south shore of the river adjacent to Deposit N, owned by Inter Lake Papers (subsidiary of Consolidated Papers Inc.). This access agreement included a third-party review of plans, construction reviews, shoreline stability analysis, and an insurance agreement to protect Inter Lake Papers from possible impacts to their paper production activities.

- The north shore access area, owned by the Bellin family.

Access agreement terms and conditions were incorporated into the contract with the remediation contractor.

5 Contracting Arrangements

5.1 Bid Document

The Wisconsin Department of Administration's Division of Facilities Development (DFD) was the contracting agency for the state on behalf of the WDNR and USEPA. DFD's nation-wide invitation to bid included a two-step bid process involving first a proof of qualifications to perform the work and a subsequent cost bid with a proposed construction approach. Only qualified bids which met the qualification requirements were opened and considered for this project.

The contracting strategy centered on a performance-based contract with specific performance criteria, e.g., monitoring requirements, water discharge requirements, dredging criteria, sediment strength criteria. The performance specifications, developed by the design engineering team, allowed contractors the flexibility to propose specific construction approaches while maintaining the project performance specifications. Contractor designs were reviewed by the project design team prior to implementation in the field to verify compliance with the performance specifications.

5.2 Contractor

Project Bid Documents were available to contractors on June 4, 1998. The bid opening occurred in July 7, 1998. Koester Environmental Services, Evansville, Indiana was awarded the remediation contract, based on being the lowest qualified bidder.

5.3 Project Schedule

The overall project schedule for Deposit N is shown on Figure 2. A pre-construction meeting was held on October 14, 1998 at the Little Chute Civic Center, Little Chute, Wisconsin. Site preparation work began on October 19, 1998. Following a complete mobilization and installation of project equipment, a pilot test was conducted on November 23 and full-scale dredging and dewatering work began on November 26, 1998. This work continued until December 22 when the project was shut-down over the Christmas holiday. The project restarted on December 28 and operated until December 31, 1998 when a joint contractor/State decision was made to cease the project operation due to sustained sub-zero weather producing unacceptable ice and cold conditions.

During the winter and spring of 1999, project data were evaluated and compared to project objectives to determine the benefits of remobilization of the project. Following this evaluation, a decision was made to remobilize the project. Remobilization of Deposit N began on August 2, 1999 and sediment removal work occurred from August 20, 1999 to October 4, 1999.

Following removal of sediments at Deposit N to contract specifications, additional dredging occurred in the Fox River at Deposit N from October 5 to October 14, 1999 and at Deposit O, an adjacent sediment deposit, from October 15, 1999 through November 9, 1999.

6 General Project Design and Operation

Hydraulically dredged sediments from Deposit N were pumped to the on-shore treatment facility (Figure 1) where the sediments were dewatered, carriage water was treated and discharged back to the Fox River, and dewatered sediments were transported off-site to approved landfills. A schematic of the treatment process used at Deposit N is presented in Figure 3.

6.1 Background Studies

The project site was selected based on a number of earlier studies of the Fox River and of the Deposit N site. A site-specific RI/FS published in 1997 documented the extent of contamination at the site, the risk to the environment and human health from PCB contaminated sediment, and evaluated cleanup approaches for Deposit N. The RI/FS in turn built upon several earlier studies of the site. Some of the data from these earlier studies are presented in Section 7.1.5. The RI/FS after an evaluation of feasible technologies advanced two options for remediation at Deposit N; containment in-place within a sheet pile cofferdam with filling of the river bed to the existing shoreline grade and dredging with off-site disposal of the sediment.

6.2 Pre-Design Study Report

The pre-design project work provided the foundation for development of the construction performance specifications for sediment removal by hydraulic dredging at Deposit N. Bench test and field surveys were necessary to properly set minimum performance specifications. For example, sediment dewatering bench tests were conducted whereby a target sediment water content, corresponding to a minimum unconfined compressive strength of 0.4 tons/sq ft, was set for cohesive sediments. This water content target was set through consultations between the project design team and WDNR based on test results on Deposit N sediment. In these tests the sediment was tested with several dewatering technologies, e.g., enhanced drainage, filter press, and stabilization. Bench tests also developed and refined effective carriage water treatment technologies which ultimately resulted in acceptable effluent concentrations of PCBs and mercury. The complete pre-design bench test results were included in the Project Contract Bid Document.

6.3 Project Design Objectives

The objectives of the project design were as follows:

- Achieve sediment removal by hydraulic dredging.
- Minimize resuspension and off-site loss of sediment, PCBs, and other constituents.
- Protect river water quality, including the industrial water intake located immediately adjacent to the dredging area.

- Conduct on-shore sediment dewatering.

- Conduct public outreach (visitor area, interpretative signs, open house, etc.).

- Achieve treatment of carriage water (water from dewatered sediment) to meet WPDES permit conditions for discharge to the Fox River.

- Achieve project specification sediment removal goals:

    - West Lobe: average remaining sediment thickness 3 inches or less with no thickness above 6 inches.

    - East Lobe: average remaining sediment thickness 6 inches or less.

6.3.1 General Site Preparation (On-Shore Treatment Facility)

The on-shore treatment facility was graded and shaped using standard earthmoving equipment. Surface water control structures were constructed and erosion control measures were installed. Security fence was also installed around the perimeter of the site.

A protective barrier placed on the graded subgrade consisted of a geotextile fabric, a 60 mil HDPE liner, 6 in of sand, 6 in of gravel and 4 in of bituminous concrete. This subgrade protective barrier was constructed in the area where the dewatering and carriage water treatment equipment, dewatered sediment stockpiles, truck loading area and truck scale area were to be located.

The subgrade protective barrier was sloped to direct precipitation to a sump area where site contact water could then be collected and pumped to the dewatering/water treatment process.

A separate visitor area was constructed in the northeast portion of the site accessible via a separate entrance. The area had parking for cars and buses and had a handicap accessible raised deck for viewing dredging and treatment work at Deposit N.

6.3.2 In-River Environmental Controls

To ensure that river water quality was protected during the Deposit N project, a system of environmental controls was developed by the design team. Specifications were given to the remediation contractor which required the use of dredging equipment and environmental dredging techniques to minimize disturbance to the river sediment. In addition, various in-water barriers were used to isolate the work site and to ensure that the water intake of the local paper mill was protected. Finally, an innovative real time water quality monitoring system was deployed in the river to provide the design team, regulators, contractors, and the local paper mill with continuous data on possible changes to the river as a result of dredging.

A perimeter turbidity containment barrier consisting of 80 mil HDPE was constructed around the perimeter of the deposit. The perimeter turbidity barrier was anchored and fastened to the river bottom and connected to the shoreline. The barrier was also weighted down at the bottom with rail lengths inserted into manufactured pockets in the HDPE. Twelve-inch diameter floats were inserted into the barrier and used to provide buoyancy for the top of the barrier.

In addition to the perimeter turbidity barrier, two other barriers were constructed to further protect the river and the local paper mill water intake from possible impacts due to dredging. These two barriers consisted of a deflection barrier constructed from 80 mil HDPE and a silt curtain. The deflection barrier was installed approximately 20 ft upstream of the paper mill intake and positioned to extend approximately 200 ft downstream of the intake. The silt curtain was deployed within the confines of the perimeter barrier. The barriers were removed from the river following the winter 1998-99 shutdown.

Construction observation and in-river monitoring verified that dredging in 1998 did not degrade river water quality. With this information the design team and the remediation contractor requested permission from the permitting agencies and programs and local paper mill (Inter Lake Papers) to not deploy the perimeter turbidity barrier for the summer 1999 dredging. Regulatory approval was secured and the perimeter barrier was not used for further work at Deposit N. For the 1999 dredging work, a silt curtain was used at a downstream distance of 150 ft or less from the dredge. The deflection barrier was again deployed in 1999 adjacent to the Inter Lake Papers intake but extended only 20 ft downstream of the intake.

6.3.3 Dredging Procedures

Dredging was accomplished using a Moray/Ultra Dredge with a swinging ladder configuration (Figure 4). A rotating, variable speed, cutter surrounds the intake at the pump suction line. The dredged material was pumped from the dredge, through an 8-in diameter, HDPE pipeline in the rear of the dredge, across the river to the on-shore treatment facility. In 1998, the 8-in pipeline used to transport the sediment slurry across the river was encased inside an 18-in diameter HDPE pipeline as an added protective measure. Performance results and monitoring data in 1998 demonstrated that dredging could safely be performed with a single-wall pipeline. Therefore, all work in 1999 used only a single 8-in diameter pipe to convey the dredge material to the on-shore treatment facility.

For final dredging cleanup work of sediment close to the bedrock, the dredge was modified by extending the suction pipe mouth inside the cutterhead and reducing the area of mouth opening by 15% to increase vacuum pressure.

6.3.4 Sediment Dewatering and Water Treatment System

The dredged sediment slurry was delivered to the treatment system (Figure 3) where a 3/8-in shaker screen was used to remove gravel-sized stones and debris from the slurry. The remaining slurry dropped into a 12,000-gal V-bottom tank. The settled slurry was augured and pumped through two hydrocyclones to remove +200 sieve material. The remaining slurry was then delivered to four 20,000-gal mixing tanks where polymer was added and mixed with the slurry to provide a conditioned slurry to increase the percent solids by weight in the finished filter cake. The conditioned slurry was then pumped into two 200-cu ft filter presses and loaded to a pressure of 200 psi. Upon completion of pressing, the filter cake was delivered to 250-cu yd stockpiles and tested for PCBs, mercury, free water and percent solids.

Filtrate (carriage water) generated from the presses was pumped through bag filters, to sand filters, and finally liquid phase carbon adsorbers before being discharged back to the Fox River. The effluent discharge velocity to the river met a minimum of 10 ft per sec and the discharge pipe was configured properly to satisfy a zone of initial discharge (ZID) requirement. Discharge water was tested for a wide variety of parameters, including PCBs, total suspended solids (TSS), ammonia, mercury, priority pollutants and whole effluent testing.

6.3.5 Sediment Hauling and Disposal

Dewatered sediment and debris were loaded into haul trucks using a front-end loader. The outside of the truck body was decontaminated immediately after loading with a jet spray washer. The bituminous concrete in the area of loading was then power washed after each truck wash event. All waste contact water was contained on the treatment pad which was sloped to deliver free liquid to the sump. From the sump the material was pumped to the treatment process.

After decontamination, the loaded trucks were weighed using an on-site scale and properly placarded. Each truck had sealed tailgates and the hauled materials were covered.

Dewatered sediment classified as TSCA material (greater than 50 ppm PCBs) was transported for disposal at the Wayne Disposal landfill in Bellevue, Michigan. Dewatered sediment classified as non-TSCA material (less than 50 ppm PCBs) was transported for disposal at Winnebago County Landfill located 28 miles from the site. Some low-level PCB contaminated sediment (400 tons) was shipped to Wayne Disposal, as the original non-TSCA disposal contractor withdrew its services from the project. This change of disposal contractors and the out-of-state disposal increased project costs.

6.3.6 Environmental Sampling and Analysis

A USEPA Category II QAPP was developed by the contractor for the sediment removal operation of this project. The QAPP provided field and laboratory quality objectives for monitoring work associated with riverwater, effluent, sediments, sediment surveys and air monitoring. Sampling procedures, equipment and corrective action responsibilities were defined by the QAPP. The data obtained following the QAPP requirements form the basis of this report and the *Appendix to Summary Report*.

7 Project Performance

This section presents a summary of the sediment removal work.

Site preparations, including grading, construction of the on-shore subgrade protective barrier, and mobilization and setup of equipment initially began at Deposit N on October 18, 1998. With the exception of equipment down time, sediment was dredged and dewatered at Deposit N 24 hours a day from November 26 through December 21, 1998 and then again from December 28 through December 31, 1998. Following remobilization, Deposit N and Deposit O dredging activities began on August 20, 1999 and went through November 9, 1999 with one 10-hour work shift per day. Project data, generated daily at the site, included test results from sediment, river water, treated carriage water and air. Analytical procedures and methods followed those from the approved Quality Assurance Project Plan (QAPP).

7.1 Deposit N

7.1.1 Pilot/Start-up Process

To begin project operations, on November 23, 1998, a pilot or start-up test was conducted at Deposit N. The intent of the pilot test was to verify that the contractor had constructed the project to plans and specifications. WDNR and Foth & Van Dyke engineers and scientists observed and verified that dredging, water treatment, solids handling, and safety systems met project permit and performance specifications. Key metrics included minimum solids content of dewatered sediment, carriage water quality, dredge performance and turbidity barrier construction. Upon review of the test data, the contractor was granted approval to start the Deposit N cleanup operation on November 26, 1998.

After temporary shutdown of the project in winter/spring 1999, on August 20, 1999 a pilot or start-up test was again conducted at Deposit N for 1999 removal work. Upon review of the test data, the contractor was granted approval to again start the Deposit N sediment removal cleanup operation.

7.1.2 Volume of Sediment Removed

Deposit N consisted of a silty/clay Western Lobe and a sandy Eastern Lobe as shown in Figure 5, together consisting of approximately 11,000 cu yd. The November/December 1998 dredging focused on removal of the higher PCB contaminated sediment from the Western Lobe. At the completion of the 1998 sediment removal work, the Western Lobe at Deposit N was dredged to project specifications (average sediment thickness 3 inches or less with no thickness greater than 6 inches). Approximately 3,920 cubic yards of sediment was removed during the November/December 1998 time period. A small area adjacent to the shore was not dredged due to the presence of large boulders resting on the river bed.

The August to October 1999 dredging work focused on removal of sediment from the Eastern Lobe containing sandier sediment with lower PCB sediment concentrations. At the completion of 1999 sediment removal work, the Eastern Lobe was dredged to project specifications (average sediment thickness 6 inches or less). Approximately 3,100 cubic yards of sediment was removed from the Eastern Lobe during this August to October 1999 time period. Additional sediment removal, beyond project specifications, occurred from the West Lobe from October 5 to October 14, 1999 resulting in the removal of an additional 140 cu yd of sediment.

Overall, the project removed 7,160 cubic yards of sediment at Deposit N, which was slightly greater than the targeted removal volume of 7,070 cu yd. The target volume represents the initial total volume less the residual volume allowed in the removal contract. Figure 6 presents a summary of the removal of sediment from Deposit N.

The project specifications for removal were intentionally set prior to implementation of the project to remove the majority of contaminated sediment but leave a residual thin layer of sediment behind. The intent was to capture the bulk of the contamination efficiently and cost effectively without exceptional efforts to try and remove the thin layer of residual sediment laying on top of the fractured bedrock surface. However, in projects where total removal is desired, diver assisted dredging and other more specialized equipment is commercially available to achieve this result.

Environmental dredging projects can experience some limitations as to the amounts of sediment that can practically be removed in the presence of bedrock and boulders. For example, at some projects deep bedrock is overlain by clean sediment where on top of the clean sediment is the contaminated sediment. Figure 7 illustrates how a dredge can cut into clean sediment beneath contaminated sediment. Also in Figure 7 one can see how shallow bedrock prevents overcutting beneath the contaminated sediment and how the uneven surface of the bedrock can result in some residual sediment left behind.

7.1.3 Mass of Sediment Removed

The dredged sediment slurry was pumped one-quarter mile across the river to the on-shore treatment site where water was removed from the sediment from filter presses. Approximately 5,660 tons of dewatered sediment were generated from Deposit N and disposed of in either the Wayne Disposal Landfill (TSCA sediments) or Winnebago County Landfill (non-TSCA sediments).

7.1.4 Mass of PCBs Removed

The dewatered sediments at Deposit N were segregated on-site into 250 cu yd piles for analytical testing prior to off-site disposal. A composite sample of the piles, each consisting of 10 subsamples, was obtained directly from a press drop as the dewatered sediment was generated, and sent to an approved laboratory for PCB analysis. A total of 111 lbs of PCBs were removed from Deposit N. Figure 5 and Table 1 present a summary of the mass of PCBs removed from Deposit N.

Overall, 78% of the PCB mass was removed from Deposit N. Further characterizing this removal by the distinct individual lobes at Deposit N shows that 87% of the mass of PCBs were removed from the West Lobe (lobe with higher PCB concentrations) and that 41% of the PCB mass was removed from the East Lobe.

7.1.5 Residual PCB Sediment Concentrations and PCB Mass

Sediment samples were obtained from the river by a certified diving contractor before and after dredging at Deposit N. Project specifications did not require either total removal of the sediment or removal to a specific PCB sediment concentration as these sediments rested on a fractured bedrock surface, preventing a dredge cut into a clean underlying layer (Figure 7). Therefore, it was anticipated that PCB concentrations of the sediment after dredging could be similar to pre-dredge concentrations.

Using the 1998 data, collected just prior to dredging, the pre-dredge average PCB sediment concentration in Deposit N was 16 ppm, with a maximum concentration of 160 ppm. The post-dredge average PCB sediment concentration in Deposit N was 14 ppm, with a maximum of 130 ppm. Of the pre-project 142 lbs of PCBs measured at Deposit N, 111 lbs were removed and approximately 31 lbs remained in the residual sediment at the completion of the project. Figure 8 shows PCB sediment concentrations pre- and post-dredge at Deposit N.

Perspective on the changes in the Deposit N site over time can be gained by reviewing the results of the several monitoring efforts conducted at this site over time:

	Pre-project measurements						Post Project
	1989	1992	1994	1997	1997	1998	1999
Volume (cu yd)	16,010	n/c	8,500	n/c	12000	11000	3840
PCB mass (lbs)	352	n/c	262	n/c	n/c	142	31
Maximum PCB concentration (ppm)	130	130	186	61	130	160	130
Average PCB concentration (ppm)	20	130	45	49	73	16	14
Maximum surface PCB concentration (ppm)	130	130	186	61	130	72	130

n/c = not calculated

The above table shows that the post-project average sediment concentration of 14 ppm PCBs compares to a range of average PCB values of 16-130 ppm measured in past studies at Deposit N. The maximum surface PCB concentration after the dredging project of 130 ppm is less than the 186 ppm measured in 1994 and equal to the values measured in most of the sampling efforts over time. Sediment sample collection during the post-project 1999 sampling event from the West Lobe (area where the 130 ppm sample was located) was difficult for the divers as they could not locate sufficient sediment to sample since dredging had been conducted to bedrock at many locations. In these instances the diving contractor was allowed to move off the predetermined locations in order to locate sufficient sediment to sample.

The variability of PCB data over time, which characterizes a contaminated sediment site in a dynamic river system, can also be observed in the table. The characteristics of sediment are heterogeneous where concentrations of contaminants can change significantly from one location or depth to another.

PCB sediment concentration data provides one perspective on project results. Given the presence of shallow bedrock, the project design allowed residual sediment volume and therefore the potential for residual PCB concentrations. Another perspective can be gained by examining PCB mass changes since it is the PCB mass which ultimately determines the contribution of PCBs to an aquatic system. Therefore, the post-dredge site conditions with a significantly lower PCB mass represents a lower risk to the river as the reduction in PCB mass in Deposit N provides less contaminants that are potentially available to contaminate downstream areas, provide PCB mass for bioaccumulation processes, or to mix with cleaner sediment washed into the Deposit N depositional area.

As presented previously, approximately 78% of the mass of PCBs was removed from Deposit N. Figure 9 presents PCB mass at Deposit N over a defined area (PCB pounds per square yard) for both pre- and post-dredge conditions and shows a considerable reduction in an available mass of PCBs to the aquatic environment.

Figure 10 is the same type of PCB mass over a surface area plot except sediment thickness, both pre- and post-dredge, are overlayed on the drawings to further depict the difference between pre- and post-project conditions at Deposit N. In Figure 10 one can observe how the project made significant progress in both the removal of the sediment and the reduction in the available mass of PCBs. This figure illustrates why the design for the project allowed for a residual thickness of sediment in the deposit. The majority of the PCB mass was removed and, given the presence of contaminated sediments directly overlying bedrock, further dredging would have captured proportionately less mass at increasing effort for the equipment used at this particular site.

7.1.6 Water Treatment Discharge Data

Water generated from the on-shore dredge slurry sediment dewatering activities was treated by passing the water in succession through bag filters, sand filters and a carbon adsorption system. Analytical testing was conducted daily on the treated water, in order to demonstrate compliance with the limits in the WPDES permit. Test results confirmed that all water returned to the river met the human health and environmental criteria set by the WPDES permit requirements.

7.1.7 Turbidity/Resuspension Data During Dredging

To measure possible sediment resuspension during dredging, turbidity meters were placed in the river and within the water intake stream of Inter Lake Papers. The meters recorded turbidity and produced a digital signal which was transmitted to the on-shore treatment site. Throughout the project, turbidity results were generated at 15 minute intervals from the monitoring stations.

During 1998 dredging operations, turbidity monitoring occurred at six stations, M-1 through M-6. Station M-1 was located upstream of dredging, M-2 on one side of the dredging location, and M-3 downstream of dredging. Station M-4 was located in the intake stream of Inter Lake Papers, and M-5 was located at a post-water treatment location within Inter Lake Papers. Station M-6 was located inside the turbidity containment barrier.

In 1999 slight changes were made to the turbidity monitoring plan. Since the containment curtain was not used, station M-6 was deleted. Similar to 1998, stations M-1, M-2 and M-3 were located upstream, sidestream and downstream, respectively, of the dredge. Station M-4 was located in the intake stream of Inter Lake Papers and M-5 was at the post-water treatment location at Inter Lake Papers.

Figures 11 and 12 show the monitoring results in the form of turbidity relative to the site background or upstream reference location M-1 for years 1998 and 1999, respectively. In both figures, results are separated into time periods of dredging and no dredging. The difference between the two figures is that in 1998 (Figure 11) a perimeter containment barrier was used to isolate the dredge area from the river, in 1999 (Figure 12) the barrier was not used.

Overall in 1998, as shown with the average bars in Figure 11, the river downstream of the dredging site was very similar to the upstream background site. Whereas in 1999, as shown with the average bars in Figure 12, the river downstream of the dredge had a slightly higher average turbidity reading. The differences in both years was slight, on the order of 2 to 4 Nephelometric Turbidity Units (NTU), and within the range of the turbidity meter accuracy. One can also observe in the two figures that the range of values, or vertical spread, for data points representing times of dredging and no dredging are similar which indicates a natural variability of turbidity in the river. The range of positive and negative values are as wide for times of no dredging as for times of dredging.

Overall, based on these turbidity data and construction observations, it appears that the contractor was successful in minimizing construction induced resuspension and off-site loss of sediment. This conclusion is further validated by monitoring performed by the paper mill adjacent to the site as the mill reported no degradation of water quality in their river water intake at any time during the dredging operation.

7.1.8 Air Monitoring Data

Air quality monitoring was conducted in 1998 with four real-time particulate monitors surrounding the on-shore treatment site. Air data showed that downwind particulate readings were consistent with upwind (background) readings.

7.2 Deposit O Sediment Removal

Starting on October 15, 1999, following the completion of dredging of Deposit N to contract specifications, funds and good weather remained to allow for a removal of additional sediments from Deposit O, an adjacent sediment deposit.

Figure 1 shows the location of Deposit O in the Fox River. Dredging of Deposit O provided an opportunity to test rapid remobilization of the dredging contractor to a new sediment deposit location in the river, while at the same time targeting additional removal of sediment and PCBs from the river. Dredging occurred from October 15 through November 9, 1999 in the east portion of Deposit O resulting in the removal of approximately 1,030 cubic yards of sediment. All sediment from Deposit O was disposed of in the Winnebago County Landfill.

Using the PCB analytical data and the solids content data of the dewatered sediment, 810 tons of dewatered sediment and approximately 0.6 lbs of PCBs were removed from Deposit O. Project sampling and reporting procedures in accordance with the QAPP were followed throughout the Deposit O work.

7.3 Deposit N Sediment Bed Model

A sediment bed model was developed and used to compute the volume and mass of sediment and PCBs removed by the project. Sediment samples were obtained by divers from in situ sediments and also by on-site personnel from dewatered sediment at the on-shore treatment site. Dewatered sediment was sampled on a regular basis for PCBs, solids, mercury and the paint filter test. In contrast, in-situ riverbed sediment sampling events were limited to November 1998, January 1999 and October 1999.

Using the on-shore sediment sampling results of PCB concentrations and percent solids, and the scale data on the weight of dewatered sediments transported off-site, the weight of PCBs (in lbs) removed by dredging was calculated for Deposit N. In-situ PCB mass estimates were derived using PCB concentration results and in-situ measurements of dry bulk density. Combining these results, along with the sediment elevation surveys, in-situ sediment volume and mass estimates of PCBs prior to dredging and post dredging were developed for Deposit N.

The Deposit N bed model was constructed following an evaluation of several estimating techniques, including Thiessen polygons, kriging, inverse distance weighting and arithmetic averaging with confidence intervals. The arithmetic averaging method was selected for use as the most appropriate model as it generated Deposit N PCB removal estimates which best fit the PCB removal data generated from the on-shore sampling data. Again, the on-shore PCB data were judged to be superior given the greater frequency of sampling and the homogenous nature of the sediment from the on-shore process.

The *Appendix to Summary Report* provides additional detail on the sediment bed model.

7.4 Deposit N and Deposit O Removal Summary

The sediment removal work at Deposit N was completed to project specifications. These specifications included removal of sediment in the river to the allowed post-project residual thickness, dewatering of sediment to the required solids (and strength) criterion, treatment of water to comply with the WPDES permit and the safe removal of sediments to protect the river and intake water quality of Inter Lake Papers.

In summary, approximately 8,190 cu yds of sediment were dredged over 104 days resulting in the generation of 6,470 tons of dewatered sediment and the removal of 112 lbs of PCBs from both Deposit N and Deposit O. Table 1 and Figure 13 presents a summary of the removal metrics for Deposit N and Deposit O.

8 Site Closeout Activities

Closeout or restoration work at Deposit N in the Fox River occurred in November 1999 and entailed the removal of the dredging equipment, including the perimeter turbidity barrier, silt screens, deflection barriers, and buoys.

Closeout work also occurred in December 1999 and January 2000 at the on-shore site with removal of the on-shore treatment pad (asphalt/gravel/sand/geomembrane liner/geotextile). The asphalt/gravel/sand layers were excavated prior to removing the underlying geomembrane liner/geotextile. The liner and geotextile were left in-place until the owner's representative could visually observe the subgrade for areas possibly impacted by liner breeches. The liner/geotextile were then removed (peeled back) by an excavator and PCB samples were collected at eight selected locations.

After test results were received from the laboratory, indicating all sampled subgrade soils had no detects of PCBs, the site was graded with a bulldozer to blend with surrounding grades. The asphaltic materials were hauled to an asphalt plant for recycling. The sand/gravel beneath the asphalt was used for haul road construction.

The erosion control devices, hay bales and silt fences, were left in-place at the on-shore treatment site. The affected areas of the site were scarified and will be seeded in the Spring of 2000 to allow for the return of vegetation to the site.

9 Project Cost

9.1 Costs

Project work at Deposit N and Deposit O included engineering design, public outreach, construction contracting, disposal, construction oversite, and access agreements. This section presents the actual expenses for the project, an analysis of what such a project may cost under more representative conditions (e.g., non-winter, in-state disposal), and costs for a larger scale project.

9.2 Deposit N and Deposit O

The total cost for design and construction at both sites was $4.3 million, which resulted in a volume removed of 8,190 cu yds of sediment for an average cost of $525/cu yd. Overall the project was performed under challenging schedule and weather conditions and incurred additional expenses for outreach and design associated with the first contaminated sediment removal project on the Fox River. These non-representative expenses are discussed in more detail in the following section. A breakout of the expenses for the two deposits include:

Site	Cost	Volume cu yd	Unit cost $/cu yd
Deposit N	$3.9 million	7160	$545
Deposit O	$0.4 million	1030	$390
Total	$4.3 million	8190	$525

The cost for Deposit N is conservatively high because some of the cost already paid to mobilize equipment, prepare the site, develop the design and permit are assumed to be borne by Deposit N when in actuality some fraction of these costs could be apportioned to Deposit O.

9.3 Future Sediment Removal Projects

The Deposit N project was performed to implement the first PCB cleanup on the Fox River and to evaluate the planning, design, dredging, monitoring, and social factors associated with sediment removal in this river. Future projects will benefit from the monitoring, technical and regulatory information obtained on this demonstration project and these projects could be performed at a significantly lower unit cost.

Lower unit costs for a similar sized future project or for a larger project (e.g., 100,000 cu yds) are feasible if proper control is maintained of key project expenses such as disposal and schedule (i.e., winter construction). Data from Deposit N show that environmental dredging can be implemented in a protective manner without many of the environmental controls and costs used at the start of the project, e.g., the full perimeter containment barrier. In addition, increased confidence was observed over time at Deposit N with environmental dredging by project stakeholders, both public and private, which could result in reduced project expenses associated with access agreements and public outreach efforts. Finally, as progress on waterway restoration increases over time, the effort and expenses for pre-design and permitting tasks such as treatability and material handling testing and criteria development are expected to decline. A projection for the cost of a similar sized future project was calculated as $250 per cu yd. Similarly, a future large-scale project (e.g., 100,000 cu yds) could be implemented for less than $200 per cu yd. These projections are described more fully in the companion document, *Appendix to Summary Report.*

10 Conclusions

Deposit N represented the first implementation of a PCB contaminated sediment removal project on the Fox River. Starting with the initial planning stages of this project, Deposit N was approached and designed to demonstrate that environmental dredging of PCB contaminated sediment can be performed in an environmentally safe manner.

Specific conclusions from the Deposit N demonstration project include:

- Sediment was effectively removed by hydraulic dredging from the river bed to meet project contract specifications, i.e., average remaining thickness of 3 inches or less in the West Lobe and 6 inches or less in the East Lobe.
- Sediment removal beyond project specifications, e.g., removal to less than 3 inches in the West Lobe, was time consuming and inefficient given that the underlying layer at Deposit N is a fractured hard bedrock (Figure 7) which precludes a dredge cut into clean sediment. However, techniques are commercially available to perform additional removal of thin sediment layers.
- Sediment removed by hydraulic dredging could be conducted immediately adjacent to a sensitive river water intake structure without affecting the quality of the intake water used by the local paper mill.
- Sediment resuspension and transport during dredging was insignificant as in-river measurements recorded little impact to river water quality.
- A real time river turbidity monitoring and data management system provided an effective means to manage river water quality data so that the dredging could be implemented in 1999 without the use, and associated cost, of the perimeter containment barrier.
- Standard sediment dewatering technologies were capable of dewatering the sediment to meet the strength requirements of this material as required by the landfill disposal specification.
- A local landfill was able to meet the technical and regulatory requirements in order to dispose of non-TSCA PCB sediments.
- An in-state landfill was not able to meet the technical, regulatory and public concerns in order to accept PCB TSCA sediments for this project. Additional planning, considerably out in front of any project, would likely be needed to acquire in-state TSCA disposal.
- Standard water treatment technologies were capable of treating the carriage water (effluent) to WPDES permit levels necessary to protect the river.

- Daily recording, evaluation and communication between the project design and contracting teams are necessary to ensure that sediment removal and dewatering production rates adhere to the project schedule and to accurately manage and report project data.

- Lease and access agreements were obtainable from local industry, government units and private individuals which allowed for implementation of the project. Lease and access agreements will be critical components of any other sediment remediation project on the Fox River. These agreements can have a significant impact on project cost and schedule.

- Local public acceptance was present for the work associated with the PCB sediment removal project at Deposit N. This acceptance may have been achieved by implementation of an early project decision which sought to involve the public throughout the design process, allowing portions of the work site to be accessible to the public, and by frequent communications with the local public and officials.

- Project schedule and costs were adversely affected by winter weather conditions such that future projects should strictly schedule construction work around the cold weather conditions.

- Rapid remobilization to an adjacent sediment deposit (Deposit O) was readily achieved by the project design and contracting team.

Table 1

Deposit N and Deposit O
Removal Summary Metrics

Removal Phase	Sediment Removed (cubic yards)	Dewatered Sediment (tons)	PCBs Removed (pounds)	Days Dredged
I (Deposit N)	3,920	2,540	95	30
II (Deposit N)	3,100	2,990	11	45
III (Deposit N)	140	130	5	12
IV (Deposit O)	1,030	810	0.6	17
Total	8,190	6,470	112	104

Table 2
Project Cost Summary[a]

Work Activity	Unit	Unit Rate	Project Units	Project Cost
Contractor				
Site Preparation	Lump Sum	381,000.00	1	$ 381,000
Turbidity Barrier	Lump Sum	525,000.00	1	525,000
Environmental Monitoring	Lump Sum	210,000.00	1	210,000
Dredging Phases 1 & 2	Cubic Yard	20.73	7,014	145,000
Dewatering Phases 1 & 2	Cubic Yard	41.52	7,014	291,000
Water Treatment Phases 1 & 2	Cubic Yard	6.69	7,014	47,000
Winterization	Lump Sum	411,000.00	1	411,000
Restoration	Lump Sum	55,000.00	1	55,000
ILP Turbidity Units	Lump Sum	17,000.00	1	17,000
Water Treatment (Interim Period)	Lump Sum	27,000.00	1	27,000
Phase III Removal		98,000.00	1	98,000
Phase IV Removal [c]		163,000.00	1	163,000
			Subtotal	$2,370,000
Transport & Disposal				
TSCA	Lump Sum	251,000.00	1	$ 251,000
Non-TSCA[c,d]	Ton	81.00	4,812	366,000
			Subtotal	$617,000
Engineering[b]				
Phase I	Lump Sum	763,000	1	$ 763,000
Phase II/III	Lump Sum	111,000	1	111,000
Phase IV[c]	Lump Sum	65,000	1	65,000
Post Construction	Lump Sum	83,000	1	83,000
			Subtotal	$1,022,000
Other				
Access/Lease	Lump Sum	28,000	1	$ 28,000
Insurance	Lump Sum	78,000	1	78,000
DFD	Lump Sum	117,000	1	117,000
			Subtotal	$ 223,000
			Total	**$4,232,000**

[a] Deposit O work accounted for an additional 1,026 cubic yards of sediment removed. Combined with Deposit N, sediment removal for all four phases totals 8,175 cubic yards.
[b] Engineering costs include bench tests, permitting, field surveys, design, bid documents, project management, construction oversight and public relations.
[c] Contains Deposit O costs.
[d] Some transport and disposal costs were paid under above line items for Phase III and Phase IV Removal, the costs not covered by these items are represented here.

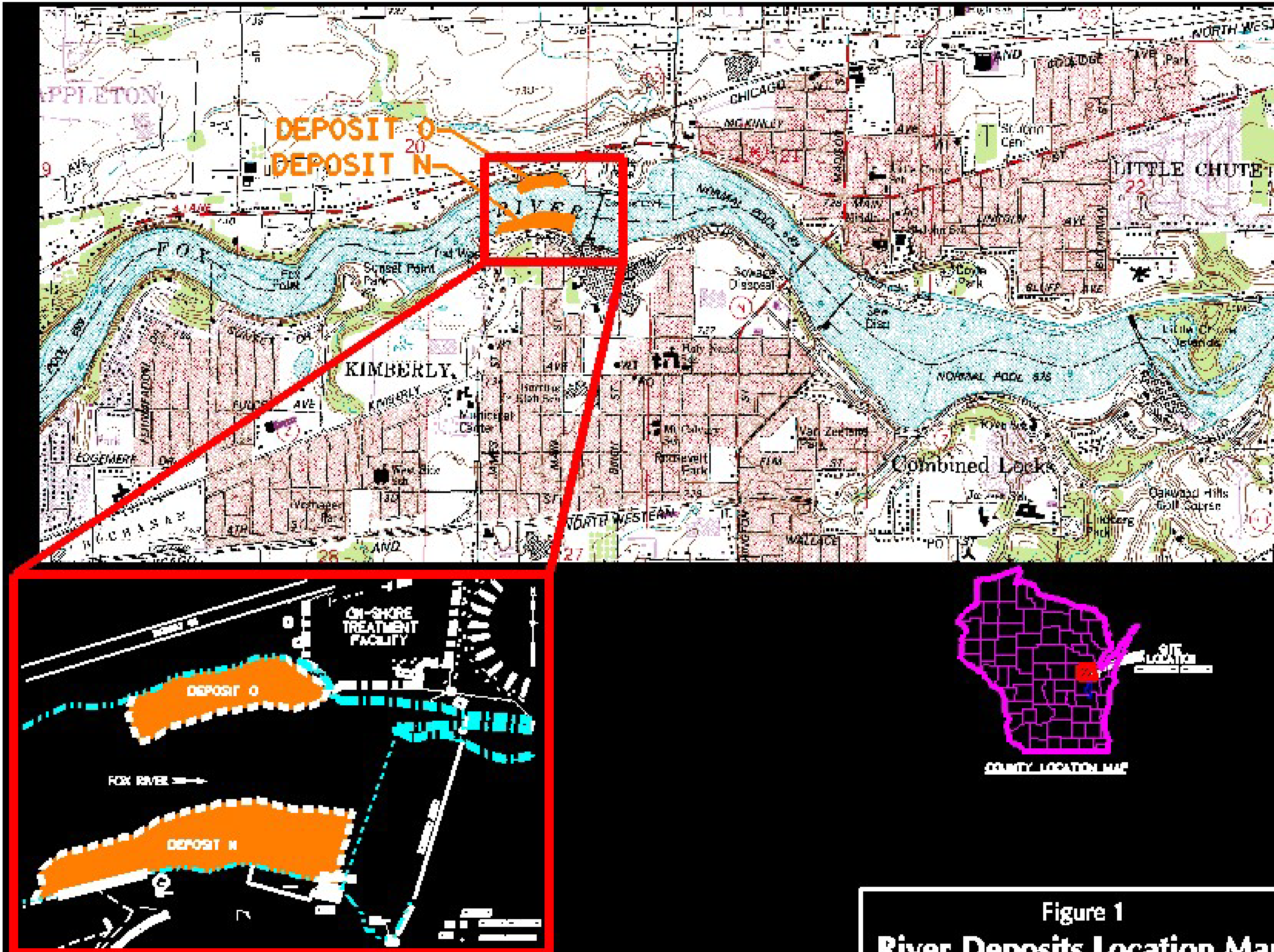
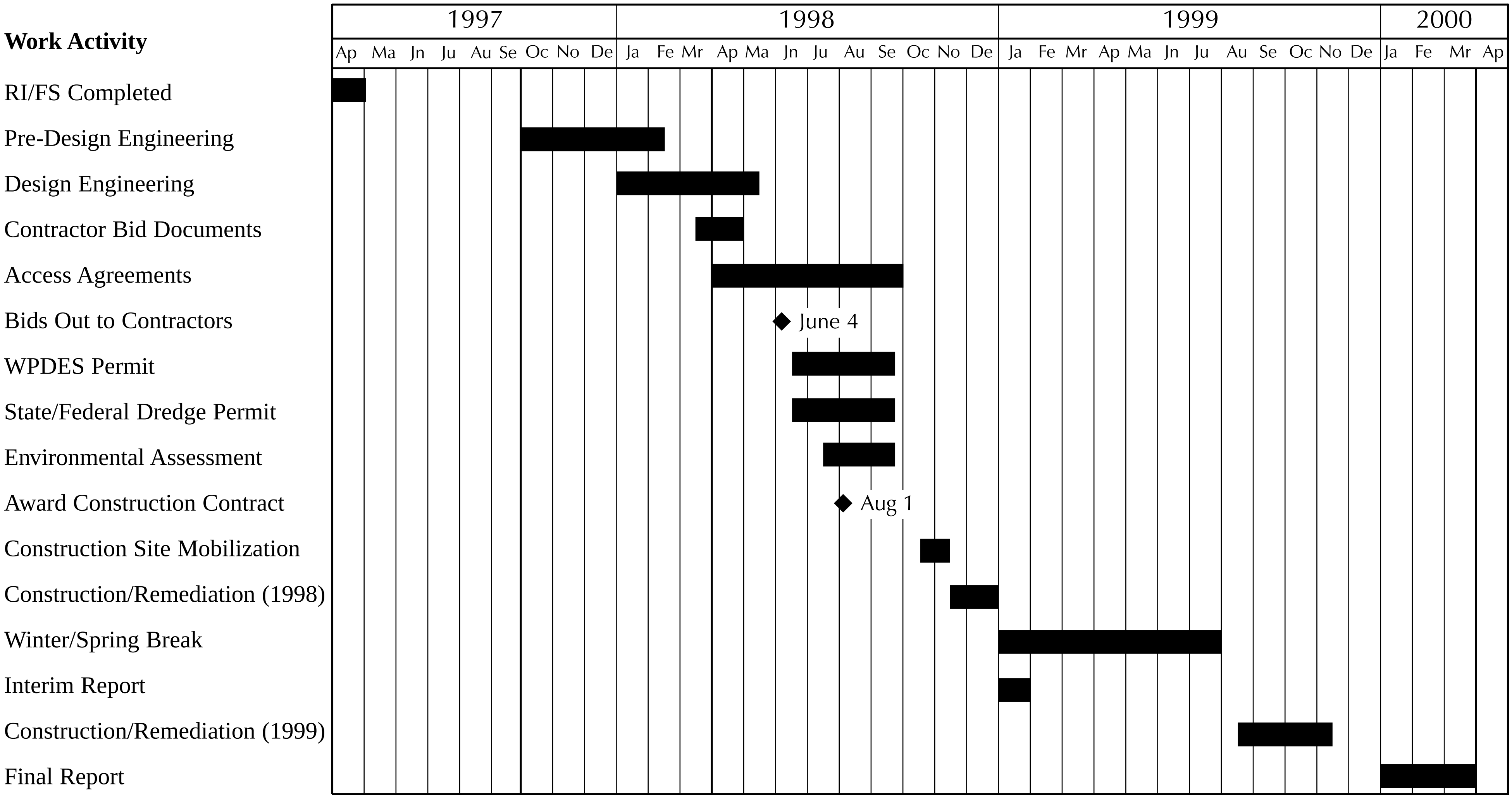


Figure 1
River Deposits Location Map

Figure 2
Schedule
Deposit N Sediment Demonstration Project



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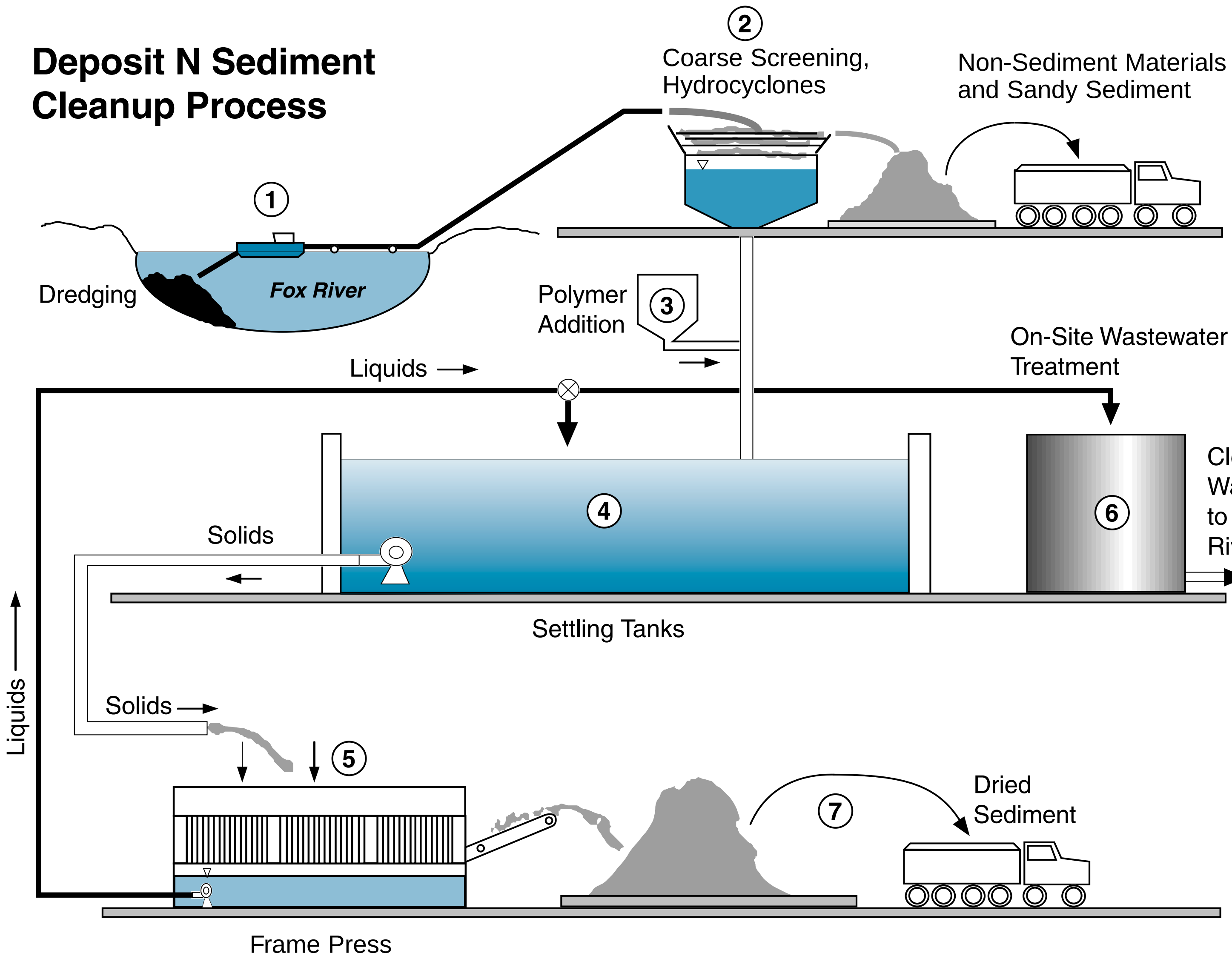


Fox River Deposit N
Removal Project

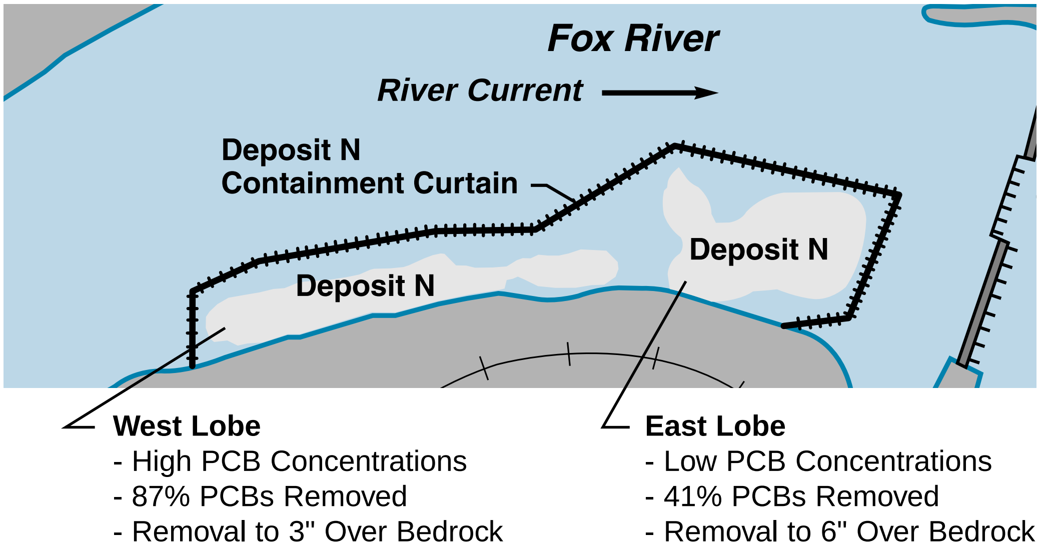
Figure 3

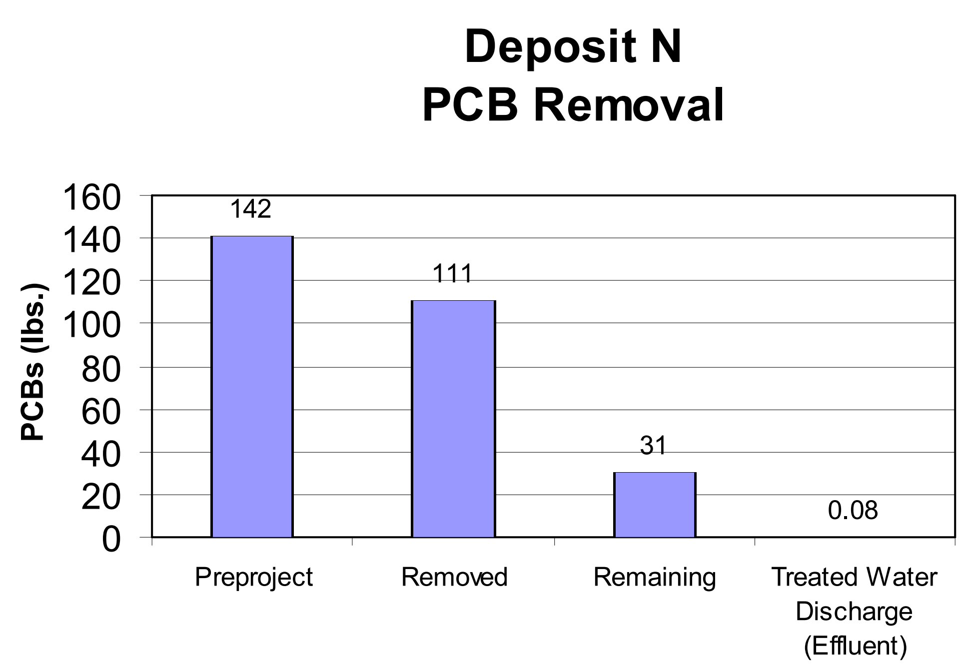
Sediment Removal, Dewatering and Water Treatment Process

Fox River Deposit N
Removal Project

Figure 4

Deposit N Dredge



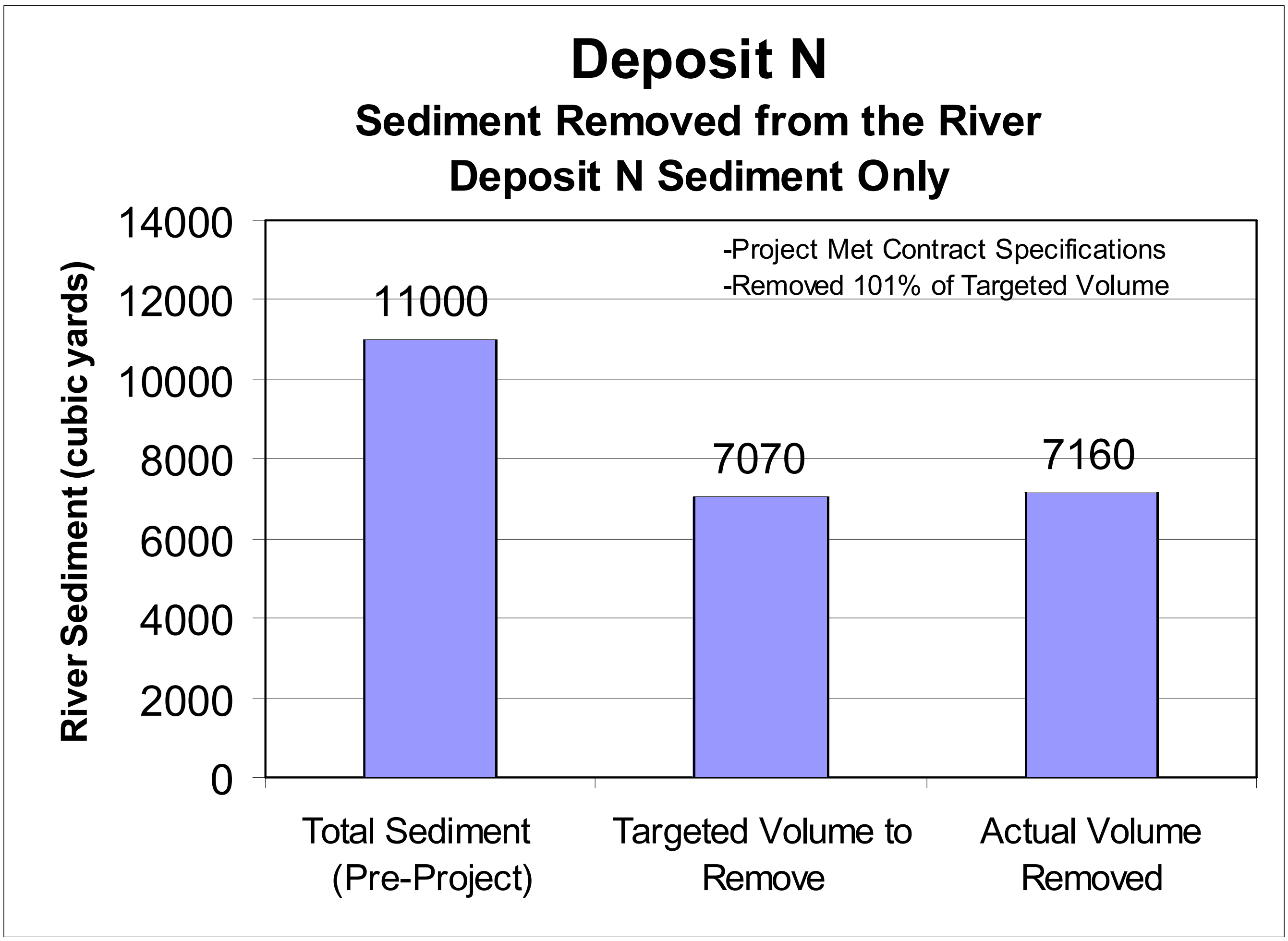


Effluent calculated with conservative assumption that no detection of PCBs = 1/2 detection limit.

Fox River Deposit N Removal Project

Figure 5

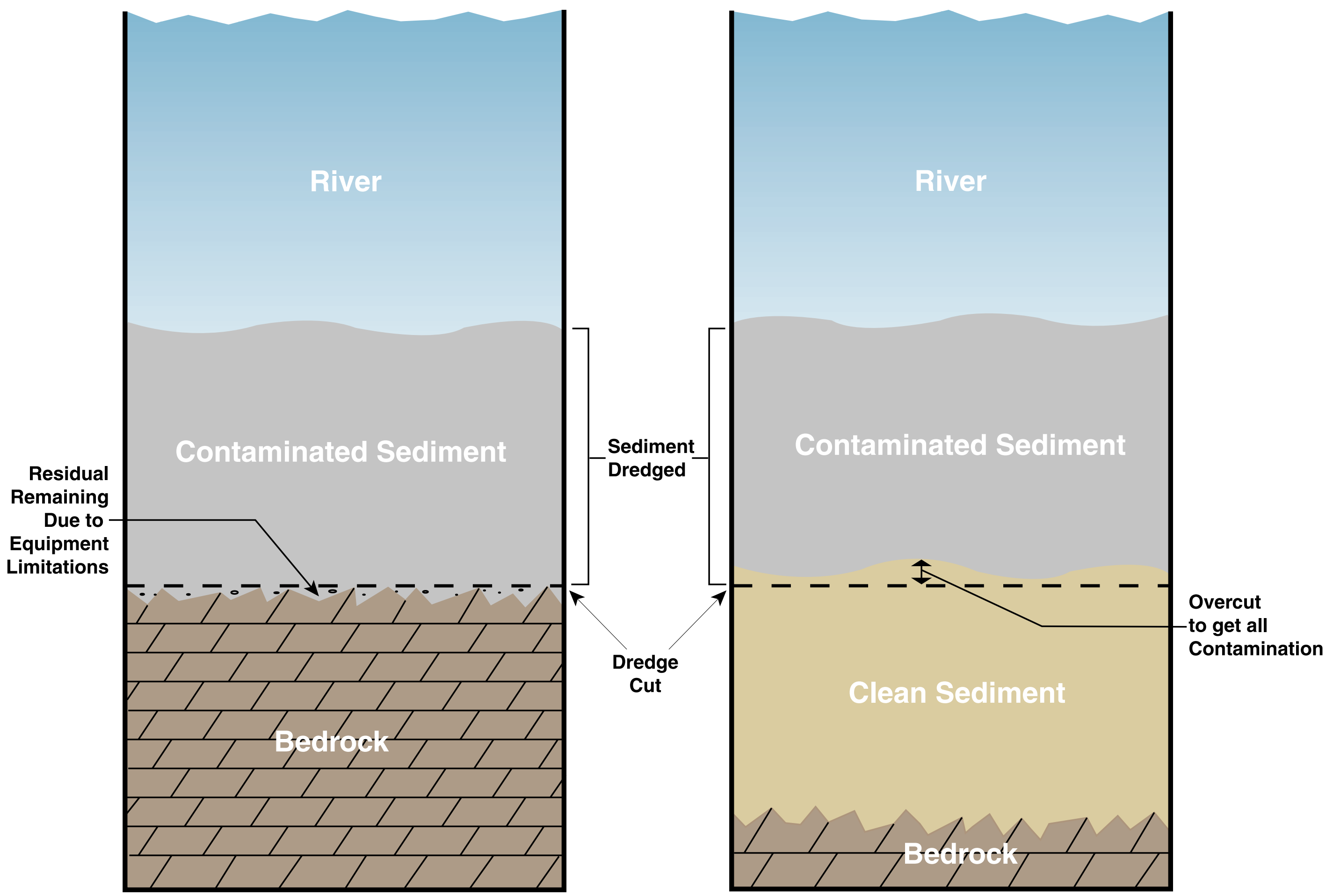
Deposit N PCB Removal



Fox River Deposit N Removal Project

Figure 6

Sediment Removed



Shallow Bedrock
(example of Deposit N)

Deep Bedrock
(example of other sites)

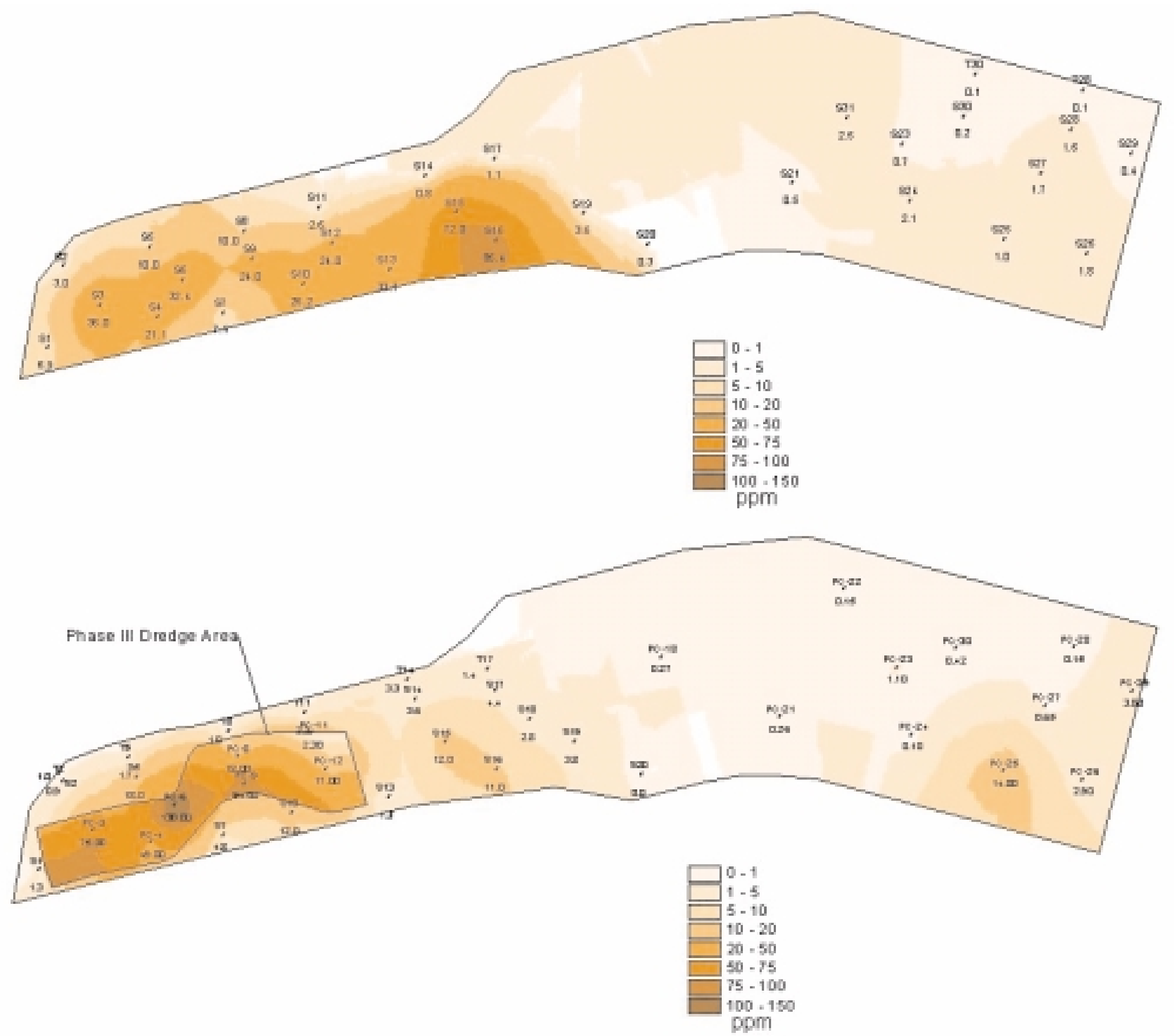
Fox River Deposit N Removal Project

Figure 7

Environmental Dredging - Limitations of Site Characteristics

Pre-Dredge

Post-Dredge



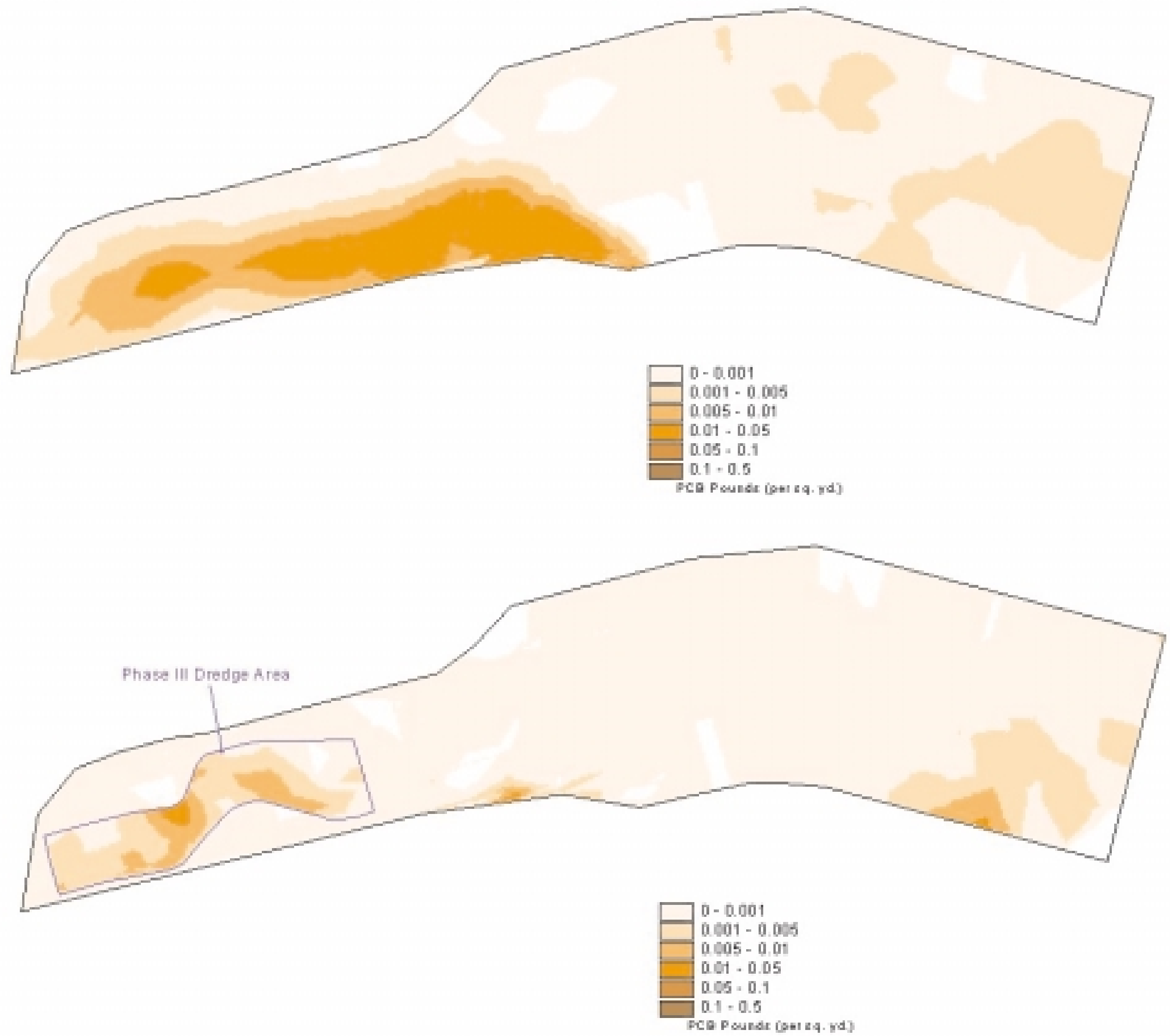
Fox River Deposit N
Removal Project

Figure 8

Deposit N PCB Sediment Concentrations

Pre-Dredge

Post-Dredge

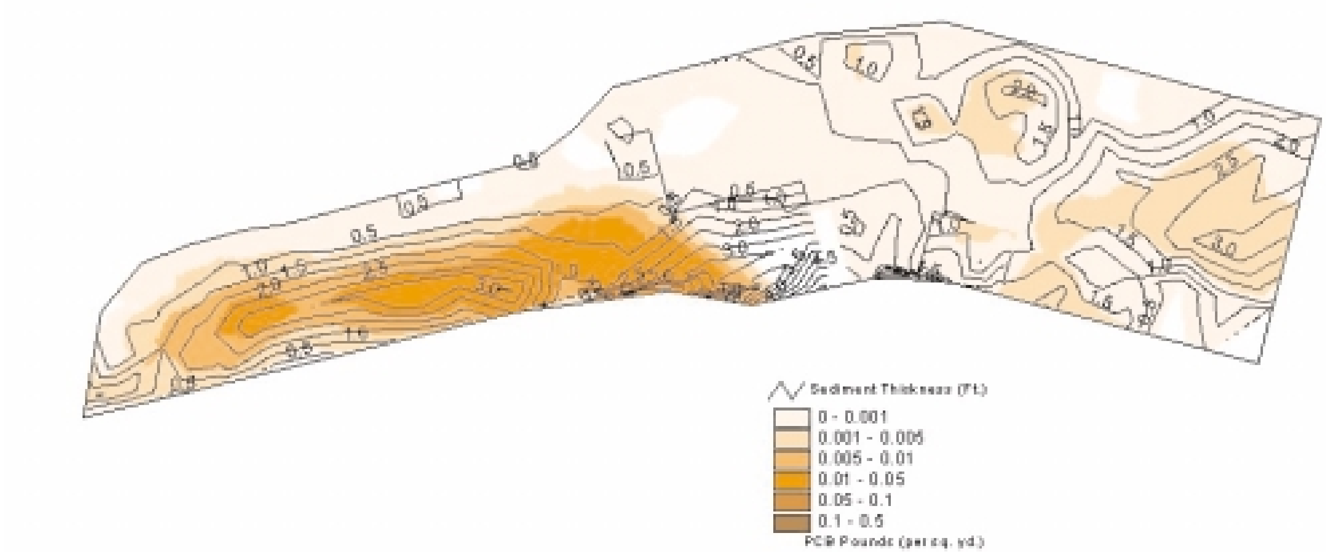


Fox River Deposit N
Removal Project

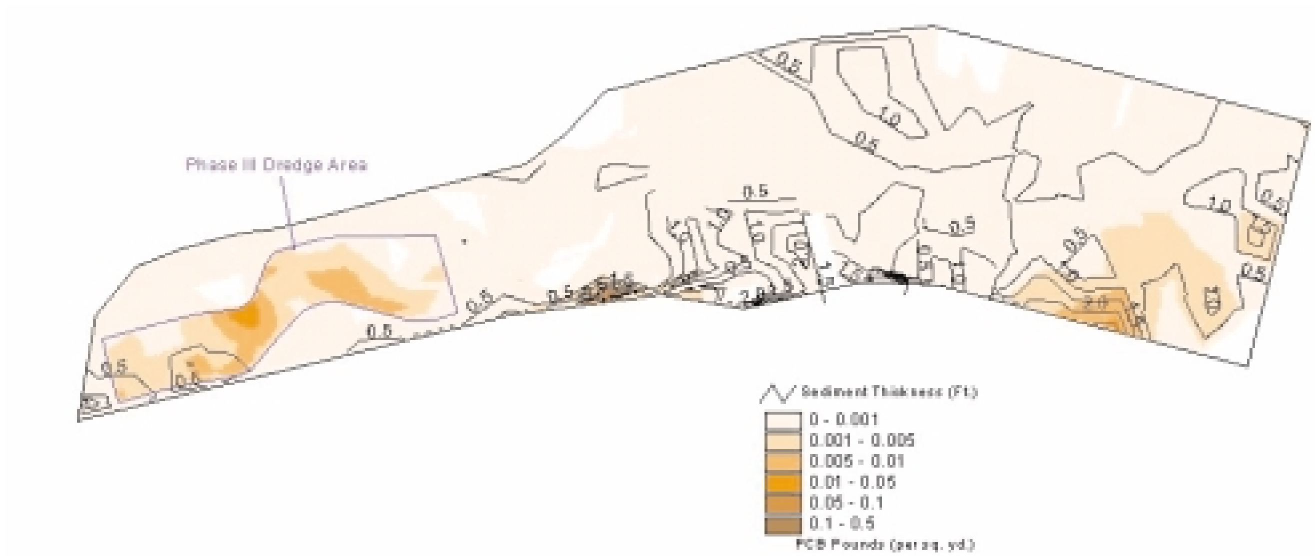
Figure 9

Deposit N PCB Mass

Pre-Dredge



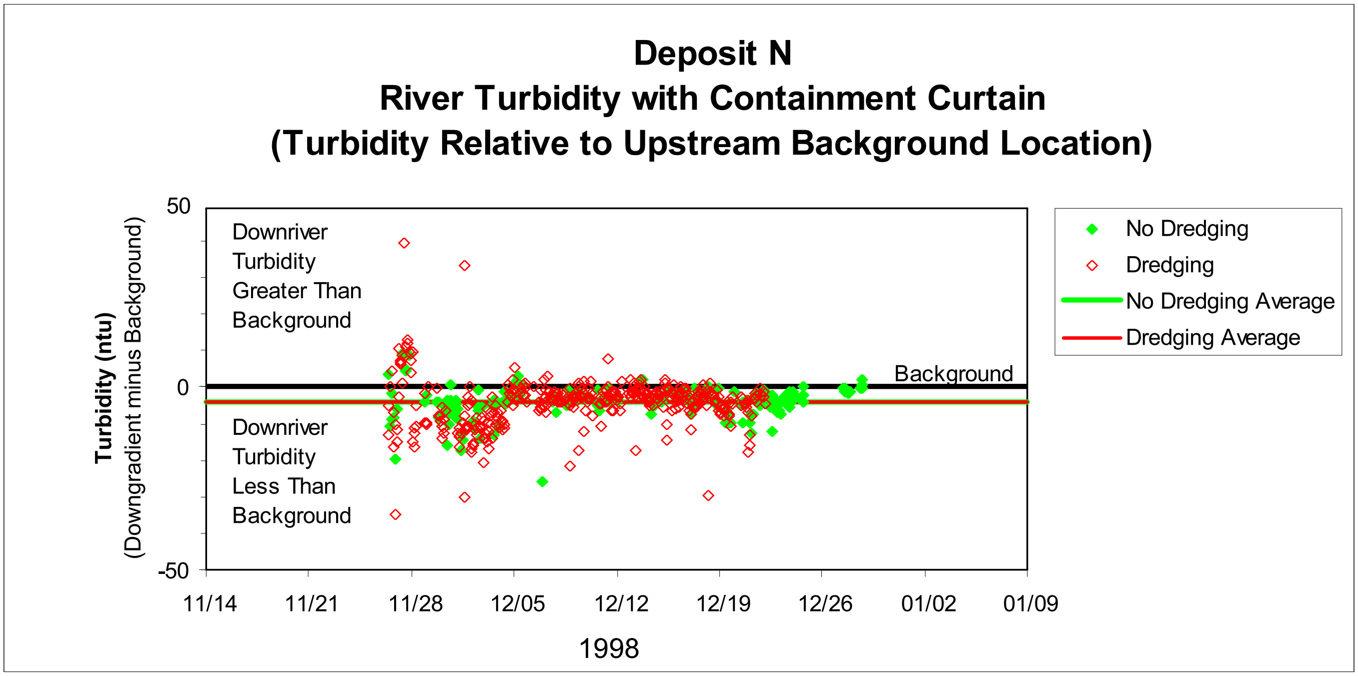
Post-Dredge



Fox River Deposit N Removal Project

Figure 10

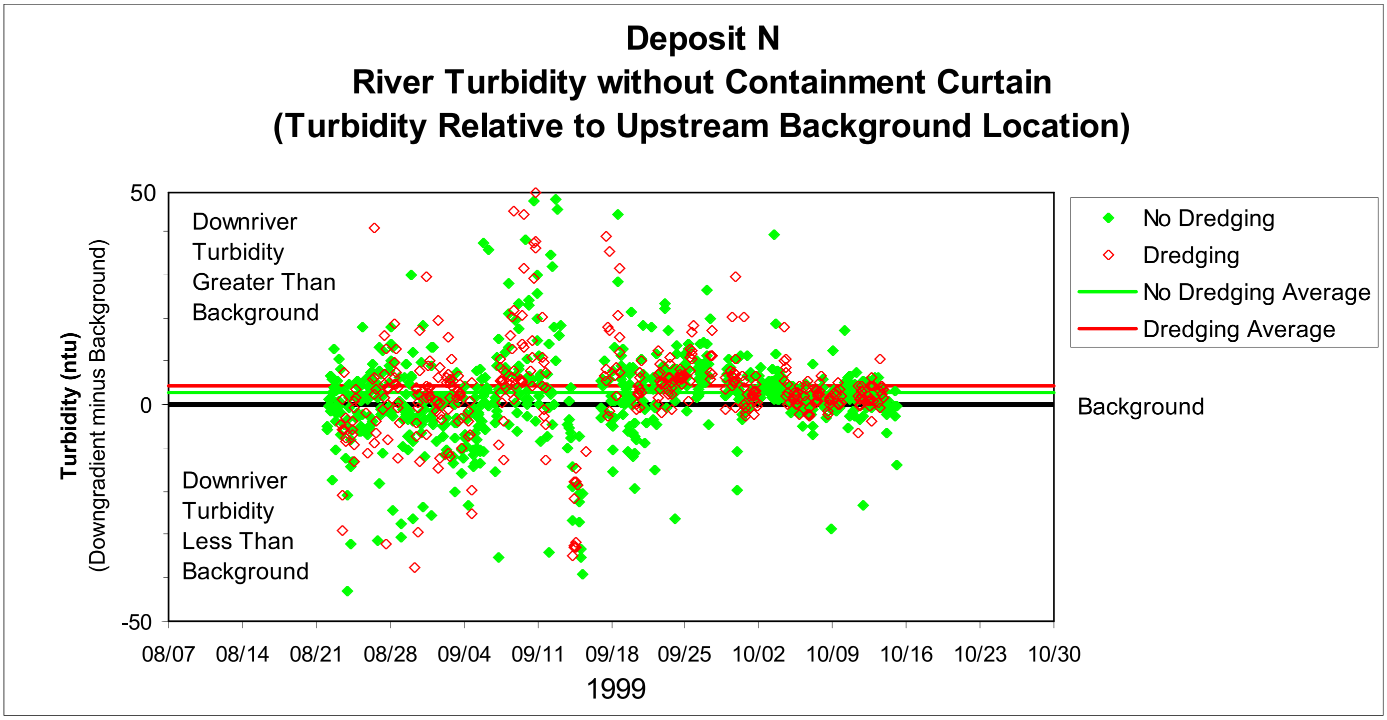
Deposit N Sediment Thickness and PCB Mass



Fox River Deposit N
Removal Project

Figure 11

River Turbidity Measurements
(with Containment Curtain)

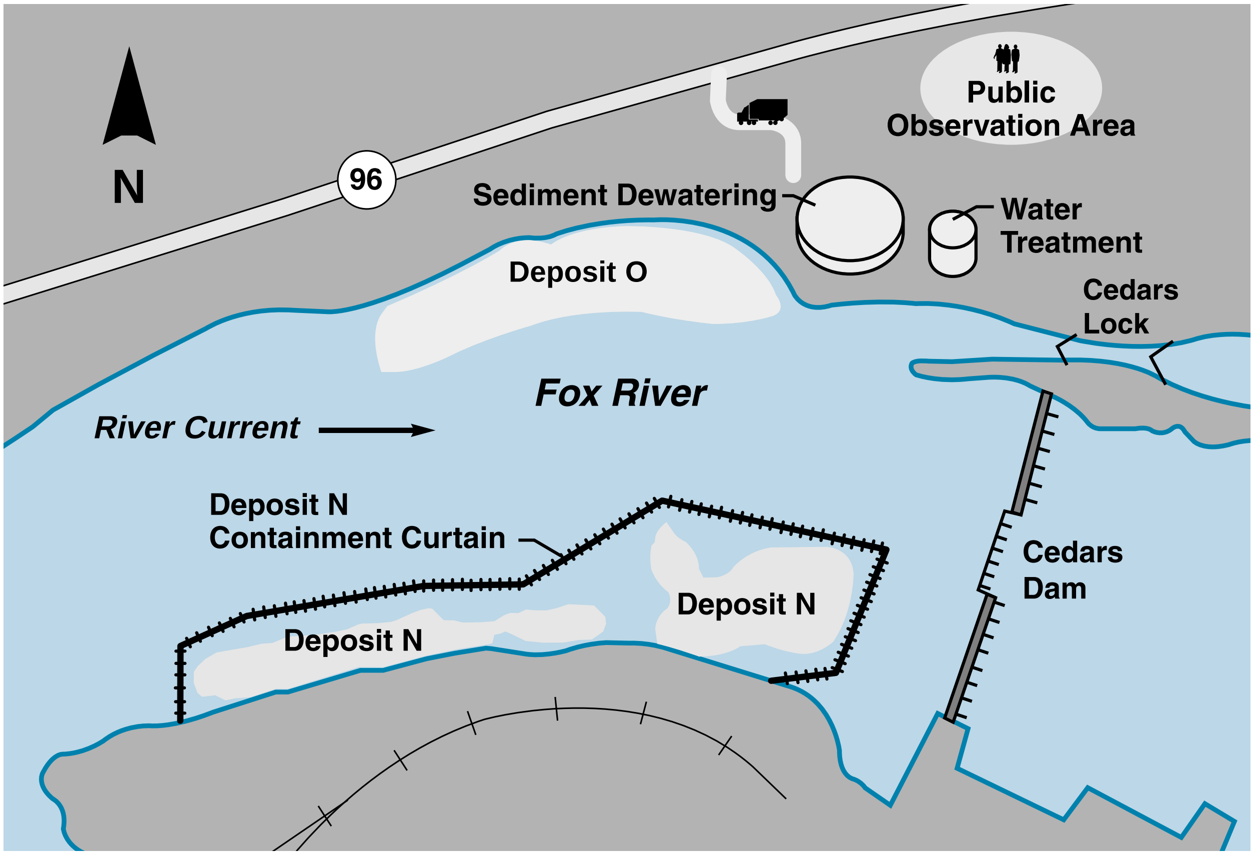


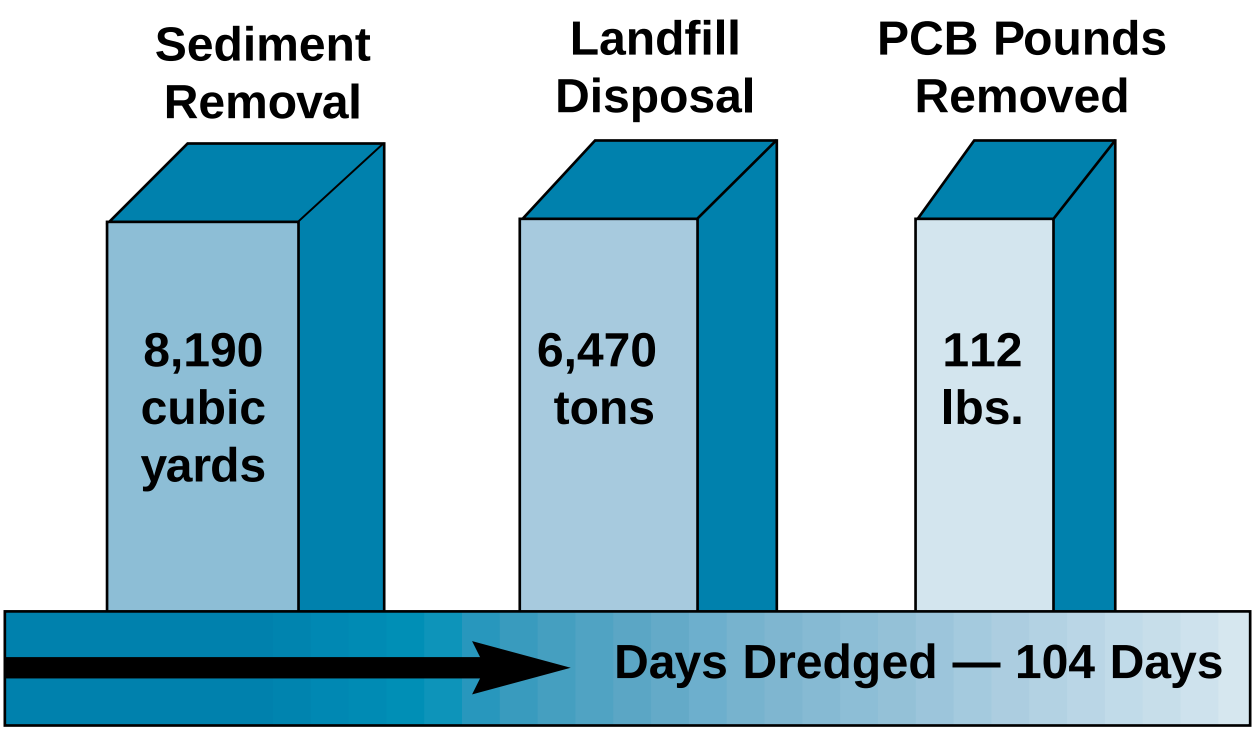
Averages Excluding Upper and Lower 1st Percentiles

Fox River Deposit N Removal Project

Figure 12

River Turbidity Measurements (without Containment Curtain)





Fox River Deposit N
Removal Project

Figure 13

Project Removal Summary