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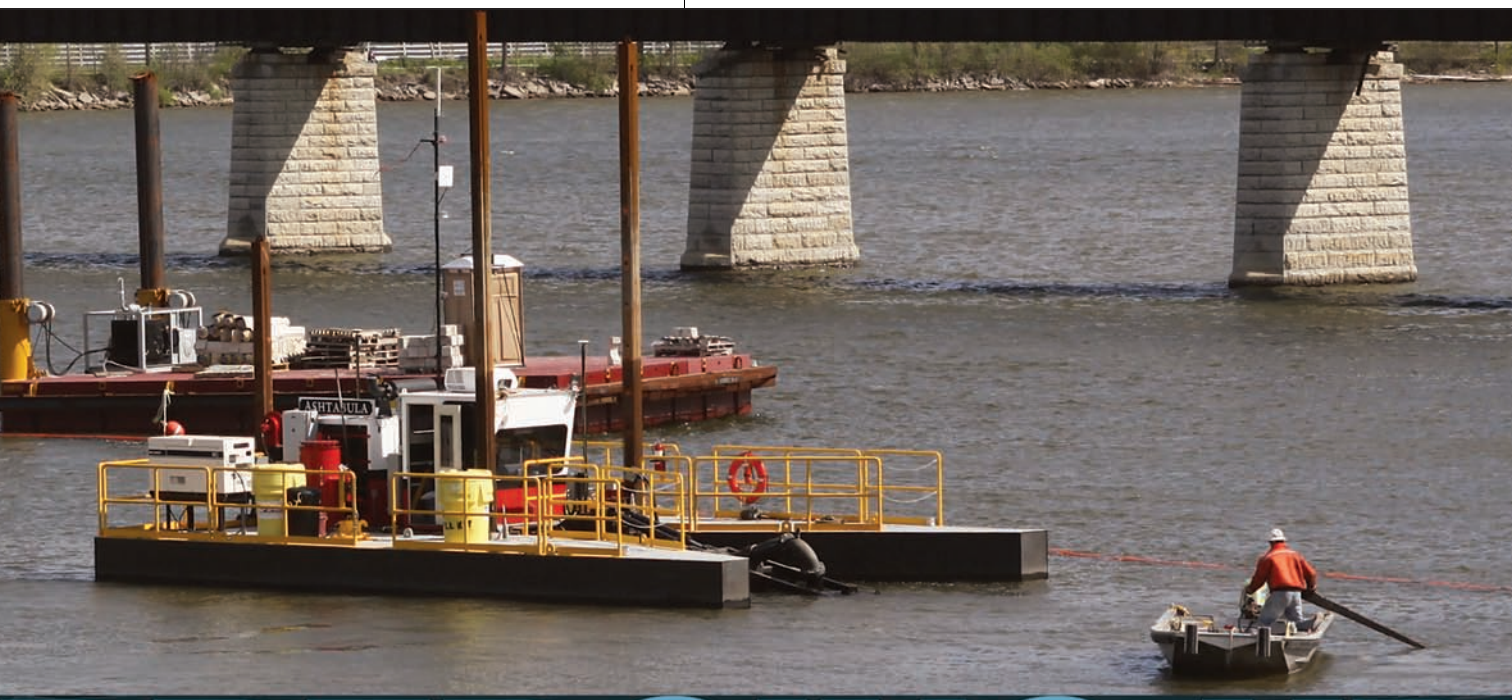

DREDGING UP EFFICIENCY

Laser-like precision at Wisconsin Superfund Site Saves Millions

COVER PHOTO COURTESY OF J.F. BRENNAN CO. INC.

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By Mike Larson

Just-in-Time Dredging Pulls Out Toxins

A nine-year, $600-million riverbed remediation in northeastern Wisconsin—the world's largest river cleanup of its kind—is proving that dredging doesn't have to be drudgery. Operating in a mode more akin to just-in-time manufacturing and with laser-like precision, contractors there are using a very efficient system of mapping, dredging and filtering river sediment as they clean up 13.3 miles of the lower Fox River near Green Bay, home to the largest concentration of pulp and paper mills in the world.

Over the course of the nearly decade-long project, the massive cleanup will dredge and process 3.8 million cu yd of sediment contaminated with polychlorinated biphenyls (PCBs) to levels reaching 3,000 parts per million. PCBs cause severe health problems for wildlife and are considered a probable human carcinogen. The U.S. Environmental Protection Agency and Wisconsin Dept. of Natural Resources (DNR) mandated the cleanup after identifying eight companies that had flushed 700,000 lb of PCBs into the river from the 1950s to the 1970s, mostly while making and recycling carbonless duplicating paper.

Three of the companies—Appleton Papers Inc., Georgia-Pacific and NCR—have formed the Fox River Cleanup Group and are entirely funding the $600-million effort. The site is on the federal Superfund program's National Priorities List.

In March 2008, the group named Tetra Tech EC Inc. prime contractor. The contract required full-scale sediment processing to begin by EPA's and DNR's deadline of May 1, 2009. That meant the company had to select its team and design, build, equip and commission a processing plant in about a year. Tetra Tech EC, Morris Plains, N.J., is the environmental division of Tetra Tech Inc., Pasadena, Calif.

To fix 600 acres of contaminated riverbed that can't be dredged effectively, the Tetra Tech team will contain silt with contamination levels up to 50 ppm in place by capping it with combinations of sand, gravel, and rock ranging from 6 in. to 33 in. thick. Dredged slurry now is pumped directly to a custom-designed, computer-controlled processing plant that removes debris and sand before squeezing the water out of the contaminated silt to make a dry filter cake that is landfilled.

Sand removed during processing is washed and tested to be sure it meets cleanliness standards, then reused as fill or sold for other beneficial reuse, such as making concrete. The water removed from the slurry during processing is highly filtered, then used in the processing plant or returned to the river.

The project's objective is to cut costs by capturing only the contaminated silt. "The PCBs adhere to the organic silt in

the river, so that's what you need to landfill. There's no use in excavating and processing more silt than necessary, and there's no sense in incurring the expense to landfill any more sediment than you need to," says Ray Mangrum, Tetra Tech's vice president of remediation and project manager. "We are dredging and processing only the amount of sediment necessary."

Tetra Tech's plan has resulted in a total cost of about $160 per cu yd, including landfilling. Overall, it will cost $50 million to $100 million less than other cleanup methods, the company claims. The cleanup will take nine years to complete, with crews dredging 24 hours a day, five days a week, from April to November, depending on the length of Wisconsin winters. Covering and capping will run 10 hours a day, five days a week.

"This is the largest cleanup of its kind in the world," says Bruce Baker, a Wisconsin DNR administrator who oversees the project. "For a U.S. river with contaminated sediment, nothing before has even come close in volume moved and processed."

Keeping Material Moving

Work begins with three hydraulic-suction dredges that excavate contaminated sediment from the riverbed. A 12-in. dredge works areas that need high production, and two 8-in. dredges work smaller areas and finish-cut behind the larger machine. Continuous runs of high-density polyethylene pipe carry the slurry directly from the dredges to the processing facility up to 10 miles away. Barge-mounted booster pumps positioned at every mile keep the flow at up to 6,000 gallons per minute, or about 150 cu yd of sediment per hour.

The pipelines from the dredges connect directly into the processing plant without a buffer pond, an unusual method that requires precise coordination between the dredges and processing plant to keep the slurry flowing smoothly. Computerized controls, expert operators, and good communication are needed to make the system work efficiently.

▲ **Cleanup Crew.** Clockwise from top, Tetra Tech's Ray Mangrum, left, and Steve McGee; an operator dredges by computer; HDPE pipe delivers slurry directly from dredge to processing plant.

"Although hooking the dredges directly into the processing plant requires precise flow control, it is faster and cheaper than using a buffer pond," says Steve McGee, another Tetra Tech vice president. "In this case, it also eliminates the problem of having an open pond hold contaminated material near stakeholders and the public."

The cleanup is making extensive use of computerized mapping and project controls to define areas that need remediation, guide precision contour dredging, and verify the results. Before dredging started, engineers and scientists used a combination of GPS, multibeam sonar, laser scanners and aerial orthophotography to map every inch of the river, shoreline and re-

PHOTO CBNTER AND TOP BY MIKE LARSON FOR ENR; BOTTOM COURTESY OF J.F. BRENNAN CO., INC.

lated structures in the 13.3-mile site. They also took more than 2,000 core samples of riverbed to identify the location, size and depth of PCB pockets.

A software program from Hypack Inc., Middletown, Conn., produced a three-dimensional grid map that is accurate to within inches. Color codings on the map show where to dredge and the depth of the contaminated sediment, which ranges from 6 in. to 10 ft deep.

"The mapping took a lot of effort and was not inexpensive," says McGee. "But it helped us come up with an efficient approach that will save millions of dollars over the life of the project. Nobody has done this on such a large-scale remediation project before."

As dredging continues, the information is updated daily, and color-coded screen displays guide dredge operators in cutting specific contours to remove exactly the right amount of sediment.

Greg Smith, one of dredging contractor J.F. Brennan's project managers, says onboard GPS compensates for barge movements, so the dredge operators can be accurate to within centimeters.

"Neat-line contour dredging has never been done before on this scale, but if it's done right, it minimizes the amount of clean material that's removed unnecessarily and also minimizes the amount of contaminated material that gets missed," says Mangrum. So far, three of four dredged areas have met standards on the first pass, and the one that didn't was "really close," he adds.

Normally, it would take 18 months to build a processing plant like the 247,800-sq-ft facility Tetra Tech is using at the downstream end. But this one was done in just nine months, thanks to design-build techniques and precise on-site coordination among more than a dozen contractors involved.

"At times, erectors were placing new steel next to electricians, who were mounting motors to beams that had been placed only 10 minutes before," says Eric Schmidt of electrical subcontractor Van Ert Electric Co. Inc., Kaukauna, Wis., which worked under Miron Construction Co. Inc., Neenah, Wis., the plant's general contractor. Despite having some 300 workers operating in such close proximity, there were no lost-time accidents throughout nine months and 360,000 man-hours of construction, the contractors report.

Process Flow

The incoming slurry first runs through a scalping screen that takes out rocks, wood chips, bottles, and other debris larger than 6 mm in diameter. Debris is sent to a landfill, and remaining sand, water and silt move on to separator cyclones that remove the sand from the remaining slurry. The first set of separators removes grains measuring from 6 mm to 150 microns in diameter, the preferred size for making concrete. The second set removes grains down to 63 microns.

From there, the remaining silty water goes to a conditioning tank, where it is

MAP BY NANCY SOULLARD FOR ENR; PHOTOS THIS PAGE: TOP AND BOTTOM COURTESY OF BOSKALIS DOLMAN BV; LEFT PHOTO COURTESY OF TETRATECH EC INC.

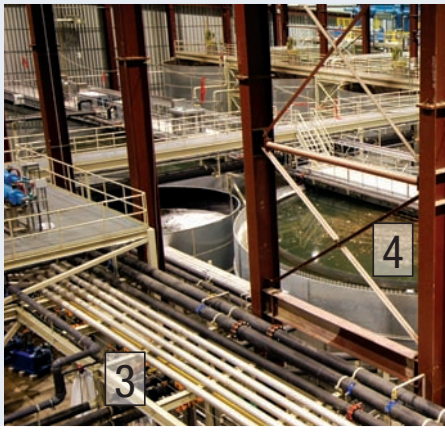
FOX RIVER CLEANUP PROCESS

1

Screening. The first stop for incoming slurry is the scalping screen, which removes debris larger than 6 mm in diameter. Items removed include wood chips, bottles and large rocks.

2

Desanding. Cyclones remove sand, which is washed, tested and reused.



Lean and Clean. The just-in-time cleanup covers 13.3 miles of the lower Fox River in northeastern Wisconsin. The last miles of the river's northward path take it through Green Bay. A dedicated processing plant separates PCB-contaminated silt that is delivered directly from dredges, eliminating buffer ponds.

dosed with a polymer and stirred to uniform consistency before being pumped into a settling tank. There, the silt and polymer settle to the bottom as sludge, while the water rises to the top and is pumped to the plant's water-filtration system for cleaning, testing, reusing or returning to the river.

The water-treatment system has three identical filter trains that can each process 3,000 gpm. Each train consists of eight 10,000-lb sand filters, 24 bag filters, six 20,000-lb carbon filters and 12 canister filters. While the water goes for filtering, the sludge is pumped to eight of the world's largest filter presses. Each 620,000-lb giant can squeeze 600 cu ft of wet sludge into 18 tons of dry filter cake in 75 minutes.

"Not only are these membrane filter presses the largest in the world, they operate at up to 225 psi, the highest pressure of any press of this type," Mangrum says. "That helps squeeze more water out of the sludge to make a drier filter cake. And that means less water goes to the landfill, which reduces landfilling cost."

The press drops the cake onto a conveyor, which stockpiles it in a storage area until it is loaded into covered trucks and hauled 37 miles to a landfill. About 85 truckloads hauling 1,940 tons of filter cake go to the landfill daily. About 4% of the total, containing PCB levels of 50 ppm and more, are trucked to a dedicated landfill in Michigan.

The system is run by a sophisticated programmable-logic controller monitored around the clock by plant operator Boskalis Dolman, the Netherlands. Testing of plant samples and river sediment is done by an independent third party. The results are reviewed and approved by both DNR and EPA.

Mangrum says the company has built up a sophisticated community-relations program to ensure transparency and react to the public's concerns. That program includes keeping the public informed through a Website, local media and public meetings, stopping work on weekends so as not to interfere with fishing and boating on the river and hiring local contractors and suppliers for about $200 million worth of work so far.

The project may influence future cleanups. McGee says he knows of nine more PCB remediation projects in various stages of development in the U.S. that could benefit from the dredging systems developed for the Fox River job. The precision contour dredging used on the Fox River will also be useful for cleaning up a variety of other chemicals that require dredge spoils to be managed as a regulated waste, he notes. One example is in ports and harbors that need to be dredged or expanded but have contaminants in their sediment.

"This precision contour dredging and sediment-processing system will be particularly beneficial on any project where landfilling costs are high," Mangrum adds. "The savings should more than make up for the initial investment." ■

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3

Dosing Units. These add a polymer to contaminated silt so it settles.

4

Settling Tanks. Sludge settles to the bottom, while clean water rises to the top. The PCB-laden sludge heads off to the presses.

5

Filtering. The world's largest membrane filter presses squeeze wet sludge into dry filter cake.

6

Loading. The finished filter cake is stockpiled and stored indoors until loaded into covered trucks and hauled to the landfill, about 37 miles away.

Tetra Tech

3475 East Foothill Blvd.
Pasadena, CA 91107-6024

(626) 351-4664

www.tetratech.com