June 2007

Sediment Dredging at Superfund Megasites: Assessing the Effectiveness

Dredging is one of the few options available to attempt to clean up contaminated sediments in rivers, harbors and lakes. However, based on available evidence, dredging's ability to decrease environmental and health risks is still an open question. Technical constraints, like underwater obstacles, can prevent dredging equipment from accessing sediments and dredging can uncover and re-suspend buried contaminants, exposing wildlife and people to toxicants. Evaluating the potential long-term benefits of dredging will require that the U.S. Environmental Protection Agency step up monitoring activities before, during and after individual cleanups to determine whether it is working there and what combinations of techniques are most effective.

Some of the nation's estuaries, lakes and other water bodies contain contaminated sediments that adversely affect fish and wildlife, which may then find their way into people's diets and carry negative health impacts. At least 14 states contain large contaminated sediment megasites, which are expected to cost over $50 million to clean up, that are particularly challenging to remediate. Private companies are responsible for the cleanup at some sites and the U.S. Environmental Protection Agency (EPA) takes the lead in managing remediation at others.

At the request of Congress, EPA asked the National Research Council (NRC) to address the technical challenges posed by the need to reduce risks at sediment megasites by forming a committee to evaluate dredging as a cleanup technique.

Clean Up Options at Superfund Megasites

The EPA Superfund program was established more than 25 years ago to address sites contaminated with hazardous chemicals. The program relies on surveys and scientific sampling of sediments under water bodies to assess the extent of the contamination and to explore ways of cleaning it up.

Cleanup techniques range from removing the sediments by using a dredge or large underwater shovel to relying on natural processes to cover the contaminants and monitoring them to ensure exposures are decreasing, to covering them with a cap of clean sediment material. Often, a combination of techniques is used. In the best cases, dredged sites are also monitored to evaluate how well a remedy is working. Because of the complexity of these megasites, they often become major engineering and public works projects that sometimes take decades to complete.

Under Some Conditions Dredging Can Be Effective

The report's authoring committee found evidence that dredging can be effectively implemented under certain conditions but that technical limitations often constrain its ability to achieve cleanup objectives. Underwater obstacles like rock formations, old piers, or hard bottom material may restrict the ability of dredging equipment to get at the contamination in some locations, reducing the likelihood that dredging will be effective.

The lack of long-term monitoring information at most dredged sites makes it difficult to evaluate the outcomes of dredging efforts. The committee's analysis of pre-dredging and post-dredging at about 20 sites found a wide range of outcomes in terms of surface sediment concentrations of contaminants: some sites showed increases, some no change, and some decreases in concentrations. In addition, the difficulty of separating the effects of dredging from the effects of natural processes that may also decrease sediment risks makes it unclear whether dredging alone has been effective in reducing health risks.

About one half of the 20 sites evaluated by the committee either did not achieve remedial goals or monitoring was insufficient to assess dredging performance. Remedial goals were met at about 25 percent of the sites, and at another 25 percent of them, not enough time had elapsed to form a judgment.

However, evidence suggests dredging can be effective under some conditions. The right hand column of Figure 1 shows significant reductions of polychlorinated biphenyl (PCBs) concentrations in three areas of the Fox River megasite in Wisconsin as a result of dredging. However, despite removal of most of the contamination, in some cases it was not reduced down to the risk-based cleanup goal for average surface concentrations of 1 part per million of PCBs (see "Post-dredging" column second from right).

Incomplete Removal and Resuspension of Contaminants are a Drawback

The report finds that dredging alone has not achieved remediation objectives at many sites.

Sub-area	Measure	Pre-dredging	Post-dredging	% reduction
POG1	PCB mass (kg)	205.5	26.6	87
	Avg. surface PCB concentration (ppm)	13.3	2.8	79
A	PCB mass (kg)	24.1	1.1	95
	Avg. surface PCB concentration (ppm)		1.0	87
C/D2S	PCB mass (kg)		1.3	96
	Avg. surface PCB concentration (ppm)	13.7	1.8	87

Figure 1. Summary of Pre-dredging and Post-dredging Verification Sampling Results (2005) from Three Subunits in the Lower Fox River. Source: Fox et al. 2006.

Dredging can permanently remove contaminants from a water body. However, it has the potential to create additional exposures by stirring up buried toxicants and creating residual contaminants in the short-term.

Because dredging activity can re-suspend contaminants as sediments are removed, water quality, fish and other organisms can be adversely affected. Figure 2 below illustrates very low levels of PCBs in the water of the Grasse River in New York until dredging began in June of 2005. At that point, re-suspension of the sediment led to spikes in PCB concentrations, posing risks to wildlife and people exposed to the water that may not have arisen if the river bottom was not stirred up in the process. When dredging ceased, the data show that levels tapered off. Such phenomena have been observed at many other sites.

It is possible these short-term risks could have been avoided if environmental managers had decided not to dredge. But such an option must be weighed against the risks associated with leaving the contamination in place including the confidence decision makers have that the contamination that remains would not resurface and put fisherman and boaters at risk in the future as a result of flooding or severe storm events.

Specific conditions at a megasite, such as water flow rates, the depth and extent of the contaminants, and other factors, influence the effectiveness of dredging. The report emphasizes the importance of adequately characterizing potential dredging sites so that adverse or conducive site conditions can be considered in arriving at cleanup decisions.

Centralized Dredging Data and Flexible Management are Key

The report recommends that EPA allow for more flexibility in how it manages megasite cleanups so that almost real-time monitoring information can be used to modify cleanup strategies. The report also concludes that cleanups should be designed to reduce risks over the long-term, and not be linked to volume-based

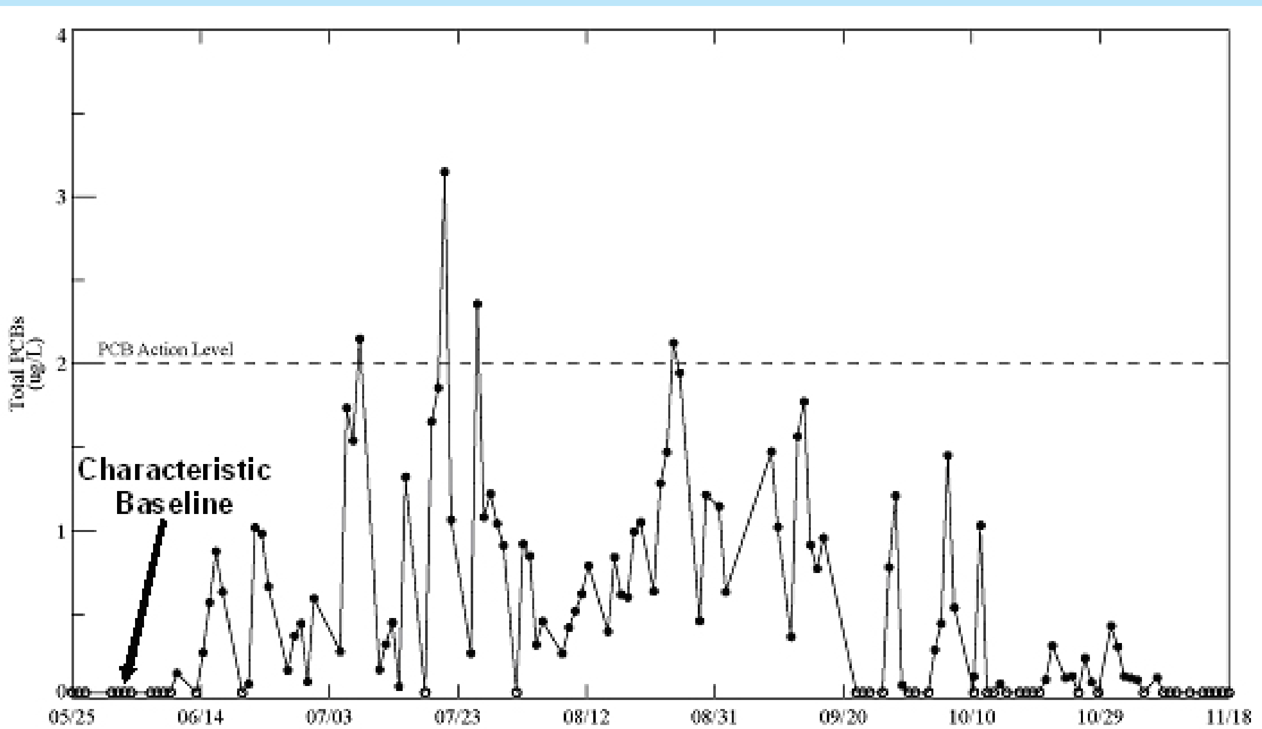

Figure 2. PCB concentrations in water samples collected approximately 0.5 miles downstream of the dredging operations in the Grasse River. Dredging began approximately June 8, 2005 and ended October 21, 2005. Source: Connolly et al. 2006.

measures, such as removal of a certain amount of material from a site. Each site has different characteristics that influence the effectiveness of various remedial options and improved site characterization will aid cleanup planners. Early indications about how well the methods used are working can then be used to adjust approaches to optimally reduce public health and environmental risks.

To support more flexibility in EPA sediment site management, the report recommends that EPA improve its pre-dredging characterization of sites, centralize sediment-related activities in its remediation offices, and improve site-tracking and monitoring.

Stepping Up Monitoring Activities Will Enhance Decision Making

The report finds that monitoring efforts have been poor at many sites, making it difficult to know how well different clean up methods work and to what extent short- and long-term health risks have been reduced.

The report therefore urges EPA to step up its monitoring activities before, during and after dredging efforts at all sediment megasites to determine whether cleanups are working and to build knowledge of what cleanup techniques are effective under various conditions. Gathering more long-term information about how well various methods work will aid future planning and management of these sites.

Dredging remains one of the few options available for the remediation of contaminated sediments and it should be considered, along with other options. To improve cleanup decisions, officials will need a variety of new types of information in order to weigh the balance between the short-term risks of implementing dredging and the potential long-term risks of not dredging and leaving contaminants in place. The report concludes that further research on dredging and sediment cleanups is warranted so that the billions of dollars that will be dedicated in the future to addressing megasites can be optimized.

Committee on Sediment Dredging at Superfund Megasites: Charles O'Melia (Chair), Johns Hopkins University; **G. Allen Burton**, Wright State University; **William Clements**, Colorado State University; **Frank Curriero**, Johns Hopkins Bloomberg School of Public Health; **Dominic Di Toro**, University of Delaware; **Norman Francingues,** OA Systems Corporation; **Richard Luthy**, Stanford University; **Perry McCarty**, Stanford University; **Nancy Musgrove**, Management of Environmental Resources; **Katherine Probst**, Resources for the Future; **Danny Reible**, University of Texas, Austin; **Louis Thibodeaux**, Louisiana State University; **Donna Vorhees**, The Science Collaborative; **John Wolfe**, Limno-Tech, Inc.

This report brief was prepared by the National Research Council based on the committee's report. For more information or copies, contact the Board on Environmental Studies and Toxicology at (202) 334-3060 or visit http://nationalacademies.org/best. Copies of *Sediment Dredging at Superfund Megasites: Assessing the Effectiveness* are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

This study was supported by funds from the U.S. Environmental Protection Agency.