



March 21, 2007

Mr. Jeffrey D. Jeep
Attorney at Law
Jeep & Blazer, L.L.C.
24 North Hillside Avenue
Suite A
Hillside, Illinois 60162

Subject: Feasibility of In-Situ Subaqueous Capping of Contaminated Sediment in Waukegan Harbor, Waukegan, Illinois

Dear Mr. Jeep:

LFR Inc. (LFR) has been requested to comment on the technical feasibility of the use of an in-situ subaqueous sediment cap to address the presence of PCB-impacted sediments located within Waukegan Harbor, Waukegan, Illinois. The following discussion and opinions are based on the current state of knowledge of the harbor, using information provided to LFR by your office, as well as other publicly available sources.

In providing this analysis, LFR expresses no opinion on whether Waukegan Harbor should be maintained as an industrial harbor, remain a federal harbor, or transition to a recreational harbor. However, in order for a sediment cap to be properly constructed and effective, it should be noted that current water depths in the harbor would certainly decrease and that various restrictions would likely be necessary such as limitations on propeller wash from large commercial vessels and other similar activities (such as future dredging) that could result in disturbing the cap.

It is not LFR's intent to present a site-specific feasibility study for this remedial alternative, but rather to discuss (i) whether in-situ subaqueous sediment capping is an accepted remedial technology that is capable of achieving the environmental objectives for the harbor (including delisting as an Area of Concern) and (ii) the expected cost of in-situ capping in comparison to dredging the harbor, pending a more detailed, site-specific feasibility analysis and final design. We conclude that capping is a cost effective alternative to dredging that is protective of the environment and should be expected to accomplish the objective of delisting the harbor as an Area of Concern.

Waukegan Harbor Background

In 1975, polychlorinated biphenyls (PCBs) were discovered in Waukegan Harbor sediments and fish that lived in the harbor. Subsequent investigation linked contaminated sediments to manufacturing activities at Outboard Marine Corporation (OMC), where hydraulic fluids containing PCBs were discharged through floor drains and released to Waukegan Harbor. The site was added to the National



Priorities List in the early 1980s, and in 1981, the U.S. and Canadian governments identified Waukegan Harbor as one of 43 Areas of Concern (AOC) within the Great Lakes Basin. Remediation efforts began at Waukegan Harbor in 1990. The remediation effort resulted in the removal of approximately 1 million pounds of PCB contaminated sediments, with disposal in two confined disposal facilities north of the OMC plant and a confined disposal facility within the harbor. The Superfund dredging project removed only those sediments with PCBs at or above 50 ppm, thereby leaving residual contamination.

Remedial Objectives

The goal of environmental remediation in general is to ensure that impacted media are treated, with the end result being protection of human health and the environment. Ancillary goals include the redevelopment and reuse of impacted areas and removal of stigma associated with inclusion of impacted areas on listings of high-priority contaminated sites. In this case, we have assumed that any remedial alternative must:

- Provide for protection of human health and the environment
- Be consistent with residential redevelopment of the surrounding land
- Provide for recreational navigation within the harbor
- Result in de-listing the harbor as a Great Lakes Area of Concern

Remedial Alternatives

In recent years, the use of dredging to remediate the impacted sediments has been the primary focus for Waukegan Harbor, a traditional approach with a proven track record. However, this approach is not without potential complication(s), including its relatively high cost and the potential for unintended impacts to (i) surrounding waterways due to re-suspension of contaminated sediment during dredging and (ii) impacts resulting from land disposal of the dredge material (*e.g.*, direct contact with impacted soil or groundwater contamination).

The purpose of this correspondence is to address the use of in-situ, subaqueous sediment capping as an alternative approach.

In-Situ Sediment Capping

In its simplest terms, this technology consists of the in-place encapsulation of contaminated sediment, with the result being that contaminants are immobilized to the point that they no longer have the potential to impact the overlying water or surrounding, non-contaminated sediment. In comparison to the dredging alternative, the end result is the same: the sediment is encapsulated to prevent migration and impact to the surrounding environment. However, whereas dredging and land disposal involves energy-intensive transportation of sediment prior to its encapsulation on land, in-situ subaqueous



capping requires only the encapsulation step without the removal and transportation of large volumes of waste.

Review of the existing literature makes it abundantly clear that the U.S. Environmental Protection Agency (U.S. EPA) regards in-situ sediment capping as a viable method of ensuring the protection of human health and the environment. The most recent publication to this effect is the December 2005 publication, *Contaminated Sediment Remediation for Hazardous Waste Sites*¹ in which the following remedial options are listed: dredging and excavation, monitored natural recovery, institutional controls, in-situ treatment, and in-situ capping, along with hybrid approaches. This publication devotes an entire chapter to in-situ capping and notes that as of 2004, this technique has been utilized as a component of remedial action plans at fifteen Superfund sites. This publication provides guidance on the basic functional components of a sediment cap and on the factors to consider in evaluating capping as a remedial alternative.

In 1998, the Great Lakes Assessment and Remediation of Contaminated Sediments (ARCS) Program published guidance for in-situ subaqueous capping of contaminated sediments². This guidance document provides a detailed description of the needs for site evaluation, cap design, placement techniques, and monitoring and management. This publication references numerous examples where sediment capping has been implemented and concludes that, "The success of projects to date and available monitoring data at several sites indicates that ISC can be an effective technique for long-term containment of contaminants." Potential Great Lakes analogs for the Waukegan Harbor site include a PCB-contaminated Superfund site in Sheboygan Falls, Wisconsin; a PCB-contaminated site in Manistique, Michigan; and a PAH-contaminated site in Hamilton Harbor, located in Burlington, Ontario. None of these sites are as large as the Waukegan Harbor site, but their success to date indicates the technical feasibility of this approach.

As stated above, a full feasibility study is beyond the scope of this correspondence. However, the two guidance documents cited above can be used to evaluate the feasibility of in-situ subaqueous capping at a first-order, screening level. The 2005 Contaminated Sediment Guidance for Contaminated Waste Sites contains a list of ten site conditions that should be evaluated to determine whether a site is especially conducive to sediment capping. A discussion of these ten points is presented below:

1. Suitable types and quantities of cap material are readily available. This appears to be the case for Waukegan Harbor. Clean sediment that is dredged from other area harbors and channels can be used as cap material, and coarse material for the surface can be obtained from demolition projects or quarries in the northern Illinois area.

¹ Contaminated Sediment Guidance For Contaminated Waste Sites, US EPA, December 2005. EPA-540-R-05-012, OSWER9355.0-85.

² Palermo, M., Maynard, S., Miller, J., and Reible, D. 1998. "Guidance for In-Situ Subaqueous Capping of Contaminated Sediments," EPA 905-B96-004, Great Lakes National Program Office, Chicago, IL

2. Anticipated infrastructure needs (e.g., piers, pilings, buried cables) are compatible with the cap. Although this item would need to be investigated in detail, LFR has seen no examples in which infrastructure would eliminate the possibility of a cap at the site.
3. Water depth is adequate to accommodate a cap with anticipated uses (e.g., navigation, flood control). A sediment cap would add one to three feet to the bottom of Waukegan Harbor. Given the anticipated recreational use of the harbor, this amount of material is not expected to interfere with harbor use. However, if the harbor is to be maintained as a commercial shipping channel (*i.e.*, use of deep draft vessels), an in-situ cap may not be a viable alternative, due to limitations based upon anticipated depth requirements.
4. Incidence of cap-disrupting human behavior, such as large boat anchoring is low or controllable. Given the recreational reuse envisioned by the city, no activities that would significantly disrupt a cap are foreseen. However, if the harbor is to be maintained as a commercial shipping channel and a cap is put in place, propeller wash from large ship activity will likely present a problem and would need to be addressed in any final design.
5. Long-term risk reduction outweighs habitat destruction. Installation of a sediment cap will destroy any existing benthic community. However, the surface of a cap would be the location for the development of a new community, and the elimination of on-going PCB release would be a significant improvement to the health of the benthic environment.
6. Hydrodynamic conditions (e.g., floods or scour) are not likely to compromise the cap or can be accommodated in the design. The future use of Waukegan Harbor as a recreational harbor would not be expected to have significant currents that would scour a sediment cap (*e.g.*, scour as a result of propeller wash from large commercial vessels). We would expect the subaqueous portion of the cap to be armored with coarse material, which would protect the bottom from what little scour might occur from recreational use. We also anticipate armoring the shoreline with either rip-rap or Fabriform to protect the waterline from potential erosion due to stormwater runoff or propeller wash from recreational vessels.
7. Rates of groundwater flow in the cap area are low and are not likely to create unacceptable contaminant releases. This concern relates to whether groundwater flow through the impacted sediments offers the ability to entrain contaminants through the cap and into the overlying sediments and waterways. Given what is understood thus far about groundwater flow (*i.e.*, no substantial upwelling from an underlying confined aquifer) and the contaminant characteristics (extremely low solubility for PCBs), this is not anticipated to present a problem. However, this should be addressed as part of any detailed feasibility analysis.
8. The sediment has sufficient strength to support a cap. Although this will need to be addressed during the feasibility analysis, we anticipate that placement of an engineered geotextile over the top of the contaminated sediments prior to installation of the cap would be fully capable of addressing this concern. The geotextile would serve (i) as a separation layer to avoid mixing during cap placement, (ii) allow for more even distribution of the loading of the cap over the



sediments to limit or eliminate sludge waves during placement, and (iii) serve to clearly identify the top of the contaminated sediments in the event of future work involving limited dredging, placement of utilities, etc...

9. Contaminants have low rates of flux through the cap. PCBs have low solubility and low mobility in the environment. They would not be expected to migrate through a properly constructed sediment cap. This is a similar concern to #7, above.
10. Contamination covers contiguous areas. Any cap in Waukegan Harbor is likely to be constructed as one large structure or smaller structures over contiguous areas.

Analysis of these ten general criteria indicate that an in-situ subaqueous sediment cap is a technically viable alternative for remediation of the contaminated sediments in Waukegan Harbor.

Such a cap is also a viable alternative in relation to the following remedial goals for the harbor.

- A sediment cap would be protective of human health and the environment. Sediment caps act to (i) physically isolate contaminated sediment from benthic and other aquatic organisms along with the human population; (ii) eliminate the chemical flux of contaminants to the overlying water column, thereby protecting the limnic community; and (iii) stabilize sediment, preventing movement into the larger water body (Lake Michigan).
- A sediment cap would leave the harbor as a viable channel for recreational use, adding a positive aspect to the re-development of the surrounding land.
- A sediment cap can be used to de-list the harbor as a Great Lakes Area of Concern. Although de-listing is a complex process involving review by local, state, and federal agencies, LFR does not see anything in the U.S. EPA delisting principles and guidelines³ or the International Joint Commission report⁴ that would obviate or prejudice the use of a sediment cap as a remedial technology appropriate for delisting.

Financial Analysis

Regarding cost, the most recent cost estimates for the various dredging options indicate costs ranging from nearly \$31 million to about \$37.5 million⁵. In comparison, preliminary costing for the capping alternative, including 30 years of monitoring, are between approximately \$10 and 13 million, with the

³ Restoring United States Areas of Concern: Delisting Principles and Guidelines. United States Policy Committee, December 6, 2001.

⁴ Commission Approves List/Delist Criteria for Great Lakes Areas of Concern. In: Focus on International Joint Commission Activities, Volume 16, Issue 1, March/April 1991.

⁵ Table attached to Request for Legacy Act Project Funding Waukegan Harbor Sediment Remediation Project, City of Waukegan, December 22, 2006.



potential for additional cost offsets if it is possible to use the dredge material from the outer harbor as part of the cap. The following items were included in developing this estimate:

- Feasibility analysis and engineering design
- Clearing the harbor bottom of significant objects
- Protection of underwater utilities, if any
- Limited dredging and re-placement of material to eliminate steep shelves
- Placement of a geotextile over the bottom of the entire harbor (approximately 52 acres)
- Dredging of sediment from Lake Michigan as source material for the cap
- Placement of the cap in Waukegan Harbor
- Placement of side armoring (i.e., rip-rap or Fabriform) along the entire harbor perimeter
- Three years of verification monitoring that the cap is remaining as placed
- Thirty years of routine monitoring of the bottom

Conclusion

Examination of in-situ subaqueous sediment capping as a remedial alternative to dredging and off-site disposal for the Waukegan Harbor has lead LFR to the following conclusions:

- In-situ sediment capping is a proven technology that has been used at U.S. EPA superfund sites as well as both U.S. and Canadian sites in the Great Lakes. The technology can achieve basic remedial goals by isolating the contaminated sediment from the surrounding environment and stabilizing the sediment to prevent migration.
- Examination of the physical setting, the ecological setting, and the proposed future land usage of the harbor indicates that it is a likely candidate for the use of this technology. LFR has identified a few site-specific factors that need to be evaluated as part of a full-scale feasibility study of sediment capping: the groundwater flux to the harbor waters needs to be fully considered and the physical properties of the sediment need to be characterized (for design of the cap). Also, the use of capping is fully consistent with future recreational use of the harbor. .
- Examination of remedial goals, including de-listing as a Great Lakes Area of Concern indicates that sediment capping is capable of achieving these goals.
- Evaluation of relative costs indicates that a significant savings can be realized by isolating the contamination in place via a sediment cap as compared to removing it to a land-based isolation cell.



If you have any questions, please do not hesitate to contact us.

Sincerely,

A handwritten signature in black ink, appearing to read 'D. Peterson'.

David M. Peterson, P.E.
Senior Engineer

A handwritten signature in black ink, appearing to read 'Daniel D. Petzold'.

Daniel D. Petzold, PhD, LPG
Senior Geologist

A handwritten signature in black ink, appearing to read 'W.A. Bow'.

William A. Bow, C.P.G.
Vice President