Concept Paper
Lower Fox River Site, Operable Unit 1
Optimized Remedy
November 19, 2007

Executive Summary

This Concept Paper proposes the adoption of a modified Optimized Remedy for Operable Unit 1 of the Lower Fox River site ("OU1") and explains the underlying rationale for the proposed changes to the remedy set forth in the OU1 Record of Decision (individually, the "ROD" and the "ROD Remedy"). The Optimized Remedy is based on four years of dredging experience in OU1 implementing the ROD Remedy, including considerable new data gathered to delineate PCB concentrations and sediment characteristics, post-dredging residual data, additional modeling to incorporate the new data, and actual operational and cost experience.

The ROD Remedy is based upon the findings of the Final Baseline Human Health and Ecological Risk Assessment (the "Risk Assessment"), prepared by the RETEC Group, Inc., dated December 2002. The ROD specifies a risk-based goal for the OU1 remedial action: the attainment of a post-remedy surface weighted average concentration ("SWAC") in sediments of 0.25 ppm PCB. To attain the 0.25 ppm SWAC, the ROD requires that all sediments above a projected cutline set at a 1.0 ppm Remedial Action Limit ("RAL") be dredged. While the 1.0 ppm RAL serves to physically implement the OU1 cleanup and to assure the permanence of the remediation, the 0.25 ppm SWAC is the remedial goal that serves to protect human health and the environment, as directed by CERCLA.

By applying the models used to set dredge prisms and the considerable new data obtained post-ROD in OU1, GW Partners has found that even if dredging equipment could dredge precisely to the 1.0 ppm RAL, the post-dredge SWAC would only fall to 0.48 ppm. Furthermore, the OU1 experience to date has shown that, in fact, modern dredging equipment is not capable of dredging precisely to the 1.0 ppm RAL, and that dredging is significantly more costly than projected in the ROD. The post-ROD OU1 experience shows:

- A specified dredge-line can only be attained if a dredging contractor is granted an overcut allowance. In OU1, an average 4-inch overcut has been necessary to attain a dredge cut line to a degree of accuracy acceptable to the agencies.
- Even when the 1.0 ppm RAL cutline is achieved, dredge residuals often remain above 1.0 ppm PCBs, sometimes significantly above.
- The cost of implementing the all-dredge remedy set forth in the ROD would be more than twice the cost estimated in the ROD. GW Partners' current estimate for the ROD Remedy is between $138 and $150 million,

not the $61.7 million estimated by the ROD, due to overcut volumes and residual sand cover costs (which were not accounted for in the ROD) and costs being higher than were estimated in the ROD.

While the new information shows that dredging to a 1.0 ppm RAL is significantly more difficult and more costly, but less effective, than anticipated by the ROD, the new information also shows that, by implementing the Optimized Remedy, the 0.25 ppm SWAC risk goal specified in the ROD can be achieved in OU1. The post-ROD information includes approximately 5,900 new PCB datapoints collected in OU1, and operational experience showing that:

- the total PCB mass in the 1.0 ppm prism is less than predicted in the ROD, amounting to 2/3 of the ROD estimate;
- the PCBs in OU1 are more heavily concentrated in discrete areas of OU1; and
- the PCB concentrations in areas containing large volumes of contaminated sediment are low, in many areas only marginally above 1.0 ppm.

The above findings pave the way to a revised remedy that attains the concentration (risk) goal in the ROD, provides a more than adequate degree of mass removal (permanence), and is more cost effective than the ROD Remedy.

GW Partners has examined various combinations of available methods to achieve the 0.25 ppm SWAC, and believes the correct balance is found in taking the following steps to complete the OU1 remedy:

- Dredge any remaining areas with PCB concentrations greater than 50 ppm, remaining areas with an average PCB concentration greater than 10 ppm in the top 8-inch interval, and other areas to meet capping restraints and operational efficiencies (current estimate: 25 acres/34.4 kilograms of PCB mass(2008 dredge season));
- Place a 13-inch engineered cap (comprised of 6-inches of sand and 7-inches of armor stone, each layer including a 3-inch overplacement allowance) over remaining undredged sediments with an average PCB concentration between 2 and 10 ppm in the top 8-inch interval (current estimate: 112 acres/229 kilograms of PCB mass);
- Place 6-inches of sand cover over remaining undredged sediments with an average PCB concentration between 1.4 and 2.0 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm (current estimate: 46 acres/19 kilograms of PCB mass);
- Place 3-inches of sand cover over remaining undredged sediments with an average PCB concentration between 1.0 and 1.4 ppm over a single 8-inch

interval, with no other 8-inch interval averaging more than 1.0 ppm (current estimate: 68 acres/17 kilograms of PCB mass);

- Address post-dredge residuals with PCB concentrations greater than 5.0 ppm through either re-dredging or placement of a 13-inch engineered cap, unless operational efficiencies or cost-effectiveness dictate otherwise;
- Place 9-inches of residual sand cover over areas already dredged in Sub-area POG2 and 6-inches of residual sand cover as otherwise necessary to achieve the 0.25 ppm SWAC (current estimate: 30 acres/19 kilograms of PCB mass); and
- Perform long-term monitoring and maintenance.

The Optimized Remedy will remove about 74% of the (updated estimate of) PCB mass within the ROD's 1.0 ppm footprint and will address 97% of that mass with a combination of active remedial measures (dredging, engineered capping and sand cover). Capping will only be performed in areas where stability and permanence is assured, and the other restrictions of the ROD Contingent Remedy would apply unless the agencies agree that they are unworkable (*e.g.* water depth restriction in the near shore areas).

EPA follows nine criteria to decide how to best remediate a site. Each criterion is examined in more detail in the body of this Concept Paper. The comparison between the ROD Remedy and the Optimized Remedy shows that the Optimized Remedy is at least equally protective of human health and the environment as the ROD Remedy, and is more protective because it will achieve the 0.25 ppm SWAC risk-based goal many years before the ROD Remedy. While removing less mass (at least, in theory), the Optimized Remedy is preferable to the ROD Remedy because it reflects operational reality and real world technical limitations, and instead allows for the combination of remedial techniques to attain, in fact, the risk-based goal of the ROD, with an appropriate degree of permanence.

Finally, the Optimized Remedy is much more cost effective than the ROD Remedy. The ROD Remedy is currently estimated to cost between $138 and $150 million, whereas the Optimized Remedy is estimated to cost between $93 and $111 million. Both options are significantly more expensive than the ROD's $61.7 million estimate. Through the 2007 dredge season, GW Partners will have spent about $67 million on the OU1 remediation. This means that the future cost of the ROD Remedy would be between $71 and $83 million, as compared to a future cost of the Optimized Remedy of between $26 and $44 million.

The Optimized Remedy and Its Rationale

This Concept Paper explains the concepts underlying the OU1 Optimized Remedy and the rationale for recommended modifications to the ROD Remedy. A more detailed description and explanation of the Optimized Remedy are set forth in the OU1 Design Supplement (November 2007). As discussed below, the Optimized Remedy will result in more effective and efficient remedial action than the ROD Remedy, while assuring that the ROD's risk reduction goals are attained.

The ROD establishes a 0.25 ppm PCB SWAC as the risk-based goal for the OU1 remediation. The 0.25 ppm SWAC was specified as a result of the Risk Assessment performed for OU1, and seeks to abate risks to human health and the environment within an acceptable timeframe. The ROD implements the SWAC through the use of a RAL of 1.0 ppm PCBs for sediment removal, based on the agencies' calculation that dredging to a 1.0 ppm RAL would result in the attainment of the 0.25 ppm SWAC. The ROD directs that sediment above the RAL be dredged, dewatered, and then disposed of in a licensed landfill. The ROD includes a Contingent Remedy that, if approved, would allow the placement of engineered caps in OU1, but, in order for the Contingent Remedy to be approved, capping would have to be shown to be less expensive and as effective in risk reduction as dredging. The ROD also allows for the Contingent Remedy if it can be predicted, with a high degree of certainty, that dredging alone will not achieve the 0.25 ppm SWAC, after significant dredging of OU1 has been accomplished, and that capping is less costly than dredging, in accordance with the nine criteria set forth in the National Contingency Plan, 40 C.F.R. Part 300.

New data and information collected since the ROD issuance, including data collected after dredging of Sub-areas A, C and POG, show that the ROD's dredging remedy alone will not achieve the 0.25 ppm SWAC. The new post-ROD data, information and analyses further show that the combination of remedial techniques specified by the Optimized Remedy can achieve the ROD's risk reduction goal in less time, and in a more cost effective manner, than the ROD Remedy. The new data and information on which the Optimized Remedy is based includes detailed sediment data (including new PCB data), available actual cost information, operational experience gained from three years of in-water remedial work, and post-dredge residual information.

New sediment data was collected first as part of the post-ROD Remedial Design. During the Remedial Design, WTM I collected 5,900 samples in OU1 to locate areas to be dredged and to collect information regarding *in-situ* sediment characteristics. In addition, between 2005 and 2007, GW Partners collected approximately 1800 more samples to further characterize the PCB-contaminated sediment in OU1. These additional data have greatly advanced the understanding of the sediment characteristics and the PCB distribution in OU1. For example, this new data shows that most of the PCBs are concentrated in smaller definable areas; that several OU1 areas have a relatively thin layer of sediment containing less than 2.0 ppm PCBs; and that some contaminated sediment is buried relatively deeply under cleaner sediment.

In addition, since the issuance of the ROD, GW Partners and the agencies have been actively operating one of the largest contaminated sediment dredging projects ever undertaken in this country. In performing this work, GW Partners and the agencies have learned a great deal about the engineering and construction realities faced in performing large-scale dredging and dewatering operations. In conjunction with the new sediment characteristic and PCB data, these "lessons learned" enable better engineering design decisions to be made to achieve risk reduction going forward.

The Optimized Remedy is based on the 5,900 new PCB datapoints and the three years of experience gained in the field. GW Partners believes it is justified under CERCLA, is consistent with the National Contingency Plan and, while not perfectly suited for treatment thereunder, can largely be implemented as a variation of the Contingent Remedy. Further, the Optimized Remedy is consistent with the U.S. EPA Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (December 2005).

New Information

The OU1 Final Plan will present a comprehensive analysis of the new, post-ROD data and information. In summary:

New Information

Post-ROD sampling included the collection of approximately 5,900 samples at about 1,000 locations. The new data produced from that sampling and additional information learned during the four seasons of dredging show that:

- Dredging alone cannot achieve an OU1 SWAC of 0.25 ppm, which is the risk reduction goal of this remedial action. Assuming all of the OU1 sediment above the 1.0 ppm dredge line could be precisely removed and dredging left behind no residuals, modeling based on the new data projects that the SWAC at the end of dredging would be 0.48 ppm (assuming no sand cover of residuals).
- The three years of dredging experience in OU1 have shown that even precision dredging with modern equipment and highly-skilled operators cannot attain 100% effectiveness. After dredging, residuals of varying PCB concentrations are left behind. Many of these residual concentrations have been higher than concentrations in OU1's low PCB concentration areas.
- A dredging operation needs to remove an average of 4 inches of additional "overcut" sediment to assure that the targeted dredge elevations are achieved. The ROD did not account for this overcut volume when evaluating time to complete the remedy, disposal options, or costs.
- The updated estimate of the pre-Project PCB mass within the OU1 1.0 ppm dredge footprint is 1,143 kilograms -- 33% less PCB mass than the

1,715 kilograms estimated by the ROD.

- PCBs are not uniformly spread throughout OU1, but tend to be concentrated in smaller, more definable areas.
- A large volume of sediment within the OU1 1.0 ppm dredge prism is not significantly different than sediment outside the dredge prism. This volume contains large areas of sediment with low PCB concentrations, only marginally above the 1.0 ppm RAL. Sediments with PCB concentrations between 1.0 and 2.0 ppm PCBs constitute over 51% of the remaining undredged sediment area within the ROD's 1.0 ppm footprint and 32% of its remaining undredged volume, but contains only about 2.2% of the pre-dredge PCB mass in OU1, and 0.1% of the total PCB mass in the Lower Fox River.
- There is limited regional landfill airspace for the disposal of dredged sediments, especially if such sediments are not capable of being worked into the operating face of a municipal solid waste landfill. Despite innovations in the dewatering process, geotextile tubes generally do not produce workable material from OU1 sediments, meaning that dewatered sediments from the geotextile tubes must be disposed in more expensive monofills within the landfill.
- Experience gained during ongoing OU1 operations shows that implementation of the ROD Remedy will cost more than twice the amount estimated in the ROD, and will take five years longer to implement than is estimated in the ROD.

<u>Comparison of the ROD Remedy and the Optimized Remedy</u>

There are several components of the Optimized Remedy that duplicate components of the ROD Remedy. These include:

- The risk-based goal of the remedial action is to reach a SWAC of 0.25 ppm PCB. Based on the new information gained in OU1, it can be predicted with a high degree of certainty that the Optimized Remedy will achieve the 0.25 ppm SWAC, while the ROD's dredging remedy will not.
- A large volume of sediment, and PCB mass, would still be dredged. Under the Optimized Remedy, GW Partners will dredge, dewater and dispose of a total of approximately 406,100 cubic yards of *in-situ* sediment (containing approximately 843 kilograms of PCBs), making OU1 one of the largest environmental dredging projects ever performed in the United States.
- A post-dredge sand cover may be used to manage sediment residuals (after dredging to the 1.0 ppm RAL) to meet the 0.25 ppm SWAC.

- Institutional controls and long-term monitoring will be used to monitor reductions of PCBs in the ecosystem.

The modifications to the ROD Remedy proposed in the Optimized Remedy are summarized in Table 1, which compares all key aspects of ROD Remedy and the Optimized Remedy. Following the table is a discussion of the changes.

TABLE 1. Comparison of ROD Remedy and Optimized Remedy.

Remedy Element	**ROD Remedy**	**Optimized Remedy**
Post-Remedy SWAC	• 0.185 ppm (ROD estimate) • 0.48 ppm (updated estimate)	0.25 ppm
Dredge RAL	1.0 ppm	1.0 ppm
Dredge Volume (includes 4-inch overcut)	928,400 cubic yards	406,100 cubic yards
PCB Mass removed	• 1715 kilograms (ROD estimate) • 1143 kilograms (updated estimate)	843 kilograms
Non-dredging remedy components	Post-dredge sand cover may be used if the 1.0 ppm RAL is not achieved, to reach 0.25 ppm SWAC. Capping allowed under approved Contingent Remedy.	Utilize engineered capping over 265,800 cy of sediment, sand cover over 120,800 cy of sediment (both w/o overcut), and residual sand cover to the extent necessary to achieve the 0.25 ppm SWAC.
Use of Engineered Caps (over undredged areas)	Authorized under approved Contingent Remedy	Utilize in areas generally meeting Contingent Remedy limitations regarding physical characteristics. Must have sufficient thickness to ensure PCB containment and resistance to burrowing organisms.

Remedy Element	**ROD Remedy**	**Optimized Remedy**
Use of Sand Cover (over undredged areas)	Not specifically authorized, but possible under approved alternative remedy, as provided for in the OU1 Consent Decree	Utilize over undredged sediment with average PCB concentrations between 1.0 and 2.0 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm
Post-dredge sand cover	Can be used if 1.0 ppm RAL not attained, but otherwise not required	Utilize to the extent required to attain 0.25 ppm SWAC
Sediment Dewatering	Mechanical	Geotextile tubes
Transportation of dewatered sediment	Trucks	Trucks
Disposal of dredged sediments	Contaminated sediments will go to a landfill that complies with all applicable laws and regulations	Contaminated sediments will go to a landfill that complies with all applicable laws and regulations
Institutional Controls until all goals are met	Required	Required
Long-term monitoring of fish tissue and water column	Required	Required
Long-term monitoring and maintenance of cap	Required for Contingent Remedy	Required

In short, the Optimized Remedy seeks to amend the ROD Remedy to accommodate two changes: (1) the authorization of the Contingent Remedy for capping of specified areas; and (2) the use of sand cover over undredged, low PCB concentration areas (both as noted above). In more detail, the Optimized Remedy calls for the following modifications or clarifications to the ROD Remedy:

- **Use of Contingent Remedy for Capping**. The ROD contemplates the use of engineered caps, subject to certain restrictions, as a Contingent Remedy. The Optimized Remedy, consistent with the OU2-5 Optimized Remedy, includes the use of engineered caps in certain areas, where permanent stability and performance can be assured, consistent with the Contingent Remedy.

- **Criteria for Engineered Capping**.

    - *Depth Requirements for Areas to be Capped.* The ROD prohibits caps where the water elevation is less than three feet. Both the ROD Remedy and the Optimized Remedy recognize that certain near shore areas cannot be dredged without a risk of undermining the shoreline. In near shore areas that cannot be dredged for this reason, the Optimized Remedy would allow sand cover or engineered caps, as appropriate, to be placed in areas that are determined to be infeasible or impracticable to dredge.

    - *Use of Engineered Capping Near Utilities and Infrastructure.* The ROD prohibits engineered capping near utilities or infrastructure. Because neither dredging nor capping can be safely implemented in these areas, the Optimized Remedy includes an option to apply sand cover near utilities and infrastructure, with specific actions to be determined on a case-by-case basis during Remedial Design.

- **Use of Sand Cover on Undredged Areas**. The ROD contemplates the use of a sand cover to manage dredge residuals; however, the ROD does not specifically authorize the use of sand cover in areas that have not been dredged. New data indicates that certain OU1 areas consist entirely of low PCB concentration sediments. Because of the limitations and tolerances of dredging, removal of such relatively low-risk sediment deposits would result in removal and disposal of a substantial volume of sediments containing PCB concentrations less than the 1.0 ppm RAL, with little or no net environmental benefit. Dredging these sediments would add significantly to the cost of the remediation, even though the risk reduction achieved thereby could be replicated by much less expensive methods.

Within many of these areas, the information developed since the ROD indicates that placement of a sand cover can reliably achieve the risk-based performance objectives of the ROD. As a result, the Optimized Remedy includes the use of sand cover as an alternative to dredging, in areas where the average PCB concentration is between 1.0 ppm and 2.0 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm.

Approximately 120,800 cubic yards of sediment (without overcut) targeted for dredging by the ROD Remedy would be sand covered under the Optimized Remedy. These sediments contain approximately 36 kilograms of PCBs in total. The average sediment PCB concentrations in these areas is 1.5 ppm. These areas constitute approximately 27% of the ROD's 1.0 ppm footprint, but contain only slightly more than 3% of the PCB mass within the footprint.

In comparing remedial alternatives and evaluating the significant process to date in OU1, it is useful to consider the following SWAC estimates:

Pre-Project SWAC (in OU1 1.0 ppm prism)	4.9 ppm
Pre-Project SWAC (in entire OU1)	1.9 ppm
Post-2007 RA SWAC	0.63 ppm
OU2 SWAC (No Action)	0.61 ppm
Post-ROD Remedy SWAC (dredging to 1.0 ppm)	0.48 ppm
Post-Optimized Remedy SWAC (w/o residual sand cover)	0.32 ppm
Post-Optimized Remedy SWAC	0.25 ppm

In addition, the following PCB mass per volume values illustrate how the Optimized Remedy focuses on the relative risk and PCB concentrations of the various OU1 areas within the ROD's 1.0 ppm dredge prism. The highest concentration areas have been dredged or will be dredged in 2007 or 2008, and the remedial alternatives for the remaining areas are based on the declining PCB concentrations of those areas:

- removed in 2004-2006: 3.5 g/cy
- removed after 2006: 1.9 g/cy
- remaining areas after completion of all dredging: 0.7 g/cy

- 0.9 g/cy in the proposed cap regions
- 0.3 g/cy in the proposed sand cover areas

For the ROD Remedy and for the Optimized Remedy, Table 2 below summarizes the areas addressed, the volumes of sediment addressed, the mass of PCBs remediated and the pre-project PCB SWAC in the areas in which each remedial component would be implemented.

Table 2. OU1 Sediment Characteristics, the ROD Remedy and the Optimized Remedy[1]

Remedial Action	Description	Area (Ac)	Volume to 1.0 ppm with 4" overcut (cy)	Volume to 1.0 ppm (cy)	PCB Mass to 1.0 ppm (kg)
Pre-Project Conditions	Entire OU	1363	---	---	---
ROD Remedy	Addresses sediments greater than or equal to 1.0 ppm, horizontally and vertically	426	928,400[2] (updated est.)	784,000 (ROD est.) 721,200 (updated est.)	1,715 (ROD est.) 1,143 (updated est.)
<u>Optimized Remedy Components</u>					
Dredge	Dredge[3]	216	406,100	296,300	843

[1] The figures presented in this table are modeled estimates, except for the dredge and residual sand cover components, which are based primarily on actual data. Because of variation between actual conditions and modeled estimates, the total acreage, sediment volume, and PCB mass projected for the Optimized Remedy vary from the acreage, sediment volume, and PCB mass estimated for the ROD Remedy.

[2] The ROD estimate did not account for overcut or high subgrade. The overcut volume of 207,200 cubic yards contains only 26 kg of PCB mass. In addition, the 928,400 cubic yard estimate is a modeled estimate and does not account for high subgrade. Based on actual dredging experience, high subgrade is estimated to reduce the total dredge volume by up to 90,000 cubic yards.

[3] Values indicated are based on actual data for the 2004-2006 RA activities and projections for the 2007 and 2008 RA activities. The Optimized Remedy includes dredging in the following areas beyond those areas already identified by the 2007 RA Work Plan: re-dredge of Sub-area POG2 and areas north of the trestle trail with residual concentrations above 5.0 ppm; 7-8 acres in Sub-area D1; 40 acres in Sub-areas D2 North, E3 South, E3 North, E4, F, and POG4 (due to propeller wash/capping constraints, based on a 6-foot post-cap water depth requirement); and 0.7 acres in Sub-area E2 (formerly, a 16-inch engineered cap area). The projections for the 2007 and 2008 RA activities do not account for high subgrade.

Remedial Action	Description	Area (Ac)	Volume to 1.0 ppm with 4" overcut (cy)	Volume to 1.0 ppm (cy)	PCB Mass to 1.0 ppm (kg)
13-inch Engineered Cap[4]	Sediment with average PCB concentrations between 2.0 and 10 ppm in top 8-inch interval, and less than 50 ppm at depth	112	325,100	265,800	229
6-inch Sand Cover	Sediment with average PCB concentrations between 1.4 and 2.0 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm	46	76,800	53,000	19
3-inch Sand Cover	Sediment with average PCB concentrations between 1.0 and 1.4 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm	68	102,000	67,800	17
Residual Sand Cover	As necessary to attain 0.25 ppm SWAC (includes 5.5 acres covered in 2007)	30	21,100	19,100	19

[4] The 13-inch engineered cap design includes 3-inch overplacement allowances in both the sand and the armor layers.

Dredging in the Optimized Remedy

By the end of the 2006 season, GW Partners had dredged approximately 210,000 cubic yards of sediment from the highest PCB concentration areas of OU1. In 2007 and 2008, the following additional areas are currently being dredged to 1.0 ppm vertically:

(1) Sub-area POG3 North;

(2) Portions of Sub-areas E4, E5, and E6 that were not efficient to cap or cover;

(3) An area adjacent to the Route 441 Bridge to allow its expansion without disturbing cap/cover;

(4) Areas with PCB concentrations greater than or equal to 50 ppm;

(5) Areas with PCB concentrations greater than 10 ppm in the top 8-inch interval; and

(6) Areas with less than 7.08 feet of overlying water and PCB concentrations in any 8-inch interval greater than 2.0 ppm, or greater than 1.0 ppm in any two 8-inch intervals (to meet minimum post-cap water depth).

Engineered Caps

Under the Optimized Remedy, caps would only be placed where stability and performance can be assured and without affecting flood capacity and recreational or navigational use of the river. Armor stone would be used to maintain cap stability during high flow events and to resist movement under the forces such as those associated with propeller wash. Design considerations include ensuring that caps would remain stable during large storm events and wind-induced waves, would be sufficiently resistant to propwash, and not be placed in areas with potential for ice scour. The cap thickness and placement are consistent with EPA and U.S. Army Corps of Engineers guidance to ensure permanence and protection of human health and the environment. These design elements meet the standards described in the EPA guidance document for physical isolation, stabilization/erosion protection, and chemical isolation. Other factors discussed in the guidance and also considered in this proposal include sediment characteristics, waterway uses and infrastructure, and habitat alterations.

In November 2006, GW Partners and the agencies established a Work Group to discuss and evaluate OU1 cap design issues. The Work Group consensus is that a 13-inch armored cap should be used to address areas with average PCB concentrations between 2.0 and 10 ppm in the top 8 inches of sediment. The 13-inch cap design will incorporate a 3-inch overplacement allowance in both the sand and the gravel layers. The Work Group discussion is ongoing and the engineered cap design will be based upon final conclusions from the Propwash and Wind-Wave studies.

Sand Covers

The Optimized Remedy calls for the placement of a 6-inch sand cover over areas with average PCB concentrations between 1.4 and 2.0 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm. Similarly, the Optimized Remedy calls for a 3-inch sand cover to be placed over areas with average PCB concentrations between 1.0 and 1.4 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm. These sand covers would be placed to reduce the exposed PCB concentrations and provide acceptable risk reduction. These sand cover areas constitute approximately 27% of the area in the ROD's 1.0 ppm footprint. From a permanence perspective, the mass of PCBs that would be remediated in this manner would be quite small (36 kilograms).

In addition, the Optimized Remedy would utilize post-dredge residual sand cover, if necessary, to assure attainment of the 0.25 ppm SWAC goal. At this point in time, it is estimated that 24.5 acres of residual post-dredge sand cover would be necessary to achieve this goal, in addition to the residual sand cover placed in 2007 (POG3 – 5.5 acres; POG2 – 3.7 acres).

Comparative Evaluation: ROD Remedy and the OU1 Optimized Remedy

This Section compares the OU1 Optimized Remedy with the ROD Remedy using the nine evaluation criteria set forth in the National Contingency Plan ("NCP"), 40 C.F.R. Part 300. The ROD Remedy itself was determined to meet each of the individual NCP criteria as shown on Table 18 of the ROD. The ROD further indicated that if certain additional requirements were met, the ROD Contingent Remedy was a viable and protective alternative to supplement the ROD Remedy.

The collection of considerable new information -- including pre-design data, data gathered during the remedial action to further delineate the 1.0 ppm areas and define sediment characteristics, post-dredging residuals data, and three seasons of experience implementing the ROD Remedy -- led to the proposed refinements of the ROD Remedy described in the Optimized Remedy. The refinements combine elements of the ROD Remedy, the ROD Contingent Remedy, and alternative remedies to fine tune the overall remedy.

Choosing the most appropriate remedy to be performed at a CERCLA site involves the review of nine criteria, which have been categorized into three sets. The first two criteria are Threshold Criteria, which are requirements that each alternative must meet. The next five criteria are Balancing Criteria, which are used to weigh major trade-offs among alternatives. The last two criteria are Modifying Criteria, which will be fully considered only after public comment is received on the Proposed Plan.

Threshold Criteria

Overall Protection of Human Health and the Environment

In the OU1 ROD, the ROD Remedy (including the ROD's Contingent Remedy, if subsequently approved) was determined by the agencies to be protective of human health and the environment. In the OU1 ROD, the agencies selected 1.0 ppm as the RAL for dredging because dredging to a 1.0 ppm RAL was believed to result in attainment of a 0.25 ppm SWAC. Based on the Risk Assessment performed for the site, a 0.25 ppm SWAC would reduce the PCB loading in the ecosystem to a point where it would naturally recover within an acceptable time period. The ROD estimated that implementation of the ROD Remedy would achieve acceptable fish tissue PCB concentrations within approximately 14 years for human receptors and carnivorous birds, with shorter time frames for organisms that are lower on the food chain.

The Optimized Remedy combines remedial elements from the ROD Remedy and the ROD Contingent Remedy (*i.e.*, dredging, post-dredge sand cover as needed to further reduce surficial concentrations, and engineered caps), plus sand cover of certain low PCB concentration areas. The components of the Optimized Remedy, taken together, will be equally or more protective of human health and the environment than the ROD Remedy.

The higher level of protection results from the improved exposure reduction components found in the Optimized Remedy. Information gained during the OU1 dredging and data collection to date shows that residual PCB concentrations occur when currently-available technologies are employed. Based upon this experience, GW Partners estimates that the post-dredging SWAC in OU1 for the ROD Remedy would be 0.48 ppm, almost twice the SWAC goal. This estimate assumes that the sediment within the 1.0 ppm dredge prism could be precisely removed. Dredging, however, cannot precisely remove sediment, meaning that the actual SWAC that would be achieved by dredging as specified in the ROD would likely be greater than 0.48 ppm.

The Optimized Remedy will achieve a post-construction SWAC of 0.25 ppm. The Optimized Remedy's various components are tailored to the different PCB concentrations found in different areas of OU1, based on post-ROD data showing that the distinctions between areas is more significant than known at the time the ROD issued. All OU1 areas with PCB concentrations above 50 ppm and with average PCB concentrations between 10 and 50 ppm in the top 8-inch interval have been or will be dredged. Remaining areas with average surficial PCB concentrations between 2.0 and 10 ppm will be capped with a 13-inch armored cap. A 6-inch sand cover will be placed over areas with average PCB concentrations between 1.4 and 2.0 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm. A 3-inch sand cover will be placed over areas with average PCB concentrations between 1.0 and 1.4 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm. Going forward, post-dredge areas with PCB concentrations greater than 5.0 ppm will be capped or re-dredged (unless operational efficiencies dictate otherwise). Finally, sand cover will be placed over remaining residuals as needed to achieve the 0.25 ppm SWAC endpoint.

Because the Optimized Remedy will be completed in less time than the ROD Remedy and will achieve a lower SWAC at the completion of construction, the Optimized Remedy is expected to reduce water column and fish tissue concentrations sooner than the ROD Remedy. While GW Partners has not completed the modeling to demonstrate the precise timeframes for each indicator species examined in the Risk Assessment, the improved timeframes would be commensurate with the improvement in the post-construction SWAC.

The Optimized Remedy will apply engineered caps and sand cover only to those areas of OU1 where the agencies agree that the probability for permanent stability and performance is acceptable, based upon analytical data and detailed engineering evaluations. The Optimized Remedy provides permanent chemical isolation and prevents future exposure to confined subsurface sediments, and also uses sand cover to reduce surficial concentrations in certain low PCB concentration areas. The technical framework for cap design has been submitted to the agencies, *OU1 Cap Design Revision No. 1 (Foth & Van Dyke October 2006)*, and is based on agency guidance to ensure protectiveness (Palermo, et al., 1998a), consistent with ROD requirements for the Contingent Remedy. Furthermore, the long-term monitoring, maintenance, and contingent response requirements associated with cap designs are included as integral parts of the Optimized Remedy to ensure continued protectiveness. Based upon these considerations, the Optimized Remedy provides for the overall protection of human health and the environment, at a level that is at least equal to that provided by the ROD Remedy.

Compliance with ARARs

CERCLA Section 121(d)(2)(A) requires that the remedial action at the site attain, at its completion, certain "applicable or relevant and appropriate requirements" ("ARARs"), which are typically set forth in local, state, and federal statutes and regulations. The ROD Remedy and the Contingent Remedy were deemed to comply with the ARARs identified. The Optimized Remedy combines elements of the ROD Remedy and the Contingent Remedy with alternate remedies, and will similarly comply with ARARs. During the remedial and detailed design phases of the Optimized Remedy, GW Partners will consider the design and operational alternatives so as to assure compliance with ARARs.

<u>Balancing Criteria</u>

Long-Term Effectiveness and Performance

Both the ROD and the Optimized Remedy provide long-term effectiveness through a combination of dredging and containment of contaminated sediments. Both remedies also require some degree of institutional control (*e.g.*, fish consumption advisories). Both the ROD Remedy and the Optimized Remedy direct that all dredged sediments be disposed of in off-site, upland landfills. After the dredging specified by the Optimized Remedy is completed, the PCB mass left in OU1 under the Optimized Remedy will be found predominantly in the following areas:

- Engineered cap areas over sediments (112 acres/229 kilograms of PCB mass;
- Sand cover areas over undredged sediments with average PCB concentrations between 1.0 and 2.0 ppm over a single 8-inch interval, with no other 8-inch interval averaging more than 1.0 ppm (114 acres/36 kilograms of PCB mass); and
- Post-dredge residual sand cover areas, as necessary to address residuals with PCB concentrations greater than 5.0 ppm (unless operational efficiencies or cost-effectiveness dictate otherwise) and/or to achieve the 0.25 ppm SWAC.

Like the ROD Remedy, the Optimized Remedy requires that any engineered caps utilized ensure the permanent containment of contaminated sediments. Cap designs will provide protective and reliable chemical isolation, and they will ensure that erosion of underlying sediment will not occur even during major erosion events, such as floods, propeller wash, wind-induced waves, and ice scour.

To ensure the adequacy and reliability of controls for engineered caps, a long-term monitoring, maintenance and contingency response plan, including institutional controls and repair (as needed) is included as part of the Optimized Remedy. The long-term monitoring plan will include a review of the physical integrity of engineered caps to verify the continued protectiveness of caps over time. Specific institutional controls necessary to ensure long-term cap integrity will be further assessed during remedial design, detailed design and development of the long term monitoring plan.

Natural recovery modeling, as reported in the Remedial Investigation/Feasibility Study, suggests that any residual sediment contamination remaining on the post-dredge (or post-cap/cover) surface will be expected to decline following implementation of either remedy, as a result of regulatory prohibitions on PCB use and manufacture, and control over resuspension of formerly contaminated sediments.

Reduction of Toxicity, Mobility or Volume Through Treatment

This criterion evaluates the use of treatment to reduce the harmful effects of contaminants, their ability to move in the environment, and the amount of contamination present. Both the ROD Remedy and the Optimized Remedy remove large volumes of PCB mass and corresponding sediment from OU1. Dredged materials are placed in secure upland landfills, which eliminates mobility altogether. Both remedies use in-place containment to eliminate mobility of any remaining PCBs. Neither the ROD Remedy nor the Optimized Remedy satisfies the statutory preference for treatment. As described in the Final Basis of Design Report for Operable Units 2-5 of the Lower Fox River site

(June 16, 2006), physical treatment of PCBs by vitrification has been determined not to be cost-effective.

Short-Term Effectiveness

Short-term effectiveness relates to the length of time needed to implement an alternative and the risks associated with implementation. Based upon experience, the ROD Remedy would take approximately 7 years to complete following the 2007 RA activities. The Optimized Remedy is expected to take approximately 2 years to complete following the 2007 RA activities.

Compared to the ROD Remedy, the Optimized Remedy can be implemented in a shorter period of time. Potential impacts on human health and the environment during remedial construction will be less for the Optimized Remedy than for the ROD Remedy. A commensurate reduction in noise, truck traffic, and interference with river activities during remediation is expected under the Optimized Remedy. With completion in approximately 2 years versus 7 years (post-2007), the Optimized Remedy will achieve protectiveness more rapidly than the ROD Remedy. Considering that the Optimized Remedy will result in a 0.25 ppm SWAC and the ROD Remedy (without considering residual sand cover or the impact of overcut) will result in a SWAC of no less than 0.48 ppm, the natural recovery after the completion of the work will progress more rapidly under the Optimized Remedy than under the ROD Remedy.

Implementability

Implementability addresses the technical and administrative feasibility of a particular remedy from design through construction and operation. Factors to be considered include the availability of services and materials, administrative feasibility, and coordination with other governmental entities. Sediment dredging, transportation, and disposal are feasible from an operational, technical and administrative standpoint, as proven during implementation of the ROD Remedy from 2004 to 2007. Similarly, as reflected in the ROD, placement of sand cover and capping materials is a readily implementable engineering activity. The availability of resources necessary for engineered caps and sand covers (*e.g.*, sand, gravel, etc.) is well-established within a reasonable distance of OU1.

From a dredging perspective, the Optimized Remedy is more implementable than the ROD Remedy, because the strain on disposal infrastructure (including landfill capacity) is lessened significantly by the Optimized Remedy. The Optimized Remedy utilizes similar technologies to the Contingent Remedy. The use of these technologies varies with water depth, PCB concentrations, and related factors, but all are readily implementable based on experiences at similar projects.

Cost Effectiveness

The analysis of costs contained in the ROD includes estimated capital and long-term monitoring costs. Cost-effectiveness refers to the relative costs of implementing remedies that would be equally protective of human health and the environment. The original present net worth calculation for the dredging, dewatering, water treatment and disposal portions of the ROD Remedy was $61.7 million to remove 784,200 cy of contaminated sediments. Post-ROD data indicates that 928,400 cy (including a 4" overcut, but not accounting for high subgrade encountered) would need to be removed to achieve the 1.0 ppm RAL set forth in the ROD.

By the completion of the 2007 RA activities, GW Partners will have spent approximately $67 million to remove approximately 380,000 cy of contaminated sediments. Using this experience as well as future cost projections, GW Partners has estimated that the implementation of the ROD's dredging remedy would cost between $138 and $150 million, not $61.7 million. The Optimized Remedy is estimated to cost between $93 and $111 million. When the costs of the future remedial work in OU1 are analyzed, the relative cost difference between the ROD Remedy and the Optimized Remedy is more dramatic. The ROD Remedy's future cost are estimated to be between $71 and $83 million, whereas completing the Optimized Remedy is estimated to cost between $26 and $44 million.

Under the ROD's comparative evaluation, the ROD Remedy was found to be cost-effective. In hindsight, it turns out that the ROD Remedy is not as cost-effective as was believed at the time of the issuance of the ROD. The Optimized Remedy presents a more cost-effective remedy than the ROD Remedy in that it is at least equally protective of human health and the environment as the ROD Remedy, but it is significantly less costly.

Modifying Criteria

State Acceptance

The Optimized Remedy will require administrative approval from EPA through a ROD Amendment. In addition, agency approval of the various design and planning documents and submittals will be required prior to the implementation of the Optimized Remedy. In the meantime, active agency participation in discussions relating to the Optimized Remedy through the Agency/Oversight Team has been occurring, and will continue, to ensure timely resolution of agency concerns.

Community Acceptance

The level of community acceptance of the Optimized Remedy will be assessed through public comments received as part of the administrative process.

Comparative Evaluation Summary

A detailed summary of the specific elements of the ROD Remedy and the Optimized Remedy, highlighting key similarities and differences, is presented in Table 3.

TABLE 3. Evaluation Criteria Comparison.

CERCLA Criteria	ROD Remedy	Optimized Remedy
Threshold Criteria		
1. Overall Protection of Human Health	YES – While the ROD predicted the ROD Remedy would achieve a 0.185 ppm SWAC, updated calculations based on data accumulated since ROD issuance indicate that it will achieve no better than a 0.48 ppm SWAC with dredging alone (assuming no overcut or dredge residuals).	YES - Will achieve a 0.25 ppm SWAC with associated level of protectiveness. Long-term monitoring and contingent response requirements will ensure that cap/cover remains protective.
2. Compliance with ARARs	YES - Expected to meet ARARs.	YES - Expected to meet same ARARs as ROD Remedy plus additional ARARs applicable to capping and sand cover. (The Optimized Remedy would meet the same ARARs as the 2007 OU2-5 ROD Amendment.)

CERCLA Criteria	**ROD Remedy**	**Optimized Remedy**
Balancing Criteria		
3. Long-Term Effectiveness and Permanence	YES - Some degree of institutional controls (*e.g.*, fish consumption advisories) are still required, but the ROD Remedy would remove at least 92% of the PCB mass in the ROD's 1.0 ppm footprint.	YES - Removes about 74% and sequesters or otherwise addresses 97% of the mass within the ROD's 1.0 ppm footprint. Capping only where stability and permanence assured. Other restrictions apply (no capping in shallow water/TSCA sediments, etc.). Long-term cap maintenance to assure permanence.
4. Reduction of Toxicity, Mobility, or Volume through Treatment	YES - Overall mobility reduction is achieved through dredging and placement in secure upland landfills.	YES - Overall mobility reduction is achieved through dredging and placement in secure upland landfills. For PCBs not dredged, mobility will be reduced via cap containment and isolation.
5. Short-Term Effectiveness	YES - Projected duration to complete the ROD Remedy is another 7 years after the completion of the 2007 RA activities, reflecting steady progress in light of dredging/dewatering infrastructure.	YES - Projected duration to complete is another 2 years after completion of the 2007 RA activities. Dredging, capping and cover should reduce surface concentrations quickly in area of remediation.
6. Implementability	YES - Services, materials, and equipment are available as demonstrated through dredging and pilot projects to date.	YES - Services, materials, and equipment are available as demonstrated through dredging and pilot projects to date.

CERCLA Criteria	ROD Remedy	Optimized Remedy
7. Total Cost	$138 - $150 million	$93 - $111 million
Modifying Criteria		
8. Agency Acceptance	YES - ROD Remedy was previously selected by EPA and WDNR.	Contingent upon approval from EPA and WDNR through an ESD or ROD Amendment.
9. Community Acceptance	YES - See public comments and responsiveness summary for the ROD.	Public comments will be solicited through an ESD or ROD Amendment process.