Document	**EPA Response to Comments from General Electric Company on Engineering Performance Standards – Public Review Copy Hudson River PCBs Superfund Site**
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Reviewer	#	Comment	Topic	Response
GE	1	First, the standards should be kept as simple as possible. If the standards can be translated into simple tasks, it will ease and quicken the implementation of the project. Simplicity also promotes transparency. The more straightforward the standard, the more easily it can be conveyed to the public and to those who must implement it. Unnecessary complexity fosters unnecessary human error. Unnecessary complexity is counterproductive.	**General** Standard simplicity	The standards have been developed with simplicity in mind. Each standard has action levels for comparison to the data collected relevant to that standard. Alternate and more complex statistical analyses could have been chosen for comparison to the residual or resuspension standards, but these options were rejected in favor of comparison to action levels. Some level of complexity must be accepted. The resuspension monitoring requirements are needed to achieve all of the data quality objectives defined for Phase 1. The actions associated with the residual standard are somewhat complex in that the average, median and individual node concentrations must be assessed, but flexibility has also been built into the standard by allowing the choice of options under certain conditions.
GE	2	Second, the performance standards are the large goals or principles that drive and guide design and operation of the project. It is important to maintain their scale and proportion to the details of the project. There should be flexibility in the detailed expression of the standards	**General** Standard flexibility	USEPA believes that the Engineering Performance Standards meet the criteria identified in these comments. The standards are as flexible as possible while meeting the requirements of the ROD.

		that recognizes and accommodates the variation of particular circumstances. The performance standards should not become a straitjacket dictating details that are at odds with common sense and varying conditions.		
GE	3	Third, the standards should be cost-effective. Cost-effectiveness is a central value of the statute. It reflects a wise and prudent use of resources. Given the size of the project, it is imperative that the standards be designed to allow their implementation in the most efficient manner possible at reasonable cost. Elements that are not required to ensure that the standards achieve the project goals should be removed from the standards. We do not suggest that these three objectives should be attained at the cost of compromising the primary goal of ensuring that the standards protect human health and the environment. Rather, they can guide the development of the standards, making sure that the standards are as simple, flexible and cost-effective as possible while still achieving their central goal. The ROD establishes an additional requirement for the standards that flows from the pioneering nature of the remedy selected for the Hudson. Because much of what is being proposed here has never been attempted or achieved before, Phase 1 must be a vigorous test to determine whether the performance standards can be attained on a consistent basis and whether the standards will ensure that the human health and environmental objectives of the ROD will be achieved. One can look to other remedial dredging projects to estimate whether resuspension will be as low as the Environmental Protection Agency (EPA) projects, whether dredging	**General** Cost-effectiveness	The primary cost associated with the standards is monitoring of the residual sediment and the water column. Detailed justification for each element of the monitoring programs has been provided in the standards. Suggested modifications to the monitoring plans will be considered by USEPA as long as achievement of the data quality objectives is not compromised. The analyses conducted during the development of the performance standards indicate that the remediation can be conducted successfully and in compliance with the standards. Each standard has been developed to be realistic, flexible and address the factors that have caused problems on other projects. The residual standard makes allowance for difficult to dredge areas that may have elevated post-excavation concentrations allowing areas to be capped where at other sites repeated and fruitless dredging attempts were conducted. The resuspension standard has tiers of action levels to monitor the level of dredging related releases culminating in the MCL. Temporary halting of operations is required for exceedence of this level, but because the average water column concentration must

		can effectively achieve the low residual concentrations demanded by the standards, and whether, in light of the resuspension and residual standards, the project can be completed within the time allotted in the ROD. Until Phase 1 is underway, such estimates are only informed speculation. Consequently, a major theme of these comments is the necessity of recognizing the great uncertainty of attempting to determine, before the remedial design is completed and before there is any dredging experience in the Hudson, whether it will be feasible to meet the performance standards on a sustained basis. In fact, experience suggests that achieving all three standards simultaneously is unlikely.		exceed this level for one day, modifications to the operations can be made during that day, decreasing the likelihood that the standard will ever be contravened. With the results of modeling analyses and case study review and the careful planning put into the development of these standards, it is likely that a well-designed and implemented remediation will succeed in achieving all three standards simultaneously.
GE	4	GE is in agreement with the statement of the standard and the need to limit resuspension to 500 ng/L at far field stations in order to protect water quality at drinking water sources. There are several improvements that should be made to simplify the standard and reduce the cost of demonstrating that it has been met.	**Resuspension** Standard	See the response to comment 5. A cost estimate on the Resuspension Standard monitoring program is provided in a white paper attached as part of USEPA's response.
GE	5	First, the four Action Levels should be reduced to three. This would eliminate redundancy and eliminate burdensome, costly and unnecessary obligations. Under this alternative structure, exceeding the first level standard would indicate that dredging is not performing up to expectations, and an engineering evaluation should be conducted. Exceeding the second level standard would indicate that dredging is approaching unacceptable resuspension, and engineering controls need to be implemented. The third level would be the Primary Standard, the exceedence of which would result in project shut down until PCB concentrations in the water are reduced to acceptable levels.	**Resuspension** Action levels	USEPA believes that it would be inappropriate to reduce the number of Action Levels in the Resuspension Standard prior to the Phase 1 dredging. The resuspension criteria of the Resuspension Standard are essential to accomplish the Phase 1 objectives. The revisions proposed by the writer will not provide all of the needed data to address the Phase 1 concerns. The monitoring requirements for Phase 1 have two major goals: to confirm compliance with the Resuspension Standard and to obtain data to better understand the

				nature of dredging-related resuspension. As stated in the ROD: [P 62] The first phase will be the first construction season of remedial dredging. It will include an extensive monitoring program of all operations. …The information and experience gained during the first phase of dredging will be used to evaluate and determine compliance with the performance standards. Further, the data gathered will enable EPA to determine if adjustments are needed to operations in the succeeding phase of dredging, or if performance standards need to be reevaluated. [P iii] The data EPA gathers…will be used to evaluate the project to determine whether it is achieving its human health and environmental protection objectives… These objectives clearly call for an extensive monitoring program in Phase 1 to document PCB releases related to all aspects of dredging and not just the dredging operation itself. Many components of the dredging operation have the potential to resuspend PCBs, including debris removal, boat traffic, etc in addition to the dredging itself. In recognition of this, USEPA has designed a standard comprised of four Action Levels wherein increasing degrees of PCB release prompt more frequent collection of water samples to document the scale, timing and

				source(s) of the PCB releases. The lowest Action Level above baseline conditions (the Evaluation Level) represents a level of PCB release that is three times the best engineering estimate for a full scale operation derived from an analysis of other dredging sites. This is also the threshold at which dredging-related releases should be discernable over the baseline PCB load variations. During Phase 1, dredging is expected to proceed at roughly half the full scale level. Thus, this Action level is already "generous" in terms of the amount of PCB release that can occur before prompting additional monitoring (i.e. three to six times the best engineering estimate for Phase 1). Additionally, this Action Level (300 g/day) is set at half of the long-term release rate allowed by the Standard (600 g/day Total PCB or 130 kg/year Total PCB). Thus data gathered when PCB releases exceed this threshold will aid in identifying PCB release mechanisms and potential problems. This information in turn will aid in keeping long-term release conditions at acceptable levels. The PCB load criterion of the Evaluation Level is needed to characterize dredging-related releases against the best engineering estimate. The Concern and Control Action Levels serve a similar purpose, prompting additional data collection in response to higher or longer periods of PCB release. These latter Action Levels also prompt more

				frequent sampling to provide assurance of water quality for downstream water use. Taken together, the Evaluation, Concern and Control Action Levels, along with the Standard threshold, will serve to document the nature and sources of PCBs related to dredging while also documenting the safety of water for downstream users. With regard to the Concern Level, the level proposed for elimination by the writer, the criteria for this level represent the maximum allowable PCB release rates on an annual basis as well as suspended solids criteria intended to prompt additional PCB monitoring. This level is needed to both identify when average conditions exceed the desired maximum release and to prompt further examination of operations in response to this condition on more than a once per month basis. In designing the standard in this fashion, the USEPA intended to proactively direct the development of the Remedial Design. Specifically, by knowing the acceptable levels of resuspension and PCB loss, the remedial operation can be designed to meet or exceed these requirements. In this fashion, frequent exceedences of the various action levels can be avoided, helping to minimize monitoring costs as well as disruption to the dredging operation.

				While it may be possible to drop the Evaluation Action Level and simplify other action level requirements at the end of Phase 1, it will only be as a result of the data set obtained during Phase 1. This data set should provide a much greater understanding of dredging-related PCB releases and thus enable improved control of PCB releases during Phase 2. In addition to keeping the current structure of the resuspension criteria, the individual revisions to the various criteria proposed in the table provided by the commenter are not improvements. The far-field TSS criteria for the Evaluation and Control Level are necessary in order to ensure that releases at these levels do not go unnoticed. The far-field TSS criteria prompt more monitoring to provide information on the dredging operations. The 12 and 24 mg/L criteria would represent fairly muddy water, in which case it would be important to know whether or not these conditions are associated with high PCB levels from dredging. The TSS criterion as part of the Evaluation Level in the channel and 100 meters downstream is essential to understanding the influence of barge traffic as well as to document near-field TSS conditions Additionally, it is not clear which of the near-field monitoring locations will provide the most reliable indicator of sediment

				resuspension. These requirements are appropriate for Phase 1 where one of the objectives is to understand the release mechanisms and establish better monitoring practices. Modifications to the monitoring and action levels may be made based on the results of Phase 1. A near-field TSS exceedence prompts more sampling at the far-field to capture any solids plume that is caused by persistent non-routine operations. The persistent non-routine operations may potentially be causing exceedences of the Resuspension Standard (and therefore the MCL set by the Safe Drinking Water Act), which may be missed by the daily grab samples. This warrants an increase in sampling at the far-field stations. The Total PCB 350 ng/L criteria for the Control and Concern Levels are appropriate since without the data from Phase 1 there is no information about the variations that may be experienced in the water column concentrations at the far-field. Therefore it is not appropriate to set the criteria at a prediction limit. Furthermore, the use of a running average concentration is easier to implement in the field. Lastly these criteria are also necessary to discourage dredging operations from running consistently at such a high resuspension level.

				The PCB mass loss criterion is important to the health of the lower river. These criteria are necessary to ensure that the dredging operations are protective of the fish body burdens downstream. The revisions suggested in the comment would result in the Resuspension Standard being based on only a consecutive sample rather than a confirmed occurrence or the result of the 24-hour deployment of an integrating sampler. This suggestion is not appropriate due to the uncertainties associated with the baseline variations, sampling activities, and lab analyses.
GE	6	Second, the scope of the monitoring program can be reduced and simplified while still providing the information needed to assess compliance and select an appropriate response in the event of exceedence. EPA's proposed monitoring requirements are far from more extensive than any previous program used to monitor environmental dredging. We believe that the monitoring would be difficult to implement, and we estimate that the base monitoring program could cost more than $6 million over a six-month dredging season or approximately $40 million over the six years of project. Moreover, some elements of the monitoring program are not clearly related to determining the cause of high water column PCB concentrations that might result from dredging or defining corrective action responses.	**Resuspension** Monitoring program	USEPA believes that the scope of the monitoring program is appropriate for Phase 1 and, in particular, disagrees with the cost estimate asserted in the comment. The cost of the monitoring is highly dependent on the quality of the design and operations. The cost will be dependent on the action level maintained. Compliance below the Evaluation Level requires almost a quarter less sampling than at the Control Level. Therefore, proper design and diligence during operations will significantly reduce the cost of monitoring. In addition, the monitoring plan for Phase 1 may not be maintained throughout Phase 2 and cannot be used as the basis for estimating the Phase 2 costs. Many elements of the Phase 1 program are designed to provide information

				on aspects of remediation, such as release mechanisms, dissolved phase releases and the TSS and turbidity semi-quantitative relationships, therefore once the information is obtained and reviewed it is likely that the monitoring plan will be reduced. An estimate of the analytical and labor costs for implementing the monitoring plan in Phase 1 is provided in an accompanying white paper. In order for the monitoring to determine compliance with the resuspension criteria, the sampling program outlined is necessary for Phase 1. The need for each element of the monitoring plan is discussed in Attachment G. Phase 1 is data collection-intensive because this information will address questions raised during the Reassessment RI/FS period, including the degree to which dissolve phase PCBs are released during the remediation. Furthermore, these data will be used to develop semi-quantitative relationships between turbidity and TSS and to examine how the TSS concentrations relate to the Total PCB concentrations observed downstream. The turbidity would provide a real-time measurement of resuspension and potential PCB release. The monitoring program is comprehensive, but proper use of the information has the potential to substantially reduce the monitoring requirements (and associated costs) during

				Phase 2.
GE	7	Improvements that should be made include: • Reducing substantially the frequency of the near-field TSS sampling, which is duplicative of other data being collected and extremely expensive to collect, and instead using turbidity monitoring, which can be correlated with TSS. • Replacing the sampling teams required to collect discrete PCB samples during all times of dredging operations with ISCO monitors for PCBs, which provide data of equivalent utility and would make monitoring far simpler, safer and less expensive. • Eliminating separate monitoring for dissolved and particulate PCBs.	**Resuspension** Frequency-Parameters	USEPA believes that it would be inappropriate at this time to reduce the frequency of TSS sampling. As noted throughout the text, TSS sampling only is required at a high frequency if a TSS-Turbidity relationship is not found prior to Phase 1. Development of such a relationship is strongly encouraged by the USEPA, as also noted in the text. In order to develop such a relationship, a laboratory study will be necessary prior to Phase 1. TSS sampling may be relaxed in Phase 2, if the relevant studies are successful during Phase 1. Any automatic sampler utilized must meet the data quality objectives. In particular, the DQOs require discrete samples, cross-section sampling and the grab samples must be filtered immediately after collection under non-routine monitoring (see response to GE comment 11, below). USEPA also believes that it would be inappropriate to eliminate the sampling for both dissolved and particulate PCBs, where required by the Resuspension Standard. As stated in Appendix A of GE's comments, "the evaluation of water quality impacts cannot rely solely on the volumetric concentrations of particulate PCBs, but also must consider the TSS and dissolved PCB concentrations." In Attachment G, the Resuspension Standard notes that the calculations performed to determine the

				primary mechanism of release need to be verified in order to be certain that the goals of the ROD can be achieved (long-term recovery of the river, protection of the environment and human health). This will be accomplished by the split phase sampling (*i.e.*, both dissolved and particulate phases will be measured) for PCBs at the two far-field stations closest to the dredging operations. Note that this requirement only applies when one of the resuspension criteria is exceeded; it is not required as part of routine monitoring.

GE	8	Improvements that should be made include: • Reducing the number of near-field stations at each dredge location from six to four.	**Resuspension** Number of Stations	USEPA believes that the number of far-field stations specified in the Resuspension Standard is necessary. See response to GE comment 19.
GE	9	This proposed standard can be improved, particularly by reducing the amount of re-dredging and thus increasing the likelihood that the production rate standard can be met. Re-dredging inevitably slows the dredging production rate, and experience from other projects shows that, after the initial dredging pass, it is often very difficult to achieve very low PCB concentrations in the remaining sediment through continued re-dredging. Moreover, particularly in a project that requires backfilling or capping, it is doubtful that continued re-dredging would provide a material environmental benefit. The performance standard implicitly recognizes this by providing that, in a number of circumstances, re-dredging is not required and that backfilling/capping is an appropriate means to address the residual PCBs.	**Residuals** Redredging	USEPA recognizes that re-dredging decreases the production rate. This interaction between the Residuals and Prodictivity Standards serves as an inherent incentive both to establish the correct cutlines during design and to conduct the dredging operations with precision and accuracy. Re-dredging is only required when the mean concentration in a certification unit is above 6 mg/kg Tri+ PCBs or individual node concentrations exceed the established PL action levels. In these instances, the first dredging attempt may not have removed the inventory. The re-dredging attempts are limited to only those nodes with concentrations exceeding the standard, reducing the time required to re-dredge.
GE	10	GE urges two changes in the standard to address these facts – one that would apply in Phase 1 and the other relating to the use of Phase 1 data to re-evaluate the dredging sequence for Phase 2. First, GE recommends that the dredging, sampling, re-dredging sequence set out in the proposed performance standard be modified in two respects to reflect the fact that field personnel may be able to forecast reliably	**Residuals** Re-dredging and capping Dredging, sampling and redredging sequence in residual	USEPA agrees that there may be subbottom sediment conditions that are not amenable to dredging, such as rocky areas that are not otherwise excluded from the remediation as set forth in the 2002 Record of Decision. During Phase 1, the Residuals Standard will require two re-dredging attempts at all locations; the gathered data will reveal site-specific conditions that may be problematic.

		whether re-dredging in a particular local area, such as one with a rocky or uneven bottom, will be productive in reducing contaminant concentrations in the residual sediment. When the residual sediment is above an average of 6 ppm Tri+ PCB, the proposed standard currently calls for two re-dredging passes before accepting capping/backfilling. We urge that the standard be revised to provide that: (1) after the initial dredging, the EPA field personnel should have the discretion, based on consideration of local conditions, to waive the requirement of the first re-dredging pass; and (2) after the first redredging attempt (if required), the contractor should have the discretion, based on local conditions, to cap or backfill the dredged area instead of being required to make a second redredging pass. The backfill standard of 0.25 ppm Tri+ PCB would still need to be attained. Our second suggestion relates to the use of the data collected in Phase 1 to evaluate whether the dredging, sampling, re-dredging sequence can be modified for Phase 2. Specifically, we urge that the standard explicitly recognize that the Phase 1 data should be used to evaluate whether that sequence can be modified for Phase 2 to reduce or eliminate the need for post dredging sampling and re-dredging in those circumstances where it can be shown that re-dredging does not provide a material or worthwhile environmental benefit.	standard.	In Phase 2 USEPA will consider modifications to the re-dredging requirements such that areas showing little or no improvement following re-dredging may have the two re-dredging pass requirement reduced or removed. USEPA believes that it must consider site-specific data in determining whether the requested modifications to the Residuals Standard are appropriate. USEPA agrees that a review of the data on re-dredging should be conducted during or subsequent to Phase 1. If the data support a revision to the standard's requirements for re-dredging, USEPA will consider such a revision at that time. USEPA does not expect that such a revision would be possible during Phase 1, due to the inherent delays in assembly and analysis of the data. The requirement for post-dredging sampling will not be removed from the Residuals Standard because it is a measure of the effectiveness of the remediation.

GE	11	Our comments also suggest other means for simplifying the proposed standard and making it easier to implement. These include measuring compliance based solely on the average concentration criteria and allowing more flexibility in certain sampling details.	**Residuals** Sampling criteria and details	See responses to GE 48 and GE 50.
GE	12	We address two issues with regard to this standard. The first relates to the requirement that during Phase 1 240,000 cubic yards be dredged. Consistent with the ROD, GE believes it is more appropriate to specify a range of volumes for Phase 1 – between 150,000 and 300,000 cubic yards (cy), with a target of removing 240,000 cy. This will allow greater leeway in designing Phase 1 to be an appropriate test of the standards. The size of Phase 1 should be in the range above and determined during design to ensure that Phase 1 will be a fair test of the performance standards.	**Productivity** Volume requirement	The purpose of Phase 1 is not to test the Engineering Performance Standards. Rather, the data gathered during Phase 1 will be used to compare the dredging operations to the performance standards, and to evaluate necessary adjustments to the dredging operations in Phase 2 or to the standards. Although provisions for modifying the standards are included in the text, consistent with the 2002 ROD, a failure to meet these standards also will prompt an evaluation of the dredging operations. The selection of 240,000 cubic yards of dredging for Phase 1 is based on the fact that this would be an adequate amount to demonstrate that the design could, in fact, meet the Productivity Performance standard of 480,000 cubic yards per year for Phase 2, while still allowing sufficient time during Phase 1 to fine tune dredging, dewatering, water treatment and loading systems and make adjustments to the design, as necessary. Phase 1 is not a pilot study--it is the first year of the dredging project, conducted at a reduced scale. The 240,000

				cubic yard standard for Phase 1 is consistent with the intent of the ROD. For these reasons, USEPA believes it is appropriate to retain and apply the Productivity Standard for Phase 1.
GE	13	Second, GE believes that it is highly uncertain that the production rate standard can be met. The performance standard should clearly and candidly express the significant uncertainty regarding the feasibility of attaining the standard, particularly in light of the competing demands of the other standards to minimize resuspension and achieve low residual concentrations. While GE recognizes the effort EPA has made in its feasibility analysis, it is only a paperwork exercise. This issue can only be resolved by detailed design and experience gained during Phase 1.	**Productivity** Production rate	USEPA believes that the Productivity Standard can be met, in conjunction with the two other standards, by designing a system with adequate safeguards and having contingency plans available to be put into effect when problems are encountered. Discussions with dredging companies, dredging consultants, and a review of other projects indicates that it is possible to meet the production rates used in developing the example production schedule included in the Productivity Standards. In fact, the production rates used in the example schedule are considered to be conservative. At the Calumet River in Gary, Indiana, US Steel Corporation is working to remove 750,000 cubic yards of sediment from February to December 2003, and currently has a production rate of approximately 70,900 cubic yards per month using two hydraulic dredges. In comparison, the Productivity Standard requires a production rate of about 480,000 cubic yards in 7 months, which is approximately 68,600 cubic yards per month. Representatives of the environmental dredging industry state that the estimated 2.65 million cubic yards can be removed from the Upper Hudson

				River in even less time than the ROD allows. Consistent with the 2002 ROD, USEPA will evaluate the results from Phase 1 to determine whether changes are necessary to the dredging operations or to the standards in Phase 2.
GE	14	GE's review of EPA's feasibility analysis, moreover, shows that it relies in many places on either unrealistic or highly optimistic assumptions. For example, the analysis achieves the required production rate by using more and more dredges on the project, requiring for extended periods as many as 10 production dredges operating simultaneously. Yet the analysis does not examine whether it will be possible to unload, treat, transport and dispose of the large quantities of sediment being removed at these peak production rate periods. These factors affect production as much as the rate of dredging itself. Indeed, GE calculates that, to achieve EPA's example schedule, there will be periods when the following conditions will exist: • 58 vessels will be using a five-mile stretch of the Thompson Island Pool (TIP) simultaneously. Up to 9 barges may be unloading sediment at the treatment facility at the same time. • More than 9,000 tons/day of sediment will be loaded onto and transported in more than 90 rail cars/day. The analysis relies on the following unrealistic or overly optimistic assumptions: • Overestimating the production rates of the dredges. • Assuming that weather conditions will allow work to continue into late November or December	**Productivity** Production rate	The analysis assumes that a site will be selected that has sufficient area for construction of the facilities needed to unload scows, dewater sediment, treat excess water and load railcars at the rate needed to achieve the Productivity Standard. GE's comments are unclear as to how the company calculated its estimate of more than 9,000 tons per day of sediment. Assuming 1.5 tons per cubic yard of dewatered sediment, this would amount to 480,000 cubic yards in 80 days. In contrast, the probable working season is 210 days long. Thus, the tons per day would be calculated as 480,000 x 1.5/210 =~3400 tons per day, not 9000. It is expected that a temporary stockpile of dewatered sediment would contain up to 20,000 cubic yards or so. The temporary stockpile area should have sufficient capacity to permit a relatively steady flow of material off of the site rather than a widely fluctuating volume from day to day. As to the length of the operating season, USEPA does not consider an operating

		in the Upper Hudson. • Assuming that the quality of life standards will allow full scale operations to continue through the night and into the weekends. • Underestimating the time required for clean-up re-dredging. • Ignoring the difficulties of conducting dredging in the land-locked and non-navigable portion of the river.		season of 210 days to be an unreasonable assumption. Preliminary work can be done as soon as or even before the canal opens during the first week of May and cleanup work can continue after the normal canal closure during the first week of November. The normal canal operating season is 26 - 27 weeks and should be able to be extended to 30 weeks assuming that provisions are made to work in one pool of the river for the last 3 to 4 weeks, or to provide for operating the locks after the normal closure date. The quality of life standards that USEPA is developing will place limits on such parameters as noise and lights. The Engineering Performance Standards do not place any restrictions on hours or days of dredging operations. USEPA expects that this information will be included in the design documents to be submittted by General Electric Company pursuant to the Administrative Order of Consent for Remedial Design. In the absence of this design information, the example schedule in the Productivity Standard schedule as developed assumes for operations six days per week, which is typical for operations of this scale. The Residual Standard calls for two re-dredging attempts. It is assumed, based on an evaluation of case study information and the equipment used in the example schedule, that this can be done in 50% of the time it

				took to do the original dredging or less. The time spent in re-dredging will depend upon the extent of re-dredging needed, the type of equipment selected, and a host of other variables. However, production dredging is not expected to cease everywhere while re-dredging occurs in some areas. The volume of sediment to be dredged from the landlocked and non-navigable portion of the Upper Hudson is less than 3 percent of the total and should not have a major effect on the schedule.
GE	15	Whether the production rate can be met is highly uncertain, and it will remain uncertain until design is completed and a concerted effort to meet the proposed standard is made during Phase 1. We do not advocate spending time on further hypothetical analysis of the proposed production rate, but rather urge EPA to modify the performance standard document to acknowledge this uncertainty and the importance of Phase 1 to determine if the standard can be attained.	**Productivity** Production rate	The Productivity Standard allows for revision based on new information being developed during design and after Phase 1. USEPA believes that the plan for refinement of the Standard, as described in Section 4.0 of the document, addresses the concerns raised in this comment. USEPA will evaluate the results of Phase 1 to determine if changes are necessary to the standards or to the dredging operations in Phase 2.
GE	16	Finally, while the performance standard documents contain a very brief discussion of the interaction of the performance standards, there remains significant uncertainty regarding the ability to meet the three standards simultaneously. To our knowledge, this is the first environmental dredging project that will be constrained by three such standards, and there is no experience on which to base a conclusion that all three	**General** Standard Interaction Phase I reevaluation	The three separate standards have been formulated to provide flexibility to the designers. Case studies of other projects show that each of the individual standards can be met with proper design and equipment selection. Based on its work in developing and testing the Engineering Performance Standards, USEPA believes

		can be met at the same time. It is clear that attempts to reduce resuspension and achieve low residuals will increase the time needed to complete the work. The interaction among the standards must be put to a vigorous test in Phase 1. There is a clear possibility that substantial changes will have to be made in the performance standards or the project design after the completion of Phase 1. If major changes are required after Phase 1, a central question will be whether the resulting project is still the same project, which EPA selected in the ROD. Cost is a significant issue here. If the costs are significantly higher than those assumed in the ROD, a reevaluation of the remedy will be necessary. Clearly, performance standards that protect human health and the environment should be maintained, but an aggressive effort to find alternative, less expensive approaches would be required.		that all three can be met simultaneously. Consistent with the 2002 ROD, USEPA will evaluate the Phase 1 results to determine if changes are necessary to the performance standards or to the dredging operation sin Phase 2. Consistent with USEPA guidance, the accuracy of the cost estimate in a Feasibility Study is expected to be minus 30% to plus 50%. USEPA believes that its estimated cost of the remedy is within this range, but will not speculate as to what, if any, decisions would be appropriate in the event that the actual cost of the remedy exceeds the estimates in the Feasibility Study and ROD.
GE	17	GE agrees with the adoption of a zero-tolerance “primary” standard (set at the drinking water standard) and lower “trigger” thresholds requiring corrective action to prevent exceedence of the primary standard.	**Resuspension** Threshold values	Comment noted.
GE	18	The Action Levels should be reduced from four to three to simplify implementation of and reduce redundancy in the standard. This can be accomplished by eliminating	**Resuspension** Reduce the number of action	USEPA does not believe that the resuspension criteria should be modified as suggested in the comment. See the response

		the “Concern” Level: • The first level would be the “Evaluation” level, which would indicate the project is not performing to expectations. In response, an engineering evaluation would be conducted. • The second level would be the “Control” level, which would indicate that resuspension is a problem. In response, engineering controls would be required. • The last level would be the Primary Standard, the exceedence of which would result in a temporary shut-down of the project.	levels	to GE comment 5.
GE	19	The number of near-field stations around each work area should be reduced from six to four by eliminating the stations within the containment area and 100 meters downstream	**Resuspension** Number of Stations	USEPA does not believe that sufficient data exist to justify reductions in the Phase 1 monitoring program prior to the start of the remedial operations. The Phase 1 monitoring program is intended to obtain a sufficiently extensive data set that may then be used as the basis to reduce monitoring in Phase 2 while still ensuring compliance with the Resuspension Standard. A more efficient and cost-effective monitoring program cannot be devised with the current level of knowledge regarding dredging and sediment resuspension since site-specific data are not available for this purpose. Further reductions in the program risk the failure to collect sufficient data to properly describe dredging-relating river conditions and thereby yield an insufficient data set to confirm compliance with the standard. Also at risk is the data necessary to correlate near-field and far-field conditions since it is not clear at this time

				which of the near-field locations will be most useful. Recognizing this, the Phase 1 program is designed to identify the most useful monitoring locations while also describing the dredging-related river conditions in general. With the data set to be collected on the limited dredging program scheduled for Phase 1, reductions in the Phase 2 monitoring program are expected to be supportable. An additional important purpose of the near-field monitoring data is to provide real-time feedback between the amount of sediment resuspended and the dredge operator's actions. This feedback loop has a great potential to reduce dredging releases at the dredge, rather than relying on control mechanisms such as silt barriers. It is not clear which of the required near-field stations will be most valuable and thus all of the stations will be retained until such an evaluation can be made. With regard to the specific reductions stated in the comment, the 100 m location is required because the extent of any plume downstream from the containment is unknown and would be tested by the results from this station. Monitoring data from within the containment area is expected to correlate with data from the external near-field as well as the far-field stations and may also indicate the source of a dissolved phase release. This information also will be useful

				if the residuals concentrations are elevated despite having a dredging design that is appropriate for the area, indicating a failure to sufficiently control TSS within the containment area.
GE	20	Near-field TSS sampling will be difficult, hazardous, and expensive to implement. The goal of measuring excessive near-field resuspension can be met through turbidity sampling. The TSS criteria should be replaced by turbidity criteria, and TSS sampling should be reduced to a short period at the beginning of Phase 1 to determine a correlation between TSS and turbidity.	**Resuspension** TSS Frequency	USEPA does not believe that the near-field TSS sampling will be overly difficult, hazardous or expensive. A reasonable semi-quantitative relationship between turbidity and TSS would preclude the need for frequent TSS sample collection. Therefore the costs could be reduced significantly. TSS sampling will only be required at a high frequency if a semi-quantitative relationship between TSS and turbidity is not established prior to the inception of Phase 1. The monitoring requirements currently outlined for Phase 1 include TSS sampling on a daily basis. This is necessary because it will be essential to verifying the semi-quantitative relationship. Verification is necessary to demonstrate that the semi-quantitative relationship is correct for all sediment types and real dredging conditions (as opposed to simulated laboratory conditions). The data specified are necessary to achieve the objectives of Phase 1. Pending the results of Phase 1, USEPA may revise the sampling requirements (see Section 4.0 of the Resuspension Standard). The collection of TSS samples will not be especially hazardous, because the collection

				points are at a reasonable distance from the remedial operations. Therefore, the hazard should not be greater than the design sediment sampling.
GE	21	Daily far-field PCB sampling under routine monitoring (the frequency of which increases as the Action Levels are ascended) should be replaced with the simpler, safer to operate, and less expensive ISCO samplers, which can achieve the goal of measuring PCB concentrations.	**Resuspension** ISCO PCBs	Any automatic sampler utilized must meet the data quality objectives. In particular, the DQOs require discrete samples, cross-section sampling and the samples must be filtered immediately after collection under non-routine monitoring.
GE	22	Separate monitoring for dissolved and particulate PCBs is unnecessary and should be eliminated.	**Resuspension** PCB preparation	USEPA does not agree that monitoring for dissolved and particulate PCBs is unnecessary. Refer to response to GE comment 7.
GE	23	Engineering contingencies should remain flexible.	**Resuspension** Engineering contingencies	Comment noted.
GE	24	The Case Studies do not demonstrate the feasibility of achieving the resuspension standard.	**Resuspension** Case studies	Every Superfund site represents a unique setting, with different hydrologic and geological conditions, different discharge histories and site-specific contaminants. The various sites examined provide examples of the types of conditions that may be encountered in the Hudson. It is not reasonable to expect other sites to provide identical or near-identical conditions, as suggested by the comment. However, taken together, these sites demonstrate the feasibility of achieving the important aspects

				associated with targeted environmental dredging in the Upper Hudson. For example, the TSS data at various sites show that low rates of TSS release are achievable, with PCBs primarily associated with solids. Low TSS concentrations translate into low Total PCB concentrations.
GE	25	2.2.1 THE ACTION LEVEL STRUCTURE SHOULD BE SIMPLIFIED The Action Levels have the goal of identifying and correcting "remediation-related problems well before the resuspension standard threshold is reached" (Section 1.1.2, page 3). This goal is accomplished by specifying criteria indicative of a problem and mandating engineering evaluations or controls to alleviate the problem. Appropriately, the standard does not spell out what the engineering controls will be; that decision requires knowledge of the cause of the problem. However, the proposed four-level structure is more complex than is necessary to achieve the goal. It should be changed to ease implementation and to achieve the goal of the standard more cost-effectively. We urge that the Concern Level be eliminated. This level is redundant, as evident from the similar descriptions of engineering contingencies called for in it and the Evaluation Level (Section 3.4, page 83). Moreover, its value is questionable, as it only requires more monitoring as opposed to steps directed to finding a fix to the problem. Thus, it can be eliminated without reducing the effectiveness of the standard. This would result in a three-level structure that exhibits a clear and distinct function at each, as described below and displayed with numerical detail in Table 3-1:	**Resuspension** Reduce the number of action levels	USEPA does not believe that the resuspension criteria should be modified as described in the comment. See the response to GE comment 5.

		1. The Evaluation Level would be a resuspension rate that, while not posing a public health risk or a substantial threat to the expected benefits of the project, would indicate the project is not performing up to expectations. Consistent with good engineering practice, an engineering evaluation should be conducted to determine if the project can be reasonably modified to improve performance. 2. The Control Level would be a resuspension rate that is problematic – *i.e.*, indicating that there is a real risk that the drinking water standard would be exceeded or that the benefits of the project might be substantially reduced. At this level, engineering controls would appropriately be mandated to achieve a reduction in PCB release. 3. The Primary Standard would be the trigger to halt operations. If this level is exceeded, dredging would need to stop until engineering changes have been made.		
GE	26	The Action Level Structure should be further simplified and improved by eliminating or altering elements of the resuspension criteria in the following manner: 1. The net far-field TSS criteria should be removed from the Evaluation Level. The proposed criterion of 12 mg/L is the TSS level calculated to be associated with a PCB concentration equal to the Primary Standard of 500 ng/L (Section 2.3.2, page 53). As such, it is not indicative of the level of release associated with the Evaluation Level. At the same time, however, lower PCB releases will be associated with TSS levels that may be indistinguishable from baseline conditions (Section 2.3.2, page 53). Thus, far-field TSS is not an effective metric for triggering the Evaluation Level.	**Resuspension** Far-field TSS criteria should be removed.	USEPA believes that reducing the number of action levels would not improve the Resuspension Standard. The far-field TSS evaluation criteria is important as a means of prompting additional PCB monitoring when suspended solids indicate the possibility of a large PCB release. Additionally, the data collected also should help establish a relationship between real-time measurements of TSS and concentration of PCB at the far-field. Development of this relationship can result in a reduction of the monitoring requirements for PCBs in Phase 2, which would be inappropriate before site-specific data are available.

				This criterion provides a real-time indication that the best engineering estimate or release from the dredge area has been exceeded. As such, this is appropriately placed at the Evaluation Level, although the level of release corresponds to the Resuspension Standard. USEPA recognizes the uncertainty associated with the development of the TSS criteria; therefore, it would be inappropriate to require actions based on lower solids concentrations. This level is a safety net. PCB levels are likely to approach various control levels before TSS reaches 12 mg/L, but some confirmational PCB samples need to be obtained if TSS concentrations are at or above these levels. Backfill operations in particular may cause elevated TSS concentrations without elevated Total PCB concentrations, but this must be confirmed.
GE	27	2. The PCB concentration criterion for the Control Level should be made more effective. The proposed four-week running average PCB concentration of 350 ng/L may not be effective because the Primary Standard of 500 ng/L likely would be triggered before this criterion is exceeded. For example, historical variability indicates that the chance of having at least one sample with a concentration exceeding 500 ng/L when the four-week average is 350 ng/L is 81% (if sampling once per day) and 99% (if sampling four times per day). Because variability during dredging is likely to be greater than the historic variability and high concentrations are likely to be autocorrelated, assuming historic variability	**Resuspension** Resuspension Standard will be exceeded before Control Level	USEPA believes that the 350 ng/L Total PCB criteria will be effective, due to the requirements for demonstrating an exceedence of the Resuspension Standard. An average of 350 ng/L Total PCB can be maintained without the violation of the Primary Standard and resulting temporary halting of operations, because the Primary Standard is a confirmed occurrence of 500 ng/L Total PCB. The average of the initial elevated concentration and the four samples collected on the following day must be greater than 500 ng/L Total PCBs for the

		probably underestimates the likelihood of triggering the Primary Standard. A reasonable replacement for the running average would be to specify a probability threshold that would indicate that the Primary Standard of 500 ng/L might be exceeded. For example, a seven-day running average and variance could be used to compute the probability of a concentration of 500 ng/L. If that probability exceeds some defined value, say 10 percent, the second (Control) Level would be triggered.		standard to be exceeded. As long as the operations were assessed and modified immediately, it is unlikely that the elevated concentrations would persist. This may be more difficult to control during times with elevated baseline levels, but maintaining concentrations below 350 ng/L Total PCB should be readily achievable. USEPA will consider the suggestion made in the comment regarding a seven-day running average when it evaluates the Phase 1 results.
GE	28	3. The methodology for calculating net PCB flux should be improved. First, the method proposes subtracting construction and baseline PCB concentrations rather than fluxes. This can be problematic because it implicitly assumes that the construction and baseline flows are the same, which may not be true. Second, the concentrations used in the calculation are the mean for construction and the 95th percentile upper confidence limit (UCL) for baseline. The best estimate of the difference between construction and baseline is the difference between means. The uncertainty of the means can be used to determine whether that difference is likely to have occurred simply by chance. Such an approach should entail the following: conduct a statistical test to determine if the difference between the mean construction flux and the mean baseline flux is statistically significant. If a significant difference exists, calculate the resuspension flux by subtracting the mean baseline flux from the mean construction flux.	**Resuspension** Flux should be used instead of concentration	Baseline concentrations were developed from the water column data collected in the previous five years under a variety of flow conditions. In most months, the PCB concentration is largely independent of flows. The baseline value chosen is the UCL, which may be somewhat elevated given the variability in the data sets. The proposal in the comment of using a means test is a reasonable alternative, but more difficult to implement in the field than comparing the daily values to a table. In addition, the construction mean concentrations are for the 7-day running average, and not individual values.

GE	29	2.2.2.1 REDUCE THE NUMBER OF NEAR-FIELD STATIONS AT EACH WORK AREA EPA's sampling plan includes an upstream station, a station inside the containment system, and three downstream stations - one 100 meters downstream and two 300 meters downstream. The utility and necessity of the station inside the containment system are unclear. Data from this station are not used in evaluating the standard. Moreover, given the dynamic nature of the process and the movement of equipment within the containment system, data from a single location inside the containment area will be difficult to interpret. Data from the station located 100 meters downstream would be difficult to interpret because of the significant spatial and temporal variability in turbidity that is likely to exist so close to the dredging operation. Imagine an air sampling station close to the stack of a power plant. The plume from the stack is like a snake and the station will sometimes be in the heart of the plume while at other times it will be completely outside the plume. EPA's model indicates that the dredging plume will be only about 30 meters wide 100 meters downstream. The two stations 300 meters downstream are better located to evaluate resuspension. The plume will have spread to a much greater extent (EPA's estimate is that it will be about 50 meters wide), reducing the importance of the "snaking," and the use of two stations will better capture the average conditions. Both the station inside the containment system and the station 100 meters downstream of the containment system should be eliminated.	**Resuspension** Number of Stations	The near-field monitoring program outlined in the Resuspension Performance Standard is appropriate for Phase 1, which focuses on both compliance and characterization of the dredging operations. There is no basis to state whether 100 or 300 meters will provide a better indication of the plume TSS concentrations without the results from Phase 1. Modifications to the sampling locations may be made based on the results of Phase 1. It is not appropriate to reduce the number of stations in the near-field, since all the locations as currently specified are necessary for the purposes of Phase 1. See the response to comment 19. The lateral dispersion coefficient determining the spread of any dredge related release is not known with great certainty and may vary over several orders of magnitude. Variation in this parameter will determine the width of the plume at downstream monitoring locations. It is likely that the plume will have sufficient width that the monitoring locations will be able to measure representative turbidity and TSS concentrations. The degree of lateral dispersion is partially dependent on flow thus different plume widths can be expected at each monitoring location due simply to daily flow variation. As discussed in

				Attachment D of the Resuspension Standard, the coefficient used in the modeling was derived from the equation set forth in Fischer (1979) for lateral dispersion in a bounded channel and the RMA2 estimates for linear velocity and depth. Since the lateral dispersion and width of the plume are dependent on flow (as indicated by the depth term in the equation 2 in Attachment D), there is no basis on which to limit sampling to 100 or 300 meters. It is expected from the modeling and practical experience that the 100 m location is more likely to yield useful data if the settling velocities are typical of other dredging sites while the suspend solids concentration at 300 m should be at background conditions. Frequent adjustment of the monitoring location may be required to consistently capture any resuspended solids plume.
GE	30	**2.2.2.2 NEAR-FIELD TSS SAMPLING CAN BE REDUCED** Under the proposed standard, continuous monitoring of turbidity at five stations around each work area and one station within the work area (if barriers are installed) is to be supplemented by discrete water sampling for TSS determination one hour before dredging begins for the day, every three hours during dredging and each hour for at least two hours after dredging ceases at each station. This proposed near-field TSS monitoring will be difficult to implement, poses significant safety issues, and is extremely expensive. Given that there	**Resuspension** TSS Frequency	USEPA does not believe that it would be appropriate at this time to reduce the near-field sampling plan. The near-field sampling plan necessary: the frequency and number of stations are required to accurately indicate excessive resuspension. These requirements arise from the proximity of the heterogeneous PCB concentrations in the near-field, and frequent variations in conditions in the near-field during dredging. As described in detail in the Resuspension

		may be as many as ten work areas in the river, this level of monitoring would require that as many as 480 TSS samples be generated seven days per week (10 work areas x [1 sample before dredging + 5 samples during dredging + 2 samples after dredging ceases for the day] x 6 stations per area x 7 days). The proposed standard would require that the results of each TSS analysis be available within three hours of collection. To collect these samples would require multiple field crews operating for 16 to 18 hours per day and one or more 24-hour on-site laboratories. We estimate that this would cost \$25,000 to \$30,000 per day. Moreover, it would put field crews in harm's way. The processing of a TSS sample in the laboratory takes about two hours. Thus, the field crew would have one hour from the time the first sample is taken to collect five additional samples, return to shore and deliver the samples to the lab. Realistically, the crew would have to spend at least 5 minutes at each sampling location and would require at least 5 minutes to travel between stations and anchor the boat on station. Thus, little time would exist for the crew to return to shore and deliver the samples. The crew would have to operate at such a speed that mistakes and accidents are likely to occur. This concern is exacerbated by the fact that the sampling crew would be navigating amongst a fleet of work boats, frequently after dark. The work would be inherently dangerous, and an alternative must be found. The standard includes TSS monitoring for two reasons. First, the Evaluation and Control Action Levels include near-field net TSS concentrations of 100 mg/L (River Sections 1 and 3) and 60 mg/L (River Section 2) 300 meters downstream of the work area and 700 mg/L 100 meters downstream of the work area or to the channel		Performance Standard, the higher levels of monitoring will be unnecessary if the turbidity-TSS relationship is established prior to Phase 1. This may be done by laboratory studies. The study must be rigorous and determine the semi-quantitative relationships for all expected sediment types including sediment found at depth. If the relationship is not established prior to Phase 1, the TSS data will be used to both assess compliance with the standard and to develop the semi-quantitative relationship. This relationship must be developed to account for differing sediment types that can alter the relationship: coarse, fine, surficial, at depth, etc. The data collected as a part of the baseline monitoring program can be used in developing the semi-quantitative relationship, but is not sufficient because the response of the deeper sediment will not be represented and the range of concentrations will be much smaller than can be expected during the remediation. Some level of TSS monitoring will be needed to determine if the semi-quantitative relationships are predicting the TSS concentrations with a reasonable amount of accuracy. The monitoring requirements currently outlined for Phase 1 include TSS sampling on a daily basis. This is necessary since it will be essential to verifying the semi-quantitative relationship. Verification is necessary to exhibit that the semi-quantitative relationship is correct for all sediment types and real dredging conditions (as opposed to

		side of the work area. Second, the nearfield TSS monitoring provides a relative assessment of the resuspension occurring among the various work areas and evidence useful in tracking down the cause of an Action Level exceedence due to PCBs. The TSS criteria should be replaced by turbidity criteria, which can serve the same goals. Doing so would require the conversion of TSS to turbidity. While that conversion that would be subject to some uncertainty because of the less than perfect correlation that is likely to exist between these parameters, studies have demonstrated that turbidimeters can be used successfully to estimate TSS concentrations (Suk et al., 1998). Examples include: USGS in San Francisco Bay (Buchanan and Ruhl, 2001); Port Authority of Jamaica in Kingston Harbor (Technological and Environmental Management Network, LTD, 2002); and Minneapolis-St. Paul Metropolitan Council Environmental Services (MCES) in Minnesota River (Personal communication, Cathy Larson, Metropolitan Council Environmental Services, Minneapolis-St. Paul, MN, June 12, 2003). For the Kingston Harbor study, a linear relationship between TSS and turbidity was found, with a correlation coefficient of 0.97 (*i.e.*, R2). On the Minnesota River, MCES personnel determined that a log-linear correlation existed between TSS and turbidity, with R2 values of 0.90 for TSS < 50 mg/L and 0.64 for TSS $>$ 50 mg/L. If a reasonable correlation is obtained in the Hudson, any noise in the turbidity-TSS relationship likely will be unimportant in view of the manner in which the TSS criteria were developed. The 100 mg/L and 60 mg/L values were chosen based on the calculation that they would be indicative of "a Total PCB concentration exceeding 350 ng/L at the far-field station." (Section 2.3.2, page 52). The estimation relies		simulated laboratory conditions). Furthermore, it is not anticipated that ten work areas will be concurrently operating during Phase 1. After Phase 1 the TSS monitoring requirements will be reevaluated. As discussed in the comment, site specific semi-quantitative relationships have been developed for a number of sites and this may be possible for the Hudson River. Semi-quantitative relationships have not been successfully developed at all sites. Continuous particle counter measurements at the far-field and daily near-field measurements will be required to provide a possible alternative real-time measure of TSS and perhaps a better means of correlating TSS and turbidity, should turbidity measurements fail to adequately predict TSS concentrations. The particle counter data will also be useful in confirming theories on resuspended particle size. The collection of the TSS samples is possible, and not especially hazardous. Please refer to response to GE comment 20. The TSS resuspension criteria were developed using the available models. These criteria may be refined after the results of Phase 1 are obtained and reviewed. It is not currently feasible to "pinpoint measurements" of TSS associated with

		on several approximations that make the resultant TSS numbers ballpark estimates, rather than pinpoint measurements, of the levels likely to be associated with a particular PCB level at the far-field stations. Moreover, the fact that turbidity provides a continuous record of approximate TSS levels justifies its use despite any noise that might exist in the TSS-turbidity relationship. Turbidity monitoring will also satisfy the need for a monitoring tool useful for assessing which of the work areas likely is responsible for a PCB release that triggers an Action Level. It will provide an excellent relative assessment of the work areas. The proposed standard allows for the use of turbidity in place of TSS if paired TSS/turbidity data are found to yield a strong correlation. However, it requires that daily TSS monitoring be continued to provide "confirmation of, or correction to, the correlation [between TSS and turbidity]." (Section 3.3.2, page 75). We believe that this continued monitoring is unnecessary, particularly in light of the lack of precision in the derivation of the TSS criteria and the sufficiency of relative assessments in identifying the cause of high PCB releases. Thus, the TSS sampling should be reduced to a short period at the beginning of Phase 1. Paired turbidity and TSS data will be generated during the baseline monitoring program to support an initial correlation. A daily TSS sampling frequency during the initial stages of the dredging operation will be sufficient to generate data quickly to support a correlation applicable during dredging. Each work area would generate five or six samples per day. Within two weeks, a data set of 70 to 84 paired turbidity-TSS measurements would be available from each work area. Given the rough nature of the TSS criteria, there would be little need to continue the daily TSS monitoring once		particular PCB far-field concentrations, as suggested in the comment. However, the modeling does provide a basis to develop the TSS criteria. The amount of TSS samples and work crews necessary will depend on the Remedial Design. As yet there is no way to specify how many TSS samples would be taken a week if a rigorous turbidity/TSS semi-quantitative relationship is achieved. Furthermore, it should be noted that the current monitoring requirements apply to Phase 1, during which production is not anticipated to be full scale. Therefore it is likely that the number of samples (based on 5-6 crews) provided in the comment is more than will be needed for Phase 1. A cost estimate for the required sample collection effort for the Resuspension Standard is provided in an attached white paper.

		a correlation has been established. Periodic sampling at a subset of the stations at the time the turbidity meters are serviced will be sufficient to confirm that the correlation remains valid. In addition, continuous monitoring of suspended particulates using particle counters should be eliminated. While continuous turbidity monitoring is standard practice for evaluating dredge-related resuspension, suspended sediment particle counters have not been used and their feasibility has not been demonstrated in any of the relevant Case Studies cited in Appendix C to these comments. The LISST particle counters cited in Appendix F require the development of a calibration curve against known TSS measurements in much the way that turbidity monitors do. As part of this calibration, assumptions about particle density will need to be made to convert volume of particle per volume of water measurements to standard TSS measures – *i.e.*, mass of solids per volume water. Given the uncertain relationship between PCBs and TSS and the ability to correlate turbidity with downstream PCB transport, suspended sediment particle counters are duplicative and unnecessary.		
GE	31	2.2.2.3 PCB SAMPLING METHODS AND FREQUENCIES SHOULD BE CONSISTENT The standard does not use a consistent frequency or method for assessing compliance with the Primary Standard of 500 ng/L; frequencies and methods differ depending on which Action Level is in force. Under routine monitoring, where samples are collected daily, the Primary Standard would be exceeded when two samples taken 24 hours apart show concentrations greater than 500 ng/l. This time span declines as the Action Levels are ascended to a period of six hours at the Control Level. Moreover, the samples under routine	**Resuspension** PCB method and frequency	The frequency for each action level is appropriate for each criterion and the acceptable tolerance for each criterion. That is, more samples are required for the more stringent criteria because the results must be known with more certainty. This is described in detail in Attachment G of the Resuspension Standard. The different frequencies and sampling methods reflect the shift in the purpose of sampling at higher action levels. During operations at the Evaluation and Concern Levels, the

		monitoring are discrete, whereas the samples under the Control Level are 6-hour composites of hourly samples. Different sampling frequencies and methods leads to an inconsistent measure of what constitutes an unacceptably high PCB concentration as one moves through the Action Levels. This inconsistency should be fixed by using a uniform sampling protocol whose frequency is sufficient to provide an accurate assessment of the average PCB concentrations passing a far-field station during the day. This can be done most effectively with automated sampling, given the logistical difficulties and safety concerns inherent in round-the-clock sampling. ISCO samplers should be deployed and used to collect samples over less than a 24 hour period. These samplers could be serviced once a day, and a daily composite sample could be created for PCB and TSS analysis. Daily composites are better to assess compliance with the resuspension standard. They provide a highly conservative metric on which to base a comparison to the 500 ng/L drinking water standard since the drinking water standard is based upon long-term intake. Deployment of ISCO samplers would allow removal of the following elements of the proposed monitoring program, thereby making it simpler and easier to implement: • Confirmation sampling to assess the adequacy of discrete sampling. • The PCB analysis requirements at the Control and Resuspension Standard Action Levels (20 congener-specific PCB analyses per day; 18 of which are on 24-hour turnaround – in addition to the PCB analyses conducted at other routine monitoring stations and the roughly 40 PCB analyses per week conducted to support the PCB residual performance standard), which are		monitoring will provide data on the mechanisms of dredging related releases. During operations with excessive resuspension (*i.e.* Control Level or Resuspension Standard) the increased monitoring requirements are necessary for determining compliance. Alternative sampling constructs that will achieve all of the DQOs of the project will be acceptable. As stated in response to GE comment 21, any automatic sampler utilized must meet the data quality objectives. In particular, the DQOs require discrete samples, cross-section sampling and the immediate filtering of split phase samples after collection for non-routine monitoring. USEPA disagrees that the items listed in the comment could be removed from the sampling plan if automatic samplers were able to meet the data quality objectives and were utilized. Due to quality assurance considerations it is unlikely that confirmation sampling would or should be removed. Grab samples, whether collected by individuals or with an automatic sampling device, will be required during Phase 1 to have discrete measurements of water concentration. The PCB requirements at the higher resuspension action levels are necessary to assure compliance with the Resuspension Standard. Lastly, the samples

		potentially infeasible to collect. Discrete sampling at downstream stations in an attempt to track the same water parcel (a futile effort given short-term flow variability and dispersion). In addition, this change would alleviate the safety concerns associated with discrete water sampling at night and make the program simpler by eliminating the need for rules to determine when sampling frequency could be reduced following the triggering of an action level. Daily average PCB and TSS concentrations and continuous turbidity monitoring at each of the far-field monitoring stations, in concert with continuous turbidity monitoring at the nearfield stations would provide a robust data set on which to initiate an investigation of the cause of unacceptably high PCB concentrations.		must be collected to represent the dredging period. That is, samples from an affected water parcel at each far-field station must be collected. Without consideration for time-of-travel between the remedial operations and the representative far-field station, false low values may be obtained and potentially large releases may go unidentified. Time of travel considerations are not as strictly applied to all stations because the sampling is not required to track the same parcel of water but simply to monitor during the passage of an impacted water parcel. There are several incorrect statements in this comment. • The Primary Standard would not be exceeded when two samples taken 24-hours apart show concentrations greater than 500 ng/l Total PCB since the first sample over 500 ng/L Total PCB would increase the sampling so that 4 samples were taken the second day. Therefore, there would be 5 samples over 48 hours. The average of the 5 samples must exceed 500 ng/L. The Total PCB concentration in the integrating sampler that is deployed for 24-hours once a sample concentration exceeds 500 ng/L Total PCBs is another important measurement to determine if the Resuspension Standard has been exceeded. • Automatic samplers deployed and

				used to collect samples over less than a 24-hour period may not be conservative unless they can be deployed to represent the entire river cross section. Before the data from Phase 1 is available there is no way to know what sort of variations will be exhibited in the water column. • The residual sediment sampling and analyses requirements are not the same. In particular, it is likely that a less expensive and less complex PCB analysis will be required for these samples. Furthermore, there is no requirement that the residual samples and the resuspension samples be sent to the same lab. Nonetheless, it is noted that GE contracted labs are currently processing 300 samples per day, as compared to the approximately 30 sample per day requirement for exceedence of the Resuspension Standard. • The PCB analyses requirements given for the Control Level and Resuspension Standard are incorrect. The Control Level involves 19.5/day with approximately 18 on a 24-hour turnaround and the Resuspension Standard involves 30/day with 128 on a 24-hour turnaround. • Time of travel sampling was shown to be possible during the sampling performed as part of Phase 2. The standard only requires that a parcel of

				water that has been impacted by the remediation be sampled, which is far less demanding than the Phase 2 sampling. Most of the far-field samples will be collected at the bridges and dams and should not pose a safety concern. • Grab samples are necessary to provide information on dissolved and suspended matter PCB distributions in the regions closest to the dredge as a diagnostic tool to define the nature of the PCB release mechanism.
GE	32	2.2.2.4 SEPARATELY MONITORING FOR DISSOLVED AND PARTICULATE PCBs IS UNNECESSARY The proposed monitoring plan requires that separate analyses of dissolved and particulate PCBs with 24-hour turnaround be conducted once a problem has been identified. This requirement has the potential to stress laboratory capabilities, and the generated information may or may not be helpful or necessary, depending on the nature of the problem. If the cause of the problem is obvious from the existing data, there would be no need to know the phase distribution of the PCBs. Decisions regarding data collection beyond the base program should be left to the team investigating the problem. With real-time knowledge of the situation, they will be in the best position to design specific investigative sampling programs. Therefore, the requirement to conduct separate analyses of dissolved and particulate PCBs can be dropped from the proposed monitoring program without impacting its efficacy.	**Resuspension** PCB preparation	USEPA believes that separate analysis of dissolved and particulate phase PCBs is appropriate in certain circumstances. The Resuspension Standard requires sampling beyond the routine monitoring when there is an exceedence of the resuspension criteria. The additional sampling frequency will provide critical information on the magnitude of the additional release as well as its temporal extent. These requirements can be put in place now without additional input from the Remedial Design because they essentially represent the minimum level of sampling required to document and diagnose any PCB release above routine conditions. This is further documented in Attachment G of the Resuspension Standard. When split phase sampling is required, PCB releases are well beyond those anticipated by best engineering estimates. In these

				instances it is essential to document the nature of the PCB release (*i.e.,* dissolved phase or suspended matter phase release). While theoretical arguments indicate that any release ought to be suspended matter-based, data in the literature suggest that there may be significant dissolved phase releases. This split phase requirement is only invoked when the action levels are exceeded, and not under routine monitoring. Thus there is no additional burden when PCB releases are kept to a minimum. Additionally, the requirement is restricted to the two major stations in the Upper Hudson, TI Dam and Schuylerville, which are sufficiently close to the dredging to measure differences in dissolved and suspended matter fractions due to the released. Finally, this requirement is intended to provide data during Phase 1 on the nature of significant PCB releases that can be used to determine whether it should be dropped for Phase 2. Like the increased sampling frequency for action level exceedences, the requirement for split phase analyses is considered the minimum level of data collection for diagnosis of the type of release. It is expected that sampling in addition to the split phases will be required as well. This additional sampling would be specific to determining the source of the excessive releases as required by the Resuspension Standard in the form of engineering studies.

				The basis for this requirement stems from the desire to use TSS as a surrogate for elevated PCB levels. To the extent that significant PCB releases are associated with TSS, these split phase samples will show a predominantly suspended matter–bound PCB distribution in the water column. In this case, TSS can provide a useful surrogate. If the PCB releases are shown to be predominantly dissolved phase-derived (predominantly dissolved in the water column), then TSS would not provide a useful surrogate and additional PCB monitoring may be necessary, even under routine conditions. Note that this sampling may never be required if the dredging-related releases remain below the resuspension criteria. Although the turn-around time is short for a subset of the water column samples, the quantity of samples is not large as compared to the current sediment sampling effort. As part of the current effort, individual laboratories routinely process 60 samples a day. The water column monitoring requirements would only begin to approach half this daily rate when the 500 ng/L Total PCB standard has been exceeded (30 samples/day) and this would only be required for a 24 to 48-hour period. Exceedence of the next highest criterion would require the analysis of 20 samples per day, or about one-third of the current sediment sample throughput. This includes

				all the split phase samples required by the standard. The concurrent sediment samples requirements do not substantively change this assessment. With roughly 50 acres to be dredged in Phase 1 (10 percent of the total area), this represents 10 5-acre certification units. With a 30 week dredging season, this would yield one unit to be sampled every 3 weeks during Phase 1, producing an additional 40 samples per certification unit. If all the samples were to be analyzed in a single day and river conditions had recently exceeded the Control Level this would yield a rough combined total of 60 samples for the one day, the current rate of throughput for an individual lab. If the dredging were to be completed in 15 weeks, this would yield one 60-sample day every 1-1/2 weeks instead of every three weeks. Note that this occurs only if the river remains above the Control level for the entire Phase 1 period. In actuality, the volume of samples is likely to be much lower. Essentially the number of daily samples increases as follows (beginning with the routine requirements and ending with the requirements for exceedence of the Resuspension Standard): 5.5 to 10.5 to 15.5 to 19.5 to 30 samples per day. While the USEPA recognizes that the analytical time requirements are greater for the water column samples, the number of samples that

				would be analyzed at even the highest frequency is manageable given the current laboratory capacities employed for the Design Support Sediment Sampling. Upfront planning to ensure that there is sufficient laboratory capacity is essential.
GE	33	2.2.3 THE ENGINEERING CONTINGENCIES SHOULD REMAIN FLEXIBLE The performance standard document contains a description of engineering contingencies that should be considered if an Action Level is exceeded. Engineering contingencies are recommended for consideration at the Evaluation and Concern Levels and required at the Control Level and Primary Standard. The performance standard identifies a number of possible engineering contingency studies and defers actual implementation details to the remedial design. That is appropriate, since the standard should be flexible enough to allow field engineers to diagnose and remedy potential resuspension problems without the burden of a prescriptive engineering studies program. Similarly, the resuspension performance standard identifies a number of possible containment technologies but appropriate leaves implementation details to the remedial design.	**Resuspension** Flexibility in engineering contingencies	Comment noted. See the response to comment GE 30.
GE	34	Nonetheless, we have concerns about two of the engineering contingencies discussed in the document – the selection of alternative dredges and the modification of the dredging sequence to avoid high PCB concentration areas. First, selecting an alternative dredge that is not already on hand is an unrealistic response to an exceedence of the standard. The operational and equipment modifications identified in the standard include a list of equipment modifications that may be implemented to	**Resuspension** Dredge type	Alternate dredges were suggested because this is a preliminary stage of the project where different equipment and operational techniques can be demonstrated. USEPA acknowledges that the equipment selection will occur during the Remedial Design. However, alternate dredge selection is included as a possible engineering option but not a requirement. None of the engineering

		reduce the resuspension of sediments and associated PCBs. This list includes identifying and selecting a new dredge that might achieve a lower resuspension rate. This is inappropriate. Dredging equipment will be selected during remedial design, when there will be adequate information to consider all the relevant factors in dredge selection. Field assessments under tight time constraints are unlikely to result in selection of a dredge that will improve the ability to meet the resuspension standards. Furthermore, the availability of alternative dredges on standby, which would be needed in order to implement operational and equipment modifications, is unrealistic; while there may be opportunities to optimize the application of specific dredges, this is best done during design and not through the unjustifiably costly luxury of having a fleet of "stand by" specialty dredges ready to step in at a moment's notice. The design will specify the best type of dredging equipment for the specific dredge areas. If the results of Phase 1 indicate that dredge types should be changed, the change can be made for Phase 2.		contingencies are mandated by the standard except additional monitoring requirements and temporary halting of operations. It is not without possibility that more than one dredging technology will be assessed, tested or utilized for this project. Modifications to the remediation can be enacted during or after Phase 1, as needed. The design will attempt to specify the best type of dredging equipment, but if the Phase 1 results show that an incorrect selection has been made, it would be unproductive to not alter the design to correct for the unplanned results.
GE	35	Second, modifying the dredging sequence as part of the operational modifications to meet the resuspension performance standard is inappropriate. The list of operational modifications includes an option for altering the dredging sequence of areas dredged to avoid remediation of highly contaminated areas during times of the year when background water column PCB concentrations are high. This would lead to "leap-frogging" over more contaminated areas, which would increase the potential for downstream contamination of previously remediated areas when one returns to dredge the skipped areas. Indeed, the performance standard document acknowledges that "dredging should	**Resuspension** Dredge Sequence	These engineering conditions were listed as possible actions that might be taken, but the engineering contingencies that are deemed appropriate for the project will ultimately be selected as part of the Remedial Design. The recommendation arises from the fact that dredging the more contaminated areas during times of elevated background conditions could lead to exceedences of the action levels and should be avoided if possible. The dredging schedule will need to be flexible enough to cope with this issue and comply with the resuspension criteria.

		generally proceed from upstream to downstream or the associated resuspension will recontaminate remediated areas" (page 87). PCB resuspension from dredge areas of higher sediment PCB concentrations will need to be addressed as part of the remedial design. Skipping over such areas only to return later in the dredging season poses too great a risk of recontaminating downstream areas dredged during the interim period.		As noted, it is recommended that the dredging generally proceed downstream, but this may not always be possible. Good control of resuspension would limit the recontamination of downstream areas.
GE	36 A	2.2.4 THE STANDARD MAY NOT BE ACHIEVABLE ON A CONSISTENT BASIS The performance standard document presents case studies and near-field modeling to show that the proposed resuspension standard can be met. A closer look at the studies and modeling shows that there remains substantial uncertainty as to whether the standards can be achieved on a consistent basis.	**Resuspension** Case studies	The Case Studies were used as examples. None of the studies examined was used to provide specific estimates for the conditions in the Hudson River. Rather, the studies provided examples of the export rates achieved and the various conditions that could occur during dredging. In the case studies the monitoring plans, sediment concentrations/classifications, the nominal flows and weather conditions were different than those anticipated in the Hudson River. The case studies do not provide perfect templates and therefore they were not used as such. However, when taken together, these sites demonstrate a consistent level of site clean-up and resuspension release. The Resuspension Standard as developed does not require a greater degree of control for resuspension than that achieved by other remedial efforts. Other case studies were also examined but either there was not enough information concerning resuspension or conditions were too dissimilar.

GE	36 B	2.2.4.1 CASE STUDIES EPA examined three case studies to determine the rate of PCB release during dredging that might be expected in the Upper Hudson River: 1) GE Hudson Falls; 2) New Bedford Harbor Hot Spots; and 3) Fox River SMU 56/57. PCB losses for these studies are reported at 0.36, 0.13, and 2.2 percent, respectively. EPA states that the 2.2 percent from the Fox River SMU 56/57 case study is an overestimate of PCB resuspension during dredging; the other two field estimates are similar to model predictions and are considered valid (Section 2.2.2, page 17). Although the USGS calculation of 2.2 percent at the Fox River is subject to uncertainty, it is not appropriate to dismiss this result in favor of those from the other two case studies. Indeed, the other case studies are subject to much greater uncertainty because the monitoring programs were much less rigorous than the Fox River studies.	**Resuspension** Case studies	As discussed previously in the Responsiveness Summary for the ROD (USEPA, 2002) and in section 2.2.2 of the Resuspension Standard, there are many reasons why the field estimates for the Fox River are considered overestimated. Mainly the proximity of the monitoring locations did not allow for export to be reliably calculated. The sampling locations were located too close to the operations, and therefore export estimates from these samples did not account for settling. The samples taken in the cross sections were not combined in a representative manner to constitute the entire load. Finally, the holding time between sample collection and sample separation into dissolved and particulate fractions is unclear, confounding conclusions with regard to dissolved and suspended loads. Despite these reservations, a rate of loss equivalent to 2.2 percent was used in the modeling analysis shown in Attachment D (Please refer to Table 31). A short-term 2.2 percent export rate (over days to weeks) would not cause exceedences of the Resuspension Standard (*i.e.,* 500 ng/L) in any of the river sections. Furthermore according to the models, a release of 2.2 percent would only represent a concern for the 350 ng/L Total PCB criteria in River Section 2 due to the higher sediment concentrations. However, according to the modeling this resuspension rate would

				represent loads greater than 600 g/day Total PCB, thus prompting additional sampling and possibly additional engineering controls if these levels are sustained. The Resuspension Standard has been designed to allow for occasionally large loads without prompting immediate cessation of the operation. Best estimates and case studies from other sites indicate that sustained high levels of release are unlikely and therefore that the standard as developed is achievable. The Fox River data were not entirely dismissed (please refer to the above response to GE comment 27), however there were circumstances involving the monitoring locations and filtering times that precluded confidently determining the export rate. Thus although the sampling program may appear to be more rigorous, the concerns with the procedures yield greater uncertainties than some of the other sites examined. (Please refer to the White Paper – Resuspension of PCBs During Dredging in the Responsiveness Summary for the ROD).
GE	36 C	The GE Hudson Falls case study relies on weekly data near or below the detection limit and a back-of-the-envelope estimate of PCB mass dredged to calculate PCB loss. More importantly, there is no assessment of the differences in the type or magnitude of dredging that	**Resuspension** Case studies	USEPA believes that the Hudson Falls project is appropriate for inclusion in the analysis of dredging resuspension. For the Hudson Falls dredging project, PCBs were present in the NAPL form as well as on

		occurred at Hudson Falls and what will take place in the larger Hudson project. The Hudson Falls project is fundamentally different from this project, removing less than 1,000 tons of sediment using a clam-shell from shore in a backwater area of the river. It is inappropriate and misleading to use the Hudson Falls project to attempt to demonstrate the feasibility of achieving the resuspension standard.		sediments. The presence of this NAPL PCB has the potential to escape on its own or to supersaturate the water column. As a result the anticipated release and export rates should be higher than that expected from sediment resuspension alone. The mass of sediment removed from Hudson Falls was provided by the NYSDEC and the average PCB concentrations were taken from cores in the dredged area. Even if the calculations of the mass were off by a factor of two, the export rate would still be less than 1percent. PCB export at this rate would not exceed the Resuspension Standard in any river section, based on the modeling analysis. Furthermore, the export rates estimated for the Hudson Falls site represent upper bounds on the losses due to dredging because of the historical sources between Bakers Falls and Rogers Island, (*i.e.,* the Hudson Falls and Ft. Edward facilities). While the baseline is considered relatively well constrained as a result of controls implemented by GE at Hudson Falls, the addition of PCBs by the GE facilities was still occurring at the time, thus potentially adding to the total load and yielding an overestimate of the export from the Hudson Falls site. The Hudson Falls site itself is located along the river bank just above Bakers Falls, an area partially protected from the strongest flows but not a complete backwater. While the DNAPL discharges served to add a significantly higher level of PCBs, this area

				accumulated sediments and PCBs much the way other areas do downstream. Thus the area addressed at the Hudson Falls facility is similar to many of the areas likely to be dedged downstream, making the dredging observations appropriate for inclusion here. Overall, the conditions noted for the Hudson Falls dredging project suggest that its conditions were likely to have been much worse than those to be encountered on the Hudson. The means of estimating loads represents a conservative approach and thus provides a useful upper bound on the actual PCB export. For these reasons it was a useful site for inclusion in the analysis for the resuspension standard. As noted in the above, these studies are not expected to be comprehensive templates for dredging in the Hudson since the conditions of dredging (operations, engineering contingencies, etc.) may have been different from those to be used on the Hudson. The case studies are used to show that dredging operations at other sites (even in the Hudson) have had success with minimizing export through various techniques and engineering contingencies
GE	36 D	The New Bedford Harbor Hot Spot case study also has issues that limit its usefulness for extrapolating potential	**Resuspension** Case studies	USEPA does not agree with the comment regarding the New Bedford Harbor Hot Spot

		resuspension levels that might occur in the Hudson. That project was hampered by high background PCB levels, and the analysis failed to compare data properly. When an appropriate data comparison is conducted, the data indicate that both dissolved and particulate PCB concentrations increased by about 50 percent downstream of the dredge and dissolved phase PCB concentrations remained elevated to the most downstream sampling station (see Appendix A to these comments).		case study. The comment mentions the Hot Spot case study (Report on the Effects of the Hot Spot Dredging Operations, USACE, 1997) but then appears to refer to the Pre-Design Field Test Dredging Technology Evaluation Report (USACE, 2001) in Appendix A. It should be noted that the field test was not used to estimate a resuspension rate. Rather data from the longer dredging program as measured at the Coggeshall Bridge was the basis for the PCB export estimates. PCB loss rates in the study referred to by the writer could not be estimated due to lack of flow data.
GE	36 E	Numerous factors contribute variability and uncertainty to the release rate of PCBs during dredging: water body type (*i.e.*, river versus a shallow tidal estuary such as New Bedford Harbor); current velocities; sediment characteristics; PCB concentrations targeted for removal; dredging technique; and dredging production rate. This is evidenced by the two order of magnitude range in PCB release rates reported in Table 2-2 of the performance standard document.	**Resuspension** Case studies	Comment noted. The various factors that must be taken into account specific to this site will be discussed during the Remedial Design. The Remedial Design should provide contingencies and dredging techniques to deal with these site-specific factors.
GE	36 F	In addition to the three studies examined in detail, Table 2-2 reports PCB loss rates of 3.5 to 14 percent for the Fox River Deposit N study and states that "Average Daily Percentage Loss varied over dredge season based on dredge location and uncertainty associated with PCB removal estimation." A fifth case study at Manistique River (not included in Table 2-2) showed that the PCB loss was about 5.9 percent (GE, 2001). Given the variability and uncertainty of the PCB loss estimates, it	**Resuspension** Case studies	As noted in the White Paper – Resuspension of PCBs During Dredging in the Responsiveness Summary, the Fox River studies were complicated by the location of the monitoring stations and by older dredging technology (at Area N) With respect to Areas 56/57 (as noted in the RS for the ROD), "….[t]he fact that significant loss of PCBs only occurred when the

		is unreasonable to rely on the case studies to conclude that a 2.2 percent release rate (the highest rate of loss considered in the EPA modeling analysis) overestimates PCB releases that may occur during dredging in the Upper Hudson River (Section 2.2.2, page 17).		dredging area was close to the sampling cross-section suggests that settling of any resuspended matter occurs within a short distance of the dredging operation. Only when the monitoring location was close to the dredging could this signal be found. This suggests that the loads obtained by this study do not represent PCB released for long-distance transport. Rather, the PCBs appear to be quickly removed from the water column a short distance downstream. As such, it is inappropriate to use these results to estimate downstream transport from a dredging site." Furthermore, as discussed in the White Paper, the higher resuspension rates may also be a result of the dredge used in these operations. In fact, the New Bedford pilot study compared the sediment resuspension characteristics of a horizontal auger dredge (used in Fox River) with a conventional hydraulic cutterhead suction dredge and found a disparity similar to that observed between the Fox River and average source strength estimates. An additional concern for the Area N study relates to its small size. Only slightly more than 100 lbs of PCBs were removed, suggesting that operations were too small to become routine. Much of the loss may have been associated with start-up. It is likely that the larger project on the Fox River (Areas 56/57 with nearly 1,500 lbs of PCBs removed) is more reflective of the dredging related losses even though

				these are probably overestimated as well. The data to confirm the 5.9 percent export rate referred to by the commenter for Manistique were not available at the time of these responses, however it is known that dredging at Manistique was primarily accomplished with a cable arm bucket dredge (although other dredges were used as well). In the dredged locations, extensive areas of dense, coarse sediments and debris inhibited the effectiveness of the dredge bucket. The cable arm bucket is designed to dredge soft sediments and does not perform well where either consolidated materials or debris are present. Thereby, the Remedial Design will have to consider the type of dredge as well as the other engineering contingencies, particularly in areas identified as likely to resuspend. For these reasons, the Fox River data have only been used to provide an upper bound for the estimated rate of export for the Hudson operation. Data from Fox River Area N and Manistique Harbor were not used based on the project size as well as the application of a dredging technology that was deemed inappropriate for the Upper Hudson and unlikely to be used, based on its apparent loss rate.
GE	36 G	In sum, PCB resuspension rates during dredging vary from site to site and within sites. Given the limited	**Resuspension** Case studies	USEPA recognizes that there is some uncertainty in its estimates of PCB loss but

		number of case studies with suitable data and the variability and uncertainty associated with the PCB resuspension estimates for these sites, one cannot conclude that the resuspension standard for the Upper Hudson River will be met easily. The resuspension standard document should candidly acknowledge this uncertainty and recognize that Phase 1 is a crucial test of the feasibility of meeting the resuspension rate.		does not agree that the uncertainty is so great that the Phase 1 effort must be viewed as a test period for the concept of resuspension control. The case studies show that several sites have achieved the resuspension exports rates assumed in the development of the standard. Additionally, these studies show that with proper monitoring the export rates can be reasonably estimated. Additionally the case studies show that with the utilization of suitable dredge types and engineering contingencies the export rates can be minimized to meet the requirements of the Resuspension Standard.
GE	36 H	EPA also acknowledges that case studies provide differing conclusions regarding the importance of dissolved phase PCBs in the absence of a release of suspended solids (EPA, 2002; page ES-8). Some data from the Fox River SMU 56/57 study suggest that relatively large dissolved phase releases of PCBs are possible. In contrast, field measurements at New Bedford Harbor are said to have insignificant dissolved phase PCB releases. Our analysis of the New Bedford Harbor field study (see Appendix A to these comments) indicates that dissolved and particulate PCB concentrations increased by about 50% downstream of the dredge. Thus, while there is considerable uncertainty regarding the phase of PCBs released from dredging operations, it is likely that such releases include a significant proportion of dissolved PCBs (GE, 2001).		As noted in the White Paper – Resuspension pf PCBs During Dredging in the RS, the Fox River SMU 56/57 data are not consistent with a large dissolved phase release based on the lack of change in PCB pattern across the dredging area. A large dissolved-phase PCB contribution from the sediments, either by porewater displacement or sediment-water exchange, should yield a gain whose pattern is similar to the filter supernatant. The fact that the congener pattern is unchanged across the study area would suggest a direct sediment addition. Yet the TSS data do not document an increase in suspended sediments. Please refer to the Resuspension White Paper for further details. With respect to the dissolved phase increases at the New Bedford Harbor site, both dissolved and suspended matter concentrations increased but the suspended phase increase was

				substantially greater than the dissolved phase gain on both a relative and absolute basis.
GE	37 A	2.2.4.2 NEAR-FIELD MODELING EPA developed and applied two near-field models to evaluate the transport of sediment and PCBs that would be released during dredging operations. The first model (CSTR-Chem) predicts sediment and PCB mass losses from the immediate vicinity of the dredge-head. The second model (TSS-Chem) simulates PCB and sediment transport in the near-field plume, which extends from about 10 to 1,600 meters downstream of the dredge. These modeling analyses are used to support the conclusion that the resuspension standard can be met consistently. These analyses, however, underestimate the near-field PCB mass flux due to a faulty assumption regarding the PCB concentration on the resuspended particles. This invalid assumption results in an underestimation of the PCB load transported downstream and, thus, translates into uncertainty with respect to the frequency with which that standard may not be met. The models used in the analysis simulate the transport of two types of sediment particles: clay/silt (*i.e.*, fine) and sand (*i.e.*, coarse). A critical assumption in the development of both models is that "sediments resuspended due to dredging operation behavior . . . have uniform particulate PCB content, regardless of type" (Attachment D, page 17). This assumption is not correct, as the particulate PCB concentration on the clay/silt and sand particles are significantly different due to their different organic carbon (OC) content. Generally, clay/silt particles have a significantly higher OC content than sands; in the Upper Hudson River, clay/silt particles and sands have average OC contents of about 5.1 and 0.6 percent,	**Resuspension** Model may underestimate	The USEPA does not agree that the model estimates for PCB load are substantively underestimated due to the assumptions made in constructing the near-field transport models. These models were intended to provide an estimate of PCB transport and have incorporated many conservative assumptions. While USEPA recognizes that PCB concentrations are generally higher in fine-grained sediments relative to coarse-grained sediments when classified as a whole sample, it is not clear that this relationship can be approximated by the organic carbon content within a sample. That is, it is not clear that within a given sample, the PCB content of each grain-size fraction is well approximated by the organic carbon content for the sample. According to a study of contaminated Hudson River sediments published by GE scientists in Environmental Science and Technology (1994, 28, 253-258) titled "Application of a Permeant/Polymer Diffusional Model to the Desorption of Polychlorinated Biphenyls from Hudson River Sediment" by Carroll *et al*, the Hudson River sediments greater than 0.069 mm (sand) had percent TOC values from 3.2 to 7.3 while the sediments less than 0.069 mm (silt/clay) had a percent TOC value of 3.9. These data suggest that the organic carbon content is relatively homogeneously distributed among the grain-size fractions in

		respectively. For River Section 1, where the average bed PCB concentration is 27 ppm, the difference in OC content between sediment types results in particulate PCB concentrations of 62 and 7 ppm for clay/silt and sand, respectively. 3 To illustrate the impact this assumption has on the near-field plume model results, the CSTR-Chem and TSS-Chem models were re-constructed based on the information provided in Attachment D. The model algorithms were modified to incorporate the effects of particle dependent PCB concentration. Using data and information in Tables 1-6 of Attachment D, two model simulations were conducted to evaluate the effects the assumption regarding the PCB concentrations of the clay/silt and sand particles has on near-field PCB transport. Consistent with the EPA approach, the first simulation assumed a uniform particulate PCB concentration of 27 ppm for both clay/silt and sand particles. The second simulation assumed the particulate PCB concentrations on the silt/clay and sand particles were 62 and 7 ppm, respectively. Results of these simulations indicate the assumption of a uniform particulate PCB concentration on both sediment types (as per EPA approach) predicts a PCB mass flux of about 900 g/day at the downstream limit of the near-field plume (*i.e.*, one mile downstream of the dredge). This predicted PCB mass flux is more than a factor of two lower than the PCB mass flux of 1,950 g/day that is predicted when particulate PCB concentrations on the two sediment types that reflect the data collected from the Upper Hudson River are assumed. Because nearly all of the sand resuspended during dredging is re-deposited within about 30 m of the dredgehead, the overestimation of the PCB mass that is adsorbed to and re-deposited with these sand particles, as assumed by the EPA, results in an		fine grained sediments. The data set presented in the paper represents a limited number of samples so it is unclear how far this data can be extrapolated. Nonetheless, it indicates that organic carbon content may not vary with grain size fraction in fine-grained sediments. Furthermore the PCB concentrations for these sediment fractions did not substantively differ. The sand fraction concentrations ranged from 203-284 ppm and the silt/clay concentration was 338 ppm. These data suggest that the silt fraction concentration might range from 30 to 36 ppm relative to the mean value used for River Section 1 of 27 ppm. This would represent an increase in load of approximately 10 to 34 percent. This is substantially less than the increase (greater than 100 percent) suggested by the writer. Further support of the lack of a direct correlation between organic carbon content and PCB concentration can be seen in Figure 3-21 of the Low Resolution Sediment Coring Report (USEPA, 1999), which shows that PCB concentration does not increase linearly with TOC and that significant variation can be found at any organic carbon concentration. USEPA agrees that there may be some enhancement of PCB concentration with smaller particles, but it is not clear that the

		underestimation of the PCB transport out of the vicinity of the dredge-head and into the near-field plume. Adjusting the total PCB flux values reported in Table 2-5 of the performance standard document to correct for the error in PCB concentration yields the following: River Section, Assumed Resuspension of Dredged Sediment (%), TSS Silt Source Strength (kg/s), Net Total PCB Flux at 1 mile (g/day) 1 0.5 0.077 169 2 0.5 0.088 453 3 0.5 0.074 176 The net flux exceeds the 300 g/day Evaluation Action Level in River Section 2 and is less than a factor of two below this level in Reaches 1 and 3. Therefore, achieving the proposed criteria is not assured.		response is linear as suggested by the writer. Nonetheless, it is useful to examine the impacts predicted using each of the assumptions described in the comment. These are summarized in Table GE-33. As indicated in the table all fluxes derived from the distributions described in Carroll *et al* (1994) fall at or below the Evaluation Action Level criterion of 300 g/day. (The flux for River Section 2 with a 34 percent increase in load, *i.e.,* 309 g/day, is essentially the same as the criterion). The assumptions made by the writer yield loads that are still well below the 300 g/day criterion of River Section 1 and 3 but exceed the criterion by 50 percent in River Section 2. These results suggest that the Evaluation Level may be exceeded more frequently in River Section 2, as already noted in the Resuspension Standard text. Although these results suggest that the estimates originally presented may not be as conservative as possible, they are still quite conservative based on other assumptions made in the development of the standard. In particular, the model transport mechanisms themselves are quite conservative. For example, the source strength term is derived from an upper-bound estimate of the releases due to dredging. Secondly, the transport mechanisms have been idealized and further settling of particles is expected relative to the model predictions. Additionally, no assumption of sediment control barriers is

				made, a condition that may not be true in the most contaminated areas. The 300 g/day flux at each station will be determined relative to the estimated 95 percent upper confidence limit of the arithmetic mean baseline concentration of Total PCBs at the far-field station for the month in which the sample was collected. As currently estimated, this value is roughly 8 to 110 ng/L higher than the mean value. An increase of 300 g/day would represent only a 40 ng/L increase at 3000 cfs, a typical summer flow condition. Thus the use of the 95 percent confidence level on the mean increases the threshold by at least 20 percent relative to the net addition due to dredging. (*i.e.,* 8 *vs.* 40 ng/L). Finally, the Evaluation Level will first be applied during Phase 1 when the average dredging rate (and rate of resuspension) will generally be half of that anticipated under Phase 2. (Note that one month of full-scale production is planned for Phase 1, a period that will provide useful data for the evaluation of the Resuspension Standard under Phase 2 conditions.) These assumptions provide a sufficiently conservative basis for the development of the Evaluation Action Level. No further adjustment is necessary to account for the uncertainties in the distribution of PCBs in the resuspended sediment. It is useful to place the uncertainties regarding the development of the Evaluation Level in context with its application. The

				Evaluation Action Level is intended to prompt additional monitoring in response to increased levels of release relative to that derived from the best engineering estimates. In this manner, data on the timing, scale and mechanisms responsible for the PCB releases can be examined. As such, it has no impact on the dredging operation and requires only additional monitoring. As noted in the standard, PCB sampling requirements increase from about 5 to 10 samples per day when the Evaluation Level is exceeded. The Phase 1 areas currently under consideration are either in River Section 1 or in the somewhat less contaminated areas of River Section 2 (*i.e., hot spot* 28 is not being considered for River Section 2). Hence during Phase 1 it is anticipated that this Action Level will be exceeded on occasion but not continuously. At the end of Phase 1, this Action Level, along with the rest of the standard will be reviewed to determine whether any adjustments in the standard are necessary. Given the conservative approach used in the development of the resuspension Action Levels, no adjustment to the Evaluation Level is required prior to the completion of Phase 1.
GE	37 B	The modeling also may underestimate downstream transport of PCBs due to the underestimation of the proportion of PCBs in the dissolved phase. The two-	**Resuspension** Model may underestimate	USEPA does not believe that the modeling underestimates the downstream transport of PCBs due to an underestimation of the

		and three-phase partition model used by EPA predicts that the relative magnitude of dissolved phase PCBs to total PCBs released to the water column due to dredging would be low, on the order of 0.042 to 11 percent (Attachment C, page 14). EPA also points out, however, that high dissolved PCB releases may occur in combination with low production rates as a result of low solids concentrations in slurry and low flow rates, significant flow through the area, and high resuspension rates (EPA, 2002). EPA also acknowledges that case studies provide differing conclusions regarding the importance of dissolved phase PCBs in the absence of a release of suspended solids (EPA, 2002; page ES-8). Some data from the Fox River SMU 56/57 study suggest that relatively large dissolved phase releases of PCBs are possible. In contrast, field measurements at New Bedford Harbor are said to have insignificant dissolved phase PCB releases. Our analysis of the New Bedford Harbor field study (see Appendix A to these comments) indicates that dissolved and particulate PCB concentrations increased by about 50% downstream of the dredge. Thus, while there is considerable uncertainty regarding the phase of PCBs released from dredging operations, it is likely that such releases include a significant proportion of dissolved PCBs (GE, 2001). In sum, the estimates of downstream transport of PCBs in the near field by the model are not conservative and do not support the conclusion that the resuspension standard can be met consistently.		proportion of PCBs in the dissolved phase. Please refer to the responses to comments in Appendix A. As noted in the Resuspension White of the RS the Fox River SMU 56/57 data are not consistent with a large dissolved phase release based on the lack of change in PCB pattern across the dredging area. A large dissolved-phase PCB contribution from the sediments, either by porewater displacement or sediment-water exchange, should yield a gain whose pattern is similar to the filter supernatant. The fact that the congener pattern is unchanged across the study area would suggest a direct sediment addition. Yet the TSS data do not document an increase in suspended sediments. Please refer to the Resuspension White Paper for further details. With respect to the dissolved phase increases at the New Bedford Harbor site, both dissolved and suspended matter concentrations increased but the suspended phase increase was substantially greater than the dissolved phase gain on both a relative and absolute basis.
GE	38	The standard has several elements with which GE agrees: ⇒ Measuring compliance using surface-weighted average concentrations; and ⇒ Limiting the amount of re-dredging and providing	**Residuals** Sampling and redredging	Comment noted.

		the option of capping/backfilling; ⇒ Leaving specifics of the cap to remedial design.		
GE	39	GE recommends the following changes relating to re-dredging, given that: (a) experience at other sites shows that re-dredging slows production and does not consistently achieve low surface sediment concentrations; and (b) the ROD based its determination of the benefits of the remedy on the PCB concentration remaining in the backfill placed following dredging: ⇒ Do not specify that two attempts at re-dredging must necessarily occur. Leave this decision to field personnel, based on consideration of site-specific conditions (*e.g.*, rocky bottoms) which may indicate that re-dredging is not worthwhile. Specifically: • After the initial dredging pass, if the average surface concentration is greater than 6 ppm Tri+ PCB, the contractor should be able to apply to EPA to omit a re-dredging attempt and, instead, to cap or backfill. • If the first re-dredging pass does not achieve an average surface concentration below 6 ppm Tri+ PCB, the contractor should be free to decide whether to attempt an additional re-dredging pass or to cap/backfill. ⇒ Phase 1 data should be used to assess the efficacy of re-dredging, and, if the data warrant, to eliminate or reduce the requirements for pre-backfill sampling and re-dredging for Phase 2.	**Residuals** Redredging Dredging, sampling, redredging sequence in Phase 1 and 2	See response to comment GE 48 and 50. Review of case study data indicates that lack of benefit from re-dredging attempts at other sites was often due to improper selection of dredging equipment. The design and implementation of the dredging project should consider the need for mobilization of dredges suited to re-dredging of areas with difficult bottom conditions.
GE	40	Compliance with the residual standard should be based only on surface-weighted averages since that is what fish are exposed to.	**Residuals** Using surface-weighted averages	See response to comment GE 48.

GE	41	Only sampling nodes which cause the average concentration to exceed the criteria should require re-dredging or capping.	**Residuals** Clarification in the average concentrations exceedence	See response to comment GE 49.
GE	42	Sample type (*i.e.*, composites vs. discrete) and use of sediment profiling imaging should be left to remedial design.	**Residuals** Sampling	See response to comment GE 50.
GE	43	3.2.1 RECOMMENDED CHANGES RELATING TO RE-DREDGING The improvements to the proposed standard that GE proposes are focused primarily on redredging. The following context should be noted. First, if it is necessary to re-dredge an area after the operator has reached the appropriate sediment elevation, the dredging production rate is inevitably slowed. Re-dredging and resampling of the sediment surface also increase the cost of the project.	**Residuals** Redredging	After reaching the design cut elevation, sampling of the sediment must be conducted to verify that inventory was removed and that the Tri+ PCB concentrations in the residual layer meet the standard. The cost of re-sampling and re-dredging may be reduced by a design that maximizes targeted inventory removal and an implementation plan aimed at minimizing the creation of a contaminated residual layer. The standard assumes that careful consideration of dredge type (e.g., applicability to bottom type) during design and implementation will maximize the benefit of re-dredging attempts and also minimize bottom disturbance/ thickness of the residual layer.
GE	44	Second, re-dredging is frequently not worthwhile because, in many circumstances, it is not feasible to reduce the PCB concentration to very low levels in the post-dredging sediment, and, in many cases, the amount of PCB mass removed by the re-dredging effort is not significant. For instance, there are physical conditions, such as rocky or hard bottom, which make it unlikely	**Residuals** Redredging	Re-dredging will be required after the appropriate sediment elevations are reached, if either additional contamination is present at depth (i.e., PCB-contaminated sediment inventory not addressed by the design cut elevations), or residual concentrations are not compliant with the standard. USEPA

		that further dredging will remove material amounts of contaminated sediment. As the proposed standard recognizes, particularly in a project requiring backfilling or capping, re-dredging is frequently not worthwhile. Experience at two sites, both of which involved dredging near-shore hot spots on the St. Lawrence River, demonstrate both these points. At the Reynolds Metals project (the site is now owned by Alcoa), of the 268 cells that were dredged, 134 cells required re-dredging; of these, 56 required two or more re-dredging passes; and some cells required six to ten passes. In the end, 32 cells failed to meet the cleanup level despite multiple re-dredging passes. Moreover, removal rates slowed from 75 cy per hour in the initial pass, to 19 cy per hour in subsequent passes. Similarly, at the GM Massena project, six cells required two to six (and in some cases over 30) dredging passes. The cleanup level of 1 ppm PCBs was not reached in any of the six cells. The experience at the Reynolds Metals and GM Massena projects shows that re-dredging is slow, expensive, and often ineffective in achieving low surface sediment concentrations.		acknowledges that certain sediment types may pose difficulties; therefore, the site-specific data gathered during Phase 1 can be used to revise the Phase 2 standard requirements, if appropriate. The Reynolds Metals and GM Massena projects are excellent examples of situations where dredging was suitable for removal of the contamination from the majority of the areas, but was inappropriate for limited areas. Quite a few re-dredging attempts were made in these difficult areas, but they resulted in little additional improvement to the residual concentration. The Residual Standard addresses this "lesson learned" by limiting the required number of re-dredging attempts to two attempts, reducing unnecessary delays and controlling costs. USEPA may approve revisions to the standard during Phase 1 if sufficient data are acquired with which to make the decision.
GE	45	Third, the ROD recognizes that the ultimate goal of the project is to ensure that the average Tri+ PCB concentration in areas dredged in the bioavailable surface sediment following dredging and backfilling is 0.25 ppm. Thus, when evaluating the benefits of the remedy, the ROD used the post-backfill surface concentration of 0.25 ppm Tri+ PCBs to predict the reductions in fish tissue concentrations that would result from implementation of the remedy (ROD Responsiveness Summary, White Paper 255353 at p. 5). While the ROD also states that it is "anticipated" that dredging will achieve an average pre-backfill surface	**Residuals** Redredging	The residual concentration is a measure of the success in removal of the contaminant inventory in the certification units, which is the ultimate objective of the ROD. Reasonable assumptions were made regarding the ability of a backfill layer to isolate residuals. Simply measuring the concentration on the surface of the backfill does not guarantee that the surface concentrations will remain low if the residual concentrations are not low. It is possible for the backfill to erode and expose

		sediment concentration of 1 ppm Tri+ PCBs (ROD at p. 95), it does so as an explanation of the average pre-backfill concentration that the Agency expects would be associated with a post-backfill average concentration of 0.25 ppm.		higher levels of PCBs. The pre-backfill residual concentration must be measured and controlled to verify accomplishment of the ROD's objective and to ensure the long-term effectiveness of the remedy.
GE	46	First, the proposed standard requires that, when a 5-acre certification unit has a post-dredging residual average concentration greater than 6 ppm Tri+ PCBs, the contractor must redredge and re-sample the area. If that re-dredging does not achieve an average concentration below 6 ppm Tri+ PCB, re-dredging is again required. Only if re-dredging again fails to achieve an average of 6 ppm, is the contractor free to cap the area. In many physical settings, such as close proximity to bedrock or other hard uneven bottom surfaces, it will be apparent to the dredge operator that further dredging will yield little or nothing in the way of positive results. To reflect these practical and local conditions we urge that the Phase 1 dredging sequence be changed as follows: • If, after the initial dredging passes, the 5-acre certification area has an average Tri+ PCB concentration above 6 ppm, the contractor's field personnel may propose to EPA's field oversight personnel to waive the re-dredging requirement based on specific local conditions. The waiver decision would lie in the discretion of the EPA field oversight personnel. • If, after a first re-dredging pass (if required), the 5-acre certification area still has an average Tri+ PCB concentration above 6 ppm, the contractor would have discretion to cap or backfill rather than re-dredge.	**Residuals** Redredging and capping	The design should consider appropriate dredge selection for difficult physical settings. USEPA will evaluate the Phase 1 results to determine if changes are necessary to the Resuspension Standard or to the dredging operations for Phase 2. As part of this evaluation, USEPA will consider the relationship between re-dredging benefit and bottom conditions.

GE	47	Second, the standard should recognize that the data collected during Phase 1 should be used to evaluate the dredging, re-dredging sequence so that the sequence required for Phase 2 can optimize the dredge production rate and the reduction of the PCB concentration in the bioavailable backfill to the ultimate ROD standard of 0.25 ppm. This approach would allow an evaluation of a number of important issues. First, one could determine whether it is possible to remove the PCB inventory in one pass by targeting elevations. Second, one could determine the success of achieving low residuals with one dredging pass. Third, an assessment could be made of whether the pre-backfill residual concentration makes any material difference in the concentration ultimately achieved in the backfill surface. Finally, recognizing that the standard allows capping rather than requiring dredging to a set concentration, one could determine whether directing re-dredging prior to capping or backfilling yields a material environmental benefit. For example, if it is shown in Phase 1 that the pre-backfill concentrations below a certain level do not result in bioavailable backfill concentrations greater than 0.25 ppm Tri+ PCB, then re-dredging to reduce a residual concentration already below that level should not be required in Phase 2. Similarly, if it is shown that low residuals and mass removal can be achieved in one pass, pre-backfill sampling aimed at determining whether to re-dredge should not be required in Phase 2. Based on this evaluation, the standard could be modified in Phase 2 to reduce or eliminate pre-backfill sampling and re-dredging requirements while maintaining the environmental objectives of the ROD. This would have the significant benefit of expediting dredging in Phase 2. At a minimum, the experience	**Residuals** Redredging	Pre-backfill sampling will not be removed from the standard, because without residuals sampling there is no measure of the effectiveness of the implementation of the Remedial Design. For example, the sampling would reveal areas where the design cut lines may have underestimated the depth of contamination, leaving areas with substantial PCB inventory remaining. If the residual concentrations are not characterized, backfill placement may unexpectedly fail due to the presence of elevated residual concentrations, requiring costly and time-consuming mitigation. The ROD requires "[r]emoval of all PCB-contaminated sediments within areas targeted for remediation, with an anticipated residual of approximately 1 mg/kg Tri+ PCBs (prior to backfilling)" (p.iii). EPA's modeling for the ROD assumed a 1 mg/kg Tri+ PCB residual after dredging, and further assumed that backfilling would reduce the Tri+ PCB residual to 0.25 mg/kg Tri+ PCBs (see, Responsiveness Summary, Response to Master Comment 579). However, measurement of the concentration of the backfilled surface is not an acceptable substitute for the residual sediment sampling. If appropriate, the Residuals Standard may be modified for Phase 2 to address areas with difficult dredging conditions, based on

		gained during Phase 1 would provide information which could guide dredging and backfilling decisions in Phase 2. For example, it might become clear that there are certain areas, such as rocky bottoms, where re-dredging is ineffective in reducing residual PCB concentrations. Using this knowledge in Phase 2, one could determine that no redredging should be attempted in such areas. In short, information should be generated in Phase 1 and evaluated at the end of Phase 1 so that the residual standard can be modified to achieve its goals in the most efficient manner in Phase 2.		the information gathered during Phase 1. This decision cannot be made without site-specific data, because the intent of the ROD is to remove inventory, not to cap the inventory. •
GE	48	3.2.2.1 THE STANDARD SHOULD BE BASED SOLELY ON THE AVERAGE CONCENTRATION CRITERIA Fish exposure reflects the local average PCB concentration. Hence, the average concentration is the appropriate metric for assessing PCB residuals. The proposed residual standard's additional requirements for comparison to the maximum and second-highest concentrations are unnecessary and should be dropped. Relying on the average residual PCB concentration in a certification unit as the cleanup objective is consistent with the ROD and will ensure the intended benefit of the remedy.	**Residuals** Using surface-weighted average concentrations	The true average Tri+ PCB concentration within a certification unit is not and cannot be known. We can obtain only a sample average that is subject to uncertainty. Therefore, additional criteria such as the PL thresholds are addressed in the standard to increase the likelihood that the true certification unit average meets the objectives of the ROD. The Residuals Standard requires that individual nodes with concentrations higher than the PL thresholds be addressed by re-dredging or capping even if the average concentration is in compliance with the standard, because these discrete measurements are merely indicators of true average value. If there are several elevated values, this suggests that the true average concentration in the area may exceed the threshold. This determination is based on the observation that post-dredging residual concentrations typically have an approximately lognormal distribution. If there are several nodes with concentrations

				greater than the PL, this indicates that the true average concentration of the CU is greater than the action level.
GE	49	3.2.2.2 ONLY NODES WHICH EXCEED THE AVERAGE CONCENTRATION CRITERIA SHOULD REQUIRE RE-DREDGING The standard should be clarified to state that when re-dredging (or capping in lieu of backfill) is required, it will be performed at sampling nodes which cause the average concentration to exceed the criteria, and not across the entire certification unit. We recommend that this concept be clarified in Section 3.5 and Table 1-1. Specifically, when the term redredging is used, it should be followed by "at the nodes which cause the exceedence."	**Residuals** Clarification in the average concentrations exceedence	The extent of the non-compliant areas is determined for each node with elevated concentrations (Section 3.5.2). As a practical point, capping or dredging may extend beyond the minimum area defined by the nodes if the exceedences are scattered.

GE	50	3.2.2.3 CERTAIN SAMPLING DETAILS SHOULD BE LEFT TO REMEDIAL DESIGN The proposed standard specifies in great detail the procedures for sediment sample collection and analysis, most of which is taken directly from the *Sediment Sampling and Analysis Program – Field Sampling Plan* (SSAP–FSP) (Quantitative Environmental Analysis, LLC [QEA], 2002) and *Quality Assurance Project Plan* (QAPP) (QEA and Environmental Standards, Inc. [ESI], 2002). Some elements of the proposed sampling and analysis program, however, are not appropriate for this project, including failure to permit composite sampling and the use of sediment profiling imaging (SPI). First, composite sampling should be a design option. Compositing of individual samples does not impact the measured average PCB concentration in the certification unit and provides an opportunity to expedite decision-making and reduce cost. As noted on page 28 of the EPA document, the composite approach is often used when analytical costs are large relative to sample collection costs and the mean contaminant concentration is the parameter of interest. Both these factors apply here. When the certification unit mean exceeds the applicable criterion, archived sub-samples of the individual samples making up composite samples that exceed the criterion could be analyzed to identify the non-compliant nodes that must be redredged. The concern that composite sampling will cause delays by increasing turn-around time (page 28) is likely overstated, given that initially far fewer samples will be analyzed. Assuming, for example, that five-subsample composites are used, even if a third of them has each of	**Residuals** Composite sampling	Composite sampling will not provide the information needed to determine compliance with the PL thresholds. The average value for the certification unit based on composite sample results would give no indication of the specific nodes requiring re-dredging, resulting in more lengthy re-dredging attempts or additional delay while archived subsamples are analyzed. The cost of sampling will be lower than the cost of the SSAP sampling, because only the 0-6 inch layer is required to be analyzed and more efficient sample collection methods could be used. The program as developed allows rapid decision-making concerning non-compliant certification units. The action levels in the Residuals Standard were developed based on assumptions concerning the distribution of the residuals (i.e., approximately lognormal). There is no way to verify the assumption concerning the distribution of the data without collection and analysis of individual samples. There is also the inherent uncertainty in sample homogenization. As a result, composite samples will not be collected to satisfy the residual standard.

		its subsamples analyzed, the total number of samples analyzed will be 45% lower than if discrete sampling is employed for all samples. While the performance standard defines the prediction limit (PL) values using individual samples, this should not prevent the use of composite samples. If compositing were used, a complementary value to drive analysis of individual subsamples from a composite could be developed, and the PL could still be applied to the subsequent individual subsample results, if desired. Composite sampling is entirely consistent with the goals of the ROD and should be adopted for Phase 1.		
GE	51	Second, the standard mandates that an SPI camera be used in dredged areas to determine thickness of residuals. The SPI camera is a good technique for visually distinguishing layers of materials that show a visible distinction in characteristics (texture, color, etc.) or to assess the presence of benthic organisms in the river bottom. It is limited, however, to the top six inches of sediment. For the Hudson River, there is little evidence that the PCB-containing sediments exhibit readily distinguishable visual differences from the sediments to be left in place. Collection of grab samples, along with manual probing of the post-dredging sediment bed, should be sufficient to determine the extent of removal and potential for residual materials to be left in place. While SPI cameras may prove to be useful and should be considered during remedial design, they should not be prescribed for use in Phase 1.	**Residuals** Use of SPI camera	The purpose of the sediment profile imaging (SPI) is to discern disturbed and undisturbed sediments, i.e., the impact of dredging. It is considered an important part of the Phase 1 data collection and will be used, if necessary, to modify the required sampling depth for residuals. The standard will be modified to require SPI at approximately 25 percent of the sample locations. Enough locations will be chosen to cover the sediment types and removal technologies that will be experienced during the remediation and to have a sufficient number of locations per differing conditions to evaluate the data. It is likely that this requirement will be waived in Phase 2, if the information gathered during Phase 1 demonstrates the required sampling depth.

GE	52	The standard should not specify dredging volume of 240,000 cubic yards for Phase 1. Rather, consistent with the ROD, it should specify a production range – between 150,000 and 300,000 cubic yards – to allow greater flexibility in designing Phase 1 to be an appropriate test of the performance standards.	**Productivity** Production rate	See response to GE Comment 2 and GE Comment 12.
GE	53	There is no empirical evidence that the production rate standard can be met. • Experience at other environmental dredging sites shows that projects typically take longer than initially estimated. • EPA's feasibility analysis does not demonstrate the feasibility of achieving the production rates. • EPA's analysis focuses on sediment removal, but does not adequately consider the feasibility of transporting, processing, loading, shipping, and disposing of dredged sediment during peak production. • EPA's analysis relies on a number of unreasonable or overly optimistic assumptions: • Per-dredge production rates are higher than achieved elsewhere. • It is unrealistic to assume that in-river and land-based operations can take place in late November and December. • No consideration is given to constraints to be imposed by the quality-of-life performance standards. • No consideration is given to the removal strategies for the land-locked section and the non-navigational section.	**Productivity** Production rate	Comment noted. USEPA notes that at the Calamut River in Gary, Indiana, US Steel Corporation is working to remove 750,000 cubic yards of sediment from February to December 2003, and currently has a production rate of approximately 70,900 cubic yards per month using two hydraulic dredges. In comparison, the Productivity Standard requires a production rate of about 480,000 cubic yards in 7 months, which is approximately 68,600 cubic yards per month. The problem of transporting, loading shipping and disposing of an average of from 3000 to 4000 cubic yards of sediment per day is not insurmountable. Mines, large sand and gravel pits and similar facilities that are large materials handling operations routinely process and ship much larger amounts in a day. As to late season operations, the river rarely freezes over before mid-December. Thus assuming in-river operations until late

				November is appropriate for the estimate in the standard. Land-based operations may be impacted by an occasional early snow, but it is anticipated that operations will continue once the snow is cleared from work areas. The quality of life standards are currently under development by USEPA. The Productivity Standard does not assume any constraint in work hours. Those details are expected to be evaluated by GE's design team and included in the design documents to be submitted to USEPA. USEPA expects the Quality of Life standards to be finalized before the Engineering Performance Standards. Currently, the Agency plans to finalize the Quality of Life standards in January 2004, and to finalize the Engineering Performance Standards for Phase 1 approximately in March 2004. The volume of sediment to be removed from the landlocked and non-navigational sections of the river amount to less than 3 percent of the total and should not have a significant effect on the project duration.
GE	54	The standard should recognize that there is substantial uncertainty regarding the feasibility of achieving this standard and that this uncertainty will remain until the standard can be tested in Phase 1.	**Productivity** Uncertainty in production rate	See response to GE comments 13 and 15.

GE	55	Achieving all three standards simultaneously is unprecedented, and based on past experience, there is a strong basis to conclude that it will not be feasible to do so. For example, achieving the resuspension and residuals standards will slow production and thus influence the ability to meet the production rate standard.	**Combined Standards**	See response to GE comment 16.
GE	56	Experience at other sites does not provide evidence that all three standards can be met at the same time.	**Combined Standards**	See response to GE comment 16.
GE	57	The performance standards documents should acknowledge that there is substantial uncertainty in the ability to achieve all three standards simultaneously and that this question will be tested in Phase 1, which must provide a rigorous test of the ability to meet all three standards at once.	**Combined Standards**	USEPA believes that Phase 1 should be a rigorous test of the ability of the design to meet all three standards simultaneously, including a test of the sustainability of dredging production rates. As such, the design will include contingency plans to be put into effect during Phase 1, as necessary.
GE	58	APPENDIX A: WATER COLUMN MONITORING OF THE NEW BEDFORD HARBOR PRE-DESIGN FIELD TEST OF DREDGING TECHNOLOGY The Final Pre-Design Field Test Dredge Technology Evaluation Report for the New Bedford Harbor site (USACE, 2001) states that "the actual dredging process … appeared to have a limited impact on the water column." This conclusion is contradicted by a detailed analysis of the water column monitoring data. These data show that dredging increased water column particulate and dissolved PCB levels by about fifty percent. Moreover, the data show that the impact on dissolved PCB levels persisted to the most down-current sampling locations, despite the return of suspended solids to baseline levels. Finally, the releases observed in this pilot program are lower than would be	**Resuspension** Case studies	The analysis provided in the comment is unclear and perhaps misinformed. A detailed analysis of the New Bedford Harbor data is presented in Figures GE-35A and GE-35B. In Figure GE-35A, the Total PCB, suspended and dissolved phase PCB concentrations are presented for the dredging study noting PCB concentration as a function of distance upstream and downstream. For each PCB form (total, suspended and dissolved) two graphs are presented, one showing all data and a second showing an expanded scale. Samples in which an oil phase was noted were excluded from this presentation and analysis since these samples indicate the presence of pure

		seen in most other dredging programs because the high baseline levels of PCB probably limited the extent of desorption from resuspended dredged material.		PCB oil phase and are not applicable to the conditions anticipated on the Hudson. In each case, samples within the "moon pool" around the dredging operation (0 distance from the dredge) show very high levels relative to baseline (*i.e.,* upstream) conditions. These samples represent conditions in the immediate vicinity of the dredge. Examining the expanded scale graphs allows a comparison of the upstream *vs.* downstream conditions. In this comparison, it is clear that all three forms of PCB increased downstream of the dredge, indicative of resuspension release. These conditions represent the near-field conditions referred to in the standard. However, it is also clear that the suspended matter concentration has increased substantially more than the dissolved phase, indicating that the primary form of the net PCB increase took place in suspended matter form, consistent with the analysis provided in the standard. The suspended matter concentration increased by more than 100 percent from approximately 500 ng/L to 1000 to 1500 ng/L. The dissolved phase increased from about 500 ng/L to about 750 ng/L, an increase of about 50 percent as correctly noted in the comment. The impact of the dredging related release can also be seen in Figure GE-35B, which presents the fraction of the dissolved phase as a function of total PCB concentration and

				distance from the dredge. In the diagram relating dissolved fraction *vs*. total PCB, there is a clear trend toward lower dissolved fractions as the total PCB concentration increases. This trend correlates with the decrease in dissolved fraction PCB that occurs from upstream to downstream, as also shown in the figure. These data all support the USEPA's understanding that PCB releases due to dredging occur primarily as a suspended matter release and thus can be tracked in the near field by suspended matter or possibly turbidity measurements. The assertion in the comment that the PCB levels would be higher if the baseline PCB concentration were lower is not valid since the PCBs enter the water column as suspended matter, a process that is independent of the baseline dissolved phase PCB concentration. Subsequent to the resuspension, greater dissolution of PCBs may take place but the elevated PCB suspended matter fraction and elevated TSS levels remain, indicating that it will be possible to track PCB releases by suspended matter or turbidity. Additionally, as shown in Figure GE-35A, the Total PCB concentrations increased by roughly 1,000 ng/L or about 100 percent. Of the 1000 ng/L increase, roughly 750 ng/L were particle-borne and 250 ng/L were dissolved phase-borne. This corresponded to a comparable increase in TSS of roughly 100 percent,

				consistent with the PCB gain. This TSS signal would be readily detected by the monitoring scheme required for the standard. Notably, the dissolved baseline PCB concentrations, while elevated at 500 ng/L, are not so far above those typically found in the Hudson during peak summer time conditions (150 - 200 ng/L). Thus similar behavior of PCBs is expected in the Hudson with respect to the downstream distribution on dissolved and suspended matter fractions.
GE	59	Conclusions regarding dredging impacts on water quality for the New Bedford project were based on the spatial patterns in PCB concentration for four sampling events. These patterns are confounded by natural fluctuations in PCB levels, the degree of which is indicated by the background samples collected on August 7th 1000 feet north and 1000 feet south of the pilot dredging area. PCB levels in these samples differed by more than a factor of three. Moreover, sampling collection was not timed to follow a single water mass. Consequently, the spatial patterns do not provide reliable estimates of dredging-related PCB release and can only be used to provide an indication of the persistence of TSS and volumetric particulate PCB impacts.	**Resuspension** Case studies	As noted, the Pre-Design Field Test was not used to estimate the magnitude of dredging related PCB releases. Only the nature of the releases was examined. Nonetheless the data clearly show elevated mean concentrations of PCBs downstream of the dredge, regardless of the downstream distance. Additionally, the data show increased mean PCB concentrations on the suspended matter, as well as an increase in suspended solids at all points downstream (see Figure GE-38), clear indicators of the PCB releases process.
GE	60	Given the random fluctuations in space and time that are unrelated to dredging, the best approach for evaluating PCB releases is to pool all of the baseline/reference samples, pool all of the turbidity plume samples, and compare the two populations. A statistical summary of the data pooled in this manner is	**Resuspension** Case studies	A few of the New Bedford Harbor water column samples contained oil phase PCBs. However, the data from the oil releases and moonpool were not included in the analysis in the Performance Standard Report since these samples represent a multiphase system

		presented in Table 1. Particulate PCB levels were normalized by TSS to remove the confounding influence of variable solids concentration. The baseline water column PCB statistics shown in the table were derived from the background and up-current monitoring. The statistics show that both dissolved and particulate PCB levels in the turbidity plume were elevated in comparison to baseline levels. The increase was approximately fifty percent for both PCB components, 63 to 90 mg/kg for the particulate component and 470 to 730 ng/L for the dissolved component. Further, the dissolved concentrations remained elevated at the most downstream station in the plume, averaging 720 ng/L. The single sample taken at the dredging site inside the moonpool has a dissolved PCB level ten times higher than the baseline level. The particulate PCB concentration exceeds the baseline level by about a factor of three.		not applicable to the lower PCB concentrations typical of the Hudson. Essentially, samples labeled as "oily sheen" or "oil slick" do not apply to the sediment resuspension processes anticipated for the Hudson, since a free oil phase has not been reported in the sediment studies in the remediation areas. Exclusion of these oil-bearing samples provides a more consistent picture of the PCB release process at New Bedford Harbor, as presented in Figures GE-35A, GE-35B, and GE-38. There are two likely reasons the moon pool samples do not have the same partition coefficient (Kd) as the background and the downstream samples. First, the presence of DNAPL would greatly confound partitioning among dissolved and suspended matter. Any oil phase PCBs would be measured as an increased dissolved phase concentration, decreasing the apparent distribution coefficient. Second, it is highly unlikely that equilibrium would have been achieved so soon after resuspension, regardless of the release form. Furthermore, PCB partition coefficients will be dependent on the type of sediment (organic content) and the PCB congeners present. Based on these concerns, for purposes of the Resuspension Standard, USEPA has limited the examination of the nature of dissolved phase releases to those water column samples that were not reported to have a free

				oil phase present. The approach used in the comment to summarize the data by pooling all of the sample results is problematic. It is not appropriate to pool the oil phase sample results with the non-oil phase sample results. It also combines all of the downstream results, although clearly the station 50 m downstream from the dredge will have much higher turbidity readings than the station at 500 m or 1000 m downstream. This approach distorts the results of the study.
GE	61	The statistical summary of the data clearly shows that the New Bedford dredging project released PCBs and caused elevated concentrations that persisted to the most down-current sampling location. The high level of PCBs in the water column that exists in the absence of dredging probably limited the amount of PCB release and downstream transport. The increase in suspended solids particulate PCB concentration and dissolved PCB concentration caused by dredging depends on the concentration difference between the dredged material and the baseline levels. If the dredged material contains PCBs at concentrations less than the baseline levels, it will act as a sorbent and will reduce the water column PCB levels as resuspended dredged material redeposits. Resuspended dredged material will release PCBs to the water column if it is more contaminated than the water column solids and the extent of this release grows as the concentration difference grows. For any release to occur at New Bedford, the resuspended dredged material must have a PCB level greater than 63 ppm. Had the baseline TSS been clean or had a substantially lower PCB	**Resuspension** Case studies	See GE comment 59.

		concentration, a greater proportion of the PCBs associated with dredged materials would have desorbed and been available for downstream transport. For this reason, the results of the New Bedford pilot study are only applicable to areas having similar relative concentration differences between baseline suspended solids PCB concentrations and dredged material PCB concentrations.		
GE	62	Finally, the samples taken in the "moonpool," in the oil slick, in the MIAMI II plume and at the station closest to the MIAMI II plume exhibited unique PCB patterns that need to be understood before extrapolating the pilot study results to another dredging program. The PCB partitioning exhibited by these samples was much different from that found in the other samples. Dissolved PCB concentrations were uniquely elevated, and the partition coefficient (suspended solids particulate PCBs divided by dissolved PCBs) was reduced, as shown in Table 2. The average partition coefficient in these samples was three to four times lower than found in the background or turbidity plume samples. These results suggest a potential for enhanced PCB release under certain conditions.	**Resuspension** Case studies	See responses to GE comments 59 and 60.

GE	63	Two large buckets would achieve 50-60 cy/ hr each at best, not 82 cy/hr.	**Productivity** Bucket productivity	This would depend on how large the buckets are and whether the depth of cut is sufficient to require two passes of the dredge or one. If the cut depth is shallow and the sediment can be removed in one pass of the bucket, the production rate will be low as a result of the need to work very carefully to assure that the individual bucket cuts overlap, penetrate to the correct distance, and do not spill any material. If two or more passes are required to achieve the desired depth of cut, the removal of the upper layers of the sediment can be accomplished much more rapidly as there is less concern about achieving overlapping cuts. USEPA believes that 82 cubic yards per hour for a 4 cy bucket is a reasonable average to expect from a skilled operator.
GE	64	22 weeks of dredging per year on the Upper Hudson is probable, not 30.	**Productivity** Dredging productivity per year	USEPA does not agree with this assertion. Preliminary work can be done as soon as or even before the canal opens during the first week of May and cleanup work can continue after the normal canal closure during the first week of November. The normal canal operating season is 26 - 27 weeks and should be able to be extended to 30 weeks assuming that provisions are made to work in one pool of the river for the last 3 to 4 weeks, or to provide for operating the locks after the normal closure date.
GE	65	An assumed 13 hrs of actual dredging per day is	**Productivity**	The Productivity Standard does not restrict

		reasonable, but would likely need 20-24 hrs (three shifts) per day to achieve	Dredging productivity per day	dredging hours per day. As a practical matter, some dredging time will be lost as maintenance is carried out. Dredging contractors try to keep the dredges operating as many hours per day as possible, with the understanding that the amount of material removed each hour will likely vary considerably over the course of a day. On average, 13 hours of actual dredging at a reasonable production rate has been assumed in developing the example productivity schedule.
GE	66	Achieving the 510,000 cy per year could require simultaneous operation of as many as four large buckets and three small buckets (i.e., seven dredges instead of four). Given a probable dredging season of 22 weeks, this equates to the removal of 3,900 cy per day (about 5,850 tons) and would require 59 rail cars per day to transport the treated sediment to disposal sites.	**Productivity** Transportation and dredges	USEPA believes that the assumptions in the comment are not valid (e.g., dredge season of only 22 weeks per season and lower than expected dredge production rates). USEPA believes that dredging can continue for more than 22 weeks per season, and that reasonable dredge production rates should be assumed. Therefore, the 59 rail car per day calculation is invalid.
GE	67	Production buckets would achieve 50-60 cy/hr each at best, assuming these dredges work at the rates accomplished at previous sites; if this is the case, a third production bucket would be needed for every two listed by EPA.	**Productivity** Buckets	Mechanical dredge production rates at other sites are difficult to relate to this site, but provide at least some information as to the likely rates that can be achieved. Production rates of 50 to 60 CY per hour, as suggested in the comment, are probably related to bucket dredges that employ a crane and cables, rather than the dredge type selected for the example production schedule in the Productivity Standard. The New Bedford Harbor project reportedly achieved production rates of from 95 to 125 CY/hour

				using an environment bucket on a hydraulic excavator.
GE	68	In its estimate of the number of dredges, EPA has not included the re-dredging dredges; one or more such dredges should be added to the total number of dredges.	**Productivity** Re-dredging	Correct. The dredges used for re-dredging would presumably be small dredges with low production rates that would be designed for minimal cuts in a limited number of areas. Thus, they should not have a substantial effect on the Productivity Standard.
GE	69	Based on EPA's assumed production rates, the following number of production dredges operating simultaneously would produce the removal volumes listed below, which the Example Production Schedule calls for at higher periods of production: • 10 dredges: 6,370 cy/day (9,550 tons; 96 rail cars -- 4 loaded and dispatched per hour). • 8 dredges: 5,668 cy/day (8,502 tons; 85 rail cars). • 6 dredges: 4,996 cy/day (7,449 tons; 75 rail cars).	**Productivity** Dredging productivity	Comment noted. USEPA expects that the design documents will the number and type of dredges and supporting plant that will be required, in more detail than that provided by the example production schedule.
GE	70	GE estimates that 10 dredges operating simultaneously over a one week period with only a northern facility available (which would occur in EPA's Example Production Schedule 70% of the time during the period 5/24-8/7/07) would require the following during that period (see Table B-1): • 58 vessels operating in a five-mile stretch of the TIP. • Nine barges (three hopper barges and six deck barges) typically requiring berthing and unloading simultaneously. • A removal rate of 6,370 cy of sediment per day,	**Productivity** Dredging productivity	See response to GE comment 69.

		6 days per week (9,555 tons per day), which in turn would require 96 100-ton rail cars to be loaded and dispatched from the facility each day.		

GE	69	Many of the vessels required to carry out EPA's Example Production Schedule are extremely large. For example, a derrick barge used as a maneuverable platform to support the crane which operates a mechanical bucket can measure 120 feet long by 40 feet wide (or more) and draw six to eight feet of water. Similarly, each hopper barge can measure 130-150 feet in length and 30-40 feet in width and draw seven to nine feet of water. A tug boat for each hopper barge would be 60-70 feet in length with 800-1,000 horsepower.	**Productivity** Dredging vessels	USEPA did not consider use of a derrick barge in the example production schedule as a bucket dredge and crane were considered inappropriate for most of the work area. For hopper barges, it was assumed that the largest barges that would fit through the locks, i.e. 250' long, 43' wide and 12' draft when loaded, would be used to minimize the number of vessels on the river. The tug for the hopper barge was considered to be 50' long. The maximum practical capacity of the locks is 43.5' wide by 300' long by 12' draft. The locks are equipped with electric capstans, which can be used to pull a barge through the lock, but it was assumed that the tug would enter the lock with the barge.
GE	71	EPA's Example Production Schedule is more constrained than the scenario presented in the FS and ROD and would be very difficult to implement. Although the scenario fails to demonstrate the feasibility of the production rate, it shows that a key factor will be managing the equipment and crew logistics and the movement of sediment from the river to land to rail to disposal. In fact, there is some maximum number of dredges operating simultaneously that is feasible for this project; that number is limited by a variety of factors, such as: (a) the availability of	**Productivity** Dredging productivity conflicts	Meeting the performance goals for this project will be a challenge, but one that USEPA believes can be met through proper planning, design and execution.

		experienced crews (13 dredges operating simultaneously for three shifts per day require at least 39 experienced, skillful operators); (b) the number of vessels that can maneuver in a particular stretch of the river at one time; (c) the number of filled barges that can be berthed and unloaded simultaneously; and (d) the number of rail cars that can be loaded and dispatched daily.		
GE	72	In Section 1.2.3 of Attachment 1 to Volume 3, pgs 7-8, EPA describes its assumed production rate for hydraulic dredging: The hydraulic dredge selected for evaluation is the same dredge described in Appendix H-1 of the FS . . . it has been assumed that the effective production rate for this dredge would be from 260 to 275 cubic yards per hour, depending upon the type of sediment and distance pumped. There are a number of factors that make it very unlikely that the high production rate of 260-275 cy/hr can be achieved, including: • Achieving this production rate from a single dredge, even over short periods of time, is unprecedented on an environmental dredging project. See Case Study projects in Volume 4, and Appendix C to these comments. • The high pumping rates from this dredge would require one or more land-based facilities with redundant water handling capabilities. • Relying on one large-capacity dredge for production dredging makes the project vulnerable to equipment failures. If the dredge "goes down," in-river removal work will stop, unless one or more backup dredges of this capacity are on standby, which would be	**Productivity** Dredging productivity and practicality	The hydraulic dredge used in the evaluation is a larger dredge than has been used in previous environmental projects. However, a larger dredge will reduce the number of dredges in the river at one time and will be able to remove material that would be beyond the capability of many of the smaller, less powerful dredges used on other projects. The equipment selected must meet the needs of the project. The land-based facility must be designed to handle the flow from a large dredge, and there is no reason that this cannot be done. Reliance on a single, large dredge would not be wise. A backup dredge should be readily available. The ROD did not specify the number or types of dredges to be used during remediation, and it is therefore inaccurate to imply that the use of backup dredges goes beyond the dredging equipment contemplated in the ROD. The dredge contemplated for use in the

		extremely costly and was not contemplated in the ROD. • The draft of this dredge will preclude its use in shallow areas. • The amount of resuspension generated by this size dredge is unknown, making it impossible to predict its impact on the ability to meet the Resuspension Standard. • This dredge will not be suitable for redredging (cleanup) passes. Additional smaller dredges would be required, each requiring its own slurry pipeline and booster pumps. As a hydraulic dredge progresses farther away from the land-based facility to which the dredged slurry is being pumped, booster pumps would need to be added and the dredged slurry pipeline extended. EPA acknowledges that "each in-line booster pump can reduce the effective dredging time by from 5 to 10 percent" (Volume 3 at p. 12). It is not clear that this reduction in effective dredging time has been factored into the Example Production Schedule for the hydraulic dredging scenario. Further, using only a northern facility, (1) pipelines from each hydraulic dredge would extend 11 miles when dredging in the southern end of River Section 2; up to six booster pumps could be required for each pipeline; and (2) hydraulic dredging in River Section 3 would be impractical due to the long pumping distances.		example project schedule has a draft of 3 feet and would be able to work in any water where the post dredging depth will be 3 feet or more. Additional floatation can be installed to work in shallower water but is cumbersome. A smaller dredge would probably be less costly in shallow areas. The amount of resuspension generated by a dredge of the size contemplated in the example production schedule is estimated to be very similar, in terms of percentage of dredged sediments lost at the dredge head, to any of the smaller dredges employed on previous projects. A production dredge will probably not be suitable for re-dredging, particularly where the new dredge cut will likely be very thin. This applies to both mechanical and hydraulic dredges. Reduction in effective dredging time was factored into the example schedule. As to pipeline length, USEPA recognizes that hydraulic dredging in River Section 3 would be impractical for a single facility located in River Section 1, and so hydraulic dredging was not assumed for River Section 3 in the Productivity Standard.
GE	73	The water quality monitoring program for New Bedford Harbor was designed to assess the magnitude and down-current extent of elevated PCB levels attributable to the pilot dredging. To do this, water	**Resuspension** Case studies	It should be noted that the Hot Spot case study (Report on the Effects of the Hot Spot Dredging Operations, USACE, 1997), and not the Pre-Design Field Test Dredging

		samples were collected at a reference location 1000 feet up-current of the dredging site and from three to four locations in the dredging-induced turbidity plume at down-current distances of 50 to 1000 feet. The samples were analyzed for TSS, filterable ("dissolved") PCBs and non-filterable ("particulate") PCBs. Because the program was restricted to a single along-current transect, it did not provide information sufficient to estimate the mass of PCBs released to the water column and transported downstream. Instead, it focused on a qualitative assessment of water quality impacts.		Technology Evaluation Report performed in 2000 (USACE, 2001) was used to estimate a resuspension rate. Nonetheless, the study described by the writer did provide further evidence for the association of resuspended PCBs with the particulate phase, suggesting that TSS would be a useful surrogate for detecting a PCB release due to dredging.
GE	74	The analysis of the water quality data focused on the volumetric concentrations of particulate PCB (i.e., µg of particulate PCB per liter of water). This metric is sensitive to the PCB concentration on the suspended solids (i.e., µg of PCB per gram of suspended solids) and the TSS concentration. Concentration differences among stations can result from differences in TSS or differences in the suspended solids PCB concentration. Reductions in TSS occur as solids resuspended by dredging activity are redeposited and reduce the PCB mass transported downstream, but do not necessarily eliminate water quality impacts. PCB exposure to the aquatic food web is determined by the suspended solids PCB concentration and the dissolved PCB concentration. If these remain elevated, the dredging can have significant downstream impacts even though most of the solids resuspended by the dredging redeposit within a short distance down-current. Recent studies of PCB release during dredging on the Fox River have shown that elevated suspended solids and dissolved PCB concentrations can persist downstream even though TSS returns to background levels in the	**Resuspension** Case studies	As noted in previous comments and the White Paper on Resuspension of PCBs During Dredging in the RS: "The sample compositing strategy [of the Fox River Studies], designed to reduce the number and cost of PCB analyses, was contrary to the mass flux analysis attempted. The equal volume composites do not allow consideration of flow variation across the cross-section. USGS (2000) states that stagnant areas and even reversed flows were observed during sampling operations, confirming the errors associated with the composite PCB samples. The TSS sample composites induce less error and provide a more accurate estimate of downstream TSS flux, yet they showed an unexplained decrease in suspended sediment across the dredging operation. The decrease is almost certainly an artifact associated with compositing equal volume

		vicinity of the dredging (FRRAT, 2000; Steuer, 2000). For this reason, the evaluation of water quality impacts cannot rely solely on the volumetric concentrations of particulate PCBs, but also must consider the suspended solids and dissolved PCB concentrations.		samples from 20 percent and 80 percent depth. Even though it has long been established that velocity measurements from these depths represent the average velocity in an open channel, there is no justification for suggesting that a composite sample from these depths represents the average concentration along the profile. This is particularly true in deeper water where the two samples represent 25 feet or more of water depth." Despite the analysis performed in the Resuspension Standard Report as well as previous reports suggesting no significant dissolved release will exist at the dredge, the resuspension criteria do not rely on this. The criteria downstream are for total PCBs, both dissolved and particulate, and will therefore detect any dissolved releases.
GE	75	[2] Resuspension is touched on briefly in the text addressed to the production rate standard: "Resuspension has not been a major problem in most instances where containment systems have been used. Where such systems have not been employed, resuspension has been minimized through careful control of the dredging operation including reducing dredge production rates and limiting dredging operations during adverse weather or high flow periods" (Vol. 3, Sec. 2.2.1, at p. 8). This conveys a false sense of accomplishment on prior projects. Although resuspension has not been identified as a major problem in the past, it does not follow that resuspension was acceptably low because (a) resuspension has not been measured effectively in most		USEPA does not agree. As discussed at length in the white paper on the case studies analysis, several sites have been studied, both with and without resuspension control barriers. In several instances, release rates could be calculated despite the lack of specific resuspension criteria. In most of these cases, the resuspension releases were acceptable and were consistent with the rates required by the Resuspension Standard.

		environmental dredging projects, and (b) the resuspension criterion have been too simplistic, typically consisting of turbidity or TSS measurements with no demonstrated relationship to or measurement of actual contaminant losses.		

Reference:

Fischer, H.B, E.J. List, R. C.Y. Koh, J. Imberger, and N.H. Brooks. 1979. Mixing in Inland and Coastal Waters. Academic Press, New York, 1979.

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Interoffice Memorandum

To: Ed Garvey & Claire Hunt | Location: NJO | Date: September 24, 2003

From: Celeste Foster | Location: NJO | Job No.: 56513

Subject: White Paper – Case Studies

WHITE PAPER – CASE STUDIES

ABSTRACT

Every Superfund site represents a unique setting, with different hydrologic and geological conditions, different discharge histories and site-specific contaminants. However, a study of other dredging sites can provide information on the conditions that may be encountered. In particular these other sites provide a basis to determine what distances are reasonable for monitoring, what export rates are achievable and what type of releases will occur. As one of the largest Superfund sites, it is unreasonable to expect other sites to provide identical or near-identical conditions. However, taken together these sites demonstrate the feasibility of achieving the individual components of the Hudson River remedy.

The previous examination of the export rates for the case studies (USEPA, 2002) indicated that the range of resuspension rates modeled as the average source strengths (best engineering estimates) was reasonable. Furthermore, the data from the case studies indicated that the export rates estimated are likely to overestimate the anticipated export rate under routine conditions in the Hudson River.

The releases observed at other sites have been predominately associated with the solids. As the solids are transported downstream dissolution will occur. The magnitude of the dissolution is dependent on the sediments concentrations, distance downstream and flow. The case studies with reliable split phase concentrations support the conclusion that dredging-related PCB releases are predominately solids.

Given the limitations of these case studies they are not used directly to infer the conditions that will occur during dredging in the Hudson River. Therefore, the Remedial Design should provide contingencies and dredging techniques to deal with site-specific factors.

INTRODUCTION

None of the case studies examined provide specific estimates for the conditions in the Hudson River. Rather, the studies presented evidence for:

- The range of export rates achieved and how the export rates can be accurately determined;
- The type of releases (*i.e.* solid or dissolved phase) that generally occur.

In the case studies the monitoring plans, sediment concentrations/classifications, the nominal flows and weather conditions were different than those anticipated in the Hudson River. It is conceded that the case studies do not provide perfect templates and therefore they were not used as such.

The case studies examined include: New Bedford Harbor, Fox River and Hudson Falls. Since these sites were examined previously for the Feasibility Study (USEPA, 2000) and Responsiveness Summary to the ROD (USEPA, 2002), only new analyses or further clarification will be provided below. Other case studies were also examined, but either there was not enough information concerning resuspension or the conditions were too dissimilar.

NEW BEDFORD HARBOR, MASSACHUSETTS

Background

The New Bedford Harbor Superfund Site is located in Bedford, Massachusetts, about 55 miles south of Boston. The site is contaminated with PCBs, heavy metals, and other chemicals from industrial discharges. Removal of PCB-contaminated sediments in hot spots located on the west side of the Acushnet River estuary was completed between April 1994 and September 1995. Dredging of the hot spots was performed using a hydraulic dredge, and the slurry was subsequently pumped into a confined disposal facility (CDF). Following the hot spot dredging, a pre-design field test using mechanical dredging equipment was performed in August 2000 and documented in the Pre-Design Field Test Final Report (USACE, 2001). During the Pre-Design Field Test the area directly around the dredge was referred to as the moonpool. At times oily sheens and oily slick releases were noticed. The report contains detailed information regarding the dredging operation, water quality monitoring for turbidity, particulate PCBs, dissolved PCBs, threshold water column levels, and contingency plans to be put in effect in the event that the action level was detected at one of the monitoring stations. Since the hot spot removal was discussed in depth in the Responsiveness Summary to the ROD (USEPA, 2002) only the pre-design study is considered in this analysis.

Export Rate

Since there was not a sufficient amount of concentration and flow data collected as part of the pre-design field test, the export rate could not be estimated. A previous estimate for the export rate at New Bedford Harbor was obtained from the longer dredging program during which samples were collected at Coggeshall Bridge. This estimate was described in detail in the Responsiveness Summary to the ROD (USEPA, 2002).

Dissolved Phase Release

In the Pre-design Field Report it was noted that New Bedford Harbor contains free oil phase PCBs as well as sediment-bound PCBs. For this analysis (and the analysis in the Performance Standard Report), the data from the oil releases and moonpool were not included since these samples represent a multiphase system, and multi-phase systems are not applicable to the lower

PCB concentrations typical of the Hudson. Essentially, samples labeled as "oily sheen" or "oil slick" do not apply to the sediment resuspension processes anticipated for the Hudson. Exclusion of these oil-bearing samples provides a more consistent picture of the PCB release process at New Bedford Harbor.

In Figure GE-35A, the total PCB, suspended and dissolved phase PCB concentrations are presented as a function of distance upstream and downstream for the dredging study. For each PCB form (total, suspended and dissolved) two plots are presented, one showing all data and a second showing an expanded scale. In each case, samples within the "moonpool" around the dredging operation (0 distance from the dredge) show very high levels relative to baseline (i.e., upstream) conditions. These samples represent conditions in the immediate vicinity of the dredge. Examining the expanded scale graphs allows a comparison of the upstream vs. downstream conditions. In this comparison, it is clear that all three forms of PCB increased downstream of the dredge, indicative of resuspension release. These conditions represent the near-field conditions referred to in the standard. However, it is also clear that the suspended matter concentration has increased substantially more than the dissolved phase, indicating that the primary form of the net PCB increase took place in suspended matter form, consistent with the analysis provided in the standard. The suspended matter concentration increased by more than 100 percent from approximately 500 ng/L to 1000-1500 ng/L. The dissolved phase increased form about 500 ng/L to about 750 ng/L or about 50 percent. The impact of the dredging related release can also be seen in Figure GE-35B, which presents the fraction of the dissolved phase as a function of total PCB concentration and distance from the dredge. In the diagram relating dissolved fraction vs. total PCB, there is a clear trend toward lower dissolved fractions as the total PCB concentration increases. This trend correlates with the decrease in dissolved fraction PCB that occurs from upstream to downstream, as also shown in the figure. These data all support the assertion that PCB releases due to dredging occur primarily as a suspended matter release and thus can be tracked in the near field by suspended matter or possibly turbidity measurements. This also shows that PCBs enter the water column as suspended matter, a process that is independent of the baseline dissolved phase PCB concentration.

Subsequent to the resuspension, greater dissolution of PCBs takes place but the elevated PCB suspended matter fraction remains, indicating that it will be possible to track PCB releases by suspended matter or turbidity. Additionally, as shown in Figure GE-35A, the total PCB concentrations increased by roughly 1,000 ng/L or about 100 percent. Of the 1000 ng/L increase, roughly 750 ng/L were particle-borne and 250 ng/L were dissolved phase-borne. This corresponded to an increase in TSS of roughly 100 percent, consistent with the PCB gain. This TSS signal would be readily detected by the monitoring scheme required for the standard. Notably, the dissolved baseline PCB concentrations, while elevated at 500 ng/L, are not so far above those typically found in the Hudson during peak summer time conditions (150- 200 ng/L). Thus similar behavior of PCBs is expected in the Hudson with respect to the downstream distribution on dissolved and suspended matter fractions.

<u>Results</u>

As noted, the Pre-Design Field Test was not used to estimate the magnitude of dredging related PCB releases. Only the nature of the releases was examined. Nonetheless the data clearly show elevated mean concentrations of PCBs downstream of the dredge, regardless of the downstream distance. Additionally, the data show increased mean PCB concentrations on the suspended matter, as well as an increase in suspended solids at all points downstream (see Figure GE-38). The examination of these data shows that the suspended solids would be clear indicators of the PCB releases and that the dredging-related PCB releases are predominately from solids.

FOX RIVER SMU 56/57 1999 AND 2000 DREDGING PROJECTS, WISCONSIN

Background

The Fox River sediment management unit (SMU) 56/57 is located along the Fox River adjacent to the Fort James Plant. This river system is part of the Great Lakes Area of Concern. Approximately 80,000 cy of PCB-contaminated sediment were targeted for removal using a hydraulic cutter head dredge. After one week of dredging activities, the dredge was switched to an IMS 5012 Versi dredge in attempt to increase the solids content of the dredge slurry. The dredge was upgraded two more times during the first month of dredging in an attempt to meet an optimum production rate of 200 cy/hr. The Fox River SMU 56/57 was divided into 100 x 100 foot subunits. Dredging was conducted from August 1999 to December 1999. It was determined at the end of Phase I (December 1999) that unacceptably high residuals were left in the area dredged due to mound of sediment left behind between dredge passes. As a result, the dredging equipment was switched to a horizontal auger dredge for Phase II, which was carried out from late August 2000 to the end of November 2000. Phase I subunits were re-dredged to meet a 1 ppm PCB residual concentration. The activities were documented in the Final Summary Report for Sediment Management Unit 56/57 (September 2000) and the Environmental Monitoring Report (July 2000). The reports contain information regarding water quality monitoring, PCB water column levels and loading, turbidity measurements, and post-dredge sampling. Since, the export rate was estimated in the RS to the ROD (USEPA, 2002) the discussion below only discusses why the export estimation is likely an overestimate of the conditions anticipated during dredging in the Hudson.

Export Rate

There are three main reasons why the export rate is not directly applicable to the export rates anticipated in the Hudson include the monitoring locations, dredge type and sampling technique. However the export estimate obtained is within the range considered in the performance standard criteria.

As noted in the Resuspension White Paper in the RS, the Fox River studies were complicated by the location of the monitoring stations. The fact that significant loss of PCBs only occurred when the dredging area was close to the sampling cross-section suggests that settling of any resuspended matter occurs within a short distance of the dredging operation. Only when the monitoring location was close to the dredging could this signal be found. This suggests that the loads obtained by this study do not represent PCB released for long-distance transport. Rather, the PCBs appear to be quickly removed from the water column a short distance downstream. As such, it is inappropriate to use these results to estimate downstream transport from a dredging site.

Furthermore, as discussed in the white paper, the higher resuspension rates may also be a result of the dredge used in these operations. In fact, the New Bedford pilot study compared the sediment resuspension characteristics of a horizontal auger dredge (used in Fox River) with a conventional hydraulic cutterhead suction dredge and found a disparity similar to that observed between the Fox River and average source strength estimates.

The sample compositing may not have been performed in such a manner as to account for flow. As noted it the Resuspension White Paper in the RS: "The sample compositing strategy [of the Fox River Studies], designed to reduce the number and cost of PCB analyses, was contrary to the mass flux analysis attempted. The equal volume composites do not allow consideration of flow variation across the cross-section. USGS (2000) states that stagnant areas and even reversed flows were observed during sampling operations, confirming the errors associated with the composite PCB samples. The TSS sample composites induce less error and provide a more accurate estimate of downstream TSS flux, yet they showed an unexplained decrease in suspended sediment across the dredging operation. The decrease is almost certainly an artifact associated with compositing equal volume samples from 20 percent and 80 percent depth. Even though it has long been established that velocity measurements from these depths represent the average velocity in an open channel, there is no justification for suggesting that a composite sample from these depths represents the average concentration along the profile. This is particularly true in deeper water where the two samples represent 25 feet or more of water depth."

As discussed previously in the Responsiveness Summary for the ROD (USEPA, 2002) and in section 2.2.2 of the Dredging-Related Resuspension Performance Standard Report, there were many reasons why the field estimates for Fox River were considered overestimations. Mainly the proximity of the monitoring locations did not allow for export to be reliably calculated. The sampling locations were located too close to the operations, and therefore export estimates from these samples did not account for settling. The samples taken in the cross sections were not combined in a representative manner to constitute the entire load. Despite these reservations, a rate of loss equivalent to 2.2 percent was obtained from the previous analysis. It should be noted that, a short-term 2.2 percent export rate (over days to weeks) would not cause exceedences of the Resuspension Standard (i.e., 500 ng/L) in any of the river sections. Furthermore according to the models, a release of 2.2 percent would only represent a concern for the 350 ng/L Total PCB criteria in River Section 2 due to the higher sediment concentrations. However, according to the modeling this resuspension rate would represent loads greater than 600 g/day Total PCB, thus prompting additional sampling and possibly additional engineering controls if these levels are sustained. Ultimately, the Resuspension Standard has been designed to allow for occasionally large loads without prompting immediate cessation of the operation.

<u>Dissolved Phase Release</u>

It is unclear as to the holding time between sample collection and sample separation into dissolved and particulate fractions, confounding conclusions with regard to dissolved and suspended loads. The data provide evidence of this lag in separations. As noted in the RS the data are not consistent with a large dissolved phase release based on the lack of change in PCB pattern across the dredging area. A large dissolved-phase PCB contribution from the sediments, either by porewater displacement or sediment-water exchange, should yield a gain whose pattern is similar to the filter supernatant. The fact that the congener pattern is unchanged across the study area would suggest a direct sediment addition. Yet the TSS data do not document an increase in suspended sediments. Please refer to the Resuspension White Paper for further details.

Results

The measurements provided in the Fox River report are not applicable or appropriate for use directly in the Resuspension Performance Standard for a variety of reasons. As noted in the Resuspension White Paper in the RS, the Fox River study was complicated by the location of the monitoring stations. In this case study there was a paper mill close by that significantly affected the monitoring results. Furthermore, "the fact that significant loss of PCBs only occurred when the dredging area was close to the sampling cross-section suggests that settling of any resuspended matter occurs within a short distance of the dredging operation. Only when the monitoring location was close to the dredging could this signal be found. This suggests that the loads obtained by this study do not represent PCB released for long-distance transport. Rather, the PCBs appear to be quickly removed from the water column a short distance downstream. As such, it is inappropriate to use these results to estimate downstream transport from a dredging site." The data is not particularly useful for analysis of the release mechanisms of PCBs during dredging either, since the holding times of the split samples before separation may have allowed for further dissolution between the phases. Despite the analysis performed in the Resuspension Standard Report as well as previous reports suggesting no significant dissolved release will exist at the dredge, the resuspension criteria do not rely on this. The criteria downstream are for total PCBs, both dissolved and particulate, and will therefore detect any dissolved releases.

HUDSON FALLS

Background

Hudson River sediments were removed from around the GE pump house near Hudson Falls. Sediments in this area contained high levels of PCBs, as well as pure PCB oil. Dredging was accomplished by diver-directed suction hoses over a total period of about seven months (Oct.-Dec. 1977 and Aug.-Nov. 1998). During this period, GE conducted its regular monitoring at Bakers Falls and Rogers Island, which can be used to estimate the effects of dredging to the downstream. Since the original analysis of the export rate was provided in the previous analysis (USEPA, 2002) the following discussion is only provided to further clarify the conservative assumptions within that analysis.

Export Rate

In the Hudson Falls dredging project, PCBs were present in the NAPL form as well as on sediments. The presence of this NAPL PCB has the potential to escape on its own or to supersaturate the water column. As a result the anticipated release and export rates should be higher than that expected from sediment resuspension alone. The mass of sediment removed from Hudson Falls was provided by the NYSDEC and the average PCB concentrations were taken from cores in the dredged area. Even if the calculations of the mass were off by a factor of two, the export rate would still be less than 1 percent. PCB export at this rate would not exceed the Resuspension Standard in any river section, based on the modeling analysis Furthermore the export rates estimated for the Hudson Falls site represent upper bounds on the losses due to dredging because of the historical sources between Bakers Falls and Rogers Island, (i.e., the Hudson Falls and Ft. Edward facilities). While the baseline is considered relatively well constrained as a result of controls implemented by GE at Hudson Falls, the addition of PCBs by the GE facilities was still occurring at the time, thus potentially adding to the total load and yielding an overestimate of the export from the Hudson Falls site. Overall, the conditions noted for the Hudson Falls dredging project suggest that its conditions were likely to have been much worse than those to be encountered on the Hudson. The means of estimating loads represents a conservative approach and thus provides a useful upper bound on the actual PCB export. For these reasons it was a useful site for inclusion in the analysis for the resuspension standard.

Dissolved Phase Release
Split phase data were not available for this site.

Results
Since the export rate estimations for the Hudson Falls dredging operations were based on conservative assumptions, it is likely that the export rate has been overestimated.

OTHER SITES – NOT EVALUATED

Data from Fox River Area N and Manistique Harbor were not used based on the project size as well as the application of a dredging technology that was deemed inappropriate for the Hudson and unlikely to be used, based on its apparent loss rate. For the Fox River Area N study only slightly more than 100 lbs of PCBs were removed, suggesting that operations were too small to become routine. Much of the loss may have been associated with start-up. It is likely that the larger project on the Fox River (Areas 56/57 with nearly 1,500 lbs of PCBs removed) is more reflective of the dredging related losses even though these are probably overestimated as well. The data for Manistique are not available at, however it is known that dredging at Manistique was primarily accomplished with a cable arm bucket dredge (although other dredges were used as well). In the dredged locations, extensive areas of dense, coarse sediments and debris inhibited the effectiveness of the dredge bucket. The cable arm bucket is designed to dredge soft sediments and does not perform as well where either consolidated materials or debris are present. Thereby, the Remedial Design will have to consider the type of dredge as well as the other engineering contingencies, particularly in areas identified as likely to resuspend.

CONCLUSIONS

The export rates obtained from the case studies are not directly applicable for comparison to the resuspension criteria since these represent daily averages and the criteria pertain to running averages. The long-term effects on the river will be dependent on the export rates downstream. The case studies exhibit that the monitoring stations should be sufficiently downstream to correctly measure the release rate (i.e. the load to the Lower Hudson). As the near-field transport model of the Performance Standard Report and the Fox River case study indicated much of the TSS settle close to the dredging operations. It is likely that these solids will be removed as the dredge moves downstream.

Ultimately, these studies are not expected to be comprehensive templates for dredging on the Hudson since the conditions of dredging (operations, engineering contingencies, etc.) may have been different from those to be used on the Hudson. The case studies are used to show that dredging operations at other sites (even in the Hudson) have had success with minimizing export through various techniques and engineering contingencies.

When taken together, these sites demonstrate a consistent level of site clean-up and resuspension release when viewed on a relative basis. The Resuspension Standard as developed does not require greater degree of control for resuspension than that achieved by other remedial efforts.

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Interoffice Memorandum

To: Ed Garvey & Claire Hunt   Location: NJO   Date: September 22, 2003

From: Celeste Foster   Location: NJO   Job No.: 56513

Subject: White Paper – PCB Concentration Distribution on Coarse and Fine Sediments

WHITE PAPER – PCB CONCENTRATION DISTRIBUTION ON COARSE AND FINE SEDIMENTS

ABSTRACT

The analysis presented below uses published data from River Section 1 sediment to examine the relationships between grain size, organic content and Total PCB concentration. The limited data set was used to provide a ratio of Total PCBs for the fine and coarse-grained sediments. Using these ratios dredging-related PCB resuspension (assuming the average source strength) was modeled for different fine-grained Total PCB sediment concentrations.

The original analysis of the source strength, modeled at 4000 cfs with an average Total PCB sediment concentration of 27 mg/kg, yielded a Total PCB flux of 78 g/day. Published grain-size, organic content and PCB data indicated that the Total PCB concentration on the fine-grained sediments may range from 30 to 36 Total PCB mg/kg. The TSS-Chem transport model indicated that these concentrations on the fine-grained sediments for flows ranging from 2000 to 5000 cfs have PCB fluxes at one mile of 44 to 115 g (Total PCB) /day. Therefore, the model indicated that the Total PCB concentrations investigated do not represent a significant change in the flux or the water column concentration increase, particularly when the uncertainties in sediment homogeneity and river-wide flowrates are considered.

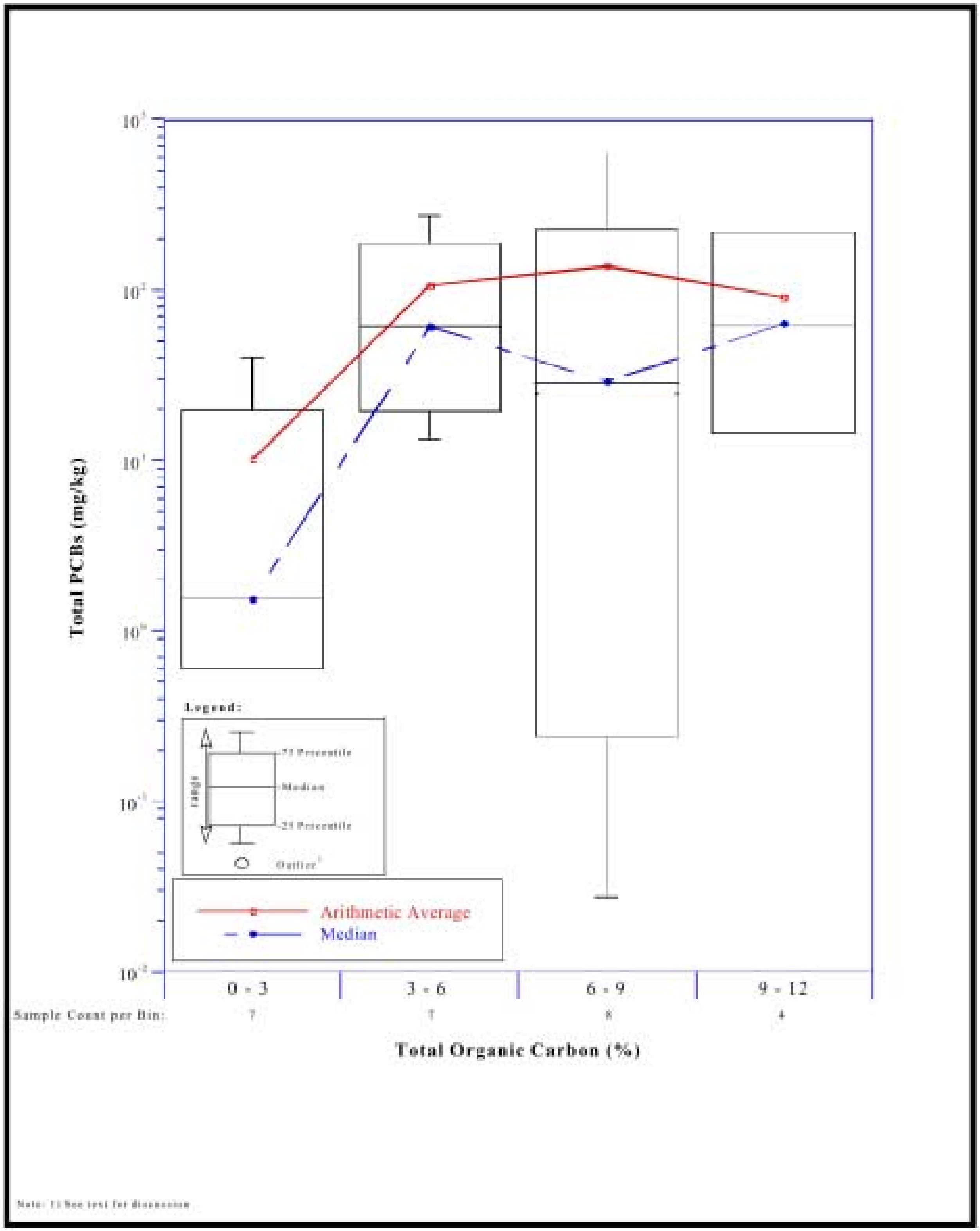
Although the results suggest that the original estimate may not be as conservative as possible, there are many other conservative assumptions in the model. Due to limitations of modeling, the resuspension criteria and action levels were based on the MCL and fish body burdens in the Lower Hudson. The modeling was used as an aid in estimating the resuspension rates each of the criteria may represent. During Phase 1 the model will be reevaluated and possibly modified.

INTRODUCTION

While USEPA recognizes that PCB concentrations are generally higher in fine-grained sediments relative to coarse-grained sediments when classified as a whole sample, it is not clear that the organic carbon content within a sample can approximate this relationship. That is, it is not clear that within a given sample, the PCB content of each grain-size fraction is well approximated by the organic carbon content for the sample.

The lack of a direct correlation between organic carbon content and PCB concentration can be seen in Figure 3-21 of the Low Resolution Sediment Coring Report (USEPA, 1999), included here for reference. This figure shows that PCB concentration does not increase linearly with TOC and that significant variation can be found at any organic carbon concentration. The USEPA agrees that there may be some enhancement of PCB concentration with smaller particles but it is not clear that the response is linear.

Figure 3-21 from the LRC

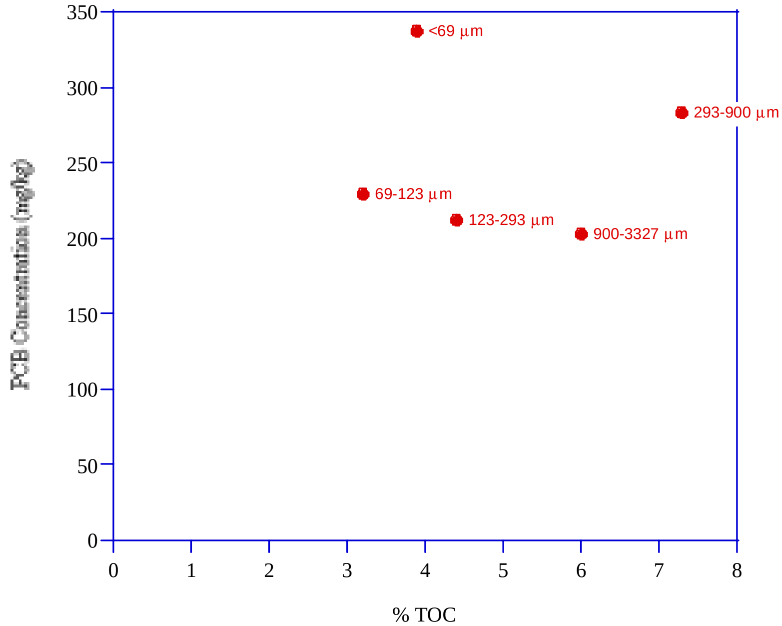


Source: TAMS/Gradient Database, Release 3.5 TAMS

Figure 3-21
Total PCBs Grouped by Total Organic Carbon

According to a study of contaminated Hudson River sediments conducted by General Electric Corporate Research and Development and MIT published in Environmental Science and Technology (Carroll et al, 1994) the Hudson River sediments greater than 0.069 µm (sand) had % TOC values from 3.2 to 7.3 while the sediments less than 0.069 µm (silt/clay) had a %TOC value of 3.9, indicating little if any difference. These data suggest that the organic carbon content is relatively homogeneous in fine-grained sediments. The data set presented in the paper represents a limited number of samples so it is unclear how far this data can be extrapolated. Nonetheless, it indicates that organic carbon content may not vary with grain size fraction in fine-grained sediments. Furthermore the PCB concentrations for these sediment fractions did not substantively differ. The sand fraction PCB concentrations ranged from 203-284 ppm and the silt/clay concentration was 338 ppm. The data are shown in Figure 1.

Figure 1
Grain Size, Organic Content and PCB Concentrations in Hudson River Sediment collected near Moreau



If the ratio of these samples (which were all taken from Moreau NY, and therefore only represent River Section 1) were assumed to be applicable to the average sediment concentration in River Section 1 (27 ppm), the silt Total PCB concentration would range from 30 to 36 ppm. The equations used to estimate this range are shown below (River Section 1 has an estimated silt fraction of 37%).

$$C_{silt} f_{silt} + C_{coarse} f_{coarse} = C_{Total}$$

where:
C = PCB concentration (mg/kg)
f = fraction (kg sediment type/kg total)

$$C_{silt} f_{silt} + (Ratio_{coarse-to-silt}) C_{silt} (1 - f_{silt}) = C_{Total}$$

or

$$C_{silt} = \frac{C_{Total}}{f_{silt} + (Ratio_{coarse-to-silt})(1 - f_{silt})}$$

Further TSS-Chem model runs were performed using River Section 1 Total PCB silt concentrations of 27, 30 and 36 mg/kg and river-wide flows of 2000, 4000, and 5000 cfs. The results are shown in Table 1.

Table 1
Average Source Strength Estimated Fluxes and Concentrations for River Section 1 with Various Flows and Silt Total PCB Sediment Concentrations

INPUT			TSS-Chem RESULTS				PERCENT LOSS	
Silt Sediment Total PCB Concentration (mg/kg)	Silt Fraction unitless	TSS Silt Source Strength (kg/s)	Net TSS Flux at 1 mile (kg/day)	Net Total PCB Flux at 1 mile (g/day)	Net Fraction Dissolved PCBs at 1 mile unitless	Total PCB Conc. increase at 1 mile (ng/l)	TSS Loss at 1 mile %	PCB Loss at 1 mile %
4000 cfs								
27	0.37	0.077	2,303	78	0.35	14	0.11	0.14
30	0.37	0.077	2,303	87	0.36	15	0.11	0.15
36	0.37	0.077	2,303	105	0.37	18	0.11	0.18
2000 cfs								
27	0.37	0.077	671	39	0.55	14	0.03	0.07
30	0.37	0.077	671	44	0.56	15	0.03	0.08
36	0.37	0.077	671	53	0.57	19	0.03	0.09
5000 cfs								
27	0.37	0.077	2,721	86	0.27	12	0.13	0.15
30	0.37	0.077	2,721	95	0.28	13	0.13	0.17
36	0.37	0.077	2,721	115	0.28	16	0.13	0.20

DISCUSSION OF RESULTS

The PCB flux using the values from the previous source strength modeling (27 Total PCB mg/kg and 4000 cfs) was 78 g (Total PCB) /day at one mile. With the different concentrations and flows the PCB fluxes ranged from 44 to 115 g (Total PCB) /day. The Total PCB water-column concentration modeled in the original analysis was 14 ng/L at one mile. With the different flows and sediment concentrations the water-column concentration was modeled to range from 13-19 ng/L. Given the dependency of Total PCB flux on flow, the uncertainty introduced by using the average sediment concentrations instead of the silt concentrations (exhibited by the data from Carroll et al, 1994) is not significant.

CONCLUSIONS

Although these results suggest that the estimates originally presented may not be as conservative as possible, they are still quite conservative based on other assumptions made in the development of the standard. In particular, the model transport mechanisms themselves are quite conservative. For example, the source strength term is derived from an upper-bound estimate of the releases due to dredging. Secondly, the transport mechanisms have been idealized and further settling of particles is expected relative to the model predictions.

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White Paper – Estimated Cost of the Phase 1 Water Column Monitoring Program

Abstract

Concern was raised over the potential cost for the water column monitoring program required by the Reuspension Performance Standard. The cost estimated by the commenter is $6,000,000 for Phase 1, or $40,000,000 for the duration of the entire remediation. This white paper presents the basis for the cost estimate for the Phase 1 monitoring program, assuming that the major costs for the monitoring program are labor to collect the samples and the analytical costs. On this basis, this cost of the Phase 1 monitoring program is approximately $4,000,000 which is on the same order of magnitude, but about one-third lower, than the commenter's estimate. The cost of the Phase 1 monitoring program cannot, however, be used as a basis for estimating the monitoring costs for the remainder of the remediation. The Phase 1 monitoring program is designed to both determine compliance with the resuspension criteria, and also to generate data to answer the comments raised by the public on the selected remedy; among these questions are the nature of contaminant releases (dissolved or suspended phase) encountered during the remedial program. [The answer to this will determine the extent to which suspended solids data (as opposed to more expensive PCB data) can be used to determine the magnitude of dredging-related releases during the remainder of the remdiatial program. This will in turn determine the extent to which the Phase 1 monitoring program requirements can be reduced and still measure compliance with the resuspension criteria with an acceptable degree of certainty.]

Introduction

A number of different sampling and data collection events will occur as part of the remediation of the Hudson River PCBs Site, of which the Phase 1 program covered herein is one part. These include:

- Pre-remediation sampling:
    - Pre-design sediment sampling (initiated in 2002) to complete the delineation of PCB-contaminated sediments which will be targeted for remediation (dredging)
    - Baseline Monitoring Program – water column sampling (not yet begun) to establish baseline water column conditions throughout the length of the project area
- Remediation Phase Sampling:
    - Phase 1 Sampling program will be conducted in the first year (i.e., 'Phase 1') of the dredging program. As discussed in greater detail in the Engineering Performance Standard, this program will include various water column sampling and analyses to assess different techniques and measurement types for monitoring and verifying compliance with the Resuspension Performance Standard; and also to generate additional data to improve understanding of the sediment and contaminant transport processes which may occur during the dredging program.

- Ongoing remediation phase sampling (also referred to as 'Phase 2' in the discussion below) – this program will be the monitoring conducted from the second year of the dredging program through its completion (estimated to be a six-year effort, including Phase 1). It is anticipated that this monitoring program will not be as intensive as the Phase 1 program, as it is expected that semi-quantitative relationships developed during Phase 1 will enable either the number of samples, or the analytical parameters, to be reduced while still maintaining compliance with the Resuspension Standard.

- Post-Remediation sampling. A long-term monitoring program will be implemented to assess the effectiveness of the remedial program and the recovery of the river after the completion of the dredging program. This program has not yet been designed but will likely include sediment, fish, and water column sampling.

In response to comments on the cost associated with the water column monitoring program required by the Resuspension Performance Standard, a cost estimate for the Phase 1 program is provided. However, the cost of the Phase 1 program cannot be used to project the monitoring costs for the rest of the remedial program, as the Phase 1 program is more sample- and analytical-intensive than the program likely to be implemented for the remainder of the remediation effort.

This estimate focuses on the two main elements of the program: labor and laboratory analytical cost. The cost estimate for the Phase 1 monitoring program is based on specific scenarios for implementing the monitoring program, which are described in detail below. Standard laboratory rates are used to estimate the analytical costs; however, it is likely that lower rates can be negotiated for this program (due to the large quantity of analyses being performed). The final cost of the Phase 1 monitoring program will also be dependent on the degree to which the operations are in compliance with the resuspension criteria.

Alternate strategies may be developed to more efficiently handle the requirements of the monitoring program. In addition, other modifications to the monitoring program which reduce the costs of the program will be acceptable, as long as all data quality objectives are met.. As such, the costs provided in this estimate are conservative.

Phase 1 Monitoring Program Cost Estimate

It is assumed that the primary costs for the Phase 1 monitoring program will be labor and laboratory analytical costs associated with sample collection. It is assumed that the quality assurance/quality control requirements will be limited because of the quick turnaround requirements. For the monitoring program described in Table 1-2 through 1-4 of the Resuspension Performance Standard, costs for these elements were developed and are described below. The labor costs are in turn a function of two variables: the level of effort (i.e., the personnel-hours required to collect the samples), and the labor rates (dollars per hour). Similarly, the analytical costs are a function of the number of analyses of each type performed (e.g., PCB analysis, TSS, total organic carbon), and the unit cost for each of these analyses.

It should be noted that the scenario on which the Phase 1 cost estimate presented herein is based assumes that two field laboratories will be established to perform the total suspended solids (TSS) analyses. As the facilities (a mobile office trailer) and equipment (scale, oven, filters, and glassware) are relatively simple and inexpensive, costs for the field laboratories (which will likely be less than $10,000 for each) are not included in this estimate. Costs for the technicians to perform the analyses are not included in this estimate; however, the costs for the TSS analysis are addressed as a laboratory analytical cost (based on the cost of an off-site laboratory performing the TSS analyses).

In the discussion below, a number of the sampling activities are discussed relative to the 'operations' which are occurring at the time. In this context, 'operations' means any remedial activities which involve sediment disturbance. These operations will be primarily the dredging operations, but 'operations' may also include other activities such as debris removal.

Labor Costs - Level of Effort (LOE)

The level of effort for both the routine monitoring and non-routine monitoring efforts are presented below. Each (routine and non-routine) is further subdivided into the LOE estimate for near-field and far-field sample collection.

Routine Monitoring

Upper and Lower River, Far-Field: The LOE for this portion of the monitoring program is driven by the 1 suspended solids sample collected for every three hours Each of the four stations (TI Dam, Schuylerville, Stillwater, and Waterford) proposed for this monitoring will require a dedicated crew. Each crew will consist of two responsible for collecting the analytical sample(s) and delivering them to the field laboratory.. Routine monitoring samples to be collected at each of these locations include:

- Daily: samples for PCB whole water analysis and organic carbon (dissolved & suspended).
- Bi-weekly PCB (large volume water samples)).

The crews will also complete the requisite custody forms. After delivering the samples to the lab, the crew will return to their station and prepare to collect the next sample round. Each of these stations will require 24-hour monitoring and, therefore, three crews (each working 8 hours of a 24-hour day) per station will be necessary. In addition, another 2-person crew will be required for the collection of the Baker's Falls (weekly whole water PCB, and organic carbon), Fort Edward (daily whole water PCB, organic carbon, suspended solids, and bi-weekly large-volume PCB), and Lower Hudson River (monthly whole water PCB, organic carbon, and suspended solids) samples. This crew could also "float" between the other stations (especially TI Dam), during times of need (for example, collection of the daily PCB and organic carbon samples).

The LOE breakdown is therefore:

(1 crew x 2 people x 3 shifts per day x 4 stations) + (1 crew x 2 people x 1 shift per day) = 26 people per day for the duration of the program.

This estimate is based on the assumption that, with the exception of the TI Dam station, all samples will be collected from bridges spanning the river. The TI Dam station presents several unique problems; not only are there safety concerns related to the dam itself, but the samples must be collected across both channels. This will require driving to either Fort Edward or to the Route 4 bridge to cross the river. (Alternatively, the “floating”" crew can assist in sample collection at this location.) Another assumption of this estimate is that there are two field laboratories set up for the analysis of suspended solids - one in Fort Edward and the other perhaps in Mechanicville. These field labs could also serve as the pick-up location for the courier to shuttle the samples for PCB and organic carbon analyses to the off-site laboratory (assumed to be located in the Albany area). The LOE estimate does not include staffing the field labs or couriers to shuttle samples to the off-site laboratory. The staffing of the field laboratory is addressed by the unit analytical cost for TSS (see below); and it is anticipated the field laboratories will be within the routine courier range for sample pickup of the off-site laboratory.

[Not necessary; sick time etc covered in the 'loaded' rate; we're costing for 168 hrs/week regardless.]

Near-Field: One crew should be able to handle up to five operations of near field sampling. Above that, a second crew will be required. Each crew will consist of two samplers and one boat operator. The crew will collect the samples, fill out required paperwork and transport the samples to the field labs described above.

The LOE breakdown (for five operations) is:

1 crew x 3 people x 2 shifts per day = 6 people per day for the duration of the program. The staffing requirement will be doubled for instances where there are 6 to 10 operations.

The major assumption of this estimate is that the dredging operations are within close proximity to one another (i.e., all are within the same pool). Additional personnel will be required if operations are being conducted in two or more pools.

Routine Montoring LOE Summary

Based on the near-field and far-field estimates and the assumptions listed above, the LOE for routine monitoring is between 32 and 38 people per day (the variability is contingent on specifics of operations) to collect samples, fill out paperwork and transport the samples to one of two field labs for the duration of the program.

Non-Routine Monitoring

Upper and Lower River, Far-Field: There is no need for additional samplers (beyond those required for the routine monitoring) for non-routine monitoring, as the one sample for TSS analysis every three hours remains constant. However, additional personnel will be required to do the field filtering of the water samples for PCB analysis to be collected at the TI Dam and Schuylerville stations. One crew per each station will be required for each sample collected (e.g., for the evaluation level, two additional crews are required at both stations; and for the Concern level, three crews would be added, etc.). The additional crew could assist in the collection of the sample prior to filtering, freeing up the Baker's Falls/Fort Edward/Lower Hudson River crew to collect the sample additions at their primary stations.

The LOE breakdown (using the Concern Level as the basis)is:

1 crew x 2 people x 3 sampling events x 2 stations = 12 additional people per day for the duration of the event.??

For Evaluation Level monitoring, the additional filtering personnel required during non-routine monitoring is eight people (two sampling events per day for each station). The maximum number of additional filtering personnel would be 16 people (four sampling events per day for each station) at the Control Level.

Near-Field: The hourly suspended solids sample collection requirement of the non-routine monitoring would require one crew per two operations, with an additional person added to each crew to shuttle samples to the field laboratories.

The LOE breakdown (assuming six operations)is:

3 crews x 4 people x 2 shifts per day = 24 people per day for the duration of the event.

With two or fewer operations, only one additional person (relative to routine monitoring) per shift would be required; five additional people per shift would be required for three or four operations; nine people per shift for five or six operations, and so on. The maximum number of additional people would be 17 people per shift at a maximum of 10 operations.

The major assumption of this estimate is that dock space can be accessed nearby the operations so that the time required to get the samples to shore for transport to the labs is not a significant factor. As with Routine Monitoring, the estimate assumes that operations are being conducted in the same pool, and the LOE is estimated only for sample collection, documentation and transport to the field labs.

A concern of the non-routine sampling is the immediate need for the additional personnel once an action level has been "triggered". The range of people required for non-routine sampling (personnel in addition to the full-time staff doing routine monitoring) issignificant, starting at 9 people (Evaluation Level, one or two operations) up to a maximum of 33 additional personnel (Control Level, 10 operations). At the maximum level, the size of the field crew essentially doubles. From a resource management standpoint, maintaining a pool of 30 qualified and trained individuals to be ready to sample with less than 12 hours notice would be difficult, at best.

Labor Rates

It is assumed that the average cost for sampling technicians during an 8-hour shift will be $416 ($52/hour loaded rate, based on a $20/hour direct rate and an overhead factor of 1.6).

Laboratory Analysis – Estimated Quantities

The estimated laboratory analysis quantities for far-field (Upper Hudson River and Lower Hudson River) and near-field laboratory analyses are provided in Tables 1 through 3.

Laboratory Analysis - Unit Costs

The estimated unit costs for laboratory analyses are listed below.

PCB Congeners (standard turnaround time)	$	300
24-hour Turnaround Time	$	600
72-hour Turnaround Time	$	525
Suspended Solids 3-hour Turnaround Time	$	20
Dissolved Organic Carbon	$	35
Suspended Organic Carbon	$	60

The PCB congener rates above assume a 100 percent surcharge for 24-hour turnaround time, and a 75 percent surcharge for 72-hour turnaround.

Reasonable Estimate of Monitoring Program Cost

The weekly costs for far-field (Upper Hudson River and Lower Hudson River) and near-field laboratory analyses are provided in Tables 1 through 3. The daily cost for far-field and near-field labor are provided in Tables 4 and 5. The costs per day are summarized below.

Phase 1 Costs/Day

Upper River Far-Field			
Level	Analytical	Labor	Total
Routine	3,678	10,816	14,494
Evaluation	7,548	15,808	23,356
Concern	10,220	20,800	31,020
Control	13,040	25,792	38,832
Threshold	20,741	40,768	61,509

Lower River Far-Field	
Level	Analytical
Routine	69
Non-Routine	306

Near-Field	Routine		Non-Routine				
No. Non-Compliant Stations:	0		1	2	3	4	
No. of Operations	Analytical	Labor	Analytical				Labor
1	100	2,496	140	280	420	560	3,328
2	200	2,496	280	560	840	1,120	3,328
3	300	2,496	420	840	1,260	1,680	6,656
4	400	2,496	560	1,120	1,680	2,240	6,656
5	500	2,496	700	1,400	2,100	2,800	9,984
6	600	4,992	840	1,680	2,520	3,360	9,984
7	700	4,992	980	1,960	2,940	3,920	13,312
8	800	4,992	1,120	2,240	3,360	4,480	13,312
9	900	4,992	1,260	2,520	3,780	5,040	16,640
10	1,000	4,992	1,400	2,800	4,200	5,600	16,640

The cost of the monitoring program will depend on the amount of time that is spent at each monitoring level. It is assumed that Phase 1 will last for 30 weeks and have 210 days of operation. Far-field monitoring will be conducted every day during Phase 1. Near-field monitoring will be conducted only on the days of operation.. During Phase 1, on average four operations will be ongoing throughout to meet the production goal of half the annual production rate. If the monitoring level is routine through Phase 1, the cost of the monitoring program will be approximately $4,000,000.

Cost if Routine Throughout Phase 1	
Upper River Far-Field	$3,043,785
Lower River Far-Field	14,400
Near-Field	608,160
Total	$3,666,354

It is likely that some amount of non-routine monitoring will be required during Phase 1, although extended periods of higher level monitoring (Concern Level, Control Level or Threshold) are not foreseen because the amount of resuspension export can be controlled by changes to the remediation like maintaining strict adherence to operating procedures. It is unlikely that the concentrations at Waterford will exceed 350 ng/L Total PCB if Phase 1 is conducted in River Section 1 and the baseline concentrations stay relatively low. Therefore, it is likely that the Lower River Far-Field monitoring will be at the Routine Level throughout Phase 1. For a reasonable estimate of Upper River Far-Field monitoring, it is assumed that Routine Level monitoring will be needed for 26 of the 30 weeks and Concern Level monitoring will be needed for the remaining four weeks. Similarly for Near-Field monitoring, it is assumed that all stations will be in compliance for 26 weeks and non-routine monitoring will be required for four weeks. This near-field non-compliant monitoring is somewhat high assuming four stations will be out of compliance at each of the 4 operations, but this additional cost may address the limited far-field monitoring that will accompany exceedances of the near-field suspended solids resuspension criteria and engineering evaluations. With these assumptions, a reasonable estimate of the monitoring program cost for Phase 1 is approximately $4,000,000.

Reasonable Estimate of Phase 1 Season Monitoring Plan Costs	
26 weeks of Routine Monitoring Upper River Far-Field	$2,637,947
4 weeks of Concern Monitoring Upper River Far-Field	868,550
30 weeks of Routine Monitoring Lower River Far-Field	14,400
26 weeks of Routine Near-Field Monitoring	527,072
4 weeks of Non-Routine Near-Field Monitoring at 4 Stations	249,088
Monitoring Cost:	$4,297,057

The present worth cost estimated for the selected remedy in the feasibility study (FS, [USEPA, 2000]) is $460,000,000. During Phase 1, approximately 10 percent of the total volume to be removed will be dredged. Assuming that the cost of Phase 1 will be in proportion to the amount of sediment dredged, the cost for the Phase 1 operations will be approximately $46,000,000. For both the minimum monitoring requirements and the reasonable estimate, the monitoring program represents 9 percent of the total cost of the Phase 1 program.

The Phase 1 monitoring encompasses more than merely demonstrating compliance with the resuspension criteria and has been developed to provide answers to questions such as the nature of the PCB releases. This data generated during the Phase 1 monitoring program can be used throughout the remediation and justifies the cost of the program. The water column monitoring cost estimated in the FS for the selected remedy was substantiallylower than the estimated cost of the Phase 1 program presented herein; however, the performance standard requirements were added during development of the ROD in response to public comments and the additional costs associated with meeting fixed standards and answering the questions raised by the public are accounted for in this estimate. One important goal of the monitoring program during Phase 1 is to gather data to demonstrate that the water column concentrations and loads can be assessed with confidence using fewer or less costly measurements (suspended solids or turbidity, as opposed to PCB analysis). If a semi-quantitative relationship is demonstrated during Phase 1, the monitoring program can be reduced accordingly for Phase 2.

The costs used in this estimate are conservative. The analytical costs used in these estimates are higher than what may be negotiated given the large amount of samples. The amount of labor needed for the monitoring program could differ from what is estimated here. For instance, if the laboratory were to filter the whole water samples for the levels other than routine, there would not be a need to add additional people for far-field sampling (with perhaps an addition of two people to shuttle samples to the lab). In addition, the monitoring program has been developed to conform to a series of data quality objectives. This allows for alteration of the monitoring plan as long as all of the data quality objectives are met. As a result, less costly means of achieving these objectives may be developed. Similarly, the costs for operating two field laboratories for seven months (assuming staffing by one technician each for 24 hours per day, seven days per week) may be on the order of about $550,000 (total for two field labs – based on the same labor rates as above; and trailer rental and equipment costs of about $10,000 for each field lab); this may be less costly than the estimate herein, which is based on off-site laboratory costs for the TSS analyses.

Conclusions

The Phase 1 water column monitoring plan developed for the performance standard measures compliance with the resuspension criteria and provides important information on the nature and impact of the remediation on the river. The estimate cost of the water column monitoring is approximately $4,000,000. This is 9 percent of the total cost estimated for Phase 1. Although the cost of the water column monitoring for Phase 1 is greater higher than would be expected based on the estimate in the FS, the higher costs are necessary to address the additional requirements prompted by the performance standard and public comments. The costs developed for Phase 1 cannot be applied to the entire remediation, because modifications to the monitoring program may be made for Phase 2; it is likely that these modification will result in cost reductions after the Phase 1 program data are reviewed and the Phase 2 monitoring program is optimized.

Reference

USEPA, 2000. Phase 3 Report: Feasibility Study, Hudson River PCBs Reassessment RI/FS. Prepared for USEPA Region 2 and the US Army Corps of Engineers (USACE), Kansas City District by TAMS Consultants, Inc. December 2000.

Table 1
Sampling Cost on a Weekly Basis - Upper River Far-Field Stations

Routine Monitoring Number of Samples per Week	Lab Turn-Around Time (hr.)	Laboratory Analyses						Integrating Sampler for PCBs	Laboratory Analyses						Integrating Sampler for PCBs
		Congener-specific PCBs							Congener-specific PCBs						
		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]	
RM 197.0 - Bakers Falls Br.	72	1			1	1			525			95	20		
RM 194.2 - Ft Edward	72	7			7.5	7.5	56	0.5	3,675			713	150	20	150
RM 188.5 - TI Dam	24	7			7.5	7.5	56	0.5	4,200			713	150	150	150
RM 181.4 - Schuylerville	24	7			7.5	7.5	56	0.5	4,200			713	150	150	150
RM 163.5 - Stillwater	72	7			7.5	7.5	56	0.5	3,675			713	150	150	150
RM 156.5 – Waterford	72	7			7.5	7.5	56	0.5	3,675			713	150	150	150
Analytical Cost/Week		36			38.5	38.5	280	2.5	19,950			3,658	770	620	750
Total Analytical Cost/Week		**38.5**	**or**	**5.5 /day**					**25,748**	**or**	**3,678 /day**				

Evaluation Level Number of Samples per Week	Lab Turn-Around Time (hr.)	Laboratory Analyses						Integrating Sampler for PCBs	Laboratory Analyses						Integrating Sampler for PCBs
		Congener-specific PCBs							Congener-specific PCBs						
		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]	
RM 197.0 - Bakers Falls Br.	72	1			1	1			525			95	20		
RM 194.2 - Ft Edward	72	7			7.5	7.5	56	0.5	3,675			713	150	20	150
RM 188.5 - TI Dam	24		14	14	14.5	14.5	56	0.5		8,400	8,400	1,378	290	150	150
RM 181.4 - Schuylerville	24		14	14	14.5	14.5	56	0.5		8,400	8,400	1,378	290	290	150
RM 163.5 - Stillwater	72	7			7.5	7.5	56	0.5	3,675			713	150	290	150
RM 156.5 – Waterford	72	7			7.5	7.5	56	0.5	3,675			713	150	150	150
Analytical Cost/Week		22	28	28	52.5	52.5	280	2.5	11,550	16,800	16,800	4,988	1,050	900	750
Total Analytical Cost/Week		**80.5**	**or**	**11.5 /day**					**52,838**	**or**	**7,548 /day**				

Concern Level Number of Samples per Week	Lab Turn-Around Time (hr.)	Laboratory Analyses						Integrating Sampler for PCBs	Laboratory Analyses						Integrating Sampler for PCBs
		Congener-specific PCBs							Congener-specific PCBs						
		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]	
RM 197.0 - Bakers Falls Br.	72	1			1	1			525			95	20		
RM 194.2 - Ft Edward	72	7			7.5	7.5	56	0.5	3,675			713	150	20	150
RM 188.5 - TI Dam	24		21	21	22	22	56	1		12,600	12,600	2,090	440	150	300
RM 181.4 - Schuylerville	24		21	21	22	22	56	1		12,600	12,600	2,090	440	440	300
RM 163.5 - Stillwater	72				7	7	56	7				665	140	440	3,675
RM 156.5 – Waterford	72				7	7	56	7				665	140	140	3,675
Analytical Cost/Week		8	42	42	66.5	66.5	280	16.5	4,200	25,200	25,200	6,318	1,330	1,190	8,100
Total Analytical Cost/Week		**108.5**	**or**	**15.5 /day**					**71,538**	**or**	**10,220 /day**				

Control Level Number of Samples per Week	Lab Turn-Around Time (hr.)	Laboratory Analyses						Integrating Sampler for PCBs	Laboratory Analyses						Integrating Sampler for PCBs
		Congener-specific PCBs							Congener-specific PCBs						
		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]	
RM 197.0 - Bakers Falls Br.	72	1			1	1			525			95	20		
RM 194.2 - Ft Edward	72	7			7.5	7.5	56	0.5	3,675			713	150	20	150
RM 188.5 - TI Dam	24		28	28	29	29	56	1		16,800	16,800	2,755	580	150	300
RM 181.4 - Schuylerville	24		28	28	29	29	56	1		16,800	16,800	2,755	580	580	300
RM 163.5 - Stillwater	24				7	7	56	7				665	140	580	4,200
RM 156.5 – Waterford	24				7	7	56	7				665	140	140	4,200
Analytical Cost/Week		8	56	56	80.5	80.5	280	16.5	4,200	33,600	33,600	7,648	1,610	1,470	9,150
Total Analytical Cost/Week		**136.5**	**or**	**19.5 /day**					**91,278**	**or**	**13,040 /day**				

Threshold Number of Samples per Day Only	Lab Turn-Around Time (hr.)	Laboratory Analyses						Integrating Sampler for PCBs	Laboratory Analyses						Integrating Sampler for PCBs
		Congener-specific PCBs							Congener-specific PCBs						
		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]		Whole Water	Sus-pended Phase	Dis-solved Phase	DOC & Susp. OC	SS	SS (1/3-hours)[3]	
RM 197.0 - Bakers Falls Br.	72	1			1	1			525			95	20		
RM 194.2 - Ft Edward	72	1			1	1	8	1/2-weeks	525			95	20	20	21
RM 188.5 - TI Dam	24		4	4	5	5	8	1		2,400	2,400	475	100	20	600
RM 181.4 - Schuylerville	24		4	4	5	5	8	1		2,400	2,400	475	100	100	600
RM 163.5 - Stillwater	24	4			5	5	8	1	2,400			475	100	100	600
RM 156.5 – Waterford	24	4			5	5	8	1	2,400			475	100	100	600
Analytical Cost/Day		10	8	8	22	22	40	4	5,850	4,800	4,800	2,090	440	340	2,421
Total Analytical Cost/Day		**30**	**/day**						**20,741**	**/day**					

Table 2
Sampling Cost on a Weekly Basis - Lower River Far-Field Stations

Lower River Sampling Requirements on a Weekly Basis

Routine Monitoring	Lab Turn-Around Time (hr.)	No. of Analyses/Week			Cost of Analyses/Week		
		Congener-specific PCBs Whole	DOC & Susp. OC	SS	Congener-specific PCBs Whole Water	DOC & Susp. OC	SS
Mohawk R. at Cohoes	72	0.25	0.25	0.25	131	24	5
RM 140 - Albany	72	0.25	0.25	0.25	131	24	5
RM 77 - Highland	72	0.25	0.25	0.25	131	24	5
Analytical Cost/Week		0.75	0.75	0.75	394	71	15
Total Analytical Cost/Week					480		

Non-Routine Monitoring	Lab Turn-Around Time (hr.)	No. of Analyses/Week			Cost of Analyses/Week		
		Congener-specific PCBs Whole	DOC & Susp. OC	SS	Congener-specific PCBs Whole Water	DOC & Susp. OC	SS
Mohawk R. at Cohoes	24	1	1	1	600	95	20
RM 140 - Albany	24	1	1	1	600	95	20
RM 77 - Highland	24	1	1	1	600	95	20
Analytical Cost/Week		3	3	3	1800	285	60
Total Analytical Cost/Week					2145		

Note:
(1) Non-routine monitoring will be triggered only when Waterford or Troy have total PCB concentration greater than 350 ng/L.

Table 3
Sampling Cost on a Weekly Basis - Upper River Near-Field Stations

Near-Field Sampling Requirements on a Weekly Basis
Routine Monitoring (with use of continuous reading probe to indicate suspended solids concentrations)

No. of Operations	No. of SS Laboratory Analyses	Cost of SS Laboratory Analyses
1	35	700
2	70	1400
3	105	2100
4	140	2800
5	175	3500
6	210	4200
7	245	4900
8	280	5600
9	315	6300
10	350	7000

Non-Routine Monitoring

	Number of SS Laboratory Samples with 3-Hour Turn-Around per Week				
No. of	Number of Stations with Exceedences of the Standard				All Stations
Operations	1	2	3	4	5
1	49	98	147	196	245
2	98	196	294	392	490
3	147	294	441	588	735
4	196	392	588	784	980
5	245	490	735	980	1,225
6	294	588	882	1,176	1,470
7	343	686	1,029	1,372	1,715
8	392	784	1,176	1,568	1,960
9	441	882	1,323	1,764	2,205
10	490	980	1,470	1,960	2,450

	Cost of SS Laboratory Samples with 3-Hour Turn-Around per Week				
No. of	Number of Stations with Exceedences of the Standard				All Stations
Operations	1	2	3	4	5
1	980	1,960	2,940	3,920	4,900
2	1,960	3,920	5,880	7,840	9,800
3	2,940	5,880	8,820	11,760	14,700
4	3,920	7,840	11,760	15,680	19,600
5	4,900	9,800	14,700	19,600	24,500
6	5,880	11,760	17,640	23,520	29,400
7	6,860	13,720	20,580	27,440	34,300
8	7,840	15,680	23,520	31,360	39,200
9	8,820	17,640	26,460	35,280	44,100
10	9,800	19,600	29,400	39,200	49,000

Table 4
Labor Cost on a Daily Basis - Upper River Far-Field Stations

Routine Monitoring Station	No.of people	No. of shift/day	No. of people/day	Labor /day
Other Stations[1]	2	1	2	
TI Dam	2	3	6	
Schuylerville	2	3	6	
Stillwater	2	3	6	
Waterford	2	3	6	
Total			26	$ 10,816

Evaluation Level Station	No.of people	No. of shift/day	No. of people/day	Labor /day
Other Stations[1]	2	1	2	
TI Dam	4	3	12	
Schuylerville	4	3	12	
Stillwater	2	3	6	
Waterford	2	3	6	
Total			38	$ 15,808

Concern Level Station	No.of people	No. of shift/day	No. of people/day	Labor /day
Other Stations[1]	2	1	2	
TI Dam	6	3	18	
Schuylerville	6	3	18	
Stillwater	2	3	6	
Waterford	2	3	6	
Total			50	$ 20,800

Control Level Station	No.of people	No. of shift/day	No. of people/day	Labor /day
Other Stations[1]	2	1	2	
TI Dam	8	3	24	
Schuylerville	8	3	24	
Stillwater	2	3	6	
Waterford	2	3	6	
Total			62	$ 25,792

Threshold Station	No.of people	No. of shift/day	No. of people/day	Labor /day
Other Stations[1]	2	1	2	
TI Dam	8	3	24	
Schuylerville	8	3	24	
Stillwater	8	3	24	
Waterford	8	3	24	
Total			98	$ 40,768

Notes:

(1) Other stations includes Bakers Falls Bridge, Fort Edward and Lower Hudson.

(2) These workers will also float between stations and assist other crews.

Table 5
Labor Cost on a Daily Basis - Upper River Near-Field Stations

Near-Field Sampling Requirements on a Weekly Basis
Routine Monitoring

No. of Operations	No.of people	No. of shift/day	No. of people/day	Labor /day
1-5	3	2	6	$ 2,496
5-10	6	2	12	$ 4,992

Non-Routine Monitoring

No. of Operations	No.of people	No. of shift/day	No. of people/day	Labor /day
1-2	4	2	8	$ 3,328
3-4	8	2	16	$ 6,656
5-6	12	2	24	$ 9,984
7-8	16	2	32	$ 13,312
9-10	20	2	40	$ 16,640