Reynolds Metals (PCBs)

0.04	0.5 U	0.5 U	0.5 U	0.93	1.60
0.05 U	0.5 U	0.5 U	0.5 U	0.93	1.70
0.05 U	0.5 U	0.5 U	0.5 U	0.94	1.72
0.05 U	0.5 U	0.5 U	0.5 U	0.97	1.74
0.05 U	0.5 U	0.5 U	0.5 U	1.00	1.77
0.05 U	0.5 U	0.5 U	0.5 U	1.01	1.79
0.05 U	0.5 U	0.5 U	0.5 U	1.03	1.80
0.05 U	0.5 U	0.5 U	0.5 U	1.04	1.80
0.05 U	0.5 U	0.5 U	0.5 U	1.07	1.86
0.05 U	0.5 U	0.5 U	0.5 U	1.07	1.90
0.05 U	0.5 U	0.5 U	0.5 U	1.09	1.93
0.05 U	0.5 U	0.5 U	0.5 U	1.09	1.99
0.11	0.5 U	0.5 U	0.5 U	1.10	2.05
0.12	0.5 U	0.5 U	0.5 U	1.12	2.32
0.13	0.5 U	0.5 U	0.5 U	1.13	2.48
0.14	0.5 U	0.5 U	0.5 U	1.14	2.60
0.14	0.5 U	0.5 U	0.5 U	1.18	2.84
0.15	0.5 U	0.5 U	0.5 U	1.20	2.86
0.15	0.5 U	0.5 U	0.586	1.22	2.90
0.18	0.5 U	0.5 U	0.6	1.23	2.90
0.18	0.5 U	0.5 U	0.61	1.23	2.91
0.18	0.5 U	0.5 U	0.624	1.24	3.09
0.19	0.5 U	0.5 U	0.651	1.24	3.44
0.20	0.5 U	0.5 U	0.67	1.26	3.65
0.21	0.5 U	0.5 U	0.683	1.26	3.93
0.23	0.5 U	0.5 U	0.689	1.30	3.94
0.26	0.5 U	0.5 U	0.692	1.31	4.19
0.27	0.5 U	0.5 U	0.696	1.37	4.37
0.28	0.5 U	0.5 U	0.696	1.37	6.94
0.29	0.5 U	0.5 U	0.7	1.40	7.14
0.29	0.5 U	0.5 U	0.717	1.44	7.73
0.30	0.5 U	0.5 U	0.719	1.45	11.1
0.31	0.5 U	0.5 U	0.741	1.45	11.1
0.32	0.5 U	0.5 U	0.745	1.46	11.4
0.32	0.5 U	0.5 U	0.773	1.47	14.1
0.33	0.5 U	0.5 U	0.78	1.49	14.7
0.36	0.5 U	0.5 U	0.797	1.50	19.4
0.40	0.5 U	0.5 U	0.811	1.50	20.1
0.40	0.5 U	0.5 U	0.835	1.50	24.0
0.42	0.5 U	0.5 U	0.835	1.52	28.1
0.48	0.5 U	0.5 U	0.847	1.53	44.2
0.49	0.5 U	0.5 U	0.866	1.54	75.3
0.5 U	0.5 U	0.5 U	0.889	1.55	120.5
0.5 U	0.5 U	0.5 U	0.901	1.59	5941

East Foundry Cove (Cadmium)

1.1 U	9.7
0.1	10.1
1.8	10.2
2.3	10.9
2.3	10.9
2.7	11.4
2.9	11.6
3	12.1
3.6	12.2
3.8	12.6
4.1	12.8
4.1	13.2
4.5	13.3
4.6	14.1
4.6	14.2
5.1	14.3
5.3	14.6
5.4	15.3
5.6	15.5
6	16.4
6.1	17.9
6.5	18.1
6.5	19.3
6.6	19.8
6.6	20.1
6.8	20.3
7	21.6
7	22.4
7	23.4
7.3	23.4
7.4	24.2
7.6	25
7.6	25.1
8	25.7
8.5	26.5
8.7	26.9
8.7	30.2
8.7	37.9
8.7	45.2
8.9	51.6
9.1	88
9.2	
9.2	
9.5	

Cumberland Bay (PCBs)

5	0.74
28	0.35
0.11	130
30	1.2
13	7.2
12.96	12
13	8.1
15	13
18.58	4.6
13	6.7
6	11
8.7	13
8.9	18
15	8.8
9.1	27
2.1	0.09
2	24
8.5	6.2
6	5.9
15	5.8
6	6.3
6	6.1
0.23	1.9
13.44	5.3
16	2.8
12	
61.92	
14	
0.76	
18	
1.9	
49	
1.5	
12	
30	
6.6	
2.7	
52	
4.6	
18	
7.3	
3.4	
11	
23	

Grasse River (PCBs)

1.1
12.7
22
34
51
55
71
86
91
130
150
260

GM Massena (PCBs)

Uncapped Area		Capped Area
0.1	3.1	0.6
0.1	3.1	0.8
0.1	3.1	3.5
0.1	3.4	4.2
0.1	3.6	7
0.1	3.7	7.9
0.1	3.8	8.2
0.2	3.8	8.3
0.2	3.8	9
0.2	3.8	9
0.3	3.9	9.1
0.4	4.1	10
0.4	4.2	10
0.5	4.3	12.8
0.5	4.5	14.5
0.5	4.7	18.8
0.5	4.7	21
0.5	4.8	23.5
0.7	4.9	27.8
0.9	5	32.3
0.9	5.5	34.5
1	5.5	38.8
1	5.7	41.2
1	5.8	57
1.1	6	63.3
1.2	6	66.3
1.2	6.1	73.9
1.3	6.4	91
1.4	6.4	6281
1.5	6.4	
1.6	6.5	
1.6	6.7	
1.9	6.9	
2.1	7	
2.4	7.4	
2.4	7.6	
2.6	7.6	
2.8	7.6	
2.8	8	
2.8	8.2	
3	8.4	
3.1	U	

Fox River (PCBs)

Deposit N	SMU 56/57
U	0.038 U
0.1	0.077
0.1	0.18
0.2	0.21
0.4	0.22
0.5	0.26
0.7	0.42
0.9	0.5
1.0	0.5
1.0	0.63
1.0	0.85
1.3	1.3
1.3	1.3
1.4	1.5
1.6	1.5
1.7	1.6
1.7	1.9
1.8	1.9
2.1	2.2
2.3	2.2
2.5	2.6
2.8	2.6
3.3	2.9
3.6	3.3
3.8	4.8
4.4	6.8
4.8	8.5
11	9.5
12	
12	
18	
19	
20	
27	
27	
37	
43	

New Bedford Harbor (PCBs)

Cores (0-1')	Grabs
0.67	0.47
3.8	6.8
7.7	18
7.9	23
8.5	29
8.6	37
10	41
13	50
14	50
16	50
17	64
19	98
28	110
36	110
56	120
65	130
82	140
130	140
	160
	160
	160
	200
	230
	240
	250
	260
	260
	270
	280
	280
	310
	420
	450
	470
	470

NOTE:
All concentrations in parts per million (ppm)

Attachment A

Table A-1
Case Study Raw Residuals Data

TAMS,
An Earth Tech Company

Interoffice Memorandum

To: Residuals Team | Location: | Date: December 2, 2002

From: Claire Hunt | Location: NJO | Job No.: 56513

Subject: New Bedford Harbor Pre Design Field Test Residuals Results

At New Bedford Harbor, a Pre-Design Field Test was performed to evaluate a dredge system. A hydraulic excavator equipped with a slurry-processing unit was selected for this study. One objective of this test was to evaluate the dredge performance relative to removal of the PCB-contaminated sediment. This objective was assessed by the ability to remove the sediments to a given depth horizon and the effectiveness of the contaminant removal. The effectiveness of contaminant removal was judged on the basis of pre and post-dredge sample concentrations.

Pre-dredge cores were collected on a grid within the 100 x 400 foot test area. The cores were sectioned into one-foot segments down to four feet below the sediment surface. One-foot deep post-dredge cores were collected to assess the removal efficiency. The regular spacing of the samples allowed the data to be mapped using geostatistical methods. A total of 23 pre-dredging and 18 post-dredging cores were collected.

Post-dredge 0-2 cm grabs were also collected at each coring location. A total of 23 post-dredging grabs were collected. These sample results were taken to assess the amount of recontamination of the surface from suspension of material during dredging and sloughing of the sediment adjacent to the target area. Recontamination from suspended material was considered likely because the sediment is high in silt and clay content with high water content.

Using geostatistical methods, it was estimated that the1,539 kg of PCBs were contained within the top 3 feet of sediment. The majority of the inventory (1,281 kg) was contained within the top foot, with lower amounts below (220 kg 1-2 feet and 38 kg 2-3 feet). Post dredging, it was estimated that only 44 kg of PCBs remained in the target area. This is equivalent to a 97% removal efficiency.

Pre dredging, the average concentration in the 0-1 foot layer was 857 ppm. The deeper layers had lower concentrations of 147 ppm in the 1-2 foot layer and 26 ppm in the 2-3 foot layer. Post dredging, the top 0-1 foot layer had a concentration of 29 ppm, which is only 3% of the pre-dredge 0-1 foot concentration.

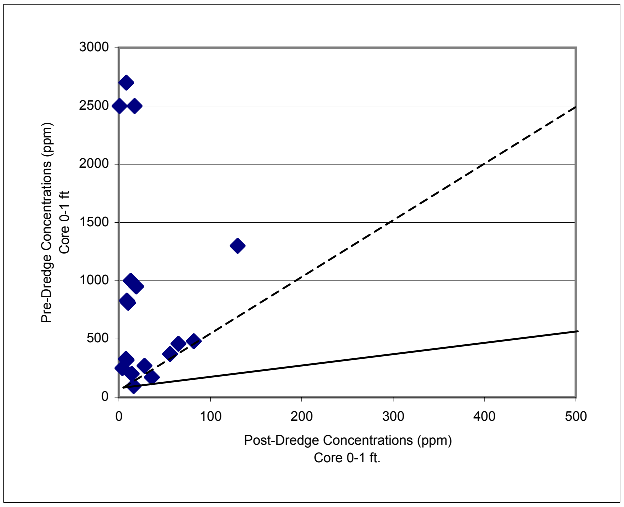
The PCB concentrations of the pre and post dredging samples are graphed for each location in Figure A-1. The top two graphs show the post dredging core results versus the 0-1 foot pre-dredge concentration and the maximum pre-dredge concentration. For all locations the concentration post dredging decreased (all points are above the solid line). In addition, most locations show at least an 80% reduction in concentration (all points except one are above the dashed line). The bottom two graphs show the post dredging grab results versus the 0-1 foot pre-dredge concentration and the maximum pre-dredge concentration. For the surface layer, there are locations that show increased concentrations over the pre-dredge concentrations (points below the solid line). There are numerous locations with concentrations that have less than an 80% reduction in concentration (points below the dashed line). If the predredging concentrations were approximately 50 ppm, all points below the dashed line would have concentrations in excess of 10 ppm.

The results of these grab samples have implications for the method of sampling for residuals. A thin veneer of highly concentrated material may be present on the surface post dredging. It would be difficult to develop a threshold for this layer that was achievable and not unreasonably high. This layer, though highly concentrated does not have an impact on the inventory or the 0-1 foot concentration both of which showed a 97% reduction. Because this layer does not have an appreciable impact on concentration, it is more reasonable to measure the concentration in the 0-6 inch layer. From an engineering perspective, 6 inches is likely to be the minimum re-dredge depth for most dredges.

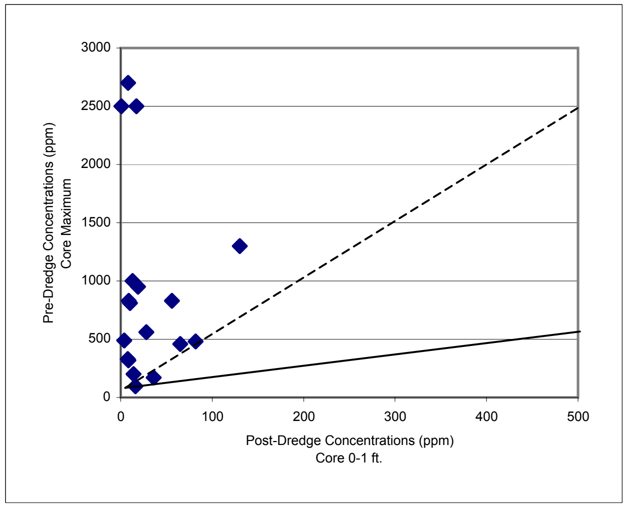
Ignoring this veneer of contamination will leave behind a portion of the inventory. Solving for the concentration in the top 2 cm of a sample, where the remainder of the 0-6 inch sample has a concentration of 1, and the length-weighted concentration of the 0-6 inch sample is 1.5 ppm, the concentration of the top 2 cm cannot exceed 4.81 ppm. Assuming a surface concentration of 4.81 ppm in a layer 2 cm thick, with a density of 1.1 g/cc for the entire 266 acres of the Thompson Island Pool, 114 kg or 0.44% of the approximately 26,000 kg of PCBs estimated to be contained in the sediments would remain. This contamination will be contained and diluted by backfill.

Figure A-1
New Bedford Harbor Pre- and Post-Dredging Residuals Concentrations

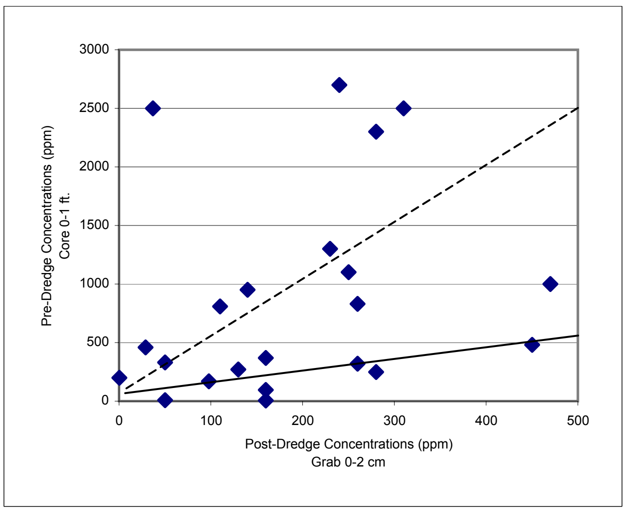
Post-Dredging Cores vs. Pre-Dredging Cores



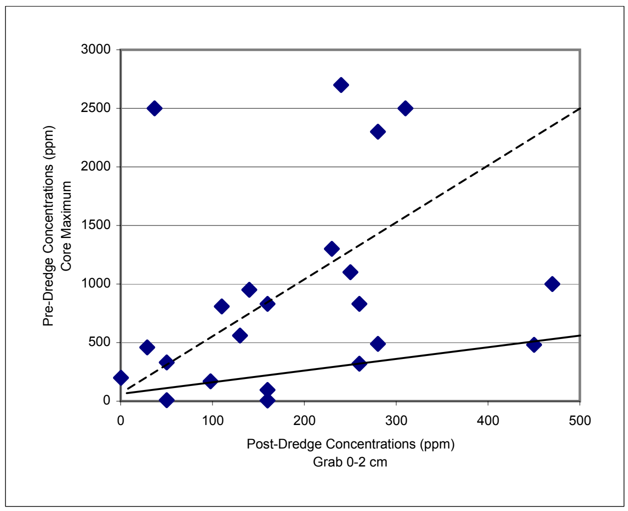
Post-Dredging Cores vs. Pre-Dredging Cores
(Maximum Concentration)



Post-Dredging Grabs vs. Pre-Dredging Cores



Post-Dredging Grabs vs. Pre-Dredging Cores
(Maximum Concentration)



Notes:

Solid line - points below this line have increased concentrations post-dredging.

Dashed line - points below this line have concentrations that are at least one-fifth the initial concentration.
(*e.g.* , if the initial concentration was 50 ppm, points below this line would be more than 10 ppm.)

Attachment A

TAMS

I N T E R O F F I C E
C O R R E S P O N D E N C E

To	Residuals Team	Location		Date	October 20, 2003
From	E. Garvey and C. Hunt	Location	NJO	Job No.	56513
Subject	Residual Corrections	Reference			

This memo is intended to stimulate discussion on the residuals issues discussed last week. The issues are simply stated:

- Do we include the values for tested backfill in the calculation of the mean for an area?
- How do we deal with the 20-acre running average if an initially acceptable area becomes non-compliant as part of the running calculation?

To address the first question, a simple example of the possibilities is helpful. Take 2 certification units, one with a mean value of 0.9 ppm and a second with a value of 2.9 ppm. The latter area has been backfilled and tested to comply with the 0.25 ppm requirement. In tallying the 20 acre mean, the first unit contributes 0.9 * 5 acres to the area-weighted average whereas the second unit contributes 0.25 * 5 acres. Thus the second unit is more "valuable" in reducing the overall mean for the 20-acre unit. In this manner, it would appear preferable to get an area to just below 3 ppm and then backfill and test it, rather than redredge, or simply dredge more thoroughly so as to achieve a value less than 1 ppm. While there may be costs associated with the testing, it is unclear which would be greater (testing *vs.* redredging or dredging better in the first place). This approach provides an incentive to be sloppy in some sense, since the operator would know that if the 1 ppm is not achieved, it will still be possible to achieve a 0.25 ppm value for the purpose of averaging. Moreover, this effectively undercuts the ROD itself, which states that a residual of 1 ppm is expected, and not 2-3 ppm with a tested backfill cover.

In effect, this says that tested backfill placed over sediments 1-3 ppm in average is better than untested backfill placed over sediments with a mean of 1 ppm or less. Since the backfill placement methods and its integrity should be the same in both instances, this is not really true. Since backfill is not a permanent maintained structure, the goal must still be to reduce the underlying material as much as possible. Counting the tested backfill surface at 0.25 ppm in the 20-acre or 40-acre mean calculation significantly undercuts this incentive.

On this basis, I think it is very important that tested backfill not be included in the mean calculation.

The second issue deals with the concern that an area may be compliant with the 20-acre running average at the time of its backfilling only to find that it is no longer compliant when averaged with subsequent certification units. A scenario might go like this:

Working sequentially downstream, the dredging for the first three CUs goes well and the mean values are 0.8. 0.8 and 0.8 ppm Tri+. The next unit is more difficult and comes in at 3.4 ppm Tri+. The dredger is very happy he did a good job on the first three, since his 20-acre running average is now 1.45 ppm and he is free to backfill and test the backfill, which he does with little problem.

He then begins his next CUs only to find to his chagrin that he achieves 1.4, 1.4 and 1.4. These areas are each compliant with the standard requirement and so individually would not require redredging. However, his running mean has crept up above 1.5 to 1.6, 1.75, and 1.9. Each of these areas is individually compliant meanwhile he has already backfilled the 20-acre unit and does not want to redo it. What happens next?

It is useful here to remember that the overall goal of the ROD is achieve an average value of one. In the situation described above, the mean value for the entire dredged area (7 CUs x 5 acres each) remains compliant with the average less than or equal to 1 (with rounding). In fact the average for the 7 CUs is 1.42 ppm. This is illustrated in the table below:

Unit Number	Certification Unit Mean (Tri+ ppm)	20-Acre Running Mean (Tri+ ppm)	Cumulative Mean (Tri+ ppm)
1	0.8		0.80
2	0.8		0.80
3	0.8		0.80
4	3.40	1.45	1.45
5	1.40	1.60	1.44
6	1.40	1.75	1.43
7	1.40	1.90	1.43

Thus, although the 20-acre running mean is temporarily non-compliant, the cumulative mean (the mean of all CUs completed to that point) remains compliant with the goal of the standard. Notably, the standard as written does not require a comparison to the 20-acre mean unless the CU mean value falls in the range of 1-3 ppm (with rounding 1.5 to 3.49 ppm). Thus in the instance above, there would no reason to re-open the 3.4 ppm unit for further remediation since the logic does not require it. That is, the logic only requires that the 20-acre mean be considered if an individual CU does not comply with the 1 ppm mean. In this example, the logic, as given by the flow diagram would not require a recheck of the 20-acre mean and thus the 3.4 ppm unit would be fine as completed (no "double jeopardy"), which I believe is the desired outcome. In this sense, the dredger can complete the 3.4-ppm CU as long as he complies with the 20-acre mean to that point. He takes no risk that he will have to reopen that CU.

Attachment A

A second case can be considered wherein the first five units occur as described above but then the 6th CU is not compliant as shown below:

Unit Number	Certification Unit Mean (Tri+ ppm)	20-Acre Running Mean (Tri+ ppm)	Cumulative Mean (Tri+ ppm)
1	0.8		0.80
2	0.8		0.80
3	0.8		0.80
4	3.40	1.45	1.45
5	1.40	1.60	1.44
6	2.80	2.10	1.67

In this scenario, the dredger would now have a second CU that requires him to check the 20-acre mean. In this instance, the 20-acre mean is well above the requirement of 1 ppm and either a redredge pass or capping is necessary. In the case of a redredging, the mean would have to be brought to below 1.5 ppm, as follows:

Unit Number	Certification Unit Mean (Tri+ ppm)	20-Acre Running Mean (Tri+ ppm)	Cumulative Mean (Tri+ ppm)
1	0.8		0.80
2	0.8		0.80
3	0.8		0.80
4	3.40	1.45	1.45
5	1.40	1.60	1.44
6	1.40	1.75	1.43

The 20-acre mean would still lie above its desired value but the unit would be in compliance and so could be backfilled without testing. Additionally, the overall cumulative mean still satisfies an overall mean of 1.

Left as it is structured, with a check on the 20-acre mean only when a CU falls in the 1-3 ppm range, removes the concern over “double jeopardy” while still providing an incentive to attain residuals less than 1 ppm whenever possible. Specifically, if the dredger runs at a mean value of 1.4 ppm, he will end up having to redredge or cap all areas falling in the 1 to 3 ppm range. Conversely, if he attempts to attain levels less than 1 ppm whenever reasonable, he produces some capacity to “absorb” an occasional 1 to 3 ppm CU with only some additional testing required.

Attachment A

If we take our example out for the full extent of Phase 1 (50 acres or 10 CUs) we might have the following scenario if the dredger decided to attain the bare minimum each time (*i.e.,* 1.4 ppm):

Unit Number	Certification Unit Mean (Tri+ ppm)	20-Acre Running Mean (Tri+ ppm)	Cumulative Mean (Tri+ ppm)
1	0.8		0.80
2	0.8		0.80
3	0.8		0.80
4	3.40	1.45	1.45
5	1.40	1.60	1.44
6	1.40	1.75	1.43
7	1.40	1.90	1.43
8	1.40	1.40	1.43
9	1.40	1.40	1.42
10	1.40	1.40	1.42

In this scenario, the overall average of 1 ppm (< 1.5ppm) is achieved. The 20-acre mean is in compliance for CU 4 when it is checked. For CUs 5-7, the 20-acre mean is not strictly in compliance but neither is it checked since the individual CUs are in compliance.

On the basis of this analysis, the only correction we need to make to the Residuals Standard is to simply exclude the tested backfill area mean from consideration in the calculations for the 20-acre mean. The standard logic as currently written, which requires no check on the 20-acre mean when an individual CU is in compliance, can remain unchanged.

Attachment B
Data Quality Objectives

1.0 Residuals Sampling Program

This section provides the Data Quality Objectives (DQOs) for the residual sediment sampling program required by the Residuals Standard and follows the guidelines given in *Guidance for the Data Quality Objectives Process* (USEPA 2000).

1.1 State the Objective

The objective of the residuals sampling program is to establish that post-dredging residual PCB concentrations in each target area have met the requirements of the ROD, (*i.e.,* approximately 1 mg/kg Tri+ PCBs prior to backfilling).

A remedial dredging operation is to be conducted to remove PCB-contaminated sediments from the Upper Hudson River. Following dredging, the Residuals Standard requires the implementation of a post-dredging sampling and analysis program to detect and characterize PCB concentrations in the residual sediments. In addition to evaluating compliance with the ROD's goals for residual concentrations, the collected data is to be used to characterize the extent of the residual sediments and the statistical distribution of PCBs in the residual sediments to optimize the sampling program design.

1.2 Identify the Decision

The implementation of the Residuals Standard will provide the answers to the following questions:

- In a particular certification unit, has the ROD's anticipated residual PCB concentration of approximately 1 mg/kg Tri+ PCBs been achieved?
- In a particular certification unit, do the mean and median residual sediment Tri+ PCB concentrations suggest the presence of undredged, contaminated sediment inventory ("missed inventory")?
- Does the combined mean of the arithmetic averages of several certification units satisfy the Residuals Standard requirement for the 20-acre joint evaluation?
- If backfill material is placed over sediments that do not meet the residual goal of the ROD, did the placement of backfill isolate the residual sediments? When this contingency is implemented, does the upper layer of the backfill have a concentration less than or equal to 0.25 mg/kg Tri+ PCBs?
- What is the statistical and spatial distribution of PCB contamination in the residual sediments?
- Is the sampling density sufficient to characterize each certification unit?

- Is the distribution of individual sample concentrations compliant with the Residual Standard (*i.e.,* no more than one greater than or equal to 15 mg/kg Tri+ PCBs and none greater than or equal to 27 mg/kg Tri+ PCBs)?

1.3 Identify Inputs to the Decision

The following informational inputs are required to resolve the decision statements presented in Section 1.2:

- Field observations regarding achievement of the design dredging cut-lines (*e.g.,* bathymetry, field notes, engineering memoranda, etc.) in a certification unit.
- Sediment sample Tri+ PCB concentrations via laboratory analyses that achieve a reporting limit (RL) of 0.1 mg/kg and a method detection limit (MDL) of 0.05 mg/kg at each sampling node (*i.e.,* no compositing).

From this information, the following will be calculated:

- The statistical and spatial distribution of residual sediment Tri+ concentrations.
- The arithmetic average and median Tri+ PCB concentration in each certification unit.
- In some cases, the mean of the arithmetic average Tri+ PCB concentration in the certification unit under evaluation and the three previously dredged units within 2 miles of the current unit (*i.e.,* 20-acre evaluation).

1.4 Define Boundaries of the Study Area

The dredge area boundaries defined in the remedial design documents will form the horizontal boundaries of each study area. The vertical boundary is initially defined as 6 inches below the depth-of-cut lines (hence a 0 to 6 inch sample) also established in the remedial design documents. The need to extend the vertical boundary further will be based on the analysis of the residual concentrations. Certification units are expected to be approximately 5 acres in size, and guidelines for the practical application of this concept to various types of dredging areas are provided in Section 4.1 of the Residuals Standard. Several certification units will be combined, as stipulated in the standard, to evaluate the running 20-acre joint evaluation.

The temporal boundaries of the Residuals Standard sediment data collection efforts are expected to span the anticipated 6-year dredging project duration. This duration is divided into Phase 1 (Year 1) and Phase 2 (Years 2-6). There may be adjustments to the Residuals Standard following the Phase 1 data collection and analysis effort.

1.5 Develop a Decision Rule

The decision rules are derived from the performance standard criteria described in Volume 1 and in this document (refer to Section 4.0). The decision rules are described in the Residuals Standard flow diagram (see Figure 3-1) and test the certification unit's compliance with the residuals standard.

Although a number of metrics are used in the decision rules (*e.g.*, median and individual concentrations), the primary criterion is the arithmetic average Tri+ PCB concentration of each certification unit. The arithmetic average is selected as the primary measure since it integrates many individual measures and is representative of the integrated PCB residual contamination.

1.6 Specify Limits on Decision Errors

Decision rules to determine the frequency of sampling:

- False rejection rate of 10 percent
- False acceptance rate of 5 percent
- Grey area of 1-1.5 mg/kg Tri+ PCBs

Note that the false acceptance rate is kept low so as to minimize the probability of certifying a contaminated certification unit as acceptable.

Using the desired limits on the decision errors listed above, an estimate of standard deviation from the case studies and USEPA's Decision Error Feasibility Trials Software (DEFT; USEPA, 2001), the selected sampling frequency is 40 samples per 5 acre certification unit. The desired false acceptance rate/false rejection rate listed above is achieved when the data from 8 certification units (40 acres) are evaluated together. This analysis is discussed in Section 2.7 of this volume.

Other decision errors that could be encountered include potential errors in sample analytical results, which could be biased high or low. The limits on the decision errors will be the laboratory QC limits. These proposed limits will be reviewed during the evaluation of the remedial design for the project, and will be evaluated during data validation.

1.7 Optimize the Design for Obtaining Data

The Residuals Standard sampling program design was optimized by adhering to industry standards, through review by an internal Quality Review Team and USACE/USEPA project management and technical staff, and a peer review process. The initial sample frequency was estimated using case study data and USEPA statistical software. The program design can be optimized once a range of site specific data is available.

2.0 Special Study for the Characterization of Residual Sediment Strata and Thickness

This section presents the DQOs for the special study for the characterization of the residual sediment strata and thickness, and also follows the guidelines given in Guidance for the Data Quality Objectives Process (USEPA 2000).

2.1 State the Objective

The objective of the special study is to investigate the sediment type, stratigraphy, and thickness of disturbed and/or resettled layer(s) in a target area, subsequent to removal of PCB-contaminated sediments by dredging.

A remedial dredging operation is to be conducted to remove PCB-contaminated sediments from the Upper Hudson River. Following dredging, the Residuals Standard requires the implementation of a post-dredging sampling and analysis program to detect and characterize PCB concentrations in the residual sediments. In addition to evaluating compliance with the ROD's goals for residual concentrations, the collected data is to be used to characterize the extent of the residual sediments and the statistical distribution of PCBs in the residual sediments to optimize the sampling program design.

As a component of the Phase 1 evaluation, the sediment type, stratigraphy, and thickness of the disturbed sediment layer and/or the resettled residuals must be characterized. Depending on the type of dredge used and other site-specific considerations, the layer of interest may be more than 1-foot thick or may consist of a veneer or "fluff" layer consisting of resettled material that escaped capture by the dredge. The information to be obtained from the special study is relevant to the requirements for sample collection and management (e.g., the requirement that a veneer or "fluff" layer be retained and homogenized as part of the 0 to 6 inch sediment sample).

For Phase 1, a residual sediment sampling depth of 6 inches was chosen, and it is unlikely that this sampling depth will need to be adjusted based on the results of this study. The 0 to 6 inch sampling depth is intended to capture a veneer or fluff layer and to provide a representative sample of the bioavailable layer (one that accounts for contaminant concentrations in the veneer). If a disturbed layer thicker than one foot is created by hydraulic dredging, the layer is expected to be well-mixed (it is unlikely that a highly contaminated lower stratum would be present below a "clean" 0 to 6 inch upper stratum), and the 0 to 6 inch sample is expected to adequately represent the disturbed layer.

2.2 Identify the Decision

The implementation of the special study will provide the answers to the following questions:

- Are the sample collection and management procedures appropriately designed to characterize the residual sediment?
- What is the type, stratigraphy, and thickness of the disturbed and/or resettled layer and does it vary with target area sediment texture and/or dredge type?

2.3 Identify Inputs to the Decision

The following informational inputs are required to resolve the decision statements presented in Section 2.2:

- Field observations regarding the sediment type, stratigraphy, and thickness of the disturbed and/or resettled layer (e.g., sediment visual and manual characterization and core sample photo documentation) for each residual sediment sampling location.
- Data obtained from a focused special study on residual sediment type, stratigraphy, and thickness via coring investigations and/or sediment profile imagery (SPI) camera investigations (specific investigation methods to be developed during project design following these DQOs).

Core samples can be used to characterize both shallow and deep disturbed layers. Sediment cores are to be collected using a clear plastic (e.g., Lexan) tube and a vibracore or a hand core apparatus, such as a piston coring device. Core tubing must be thicker-walled than that used in the 2002-2003 SSAP so as to provide a rigid container that can be easily advanced or vibrated into the sediment. A positive seal must be attained at the top of the apparatus, such as by a ball valve or piston, to avoid the poor recovery problems that occurred in the 2002-2003 SSAP. This will also provide a clear representation of the "fluff" layer that may be produced by the dredging operation. For this reason, water may not be decanted from a retrieved core sample without first identifying and examining this layer. A certified geologist will be required to examine the core, characterize the sediments, and determine the extent of the disturbed layer.

If the depth of the disturbed layer is likely to be shallow (less than 25 cm), SPI may be considered. The number of samples to be collected will be determined as part of the development of the program. Note however, that for this study, this number must be specified as the number of successful cores or SPI observations and not simply the number of locations occupied.

2.4 Define Boundaries of the Study Area

The special study will address residual sediments expected to be present in the Upper Hudson River following remedial dredging of PCB-contaminated sediments. The Upper Hudson River has been divided into three major areas: River Section (RS) 1, RS 2, and RS 3. These three River Sections will be further divided into target dredging areas by the remedial design. The special study effort will be limited to those areas selected for remediation in Phase 1. Depending on the results obtained during Phase 1, the boundaries of this special study may be expanded to include all target areas slated for remediation.

Table B-1 summarizes the possible areas for this special study. The areas were chosen based on different sediment types in the Upper Hudson, as classified by the side scan sonar and ASTM Method D422 results obtained from the pre-design investigations. Draft dredge area boundaries were used to guide the selection of the possible areas. These locations represent areas that are expected to be included in the final delineation of dredge areas; however, the final delineation will be part of the remedial design documents. Figure B-1 shows the possible study areas and associated sediment types. Out of the 13 possible areas shown, a preliminary selection of five areas was made and is presented in Table B-2. The selection of these study areas did not take into consideration other engineering factors and the type of equipment that will be used for dredging. The final selection of study areas may be different than these five areas. The final selection of the study areas will be addressed via the Phase I Intermediate Design Report.

The temporal boundaries of the Residuals Standard sediment data collection efforts are expected to focus on the anticipated Phase 1 (Year 1) dredging effort. There may be adjustments to the Residuals Standard following the Phase 1 data collection and analysis effort.

2.5 Develop a Decision Rule

The arithmetic average of the observations in a given target area would be the primary measure used to characterize the depth of the disturbed layer. Assuming that the distribution of depths is likely to be normally distributed, the arithmetic average is a measure of the central tendency of the values.

2.6 Specify Limits on Decision Errors

The number of measurements that are needed cannot be assessed at this time because there are no data on which to base this estimate. This study will be conducted in two phases. Initially, 30 measurements will be collected from a study area. These results will be used to determine the sampling frequency based on the standard deviation of the depths and USEPA's Decision Error Feasibility Trials Software (DEFT) software.

2.7 Optimize the Design for Obtaining Data

Sampling frequency needed to characterize the residual sediment depth and stratigraphy will be assessed based on the initial 30 measurements, and subsequently refined. If a more sophisticated method of measuring the disturbed layer is chosen, such as SPI, the initial 30 measurements will be used to assess the viability of the method for the remaining study areas.

3.0 References

USEPA, 2000. Guidance for the Data Quality Objectives Process EPA/600/R-96/055. August 2000.

USEPA, 2001. Data Quality Objectives Decision Error Feasibility Trials Software (DEFT) - USER'S GUIDE. EPA/240/B-01/007. September 2001.

Table B-1
Possible Study Area for Sediment Profile Imaging

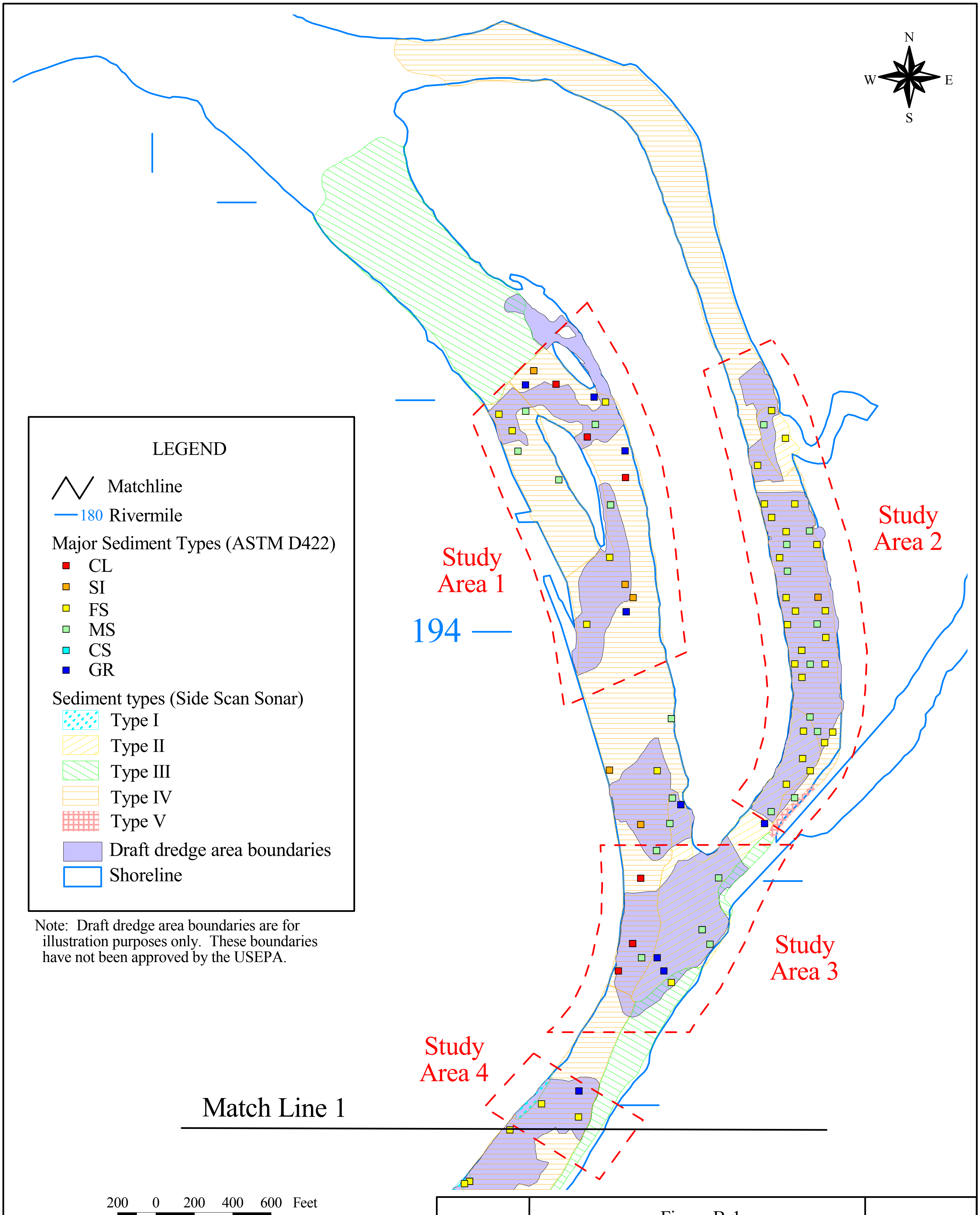
Possible Study Area[1]	Sediment Type (Side Scan Sonar)	Sediment Type (ASTM Method D422 Classification)
1	IV	CL, SI, FS, MS
2	IV	FS, MS
3	II	MS
4	IV	FS
5	IV	CL, FS, MS
6	I	SI, FS
7	II	FS, MS
8	I	SI, FS, MS
9	II	FS
10	I	CL, SI, FS
11	I	FS
12	I	SI
13	I	SI, FS

Table B-2
Preliminary Selection of Study Areas
for Sediment Profile Imaging

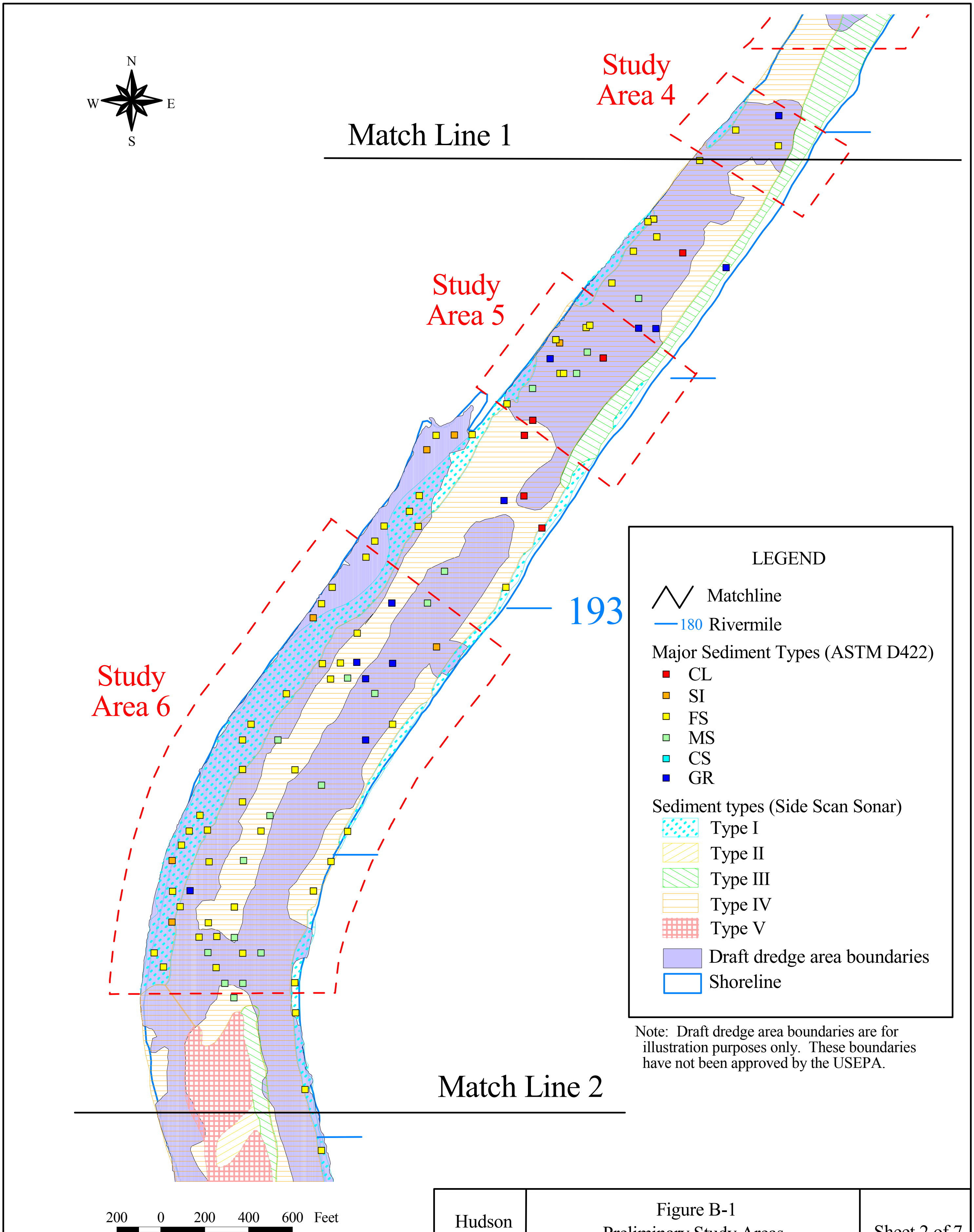
Recommended Study Area[1]	Sediment Type (Side Scan Sonar)	Sediment Type (ASTM Method D422 Classification)
1	IV	CL, SI, FS, MS
2	IV	FS, MS
3	II	MS
6	I	SI, FS
10	I	CL, SI, FS

Note:

[1] The recommended study areas are based on draft dredge area boundaries.

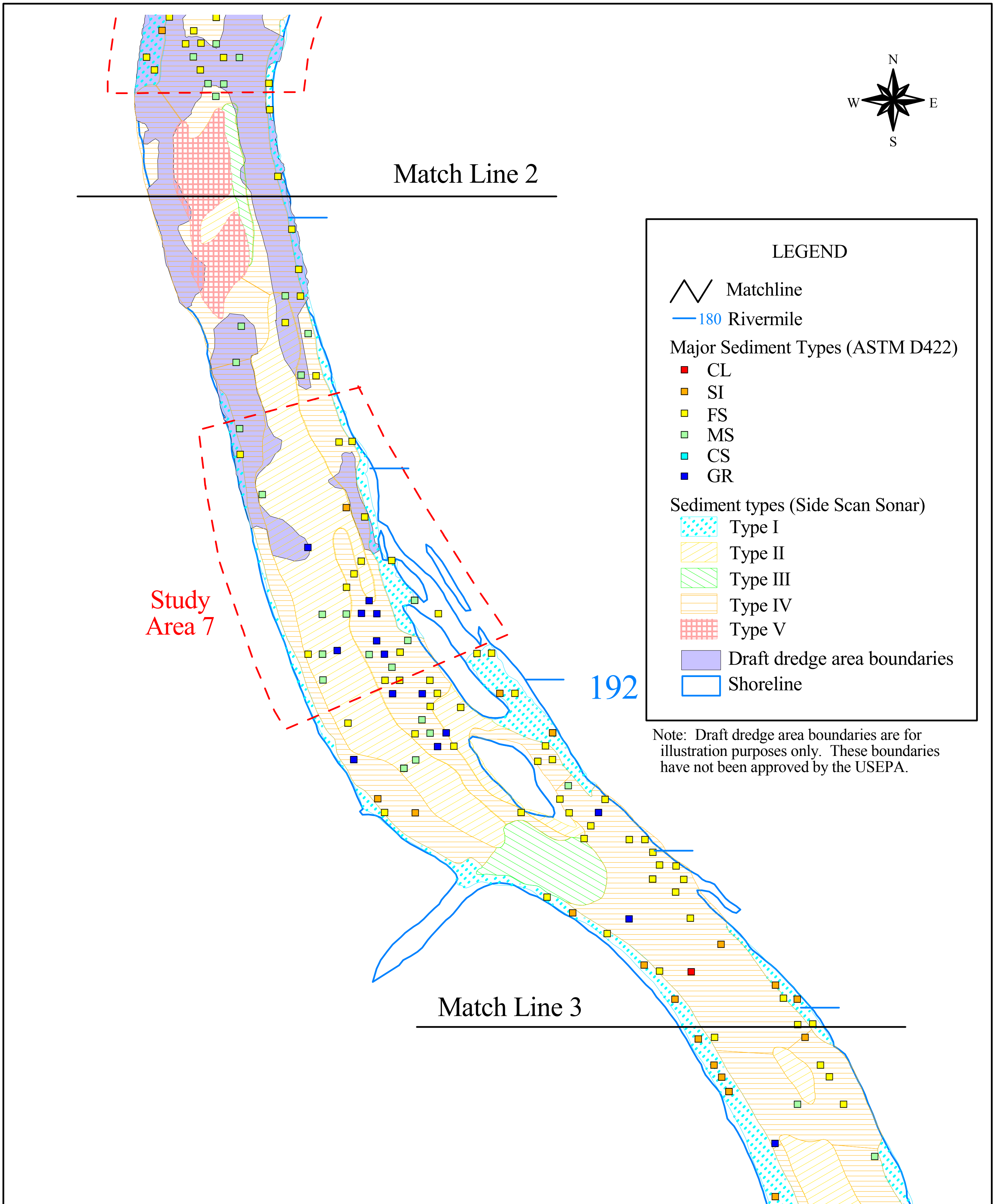


Hudson River	Figure B-1 Preliminary Study Areas for the Special Study	Sheet 1 of 7

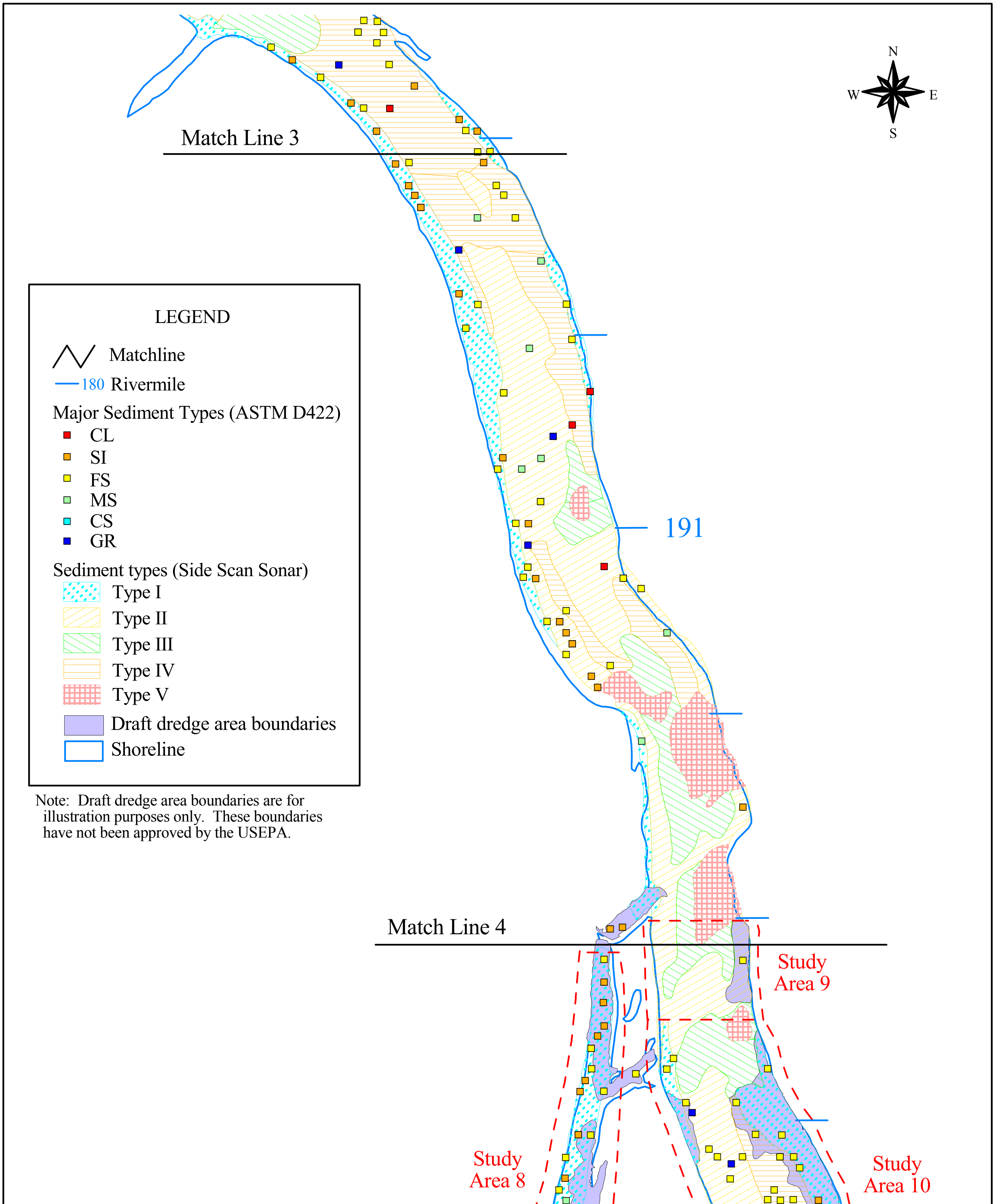


Note: Draft dredge area boundaries are for illustration purposes only. These boundaries have not been approved by the USEPA.

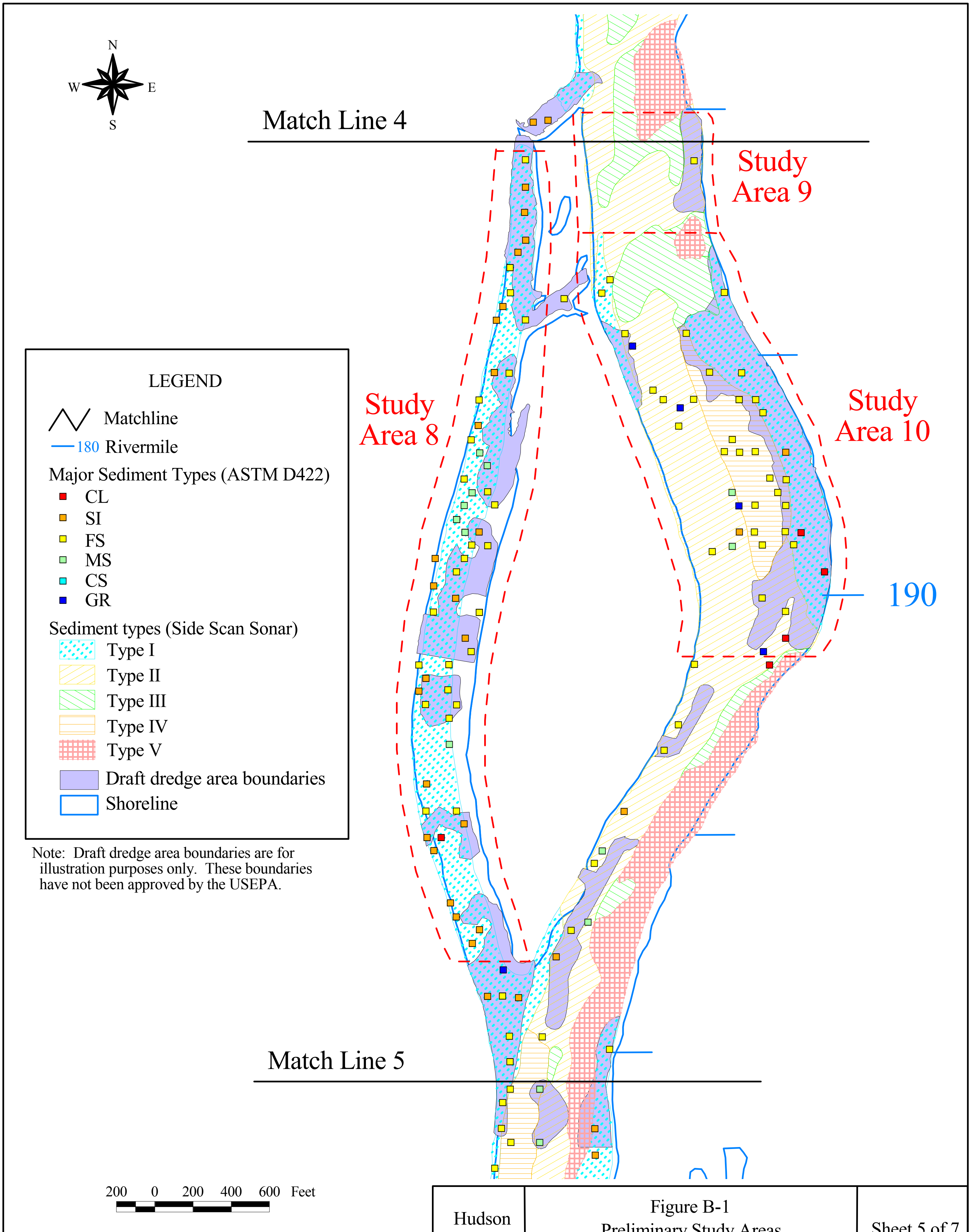
Hudson River	Figure B-1 Preliminary Study Areas for the Special Study	Sheet 2 of 7



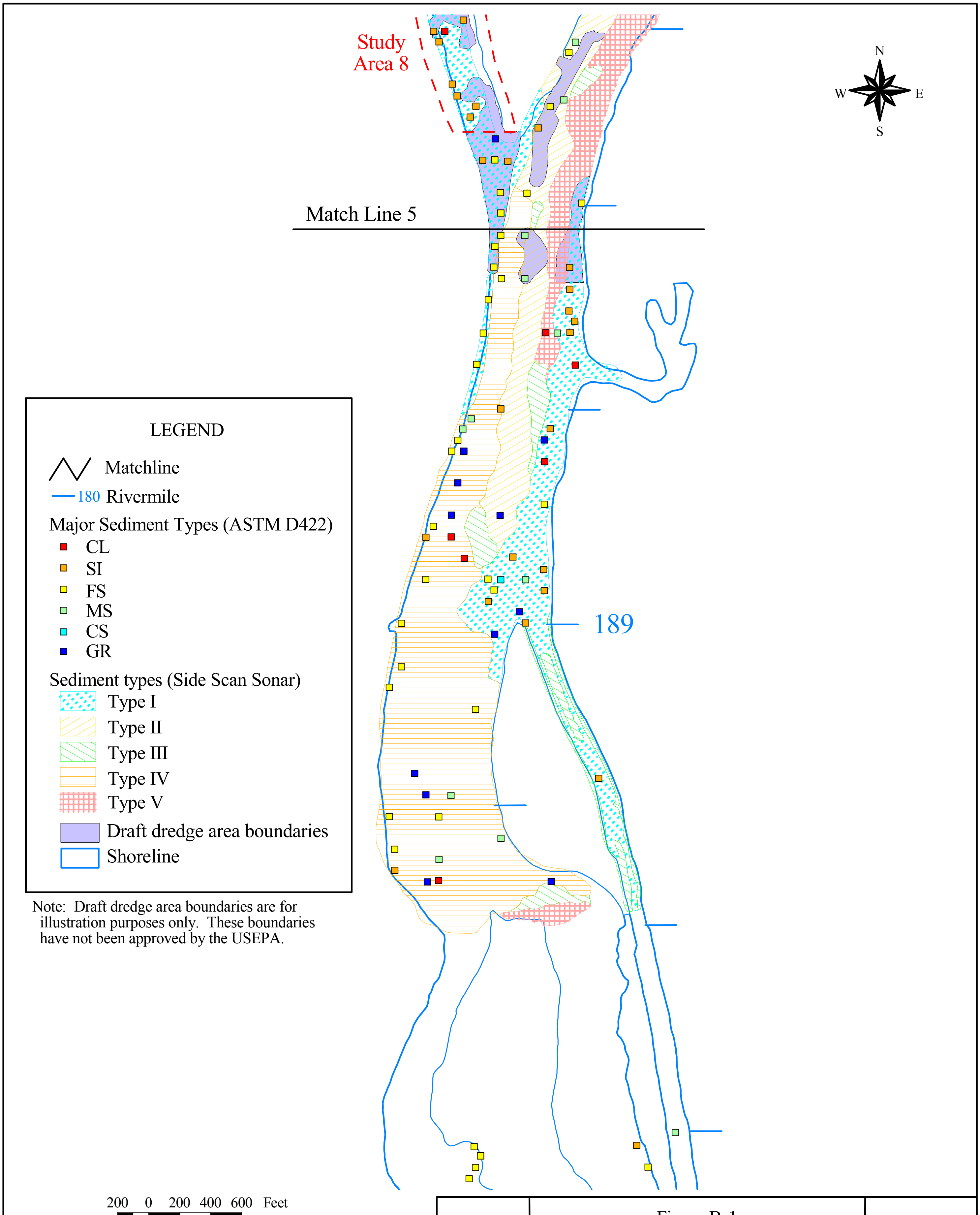
Hudson River	Figure B-1 Preliminary Study Areas for the Special Study	Sheet 3 of 7



Hudson River	Figure B-1 Preliminary Study Areas for the Special Study	Sheet 4 of 7

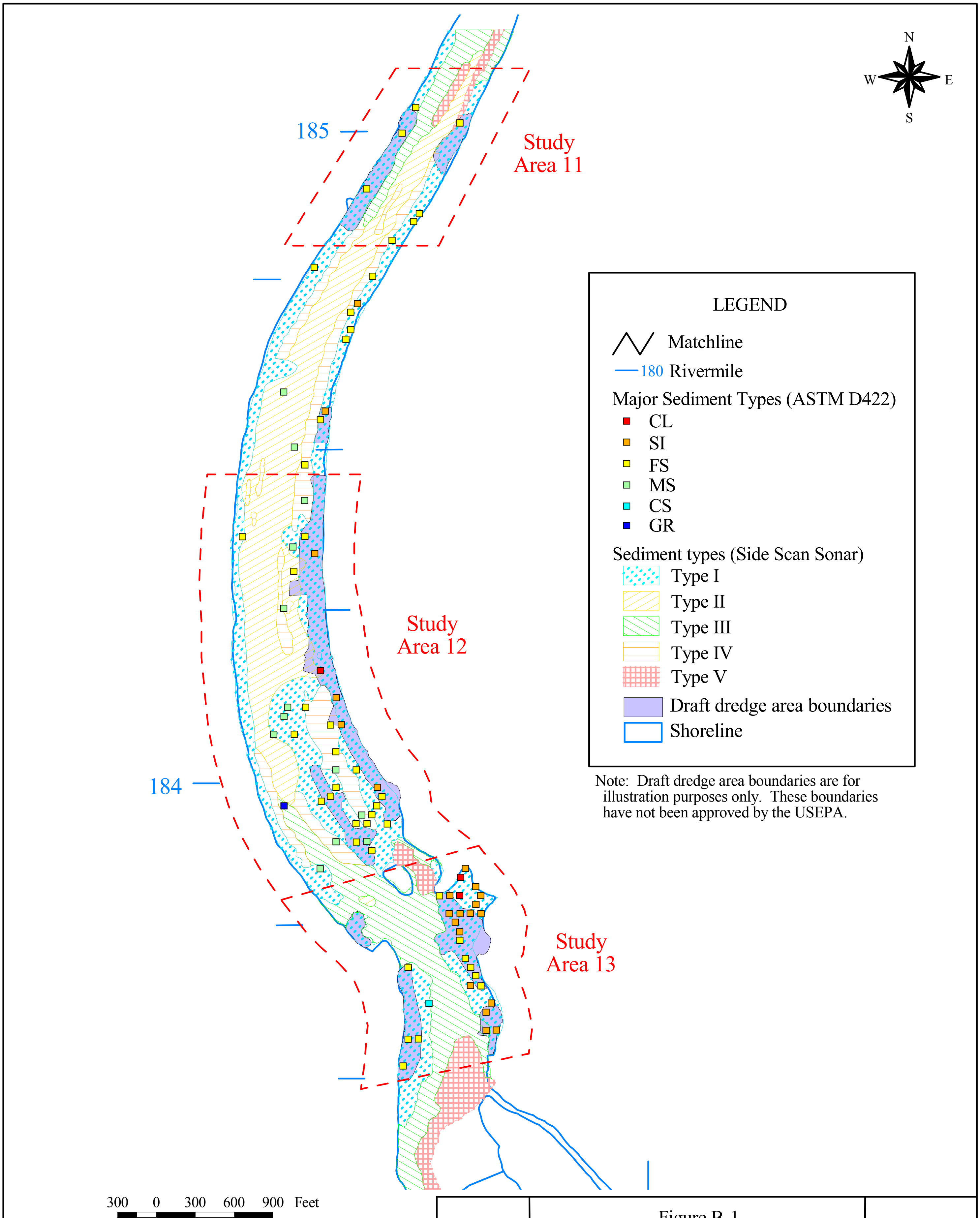


Hudson River	Figure B-1 Preliminary Study Areas for the Special Study	Sheet 5 of 7



Note: Draft dredge area boundaries are for illustration purposes only. These boundaries have not been approved by the USEPA.

Hudson River	Figure B-1 Preliminary Study Areas for the Special Study	Sheet 6 of 7



Hudson River	Figure B-1 Preliminary Study Areas for the Special Study	Sheet 7 of 7

Attachment C
Estimated Cost of the Phase 1 Residuals Sampling Program

1.0 Introduction

The residual sediment sampling program to be conducted during the remedial dredging of the Upper Hudson River is described in detail in the Engineering Performance Standard for Dredging Residuals. This attachment provides an order of magnitude cost estimate for the residual sediment sampling labor effort and associated laboratory analyses for Phase 1. The sections below describe the sampling tasks that are included in this cost estimate.

1.1 Residual Sampling

This sampling effort is to be conducted in each dredged area (certification unit) following the achievement of the design dredging cut lines, and consists of the collection and analysis of 40 0-to-6-inch sediment cores per 5-acre area dredged at a minimum (there are some exceptions to the sampling frequency for unique certification areas).

1.2 Backfill Sampling

In certification units with an arithmetic average PCB concentration greater than 1 mg/kg Tri+ PCBs but less than or equal to 3 mg/kg Tri+ PCBs, placement of backfill may be allowed with subsequent testing of the backfill, where the 20-acre joint evaluation is compliant with the Residuals Standard. In these certification units, 40 0-to-6-inch sediment cores will be collected and analyzed per acre backfilled.

1.3 Residual Sampling following a Redredging Attempt

If the first dredging attempt in a certification unit fails to result in a compliant residuals concentration, redredging attempts may be conducted. Any residuals sampling nodes in a redredged area must be resampled following the redredging.

1.4 Sampling to Recharacterize the Depth of Contamination

In certification units with an arithmetic average residuals concentration greater than 6 mg/kg Tri+ PCBs, additional sampling at depths greater than 0 to 6 inches is required to establish the vertical extent of contamination prior to mandatory redredging. If the median residuals concentration is greater than 6 mg/kg Tri+ PCBs, the entire certification unit must be resampled for vertical extent.

1.5 Special Study for Characterization of Residual Sediment Strata and Thickness

During Phase 1, a special study is required to characterize the sediment type, stratigraphy, and thickness of disturbed and/or resettled sediment layers present in target areas following environmental dredging. The data quality objectives for the study are included in Attachment B to Volume 3. The implementation details for the special study will be finalized in the remedial design.

2.0 Phase 1 Monitoring Program Cost Estimate

2.1 General Assumptions

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 a rapid analytical turnaround will be requested for the sample analyses (48 to 72 hours) to allow certification unit closure (e.g., backfilling) to proceed.

The labor costs are based on assumed level of effort (in staff hours) and the labor rates (dollars per hour). Some significant direct costs are included, specifically the direct cost for the sampling vessels required to obtain the core samples. Laboratory analytical costs are estimated using unit rates that approximate off-site laboratory analytical costs, although it is expected that an on-site laboratory may be established to address the sample throughput and turnaround times required for the remediation monitoring.

This estimate focuses on the two main elements of the program: labor and laboratory analytical cost. The cost estimate for the Phase 1 sampling program is based on specific scenarios for implementation (including estimated frequencies for the contingency elements of the program to be required), which are described below.

2.2 Sampling Frequency and Effort

To estimate the cost of the residuals sampling, it is necessary to estimate the frequency at which each type of sampling described in Sections 1.1 through 1.4 is required during Phase 1. The sections that follow estimate the required frequency for each type of sampling required in the Residuals Standard and the associated labor effort.

2.2.1 Residuals Sampling

Residuals sampling is required in all Phase 1 dredging areas. Based on the Phase 1 Productivity Standard required volume of 200,000 cubic yards and the GE-proposed Phase 1 dredging areas in the Northern Thompson Island Pool, it is estimated that approximately 40 acres of river bottom are required to be dredged during Phase 1. This would equate to eight 5-acre certification units and 320 residuals samples (40 samples per 5-acre certification unit). The collection of 0-to-6-inch cores should proceed rapidly compared to the SSAP coring effort, where the objective was to probe the sediment depth at each location and fully core the unconsolidated sediments (to depths typically greater than 3 to 5 feet).

During the SSAP, field crews obtained daily production rates of 10-15 cores per sampling vessel. Thus, for the residuals sampling, the recovery of relatively short cores will be adequate to obtain 0-to-6-inch samples, and potentially an additional one or two 6-inch segments to archive, so that the analysis of deeper segments may be conducted without remobilization, if required by the residuals standard. Therefore, it is reasonable to assume that each certification unit can be sampled at a rate of approximately 20 cores per day. Although the residual sediment samples are only required from the 0-to-6-inch depth interval, the construction manager may choose to require the collection of deeper cores with archiving of the extra segments to avoid remobilization if the initial residuals results trigger the requirement for recharacterization of the vertical extent of contamination.

The effort required for this portion of the Phase 1 residuals sampling would be approximately 16 vessel-days. It is assumed that the sampling vessels will have a crew of 2 personnel, equating to 32 staff-days for core sample collection. It was also assumed that two sampling vessels would be mobilized.

2.2.2 Backfill Sampling

This type of sampling will only be required if the 20-acre joint evaluation is invoked to evaluate a non-compliant certification unit, and the evaluation indicates that backfill can be placed with mandatory testing of the backfill. It is necessary to assume a frequency of occurrence for this case during Phase 1. Assume Phase 1 has up to 2 occurrences of backfilling with testing required; a maximum of 80 backfill samples would be required (two 5-acre units at 40 samples per certification unit). Based on the assumptions in Section 2.2.1 above, the effort would be approximately 4 vessel days of core sample collection, or 8 staff-days.

2.2.3 Sampling after Re-dredging

The productivity standard's example schedule assumes that the duration of redredging will be equal to 50% of the initial dredging duration in the example production schedule. The following conservative assumptions were made to estimate the cost of residuals sampling at redredged nodes:

- Assume redredging in four of the eight Phase 1 certification units, and addressing 25% of each certification unit.
- This would yield an additional 40 samples at redredged nodes (25% of the nodes within each of four certification units).

Based on the assumptions in Section 2.2.1 above, the effort would be approximately 2 vessel days of core sample collection, or 4 staff-days.

2.2.4 Recharacterization of Vertical Extent

The following assumptions were made to estimate sampling costs associated with additional vertical characterization that may be required by the residuals standard.

- Assume two of the units that require re-dredging have an average greater than 6 mg/kg Tri+ PCBs and require recharacterization of vertical extent of contamination. One of these fails the median test and has to be re-sampled in the entire unit. The other only requires sampling in 25% of the unit to address an elevated cluster.
- 50 total cores have to be collected to refusal; however these are still expected to be relatively short cores following dredging of the certification units. Conservatively assume that 3 segments have to be analyzed from each core (an additional 1.5 feet in depth). The associated number of residuals samples would be 150 samples.

Based on the assumptions in Section 2.2.1 above, the effort would be approximately 2.5 vessel days of core sample collection, or 5 staff-days.

2.2.5 Special Study for Characterization of Residual Sediment Strata and Thickness

The special study for characterization of the residual sediment strata and thickness may be conducted via coring or by using an innovative technology such as sediment profile imagery (SPI). Since an SPI effort involves the mobilization and rental of specialized equipment and personnel with specialized disciplines, an SPI investigation of 200 sampling locations in the Upper Hudson River was estimated for Phase 1 to provide a conservative cost estimate for the special study.

2.3 Opinion of Cost

The “order of magnitude” opinion of cost for the Phase 1 residuals sampling effort and the special study is summarized in Table C-2. The opinions of cost for each task are provided below:

- Residual sediment core sample collection: $105,000 to $125,000
- Core sample processing and analysis: $145,000 to $165,000
- Special study for residual sediment characterization: $80,000 to $100,000

The total estimated cost of the Phase 1 residuals sampling program (including the special study) is $330,000 to $390,000.

Table C-1
Summary of Estimated Phase 1 Residuals Sampling Effort

Task	Number of Cores	Linear Feet Cored	Number of Samples Analyzed
Residuals Sampling (Initial)	320	480	320
Backfill Sampling	80	40	80
Recharacterization of Vertical Extent	50	75	150
Residuals Sampling (following redredging)	40	20	40
Estimated Total	**490**	**615**	**590**

Table C-2
Opinion of Cost for Phase 1 Residuals Sampling and Special Study

Description	Unit Cost	Notes
Core Sampling		
Vibracoring Rates:		
Vessel	$1,100	per day
Crew	$1,850	per day (2 person crew)
Equipment	$925	per day
Per diem	$160	per vessel (2 person crew)
Pressure Washer	$85	per day
Subtotal	$4,120	per day
Liners	$5	per foot
Mob/demob	$550	per vessel
Mob/demob	$720	per crew
Parameters:		
# Cores	490	
# LF	615	
# Cores/day/vessel	20	
# Vessel-days	25	
# Vessels	2	
# Work days required	12	
# Calendar days reqd	17	
# Crew-Stints	2	
Costs:		
General/HASP	$10,000	
Phase I Vessel Mob	$1,100	
Crew Mob	$1,400	
Subtotal	$100,940	
Per foot costs	$3,075	
Total	**$116,515**	

Table C-2 (continued)
Opinion of Cost for Phase 1 Residuals Sampling and Special Study

Description	Unit Cost	Notes
Core Processing Rates:		
Processing Staff Parameters:	$2,775	per day 3 person crew
# Cores # Cores processed/day # Work days required Processing Costs:	490 20 25	 per 3-person processing line
Costs	$2,775	
Total	**$67,988**	
Lab Analyses Rates:		
PCBs Rapid TAT Surcharge Total Analytical Parameters:	$100 $50 $150	per sample per sample per sample
# Samples Costs:	590	
Analytical	**$88,500**	

Table C-2 (continued)
Opinion of Cost for Phase 1 Residuals Sampling and Special Study

Description	Unit Cost	Notes	
Special Study			
SPI Rates:			
Vessel	$1,100	per day	
Crew	$3,700	per day	4 person crew (2 vessel and 2 SPI)
Equipment	$1,425	per day	$925 for GPS + $500 for SPI camera
Per diem	$320	per vessel	4 man crew
Subtotal	$6,545	per day	
Mob/demob	$550	per vessel	
Mob/demob	$720	per crew	est.
SPI Mob/demob	$4,500		
Parameters:			
# SPI Locations	200		
# Vessel-days	7		
# Vessels	1		
# Work days required	7		
# Calendar days reqd	10		
# Crew-Stints	1		
Costs:			
General/HASP	$10,000		
Vessel Mob	$550		
Vessel Crew Mob	$720		
SPI Crew Mob	$4,500		
Subtotal	$45,815		
SPI ODCs	$4,000		
Data Processing	$25,000		
Total	**$90,585**		