2008 Post-Flood Opportunistic Sediment Sampling Lower Basin of the Coeur d'Alene River

PREPARED FOR: Ed Moreen/ EPA
Steve Hughes/URS
PREPARED BY: Paul Burnet/CH2M HILL
Maria Fernandez-Diaz/CH2M HILL
Ryan Mitchell/CH2M HILL
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This technical memorandum provides a description of the 2008 post-flood sediment sampling activities conducted in the Lower Basin of the Coeur d'Alene River (LBCDR) in June 2008 and summarizes the resulting data. The sampling work was performed in accordance with the Basin Environmental Monitoring Plan (BEMP) Quality Assurance Project Plan (QAPP) Addendum (CH2M HILL 2008). Sampling was performed on an opportunistic basis in response to the May 2008 flooding event and was performed during the recession of flood waters in the LBCDR; it was not intended to duplicate annual BEMP sediment sampling.

The goal of the 2008 post-flood sediment sampling was to provide a "snapshot" of significant characteristics of sediment deposited in the LBCDR floodplain by a significant flood event, especially in areas of common public use where human exposure to sediments may be likely to occur. Results of this sediment sampling were also intended to provide data useful for enhancing the conceptual site model of sediment transport and deposition associated with flooding of a defined magnitude in the LBCDR.

Background

In May 2008, the LBCDR experienced flooding as a result of rapid melting of the low elevation snow pack. Significant areas in the valley floor of the LBCDR were inundated, including many locations used for public recreation and access to the river, trails and parks. As floodwaters receded, a number of areas with freshly deposited and undisturbed flood-borne sediment became accessible, providing an opportunity to sample and characterize the deposited sediment at locations within the LBCDR.

Fifty locations were initially identified for potential post-flood sediment sampling based on the potential for significant public use, geographical representativeness of the LBCDR, and areas where sediment deposits had been noted by preliminary reconnaissance conducted by EPA and CH2M HILL. While not all locations were accessible or had deposits of sediment, several desirable sampling locations were identified during field activities and added to the list of locations. A total of twenty-six locations were sampled in the LBCDR between Enaville and Harrison, Idaho.

Samples from each location were processed for particle sizing and analyzed for selected metals (arsenic, cadmium, copper, lead, mercury, silver and zinc). Analysis was conducted on the bulk samples and for two size fractions: sand (63-250 µm), and silt (<63µm). A summary of all samples metal concentrations are shown in Table 1. A statistical analysis of the metal concentration summary is presented in Table 2. Table 3 shows each sample size fraction composition. The location of each station and corresponding concentration of arsenic, cadmium, lead, zinc (four of the most significant contributors to potential human health and ecological risk) of each of the particle size categories are shown in Figures 1 through 5.

Field Activities

CH2M HILL performed sample collection, management and documentation. Field activities were recorded in a field log book and each sample location was documented with photographs and sketches. Sampling methods, procedures, and protocols were performed in accordance with the QAPP, unless otherwise noted. Sampling was conducted at areas with public access. A summary of the field notes is included in Table 4.

Sediment samples were collected from freshly deposited, undisturbed sediment (the three-meter sampling grid approach used for BEMP sampling was not used for this effort because a three-meter area was not available at all representative areas where public access was likely). The depth of deposited sediment also varied among sampling locations, but was generally about 2 to 5 centimeters (cm) deep, with some samples as deep as 10 cm. Each sample was collected to represent the entire vertical profile of recently deposited sediment, with equal volume collected from each depth interval.

Some samples were obtained from paved areas, allowing accurate determinations of total deposition depths. In other locations judgment was required to determine the horizon between recently deposited and previously deposited sediment. In these cases efforts were made to obtain only recently deposited material, using as reference points matted vegetation or other indicators of the interval horizon.

The depth of undisturbed, deposited sediment at each sampling site was estimated (as an average across the sampling area) and recorded. Photographic records of the sediment sampling location were obtained when possible and are located in Attachment A. The site conditions of each sampling location were documented in the field notebook.

Observations of site conditions included: measurements of apparent high floodwater line (debris on fences, water marks on trees, etc.), measurements of extent and depth of depositional areas in the vicinity, description of material deposited (sandy, silty, gravelly, etc.), and observations of erosion and scouring. The exact location of each sampling site was documented using a handheld GPS unit. The coordinates of each location are included in Table 4.

The selection of sampling locations was determined in the field by the Field Team Leader. If a location was not viable for sampling, the location was moved or abandoned, and the rationale for the decision noted in the field log. Additional opportunistic samples were collected at the discretion of the Field Team Leader in locations where conditions met the desired conditions.

Samples were collected using decontaminated or disposable hand tools (typically plastic trowels and stainless steel spoons). Leaves, branches, and other woody debris were excluded from the sample material as much as possible.

A bulk sediment sample from each location was separated in the lab into three size fractions: bulk (unsieved), clay and silt (<63 µm) and sand (63-250 µm). Samples representing these categories were then analyzed for selected metals (arsenic, cadmium, copper, lead, mercury, silver and zinc). The fractionation and analytical work was performed by Bonner Laboratories, a laboratory in EPA's Contract Laboratory Program (CLP). Samples were managed under chain of custody control and tracked using Forms II Lite documentation.

Analytical Methods Requirements

Analysis of metals was conducted following EPA SW6010/6020 methodology. The QC procedures followed CLP protocols. Analyses of sample grain size were conducted following methodology described in ASTM D422-63. All analyses listed were subject to minimum quality control requirements.

Particle Size Analysis

Sediment samples were sieved to determine the mass fraction in the silt/clay fraction (<63 µm), the sand fraction (63-250 µm) and by difference, the fraction of remaining coarse particles (>250 µm). A graphical representation of the mass percentage of each fraction at each location is included in Figure 6.The percentage for the course fraction (>250 µm) tends to decrease downstream, while the sand fraction (63-250 µm) increases downstream. The silt/clay fraction (<63 µm), while variable, does not show an apparent trend along the river. Samples upstream of Cataldo generally contain proportionately more coarse material, while samples downstream of Cataldo generally contain more sandy material.

Analytical Results – In-channel and Near-channel Data

Overview

A graphical representation of metals concentrations for each of the in-channel/near-channel LBCDR sampling locations is provided in Figures 7 through 20. Two graphs are shown for each metal, with one showing the concentrations for bulk, sand and silt size fractions, and the second showing the relative proportion of the metal mass in the sand and silt fractions. It can be observed from both graphs that, although the metal concentration in the silt/clay fraction is in most cases higher than that of the sand fraction, the contribution to the total metal content in the sample from the silt/clay fraction is less, given its lower mass proportion. In general, the sand fraction contains the largest portion of metal mass relative to the silt fraction. The higher sand fraction is common in samples collected close to river channel during periods of high flow.

Most metals show a similar trend along the length of the LBCDR: concentrations decrease from Enaville to Cataldo (river miles 48.6 to 44.6), are at their lowest near Cataldo, and increase through the Dudley-Black Rock area (river miles 37.7 to 32.5. Concentrations decline gradually toward Harrison (river mile 16.5).

Most sampling stations were located within the banks of the river or on the adjacent floodplain, but several locations were located outside the river channel and the adjacent floodplain. These off-channel samples are evaluated separately in the following sections to assess the effect of sediment distributions across the floodplain.

The sample material collected at the swimming beach at Harrison Marina Trailhead contained only very thin and intermittent deposits on the sand of the swimming beach; the sample itself appeared to be characteristic of imported beach sand rather than historically or recently flood deposits. For this reason, the Harrison Marina Trailhead sample was not included in the statistical analysis of 2008 sediment samples.

The other samples collected outside the river channel and adjacent floodplain (Rainy Hill Boat Ramp, Killarney Lake Boat Ramp, and Between Latour Creek - River Bend) are also discussed separately. Samples obtained outside the channel and adjacent floodplain are reviewed as a separate data set.

Analytical results are presented relative to the 95th percentile upper confidence limit of the mean values used in the risk assessment (USEPA 2002) to indicate where newly deposited material is lower, similar or greater in metals content than currently documented sediment and soil.

Arsenic

Arsenic data for bulk, sand and silt/clay fractions are provided in Figures 7 and 8. Arsenic concentrations show relatively low variability, though the lowest bulk values are lowest near Cataldo, and the highest concentrations in the fine fraction are downstream from Medimont at river mile 27.9. The arsenic concentrations at the majority of the sampling locations were above the 95th percentile upper confidence limit values used in the risk assessment. Concentrations in the fine fractions were more than twice the UCL in some cases.

Bulk Sample

Arsenic concentrations on the lower Coeur d'Alene River ranged from 22.7 mg/kg (Cataldo Boat Ramp) to 157 mg/kg (Springston).

Sand Fraction (63-250 µm)

Arsenic was detected in the sand fraction at concentrations ranging from 29 mg/kg (Cataldo Boat Ramp) to 195 mg/kg (Harrison Slough).

Silt/Clay Fraction (<63 µm)

Arsenic was detected in the silt/clay fraction at concentrations ranging from 31.2 mg/kg (Cataldo North Rocks) to 394 mg/kg (Springston). Concentrations in the fine fraction are generally higher downstream of Dudley, and although they represent a relatively small portion of the total sample are significantly higher than the 95th percentile upper confidence limit.

Cadmium

Cadmium data for bulk, sand, and silt/clay fractions are provided in Figures 9 and 10. Cadmium concentrations in bulk samples decrease in the upper reaches, are lowest near Cataldo, increase to their highest level near Black Rock and Rose Lake, and decrease toward the mouth of the river at the lake. Cadmium concentrations of flood deposits below Cataldo were higher than the 2002 95th percentile UCL concentrations, indicating that highly enriched material was mobilized in the 2008 flood. Cadmium concentrations in the fine fraction are similar to those in the sand and bulk fractions.

Bulk Sample

Cadmium concentrations in the lower Coeur d'Alene River ranged from 5 mg/kg (Cataldo North) to 46 mg/kg (Bull Run). All bulk samples collected downstream of River Bend Wayside exceed the Cadmium UCL of 26 mg/kg.

Sand Fraction (63-250 µm)

Cadmium was detected in the sand fraction at concentrations ranging from 7 mg/kg (Cataldo Boat Ramp) to 49 mg/kg (Bull Run).

Silt/Clay Fraction (<63 µm)

Cadmium was detected in the silt/clay fraction at concentrations ranging from 6 mg/kg (Cataldo South) to 51 mg/kg (Bull Run).

Copper

Copper data for bulk, sand, and silt/clay fractions are provided in Figures 11 and 12. Copper concentrations decrease in the upper reaches, are lowest near Cataldo, increase to their highest level between Dudley and Black Rock, and decrease toward the mouth of the river at the lake. Copper concentrations in the fine fraction are similar to those in the sand and bulk fractions. Copper concentrations were generally lower than their respective 2002 UCL values.

Bulk Sample

Copper concentrations in the lower Coeur d'Alene River ranged from 36 mg/kg (Cataldo North) to 130 mg/kg (Bull Run).

Sand Fraction (63-250 µm)

Copper was detected in the sand fraction at concentrations ranging from 48 mg/kg (Cataldo South) to 152 mg/kg (Cedar Grove).

Silt/Clay Fraction (<63 µm)

Copper was detected in the silt/clay fraction at concentrations ranging from 45 mg/kg (Cataldo South) to 159 mg/kg (Downstream Dudley).

Lead

Lead data in bulk, sand and silt/clay fractions are provided in Figure 13 and 14. Lead concentrations decrease from Rivermile 48.6 (a location downstream of Enaville) to Rivermile 41.5 (Cataldo Boat Ramp), then increase to maximum concentrations near Rivermile 33.8 (between Bull Run and Black Rock). Concentrations drop from this reach downstream to Harrison. Lead concentrations in the silt/clay and sand fractions are relatively similar in many samples, except for several locations where the silt/clay fraction has higher lead concentrations (Downstream Dudley, and several locations in the lower 11 miles of the Coeur d'Alene River. All locations with the exception of the Harrison Marina Trailhead (swimming beach) have concentrations above the ecological cleanup level of 530 mg/kg (USEPA 2002) and the cleanup action level for humans. Lead concentrations on the fine fractions of the material were more than twice the UCL in some cases.

Bulk Sample

Lead concentrations on the lower Coeur d'Alene River ranged from 946 mg/kg at Cataldo Boat Ramp to 5, 680 mg/kg at the in-channel location Midway Between Black Rock and Bull Run. The highest lead concentrations were in sediments from Rose Lake boat ramp, Midway Black Rock-Bull Run and, and Black Lake Breach, ranging from 5,110 to 5,680 mg/kg.

Sand Fraction (63-250 µm)

Lead was detected in the sand fraction at concentrations ranging from 1,220 mg/kg (Cataldo Boat Ramp) to 5,010 mg/kg (Black Lake Breach). With the exception of Black Lake Breach, the highest concentrations were from samples collected in the area downstream of the Dudley Reach.

Silt and Clay Fraction (<63 µm)

Lead was detected in the silt/clay fraction at concentrations between 1,350 mg/kg (Cataldo South) to 8,690 mg/kg (Downstream Dudley). With the exception of the Downstream Dudley sample, the highest concentrations were from samples collected at four locations immediately downstream of the Medimont Boating site in the lower portion of the basin.

Mercury

Mercury data in bulk, sand, and silt/clay fractions are provided in Figures 15 and 16. Mercury concentrations decrease downstream to Cataldo and then increase at Dudley and remain relatively constant to the mouth of the river at the lake. The concentration of mercury in 2008 flood deposits below Cataldo were higher than the 2002 95th percentile UCL concentrations, indicating that enriched material was mobilized in the 2008 flood.

Bulk Sample

Mercury concentrations in the lower Coeur d'Alene River ranged from 0.5 mg/kg (Cataldo South) to 4.5 mg/kg (Cedar Grove).

Sand Fraction (63-250 µm)

Mercury was detected in the sand fraction at concentrations ranging from 1.1 mg/kg (Cataldo South) to 5.5 mg/kg (Bull Run).

Silt/Clay Fraction (<63 µm)

Mercury was detected in the silt/clay fraction at concentrations ranging from 0.9 mg/kg (Cataldo North Rocks) to 7.2 mg/kg (Cedar Grove).

Silver

Silver data in bulk, sand, and silt/clay fractions are provided in Figures 17 and 18. The silt/clay fractions appear have a higher concentration than the sand fractions. Silver concentrations in 2008 deposits were generally lower than their respective 2002 UCL values.

Bulk Sample

Silver concentrations in the lower Coeur d'Alene River ranged from 2.3 mg/kg (Cataldo Boat Ramp) to 14.4 mg/kg (Thompson Lake).

Sand Fraction (63-250 µm)

Silver was detected in the sand fraction at concentrations ranging from 3.5 mg/kg (Cataldo Boat Ramp) to 19.7 mg/kg (Cedar Grove).

Silt/Clay Fraction (<63 µm)

Silver was detected in the silt/clay fraction at concentrations ranging from 4 mg/kg (Cataldo North Rock) to 22.7 mg/kg (Downstream Dudley).

Zinc

Zinc data in bulk, sand and silt/clay fractions are provided in Figure 19 and 20. Zinc concentrations are around 2,000 mg/kg upstream of Cataldo, drop to their lowest levels around Cataldo, and then increase to maximum levels near Rose Lake and Black Rock, decreasing again toward Harrison. Zinc concentrations below Cataldo were higher than the 2002 95th percentile UCL concentrations, indicating that enriched material was mobilized in the 2008 flood.

Bulk Sample

Zinc concentrations on the lower Coeur d'Alene River ranged from 896 mg/kg (Cataldo North) to 7,180 mg/kg (Bull Run). The highest zinc concentrations detected in the bulk sediment samples were at locations immediately upstream and downstream of Bull Run.

Sand Fraction (63-250 µm)

Zinc was detected in the sand fraction ranging from 957 mg/kg (midway Latour Creek and River Bend) to 8,120 mg/kg (Black Rock). The highest concentrations were from samples collected downstream of Rose Lake Boat Ramp.

Silt/Clay Fraction (<63 µm)

Zinc was detected in the silt/clay fraction at concentrations ranging from 956 mg/kg (Cataldo North Rocks) to 8,710 mg/kg (Bull Run). Concentrations appear to show relatively low variability among particles sizes.

Analytical Results – Off-channel Data

Most of the 2008 post-flood sampling locations were along the banks of the main stem Coeur d'Alene River, or adjacent to the river. Several locations were more removed from the river channel, or in lateral lakes. These locations included the following:

- Rainy Hill Boat Ramp – 0.4 miles south of river mile 27.0
- Killarney Lake Boat Ramp – 0.6 miles north of river mile 28.9
- Midway between Latour Creek and River Bend –0.3 miles south of river mile 41.2

Metals concentrations from all off-channel locations were lower than the Lower Basin Soil-Sediment 95th percentile Upper Confidence Limit value for all metals of interest, while many in-channel locations showed post-flood values above this value, indicating that contaminant transport is most significant in or near the river. Metal concentrations for off channel locations and their immediately upstream and downstream in-channel locations are provided on Figures 21 through 27.

Sediment data from these off-channel locations indicate that metals concentrations are generally lower than comparable in-channel locations. Notably, lead levels were relatively consistent between in-channel and off-channel locations, while zinc concentrations were significantly lower at Rainy Hill Boat Ramp and Killarney Boat Ramp.

Arsenic, lead and silver showed relatively little difference in concentration between off-channel sampling locations and the closest in-channel sampling locations, while cadmium, copper, mercury and zinc showed greater variability. None of the off-channel samples showed enrichment in the concentrations of metals in the fine (silt) fraction.

Contaminant Mass Mobilized During the 2008 Flood

The mass of contaminants deposited in the Lower Basin during the 2008 flood was estimated using available river flow rating curves, suspended sediment data and sediment composition data. The mass of contaminant was estimated using suspended sediment data only and does not include mass that could have been transported as bedload sediment. However, the contribution of bedload sediments to total sediment discharged in the Lower Basin has been estimated to be insignificant ranging from less than 10 percent at Pinehurst and Enaville gauging stations to 1 percent at the Harrison gauging station (Clark an Woods 2001). The methods and data used to estimate the total amount of suspended sediment are described in Attachment B. The rating curves and suspended sediment data were obtained for three U.S. Geological Survey stations:

- South Fork Coeur d'Alene River near Pinehurst (above the confluence with the North Fork)
- North Fork Coeur d'Alene River at Enaville (above the confluence with the South Fork)
- Coeur d' Alene River near Harrison (mouth of the main stem Coeur d'Alene River at Lake Coeur d'Alene.

The rating curves allow estimating the mass of sediment entering and exiting the Lower Basin using suspended sediment data from the gauging stations. The difference between the calculated sediment mass entering and exiting the Lower Basin represents the suspended sediment mass estimated to have been deposited within the channel, floodplain, lakes, and marshes of the Lower Basin. An estimated 255,000 tons of suspended sediments (62,000 tons from the South Fork and 193,000 tons from the North Fork) were transported into the Lower Basin and 208,000 tons of suspended sediments were transported out the Lower Basin. By difference, an estimated 47,000 tons of suspended sediment were deposited in the Lower Basin during the 2008 flood event.

The average concentration of the 26 bulk samples of sediment deposited on the riverbanks and floodplains was used to represent contaminant concentrations of suspended sediment deposited in the Lower Basin. The average bulk concentration was calculated including off-channel and in-channel locations, as follows:

- Arsenic - 76 mg/kg
- Cadmium - 24 mg/kg
- Copper - 90 mg/kg
- Lead - 3,132 mg/kg
- Mercury - 2. 7 mg/kg
- Silver - 7.7 mg/kg
- Zinc - 3,633 mg/kg of zinc.

The estimated total mass of metals from suspended sediments deposited in the Lower Basin was 3.57 tons of arsenic, 1.1 tons of cadmium, 4.23 tons of copper, 147 tons of lead, 0.13 tons of mercury, 0.37 tons of silver, and 170 tons of zinc.

Summary

Sediment deposited in the Lower Basin of the Coeur d'Alene River by 2008 flooding contains concentrations of metals at levels above risk-based concentrations, which are considered detrimental to humans and ecological receptors and are above those used to document risks to humans and ecological receptors in the 2002 Record of Decision (USEPA 2002).

Concentrations of metals were lowest, for all size fractions, in the Cataldo area. This could be a result of dilution of South Fork sediments with cleaner sediment from the North Fork. Concentrations of most metals are highest, in all size fractions, in the reach between Dudley and Black Rock (river miles 21 to 15), with concentrations decreasing toward the Coeur d'Alene Lake. The significant increase in concentrations of metals in all size fractions near Dudley suggests that this reach and possibly other portions of the Lower Basin are source areas and that existing deposits of more contaminated sediment, in the river channel, bank wedges, or on the floodplain may have been resuspended and redeposited downstream.

Particle size data indicates that recently deposited sediment contains about 10—20 percent fines (silt/clay, <63µm). The sand fraction (63-250µm) is more variable, but generally averages 30 – 40 percent of the sediment mass from Enaville to Cedar Grove (river miles 32 to 19), then increases to 60 – 70 percent to the lake at Harrison. The fine fraction (<63µm) contains about 10 percent of the total mass of lead in most samples, with most of the lead present in the sand fraction. It should be noted that most sediment samples were collected in or very near to the river channel and are therefore assumed to be representative of areas with high river velocities.

The concentrations of most metals (except arsenic) in deposited sediment sampled above Cataldo were below the 95th percentile upper confidence limit concentrations used in the risk assessment (USEPA 2002). This suggests that while newly deposited sediments still pose significant potential risks to human and ecological receptors, , clean material from the North Fork significantly dilutes the highly enriched material from the South Fork. Concentrations of cadmium, mercury, and zinc in 2008 flood deposits below Cataldo were higher than the 2002 95th percentile upper confidence limit (UCL) concentrations, indicating that material was mobilized in the 2008 flood appeared to enrich contaminant concentrations in the Lower Basin. Concentrations of arsenic and lead were relatively less enriched in 2008 sediments, except for fine fractions of the material, which showed concentrations more than twice the UCL in some cases. Concentrations of copper and silver in 2008 deposits were generally lower than their respective 2002 UCL values.

The 2008 post-flood opportunistic sampling appears to provide data useful for understanding the effects of floodwater transport and deposition of suspended sediments in the LBCDR. The results can be used in conjunction with ongoing BEMP sampling, sediment gauge station data, and computer modeling to create a better understanding of the migration of contaminated sediment in the Coeur d'Alene River, and the potential effectiveness of remedies to restore the watershed. A more comprehensive sampling plan, that includes collection and physical and chemical analyses of deposited, suspended, and bedload sediments, at strategic locations is necessary to understand the effect of different flood events on sediment and contaminant transport. Continued post-flood sampling, when feasible, is recommended. Additional or alternative sites are recommended, as are sampling locations in lateral lakes, marshes, and wetlands.

References

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Tables

Table 1. 2008 Post-Flood Lower Coeur d'Alene River Basin Opportunistic Sediment Sampling

Sampling Date: June 10-12

				ANALYTE CONCENTRATION (mg/kg)						
River Mi	Station Description	Location	Size Fraction	ARSENIC	CADMIUM	COPPER	LEAD	MERCURY	SILVER	ZINC
0	Harrison Marina Trailhead	Off Channel	BULK	0.85	0.28	6.7	13.1	0.1	1.0	27.5
			63 um - 250 um	0.92	0.04	5.5	14.2	0.1	1.0	26
			< 63 um	0.79	0.05	6	14.7	0.1	1.0	26.7
1	Harrison Slough	In Channel	BULK	129	28	88	2,960	2.9	7.4	4,270
			63 um - 250 um	195	28	91	2,710	3.3	11.4	4,420
			< 63 um	200	28	92	2,590	3.3	10.9	4,630
1.1	Anderson Lake Wayside	Floodplain	BULK	121	28	99	3,650	3.1	7.6	3,860
			63 um - 250 um	189	27	95	3,080	3.2	11.8	4,100
			< 63 um	172	26	91	2,960	3.6	11.7	4,050
2.6	Springston	In Channel	BULK	157	33	119	3,890	3.4	8.7	5,080
			63 um - 250 um	139	33	115	3,620	3.5	9.4	5,230
			< 63 um	394	32	137	6,400	3.7	20.9	4,960
2.9	Thompson Lake	Floodplain	BULK	121	35	108	2,490	3.5	9.6	5,660
			63 um - 250 um	178	36	99	2,440	3.1	14.4	6,120
			< 63 um	171	34	100	2,260	5.1	14.3	5,720
3.9	Upstream Cottonwood	In Channel	BULK	114	35	110	2,990	3.4	7.7	5,390
			63 um - 250 um	93	34	116	2,780	3.9	9.3	5,450
			< 63 um	348	35	151	6,550	4.0	20.8	5,340
7.1	Black Lake Breach	In Channel	BULK	131	33	123	5,350	3.4	8.5	4,800
			63 um - 250 um	121	32	122	5,010	3.6	9.6	4,880
			< 63 um	292	28	124	6,220	3.4	18.8	4,450
10.8	Medimont Boating Ramp	In Channel	BULK	93	35	104	3,500	3.4	6.5	5,520
			63 um - 250 um	101	41	132	3,610	3.8	9.5	6,690
			< 63 um	269	29	123	6,540	3.6	17.2	4,490
10.9	Rainy Hill Boat Ramp	Off Channel	BULK	84	22	82	3,430	2.6	7.9	2,620
			< 63 um	189	19	83	3,360	2.1	9.2	2,660
			63 um - 250 um	75	22	77	3,040	2.4	9.3	2,720
13.8	Killarney Lake Boat Ramp	Off Channel	BULK	56	17	73	3,130	1.9	7.7	2,290
			63 um - 250 um	146	20	87	3,930	2.2	9.2	2,240
			< 63 um	85	20	86	3,780	1.8	9.0	2,160
15.4	Black Rock	Floodplain	BULK	68	40	117	3,710	3.1	9.6	6,170
			63 um - 250 um	157	49	136	4,170	4.4	17.2	8,120
			< 63 um	137	41	110	3,560	4.3	15.8	7,090
16.7	Midway Black Rock-Bull Run	Floodplain	BULK	97	35	112	5,680	3.5	11.1	5,140
			63 um - 250 um	143	34	94	4,470	3.6	12.5	5,360
			< 63 um	140	33	96	4,280	3.4	14.3	5,240
17.7	Bull Run	In Channel	BULK	69	46	130	5,110	4.4	12.1	7,180
			63 um - 250 um	141	49	136	4,280	4.9	17.1	8,080
			< 63 um	142	51	145	4,290	4.7	17.8	8,710
18	Rose Lake Boat Ramp	Floodplain	BULK	72	45	126	5,110	4.5	11.5	7,080
			63 um - 250 um	142	42	118	4,420	3.7	13.3	6,710
			< 63 um	148	48	142	4,820	5.2	17.1	8,110
19.1	Cedar Grove	Floodplain	BULK	67	21	103	3,370	3.6	8.2	3,560
			63 um - 250 um	169	31	152	4,400	5.5	19.7	5,290
			< 63 um	164	29	147	4,160	7.2	19.0	5,120
20.3	Downstream Dudley	Floodplain	BULK	71	36	122	4,500	4.3	14.4	5,130
			63 um - 250 um	70	39	138	4,120	4.5	8.9	4,490
			< 63 um	211	38	159	8,690	4.7	22.7	5,630

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20.6	Dudley	Floodplain	BULK	55	24	91	3,210	3.3	5.9	3,770
			63 um - 250 um	137	25	97	2,840	3.8	10.3	4,250
			< 63 um	131	28	104	2,760	4.2	12.3	5,450
22.8	River Bend Wayside	In Channel	BULK	63	22	79	2,560	2.1	8.6	3,050
			63 um - 250 um	159	29	93	2,820	2.5	10.7	4,660
			< 63 um	148	28	108	2,580	2.3	10.1	4,620
24.4	Cataldo Boat Ramp	Floodplain	BULK	23	7	42	946	0.9	2.3	1,530
			63 um - 250 um	29	9	54	1,220	1.2	3.5	1,860
			< 63 um	42	13	80	1,780	1.0	5.2	2,700
25.1	Midway Latour Creek-River Bend	Off Channel	BULK	32	9	57	1,330	1.5	3.5	1,000
			63 um - 250 um	32	8	53	1,320	1.6	3.9	957
			< 63 um	32	9	62	1,420	1.2	4.3	1,020
27.5	Cataldo South	Floodplain	BULK	39	7	44	1,360	1.1	4.2	938
			63 um - 250 um	42	7	48	1,520	1.1	4.7	1,040
			< 63 um	36	6	45	1,350	1.3	4.3	960
27.5	Cataldo North	Floodplain	BULK	31	5	36	1,530	0.5	3.6	896
			63 um - 250 um	142	8	56	1,990	1.2	8.3	1,390
			< 63 um	141	8	61	1,910	1.6	6.4	1,350
27.5	Cataldo North Rocks	Floodplain	BULK	31	9	54	1,230	1.5	3.3	940
			63 um - 250 um	33	9	59	1,400	1.5	4.4	992
			< 63 um	31	9	57	1,350	0.9	4.0	956
29.7	Backwater Bay	In Channel	BULK	50	10	67	1,960	1.4	7.4	1,600
			63 um - 250 um	53	11	64	2,030	1.8	8.0	1,830
			< 63 um	55	9	58	1,760	1.4	6.4	1,660
31.5	Downstream Enaville	In Channel	BULK	69	9	69	2,540	0.7	6.7	1,500
			63 um - 250 um	179	13	110	3,020	1.8	11.2	2,160
			< 63 um	169	12	101	2,750	2.5	11.1	2,080
31.5	Upland Downstream Enaville	Floodplain	BULK	65	15	90	2,760	2.8	9.6	1,840
			63 um - 250 um	70	17	101	3,110	3.0	10.4	2,000
			< 63 um	65	16	96	2,900	1.9	10.3	1,920

Table 2. 2008 Post-Flood Lower Coeur d'Alene River Basin Opportunistic Sediment Sampling Statistics

		ARSENIC	CADMIUM	COPPER	LEAD	MERCURY	SILVER	ZINC
BULK	Minimum	23	5	36	946	0.5	2.3	896
	Maximum	157	46	130	5680	4.5	14.4	7180
	Average	76	24	90	3132	2.7	7.7	3633
63-250 um	Minimum	29	7	48	1220	1.1	3.5	957
	Maximum	195	49	152	5010	5.5	19.7	8120
	Average	117	26	98	3094	3.0	10.3	4042
<63 um	Minimum	31	6	45	1350	0.9	4.0	956
	Maximum	394	51	159	8690	7.2	22.7	8710
	Average	157	26	103	3529	3.3	12.8	4134
Bulk	Minimum	Cataldo Boat Ramp	Cataldo North	Cataldo North	Cataldo Boat Ramp	Cataldo North	Cataldo Boat Ramp	Cataldo North
	Maximum	Springston	Bull Run	Bull Run	Midway Black Rock-Bull R	Downstream Dudley	Thompson Lake	Bull Run
63-250 um	Minimum	Cataldo Boat Ramp	Cataldo South	Cataldo South	Cataldo Boat Ramp	Cataldo South	Cataldo Boat Ramp	Midway Latour Creek-River Bend
	Maximum	Harrison Slough	Bull Run	Cedar Grove	Black Lake Breach	Cedar Grove	Cedar Grove	Black Rock
<63 um	Minimum	Cataldo North Rocks	Cataldo South	Cataldo South	Cataldo South	Cataldo North Rocks	Cataldo North Rocks	Cataldo North Rocks
	Maximum	Springston	Bull Run	Downstream Dudley	Downstream Dudley	Cedar Grove	Downstream Dudley	Bull Run

TABLE 3. Size Fraction Percentage

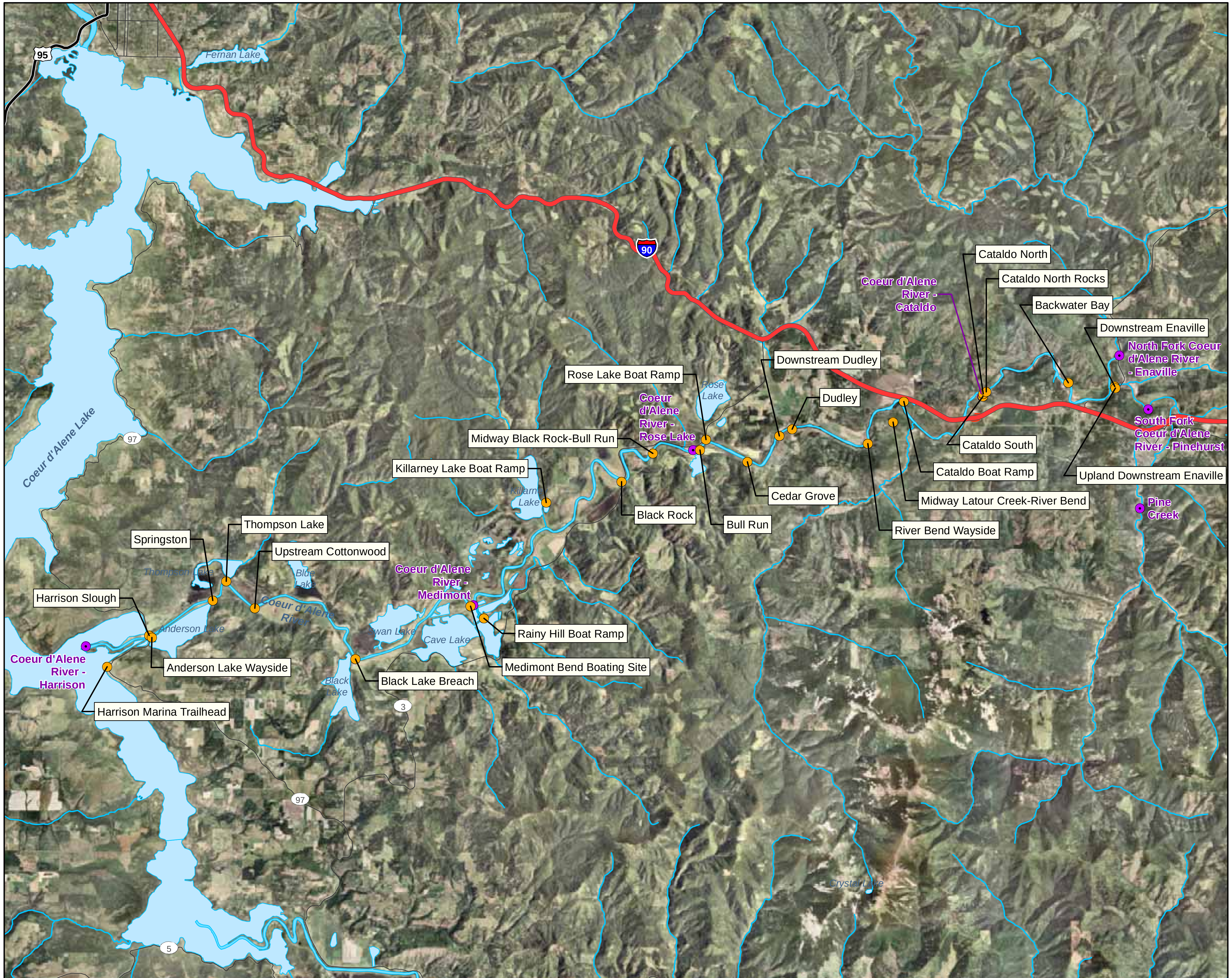
STATION	Silt/Clay Fraction	Sand Fraction
Harrison Slough	10.1%	13.0%
Anderson Lake Wayside	23.7%	18.8%
Springston	5.9%	14.4%
Thompson Lake	5.3%	1.4%
Upstream Cottonwood	10.8%	10.2%
Black Lake Breach	9.4%	32.5%
Medimont Boating Ramp	9.9%	15.0%
Black Rock	6.5%	20.1%
Midway Black Rock-Bull Run	43.4%	2.4%
Bull Run	19.7%	7.5%
Rose Lake Boat Ramp	16.6%	1.9%
Cedar Grove	0.5%	82.1%
Downstream Dudley	9.2%	21.3%
Dudley	21.0%	17.4%
River Bend Wayside	19.8%	20.6%
Cataldo Boat Ramp	8.4%	68.7%
Cataldo South	25.0%	24.0%
Cataldo North	2.2%	86.4%
Cataldo North Rocks	20.3%	41.8%
Backwater Bay	20.1%	32.0%
Downstream Enaville	1.3%	86.9%
Upland Downstream Enaville	29.6%	17.3%

TABLE 4. 2008 Lower Coeur d'Alene River Basin Opportunistic Sediment Sampling Field Notes

	Station Description	Northing	Easting	Sed. Thickness	Floodwater Depth(i)	Sediment Characteristic
1	Harrison Marina Trailhead	47°27' 16.08" N	116°47' 13.75" W	1-2 cm	-	Fine Grain
2	Harrison Slough	47°27' 57.368" N	116°45' 54.379" W	2-3 cm	-	Fine Grain
3	Anderson Lake Wayside	47°27' 54.867" N	116°45' 49.770" W	7 cm	-	Fine Grain
4	Springston	47°28' 43.271" N	116°43' 54.381" W	3-4 cm	-	Brown Fine Particles with oxidized layers
5	Thompson Lake	47°29' 8.506" N	116°43' 29.387" W	2-5 cm	-	Light brown silt with sand
6	Upstream Cottonwood	47°28' 34.163" N	116°42' 33.806" W	2-5 cm	-	Gray Sand
7	Black Lake Breach	47°27' 30.024" N	116°39' 21.114" W	3-4 cm	-	Fine Particles
8	Medimont Bend Boating Site	47°28' 40.239" N	116°35' 43.738" W	5-6 cm	-	Dark Brown Silt with some sand
9	Rainy Hill Boat Ramp	47°28' 24.812" N	116°35' 17.415" W	<1cm	-	Fine Particles
10	Killarney Lake Boat Ramp	47°30' 55.405" N	116°33' 20.184" W	2-3 cm	-	Silty-Sand with high moisture content
11	Black Rock	47°31' 22.906" N	116°30' 58.345" W	2-4 cm	4 ft	Brown Sand with some silt
12	Midway Black Rock-Bull Run	47°31' 59" N	116°29' 58.795" W	1-3 cm	-	Brown Silt with some sand
13	Bull Run	47°32' 03.448" N	116°28' 25.456" W	7-8 cm	-	Brown Sand
14	Rose Lake Boat Ramp	47°32'17.85"N	116°28'17.59"W	2-8 cm	-	Cohesive brown silty with sand
15	Cedar Grove	47°31' 49.994" N	116°26' 58.494" W	2-10 cm	-	Dark Brown Sand
16	Downstream Dudley	47°32' 23.634" N	116°25' 58.355" W	1-10 cm	-	Sand-Fine Particles
17	Dudley	47°32' 32.700" N	116°25' 33.995" W	3-6 cm	4 ft	Brown Sand with some silt
18	River Bend Wayside	47°32' 14.935" N	116°23' 09.517" W	1-3 cm	-	Brown sand with some silt
19	Cataldo Boat Ramp	47°33' 9.356" N	116°22' 0.115" W	2-3 cm	-	Fine-grained silt with dark brown color
20	Between Latour Creek and River Bend	47°32' 42.896" N	116°22' 21.205" W	1-2 cm	-	Brown Cohesive Silt
21	Cataldo South	47°33' 16.561" N	116°19' 30.515" W	2-5 cm	-	Brown Silt with some sand
22	Cataldo North	47°33' 20.07" N	116°19' 29.656" W	1 cm	-	Fine Particles
23	Cataldo North Rocks	47°33' 22.730" N	116°19' 24.488" W	1-2 cm	4 ft	Brown Fine Particles with earthy smell
24	Backwater Bay	47°33' 22.906" N	116°30' 58.345" W	1-2 cm	-	Sand with silt, lots of organics
25	Downstream Enaville	47°33' 31.028" N	116°15' 19.278" W	4-6 cm	-	Brown coarse sand with some silt
26	Upland Downstream Enaville	47°33' 29.005" N	116°15' 17.993" W	1-2 cm	1 ft	Super fine dark brown particles

i:Flood water depth was estimated by debris on fences, visual markings on trees, and other observations.

Figures



LEGEND

- Sediment Sample Location
- BEMP Annual Sediment Sampling Location
- Stream
- Lake

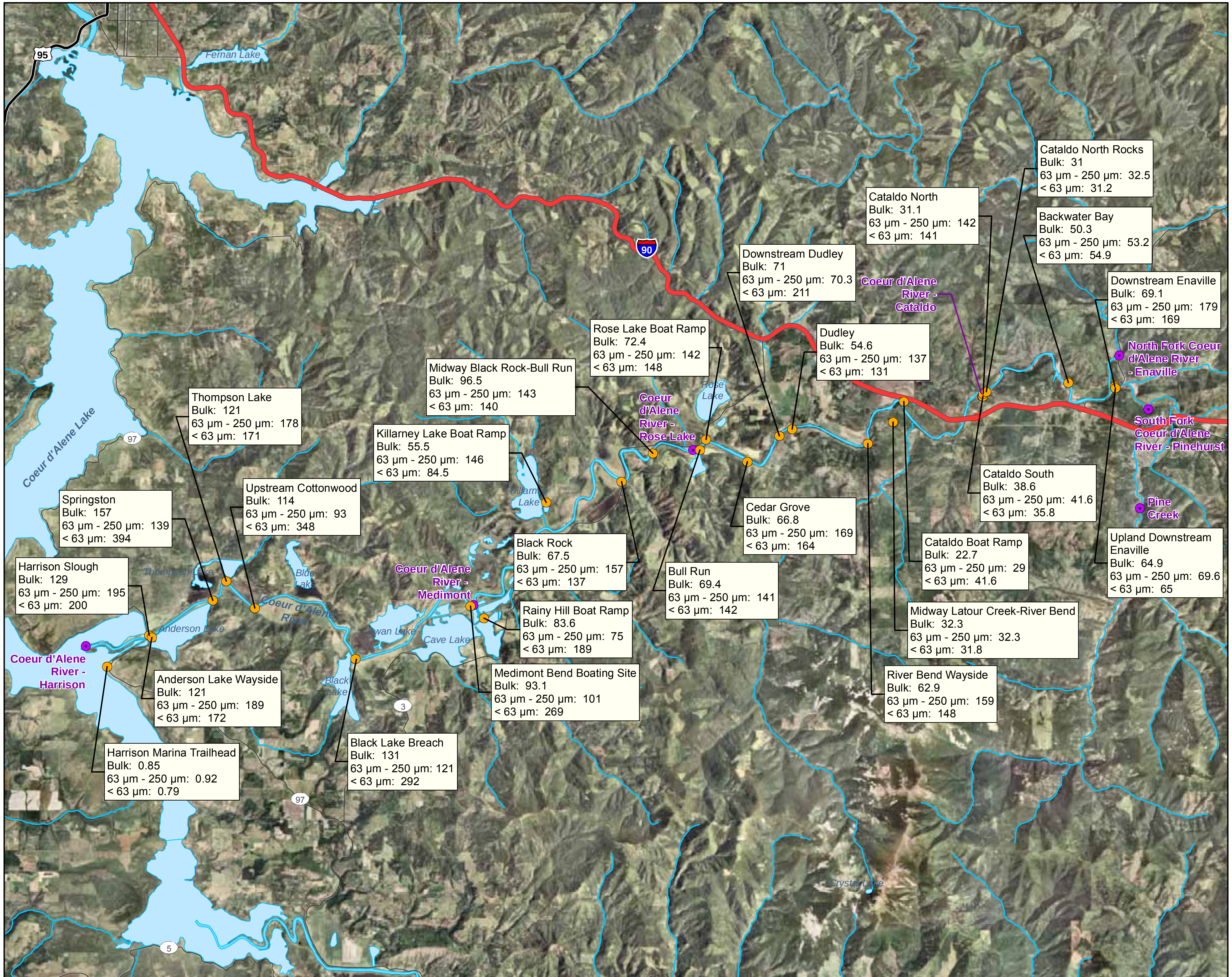
N

0 1.25 2.5
Miles

FIGURE 1
Sampling Stations
June 2008
Post Flood 2008 Lower Coeur D'Alene River Basin
Opportunistic Sediment Sampling
Coeur d'Alene Basin

CH2MHILL

File Path: \\simba\proj\USEPA\333911CDrB\GIS\MXD\SamplingResults_200808\SamplingStations.mxd, Date: October 8, 2008



VICINITY MAP

LEGEND

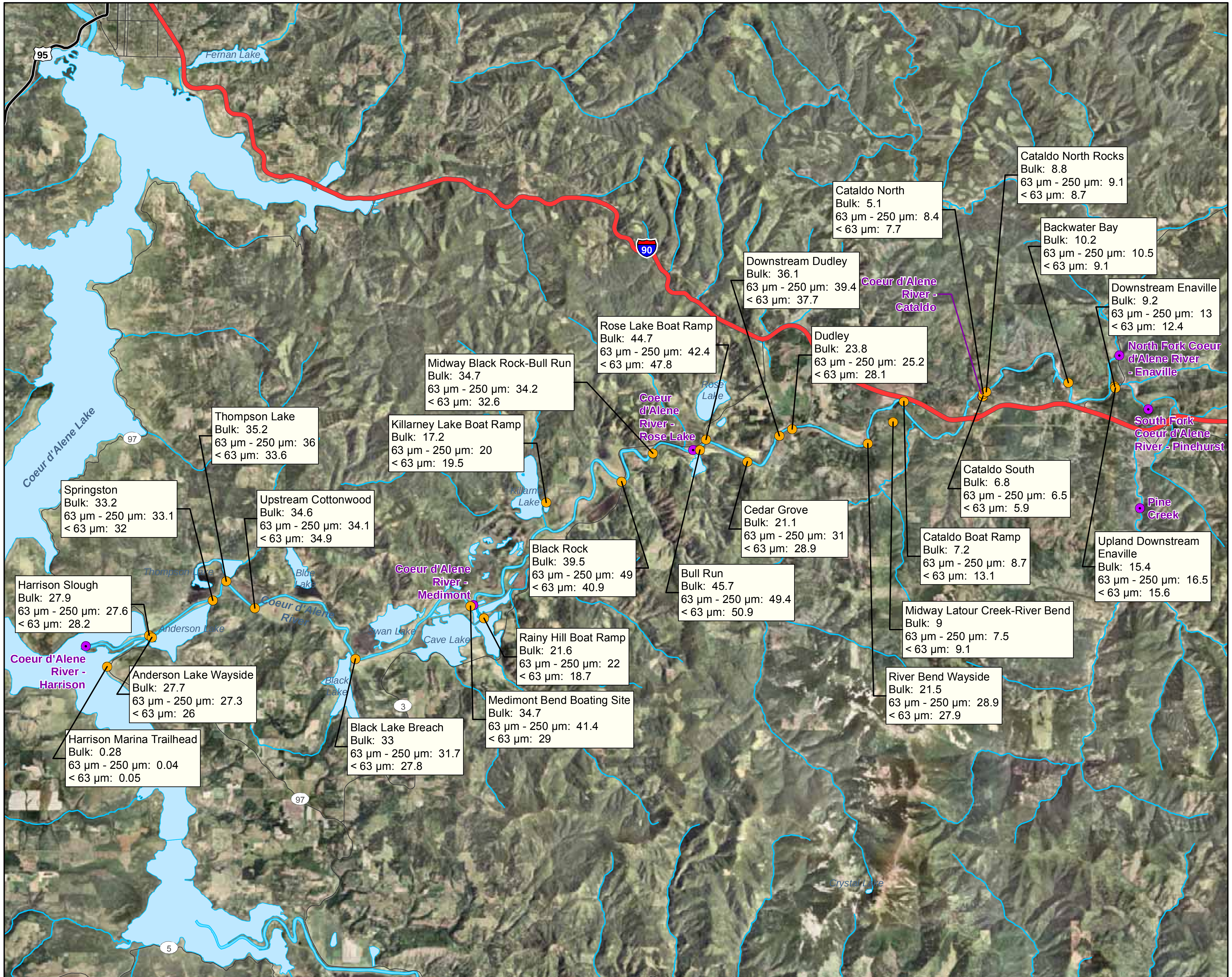
- Sediment Sample Location and Arsenic Concentration (mg/kg)
- BEMP Annual Sediment Sampling Location
- Stream
- Lake

N

0 1.25 2.5
Miles

FIGURE 2
Arsenic Concentrations in Sediment - June 2008
Post Flood 2008 Lower Coeur D'Alene River Basin
Opportunistic Sediment Sampling
Coeur d'Alene Basin

CH2MHILL



VICINITY MAP

LEGEND

- Sediment Sample Location and Cadmium Concentration (mg/kg)
- BEMP Annual Sediment Sampling Location
- Stream
- Lake

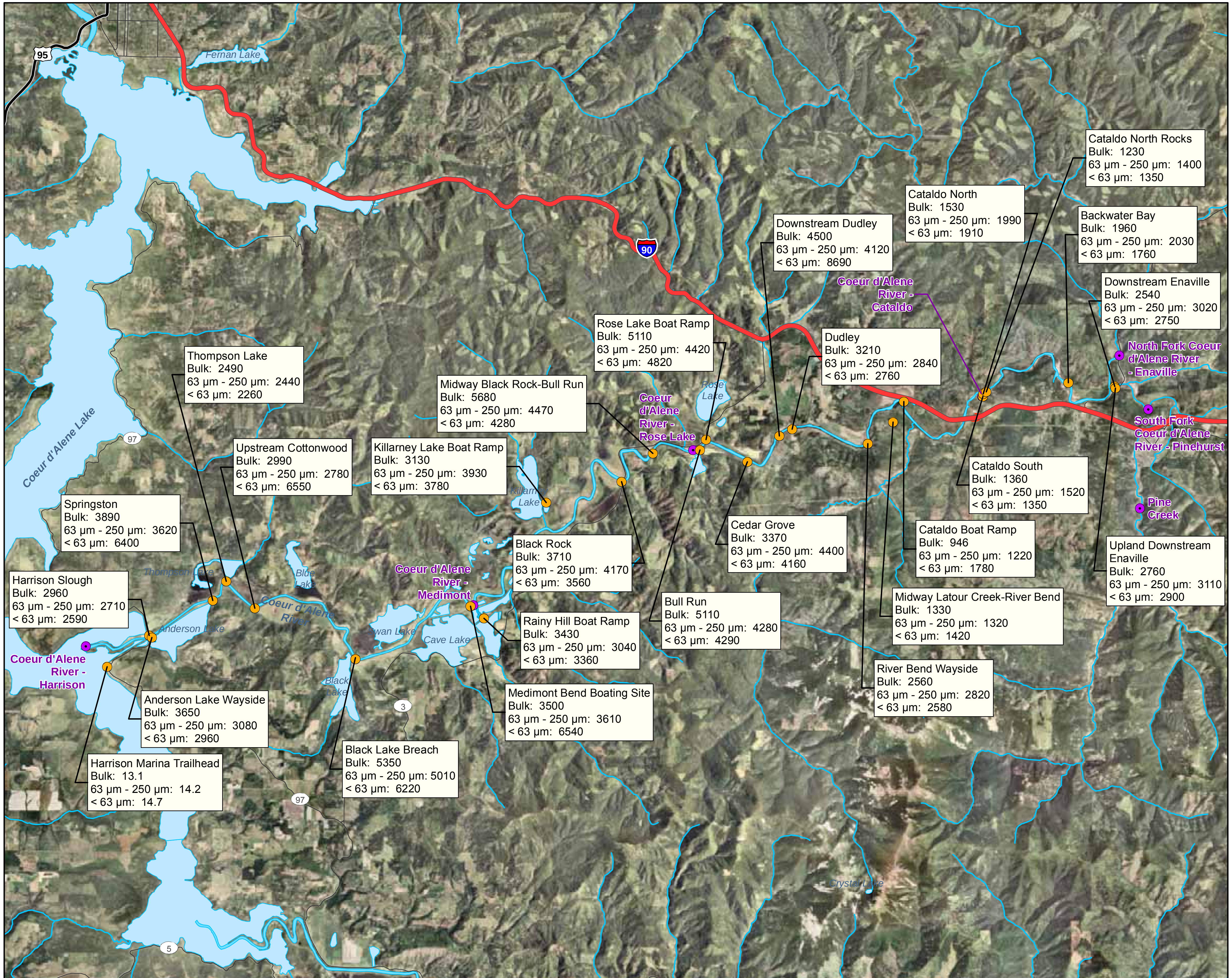
N

0 1.25 2.5
Miles

FIGURE 3
Cadmium Concentrations in Sediment - June 2008
Post Flood 2008 Lower Coeur D'Alene River Basin
Opportunistic Sediment Sampling
Coeur d'Alene Basin

CH2MHILL

File Path: \\simba\proj\USEPA\333911CDrB\GIS\MXD\SamplingResults_200808\CadmiumResults.mxd, Date: October 8, 2008



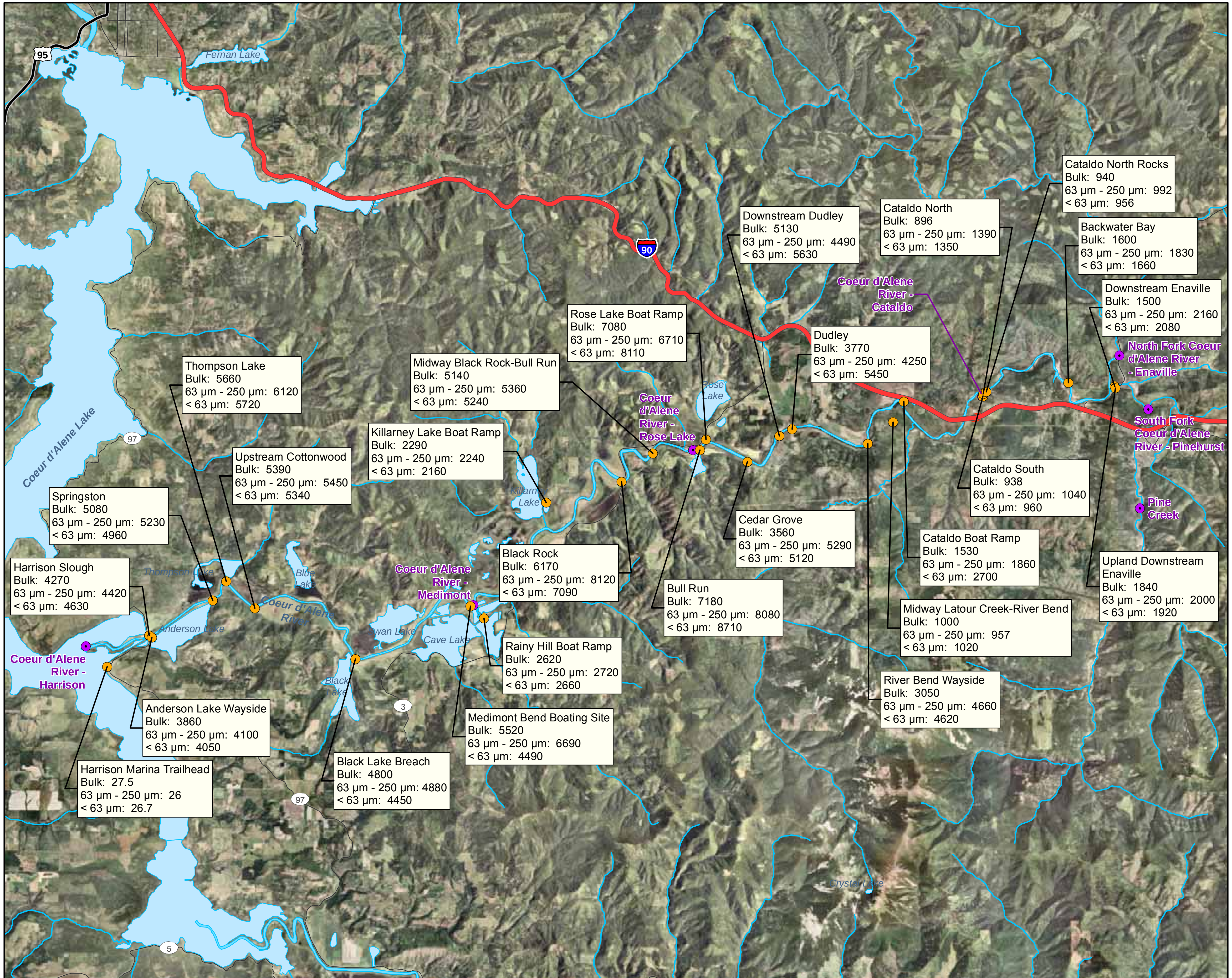
VICINITY MAP

LEGEND
- Sediment Sample Location and Lead Concentration (mg/kg)
- BEMP Annual Sediment Sampling Location
- Stream
- Lake

0 1.25 2.5
Miles

FIGURE 4
Lead Concentrations in Sediment - June 2008
Post Flood 2008 Lower Coeur D'Alene River Basin
Opportunistic Sediment Sampling
Coeur d'Alene Basin

CH2MHILL



VICINITY MAP

FIGURE 5
Zinc Concentrations in Sediment - June 2008
Post Flood 2008 Lower Coeur D'Alene River Basin
Opportunistic Sediment Sampling
Coeur d'Alene Basin

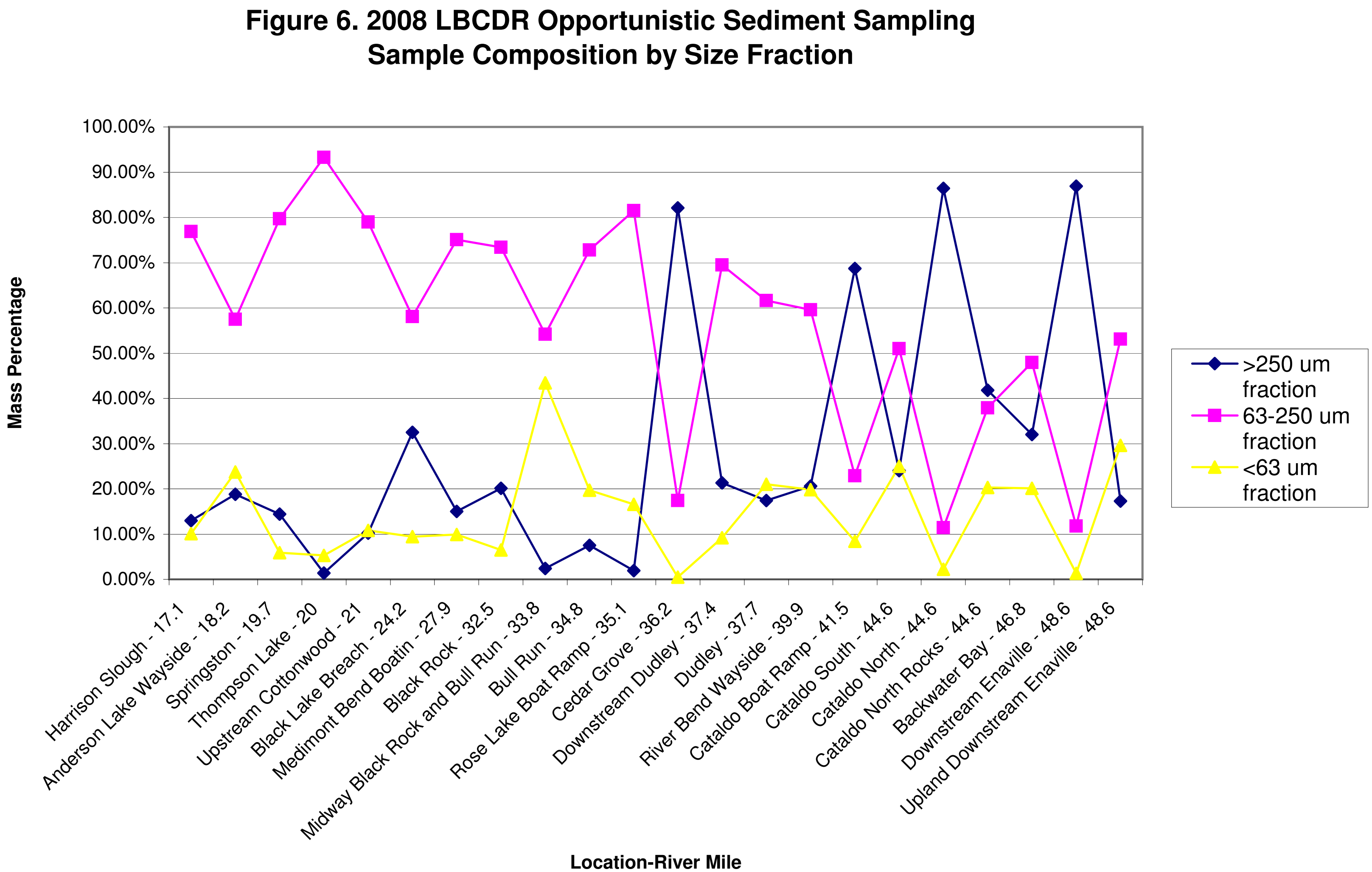


Figure 6. 2008 LBCDR Opportunistic Sediment Sampling
Sample Composition by Size Fraction
Mass Percentage
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Harrison Slough - 17.1
Anderson Lake Wayside - 18.2
Springston - 19.7
Thompson Lake - 20
Upstream Cottonwood - 21
Black Lake Breach - 24.2
Medimont Bend Boatin - 27.9
Black Rock - 32.5
Midway Black Rock and Bull Run - 33.8
Bull Run - 34.8
Rose Lake Boat Ramp - 35.1
Cedar Grove - 36.2
Downstream Dudley - 37.4
Dudley - 37.7
River Bend Wayside - 39.9
Cataldo Boat Ramp - 41.5
Cataldo South - 44.6
Cataldo North - 44.6
Cataldo North Rocks - 44.6
Backwater Bay - 46.8
Downstream Enaville - 48.6
Upland Downstream Enaville - 48.6
Location-River Mile
>250 um fraction
63-250 um fraction
<63 um fraction

Figure 7. 2008 LBCDR Opportunistic Sediment Sampling Arsenic Concentration by Size Fraction

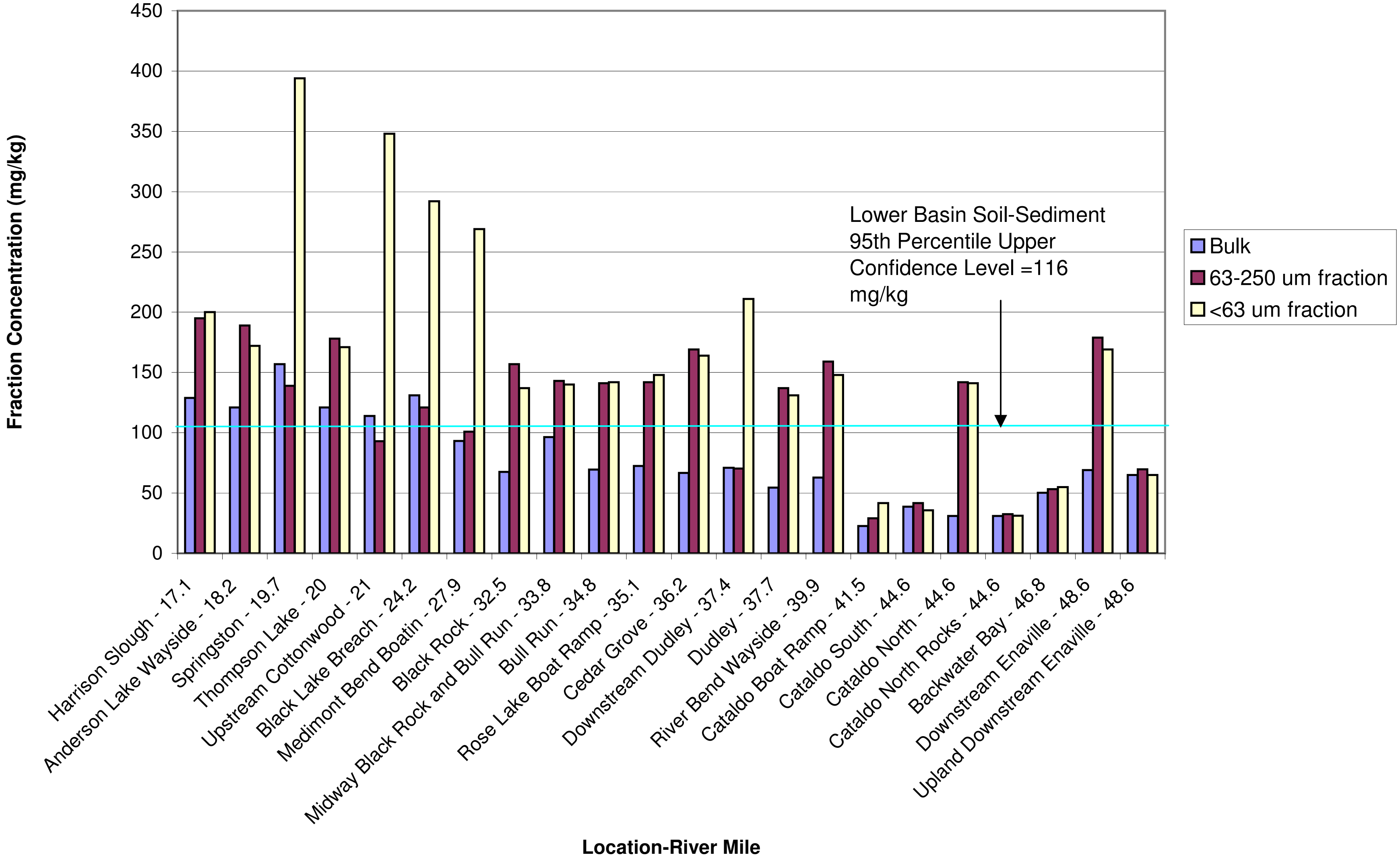
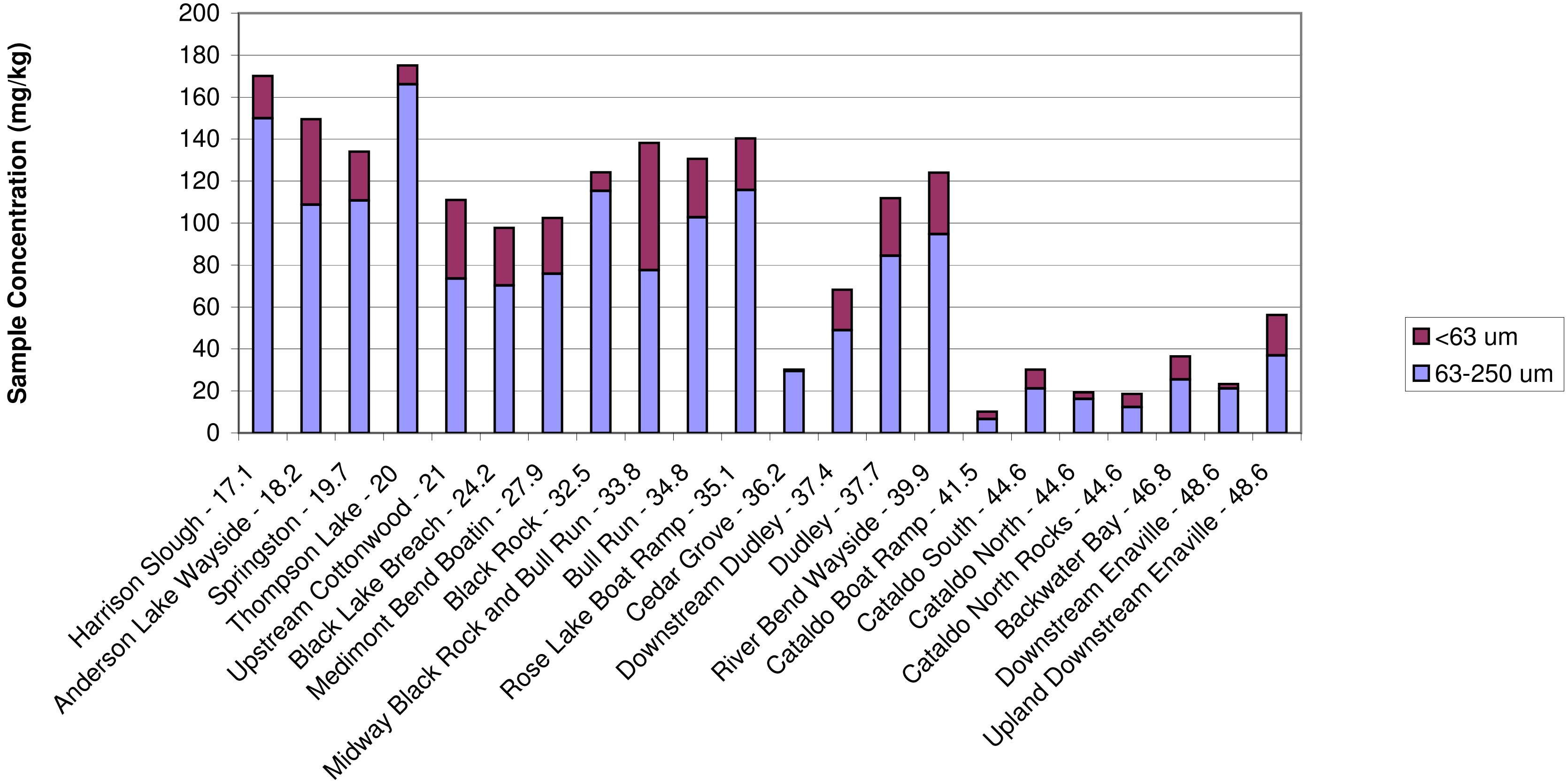


Figure 8. 2008 LBCDR Opportunistic Sediment Sampling
Silt and Sand Fraction Contribution to Arsenic Concentration



Note: The contribution was calculated by multiplying each fraction concentration by the fraction mass percentage.

Figure 9. 2008 LBCDR Opportunistic Sediment Sampling Cadmium Concentration by Size Fraction

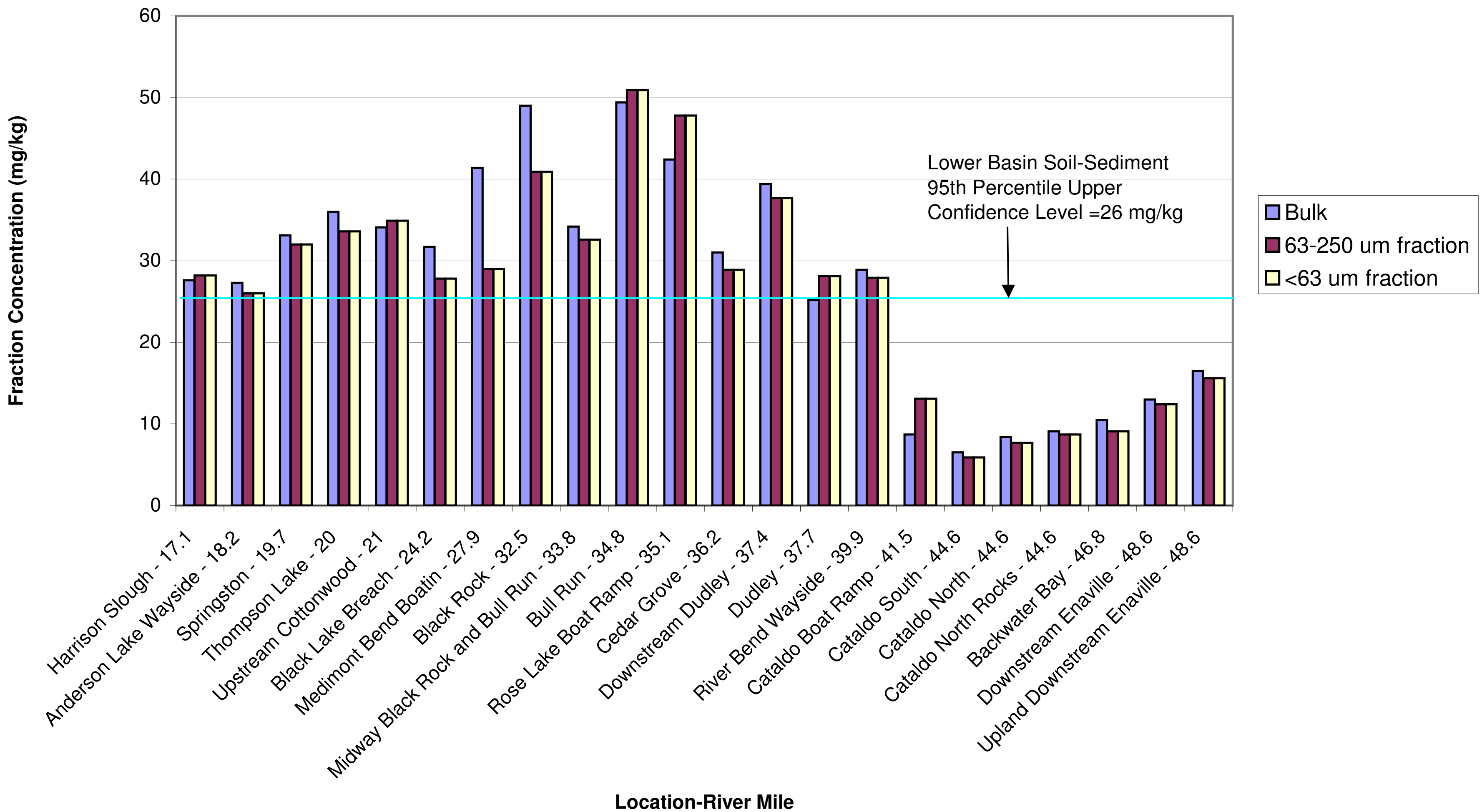
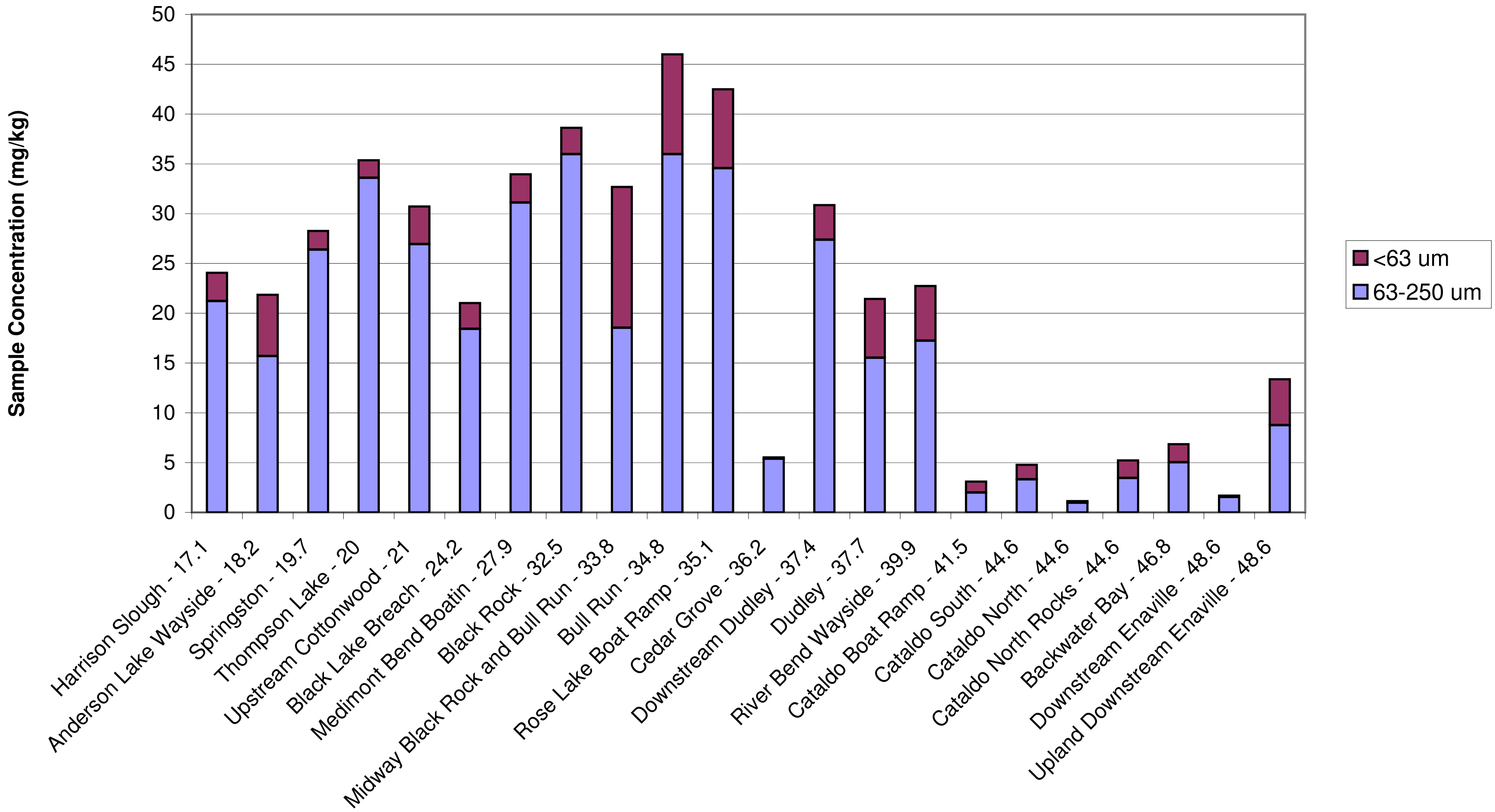


Figure 10. 2008 LBCDR Opportunistic Sediment Sampling
Silt and Sand Fraction Cadmium Contribution to Sample Concentration



Note: The contribution was calculated by multiplying each mass fraction concentration by the corresponding mass percentage.

Figure 11. 2008 LBCDR Sediment Sampling Copper Concentration by Size Fraction

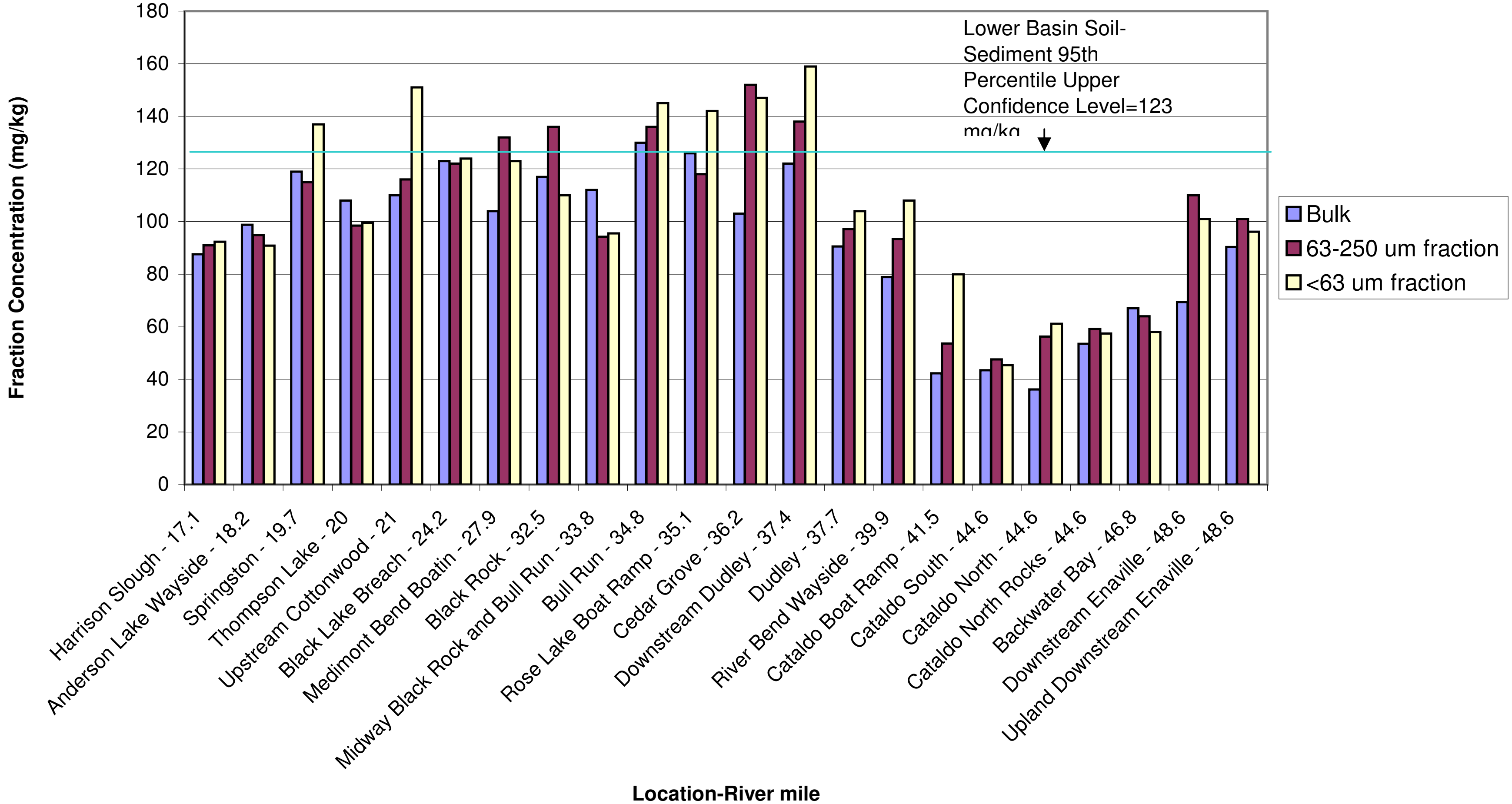
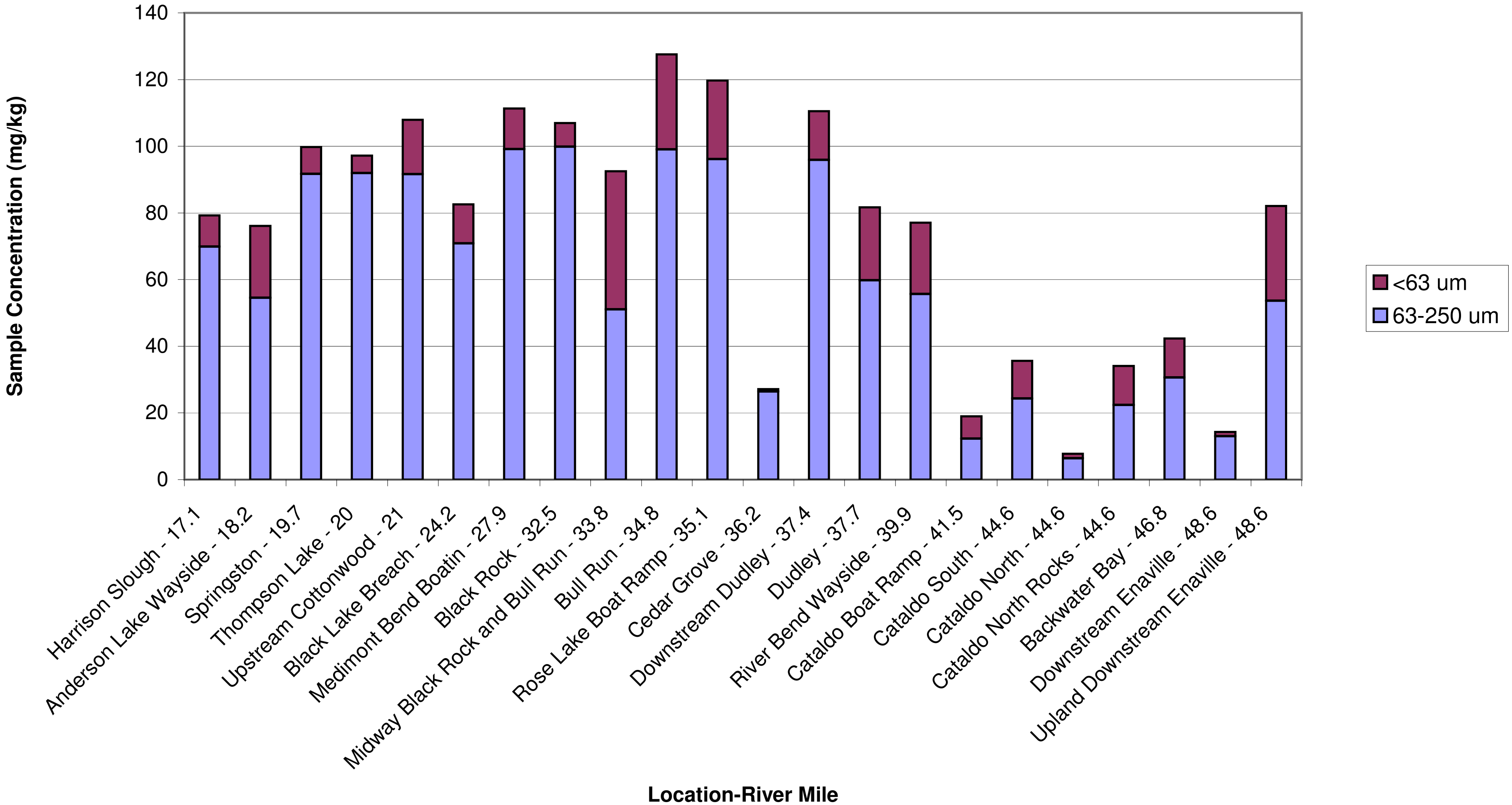


Figure 12. 2008 LBCDR Opportunistic Sediment Sampling
Silt and Sand Fraction Contribution to Copper Concentration



Note: The contribution was calculated by multiplying each mass fraction concentration by the corresponding mass percentage.

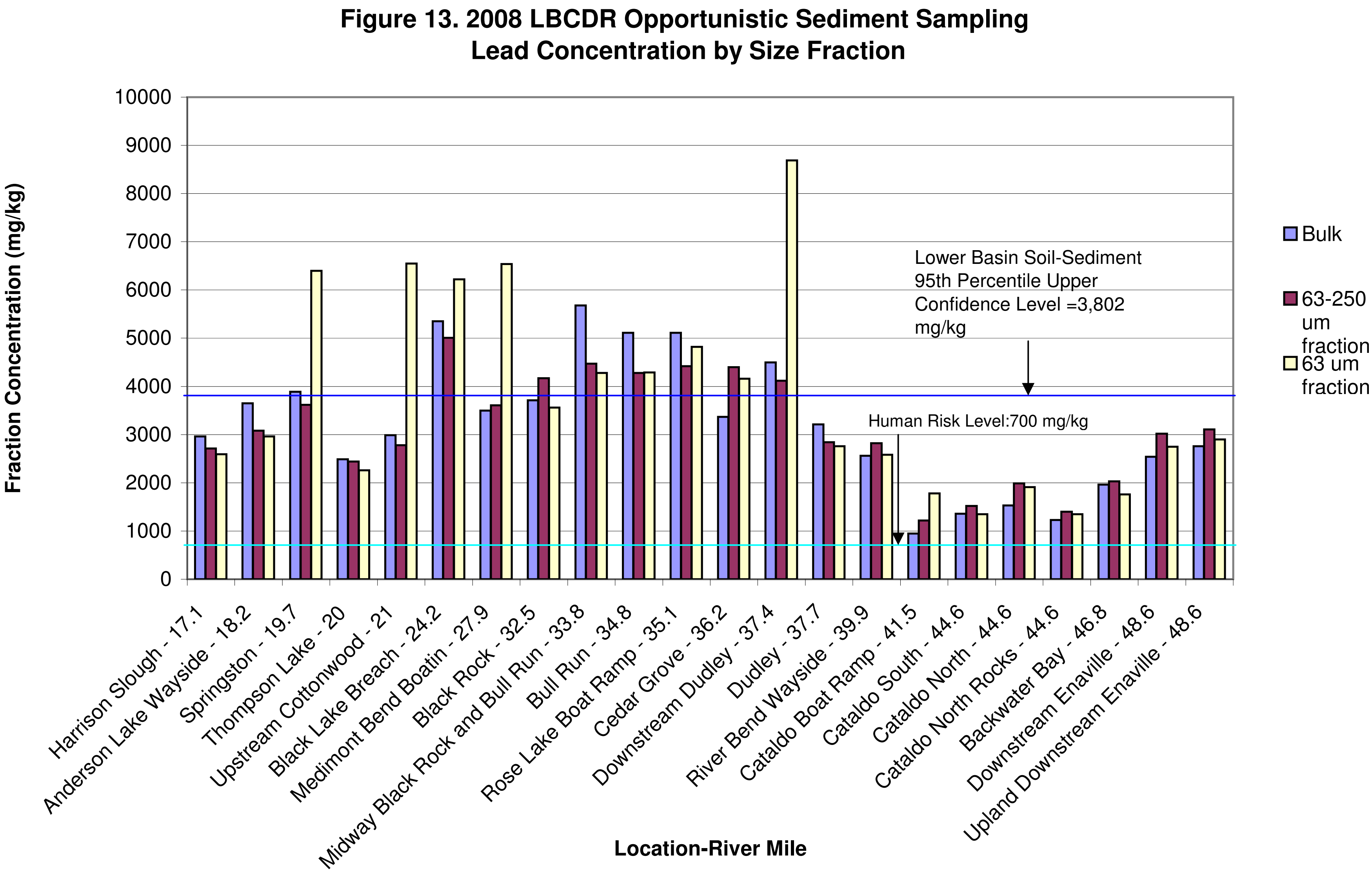
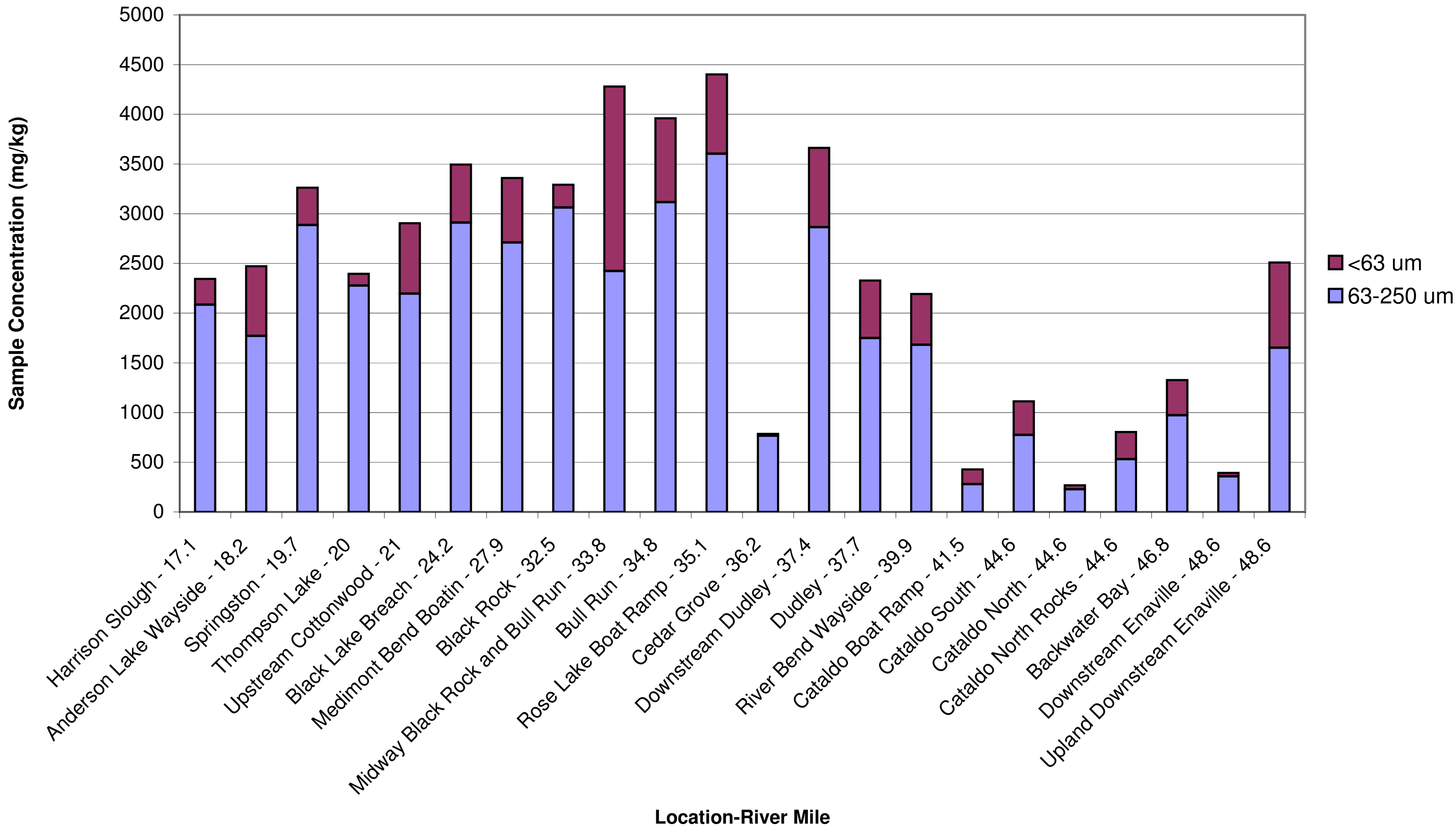


Figure 13. 2008 LBCDR Opportunistic Sediment Sampling
Lead Concentration by Size Fraction
Fraction Concentration (mg/kg)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Lower Basin Soil-Sediment 95th Percentile Upper Confidence Level =3,802 mg/kg
Human Risk Level:700 mg/kg
Bulk
63-250 um fraction
63 um fraction
Harrison Slough - 17.1
Anderson Lake Wayside - 18.2
Springston - 19.7
Thompson Lake - 20
Upstream Cottonwood - 21
Black Lake Breach - 24.2
Medimont Bend Boatin - 27.9
Black Rock - 32.5
Midway Black Rock and Bull Run - 33.8
Bull Run - 34.8
Rose Lake Boat Ramp - 35.1
Cedar Grove - 36.2
Downstream Dudley - 37.4
Dudley - 37.7
River Bend Wayside - 39.9
Cataldo Boat Ramp - 41.5
Cataldo South - 44.6
Cataldo North - 44.6
Cataldo North Rocks - 44.6
Backwater Bay - 46.8
Downstream Enaville - 48.6
Upland Downstream Enaville - 48.6
Location-River Mile

Figure 14. 2008 LBCDR Opportunistic Sediment Sampling
Silt and Sand Fraction Contribution to Lead Concentration



Note: The contribution was calculated by multiplying each mass fraction concentration by the corresponding mass percentage.

Figure 15. 2008 LBDCR Opportunistic Sediment Sampling Mercury Concentration by Size Fraction

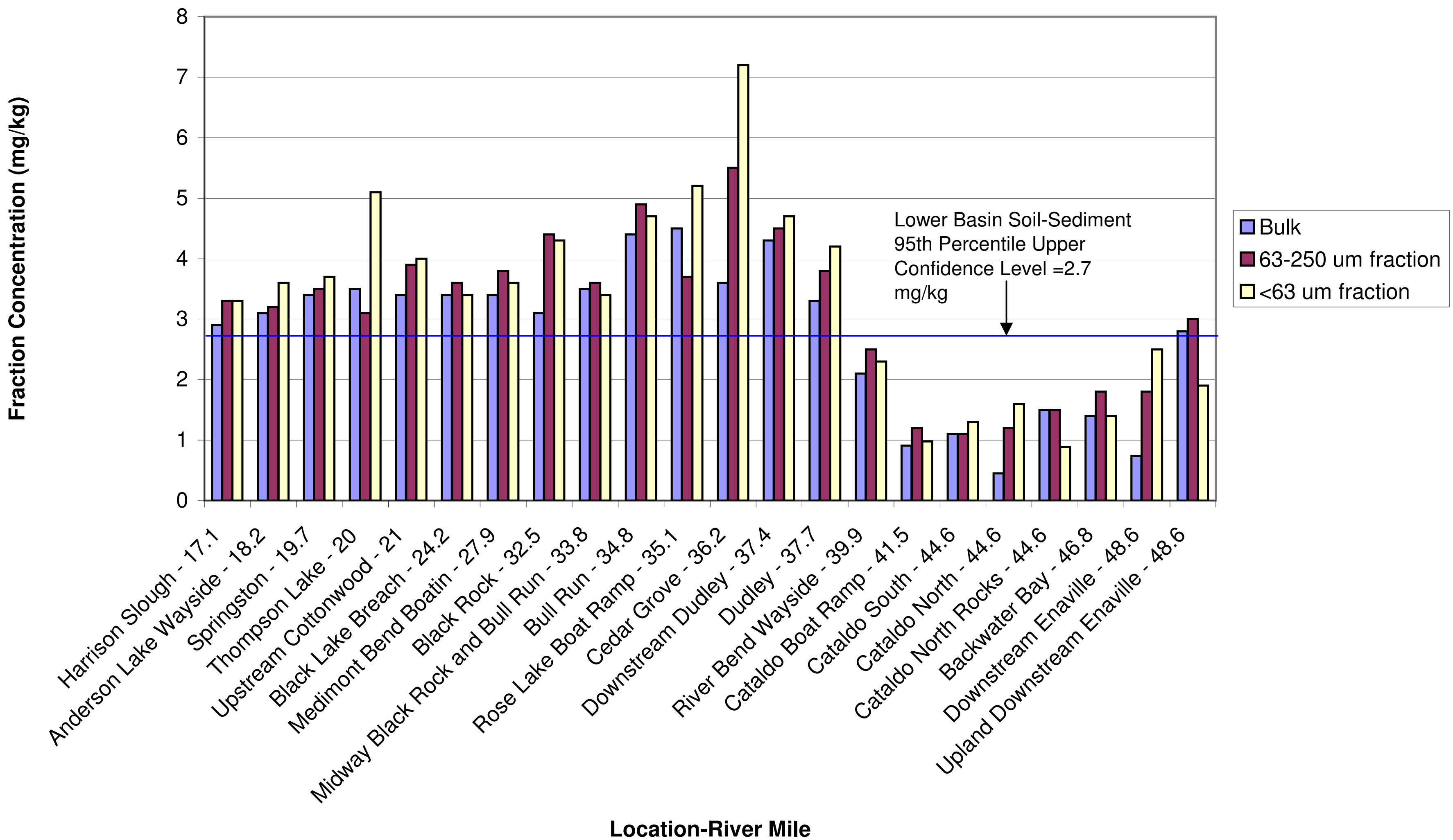
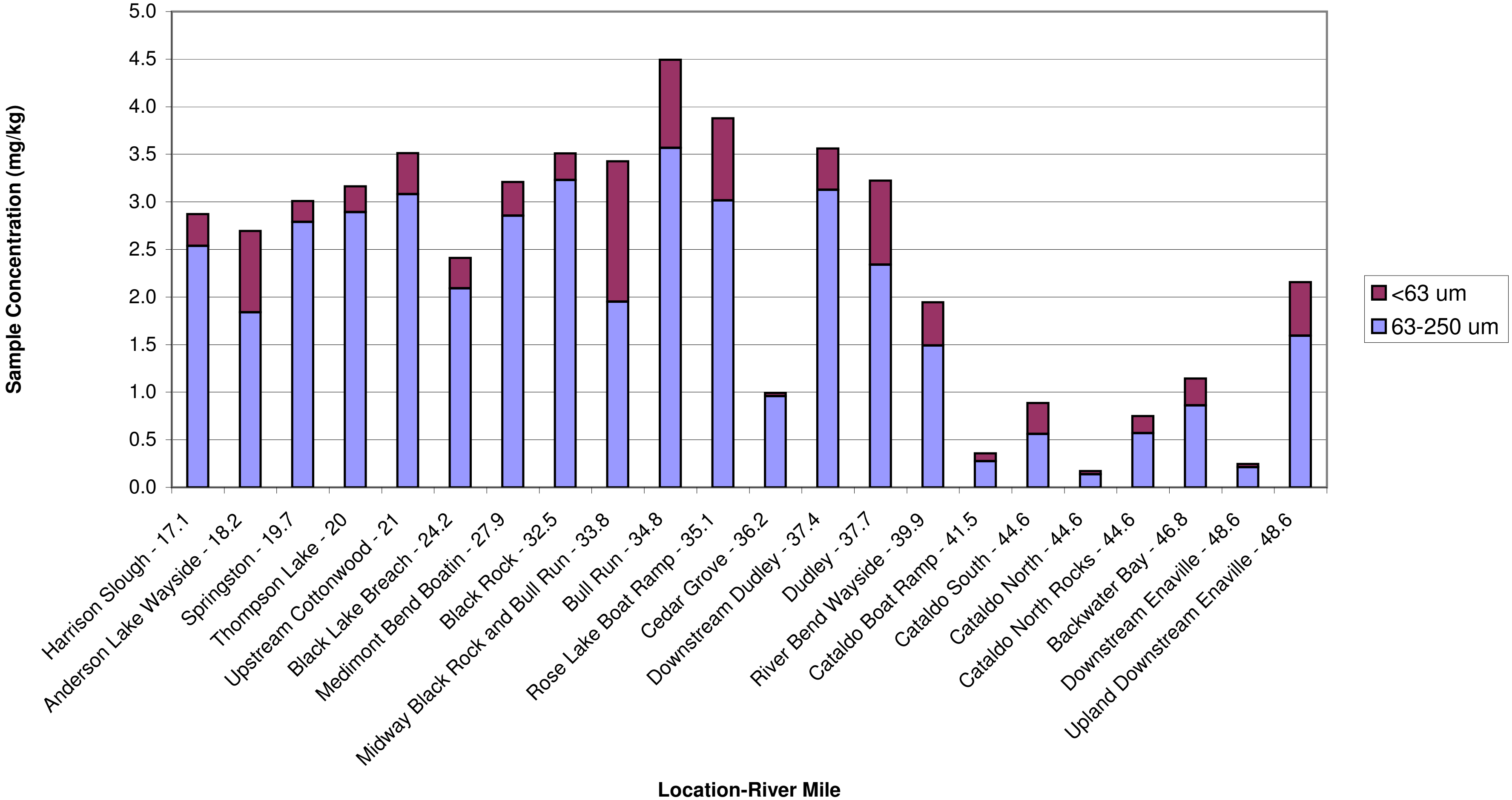


Figure 16. 2008 LBCDR Opportunistic Sediment Sampling
Silt and Sand Contribution to Mercury Concentrations



Note: The contribution was calculated by multiplying each mass fraction concentration by the corresponding mass percentage.

Figure 17. 2008 LBCDR Opportunistic Sediment Sampling Silver Silver Concentration by Size Fraction

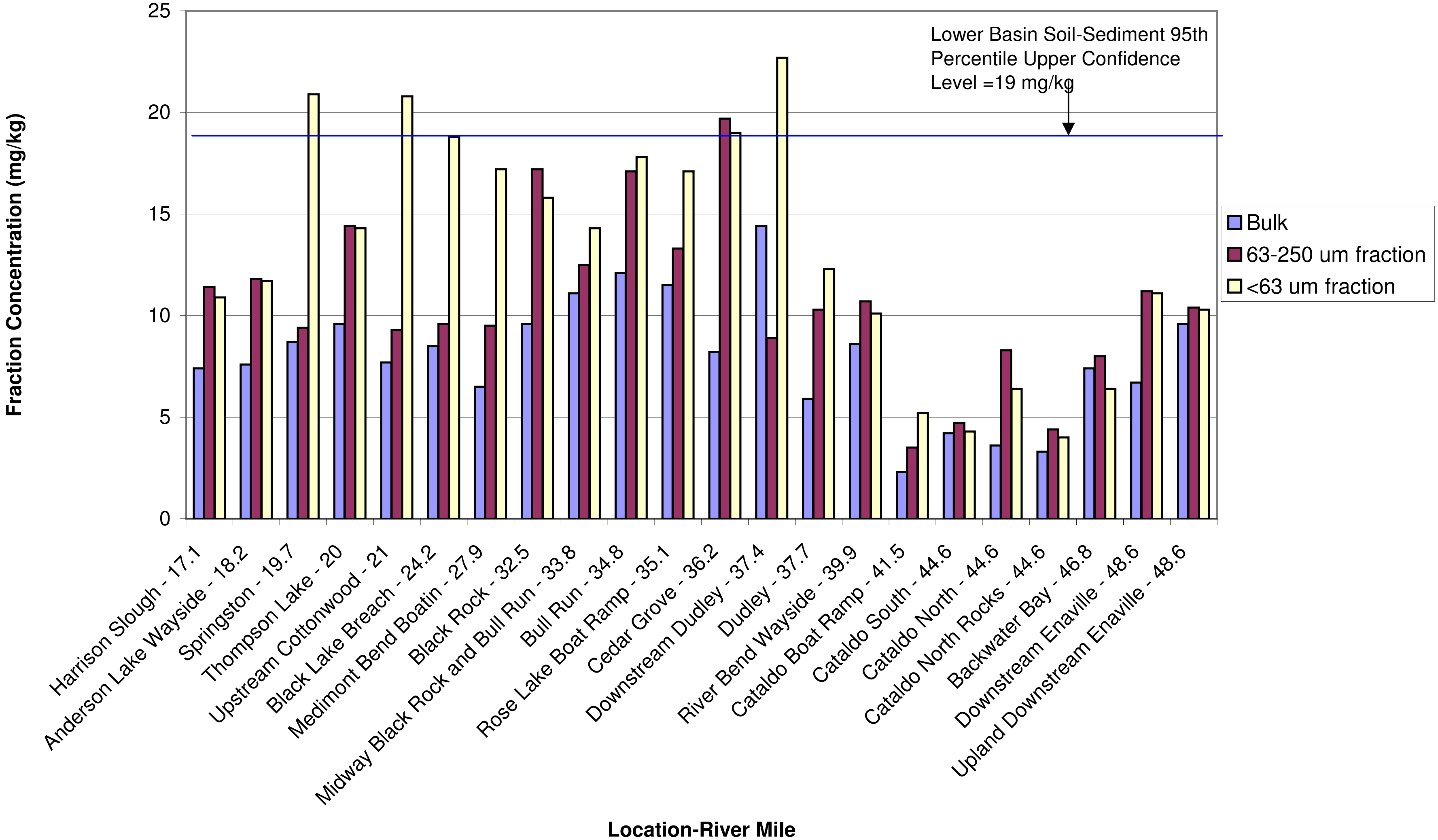
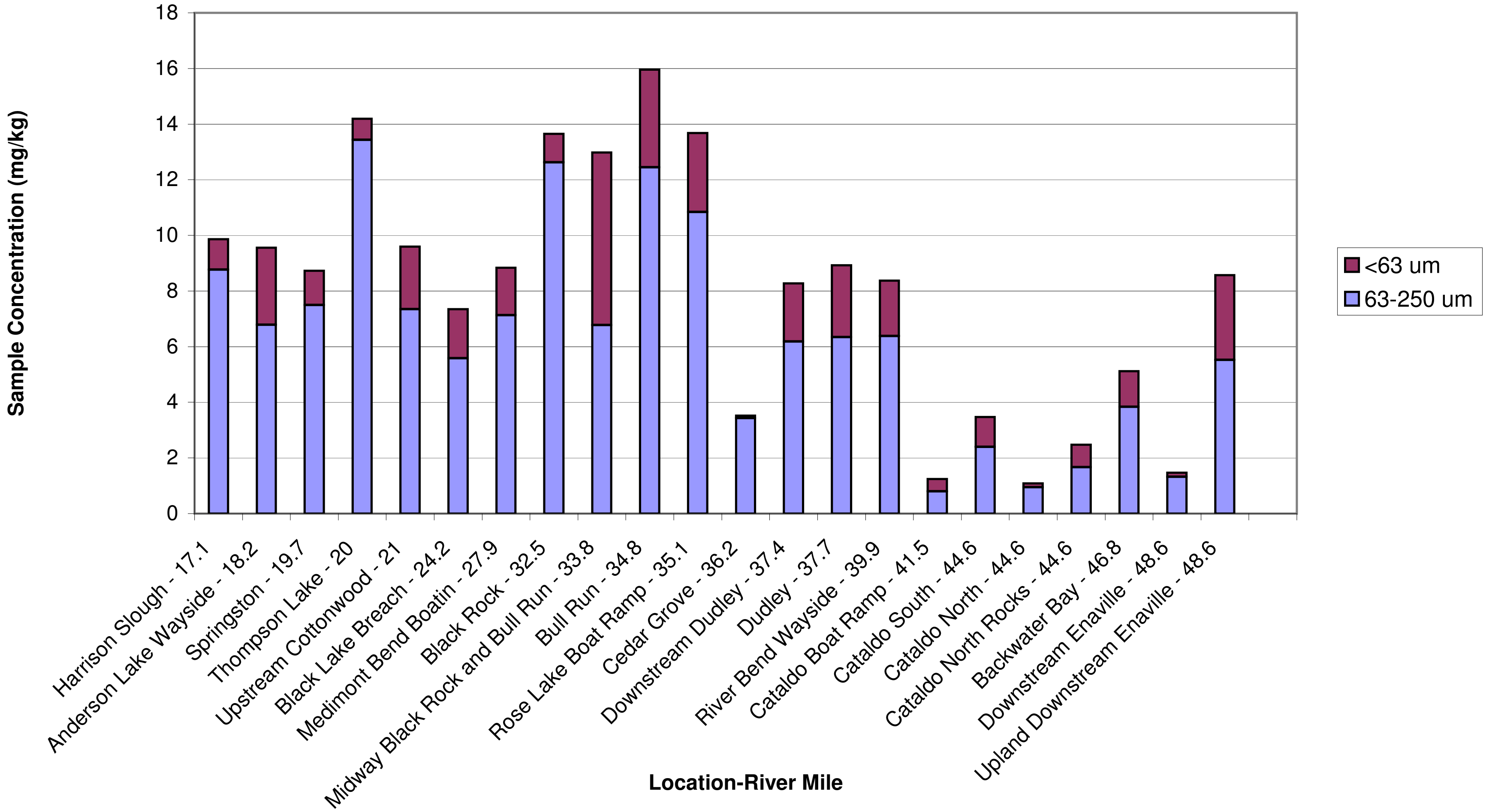


Figure 18. 2008 LBCDR Opportunistic Sediment Sampling
Silt and Sand Contribution to Silver Concentration



Note: The contribution was calculated by multiplying each mass fraction concentration by the corresponding mass percentage.

Figure 19. 2008 LBCDR Opportunistic Sediment Sampling Zinc Concentration by Size Fraction

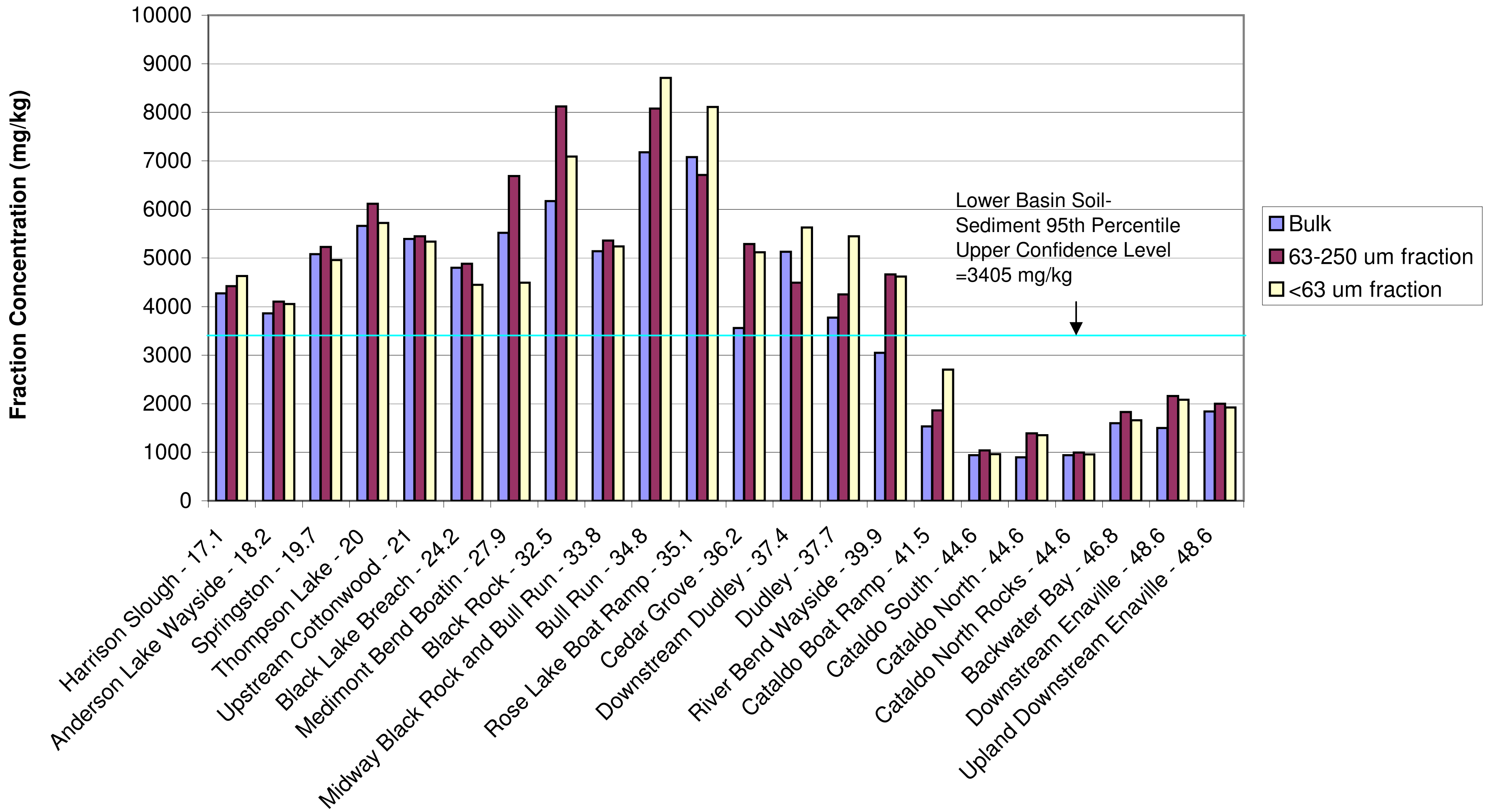
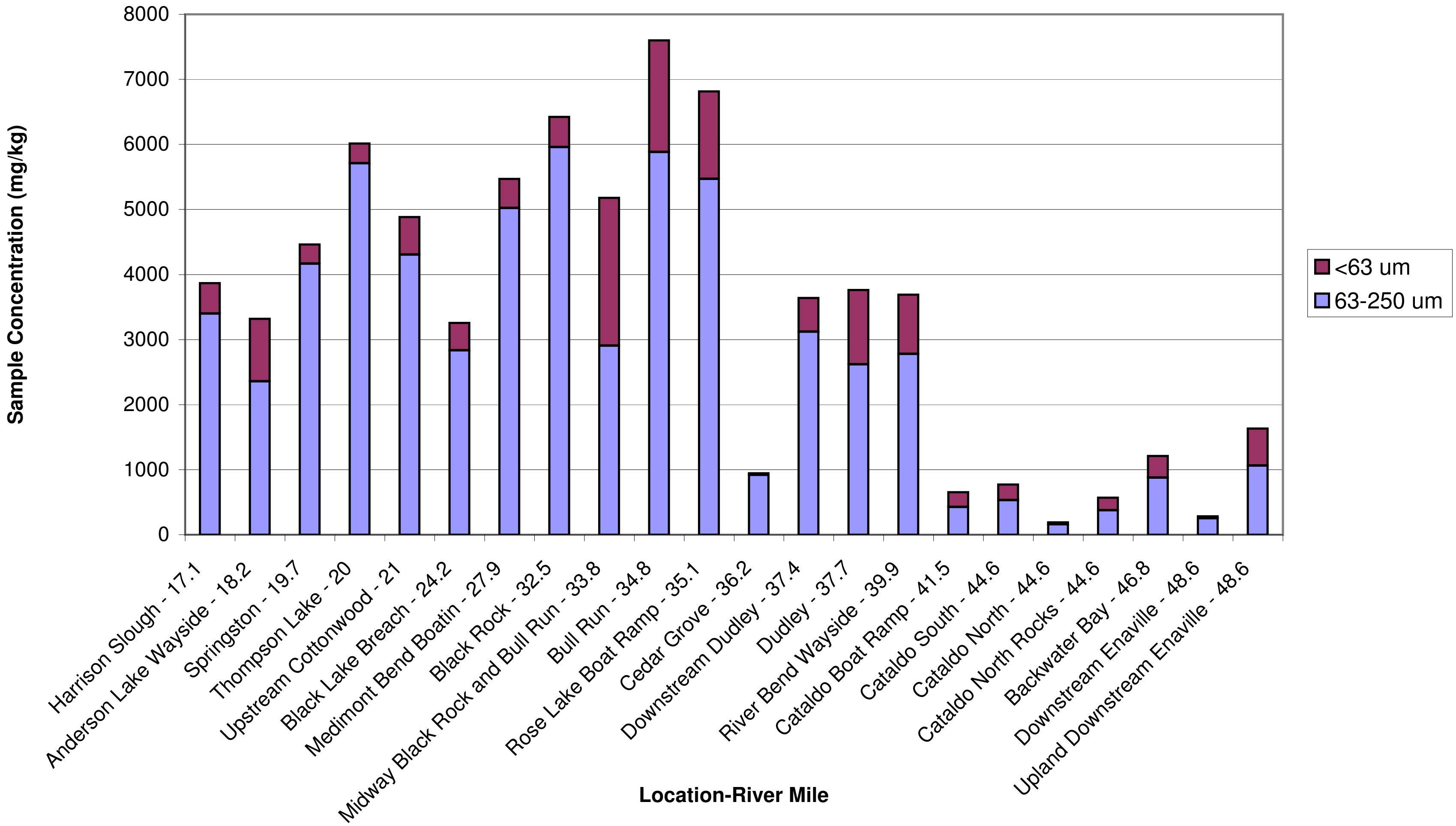
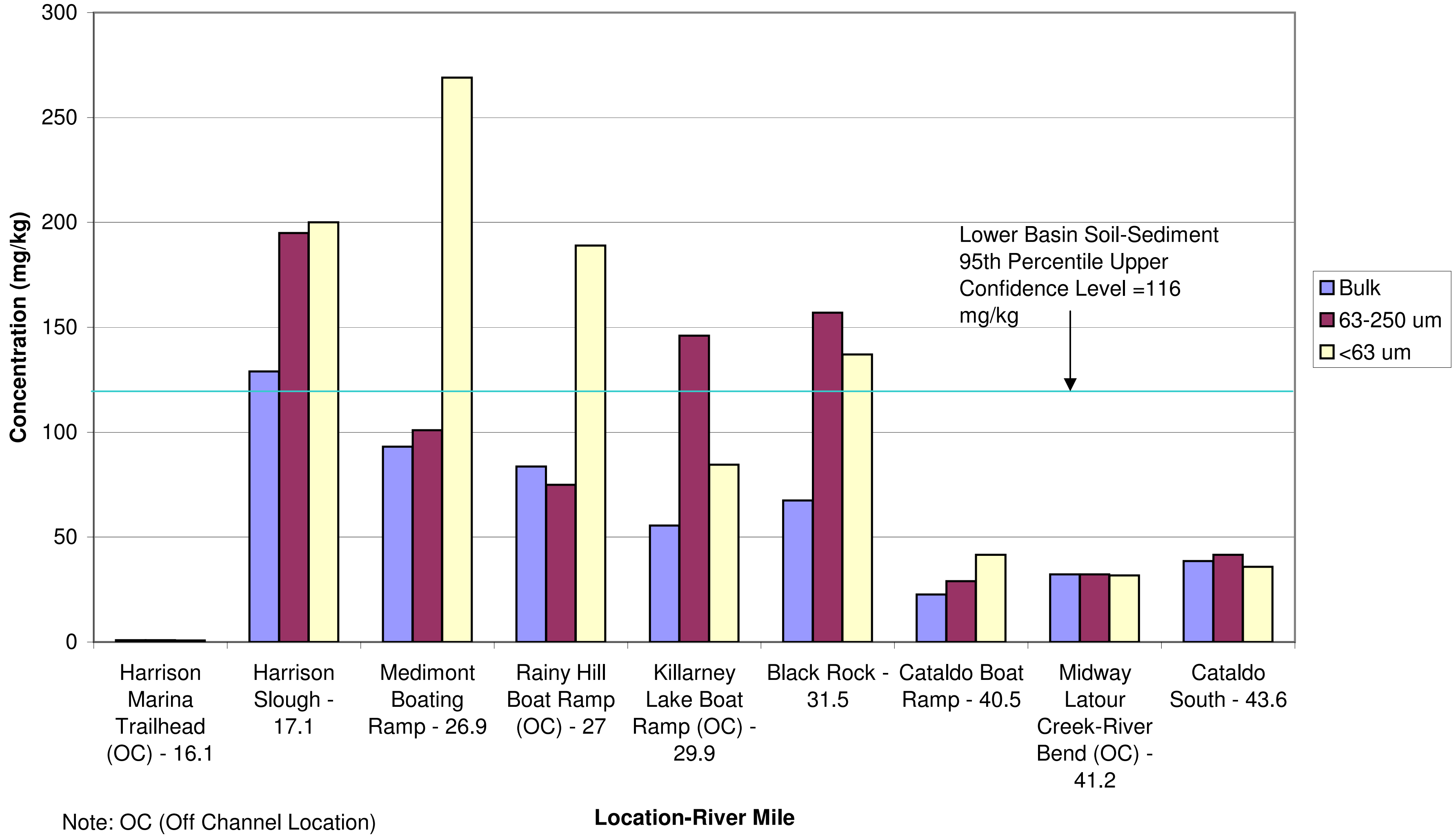


Figure 20. 2008 LBCDR Opportunistic Sediment Sampling Silt and Sand Fractions Contribution to Zinc Concentration



Note: The contribution was calculated by multiplying each mass fraction concentration by the corresponding mass percentage.

Figure 21. 2008 LBCDR Opportunistic Sediment Sampling
Arsenic Concentration by Size Fraction



Note: OC (Off Channel Location)

Figure 22. 2008 LBCDR Opportunistic Sediment Sampling Cadmium Concentration by Size Fraction

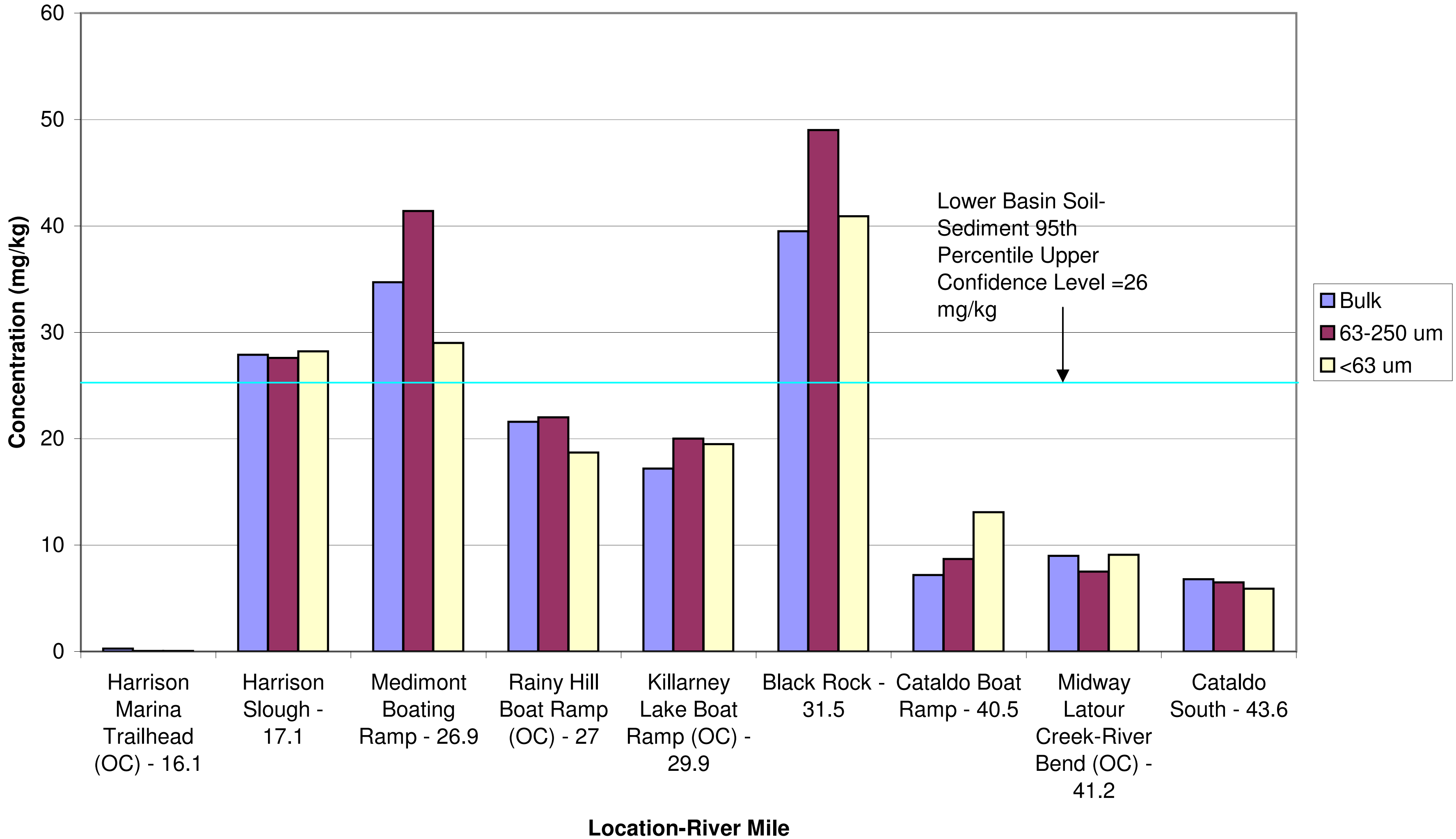


Figure 23. 2008 LBCDR Opportunistic Sediment Sampling
Copper Concentration by Fraction

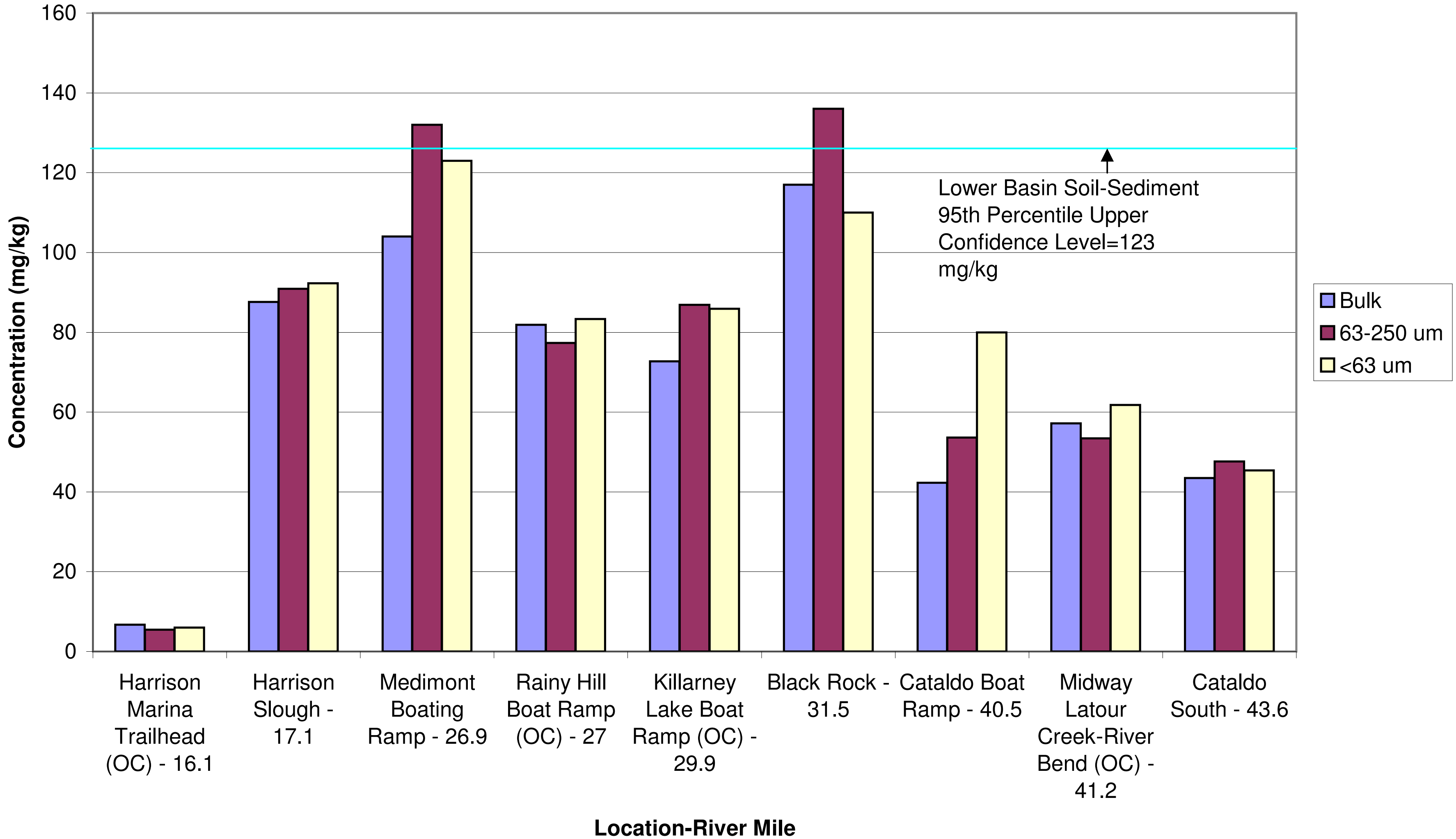


Figure 24. 2008 LBCDR Opportunistic Sediment Sampling Lead Concentration by Fraction

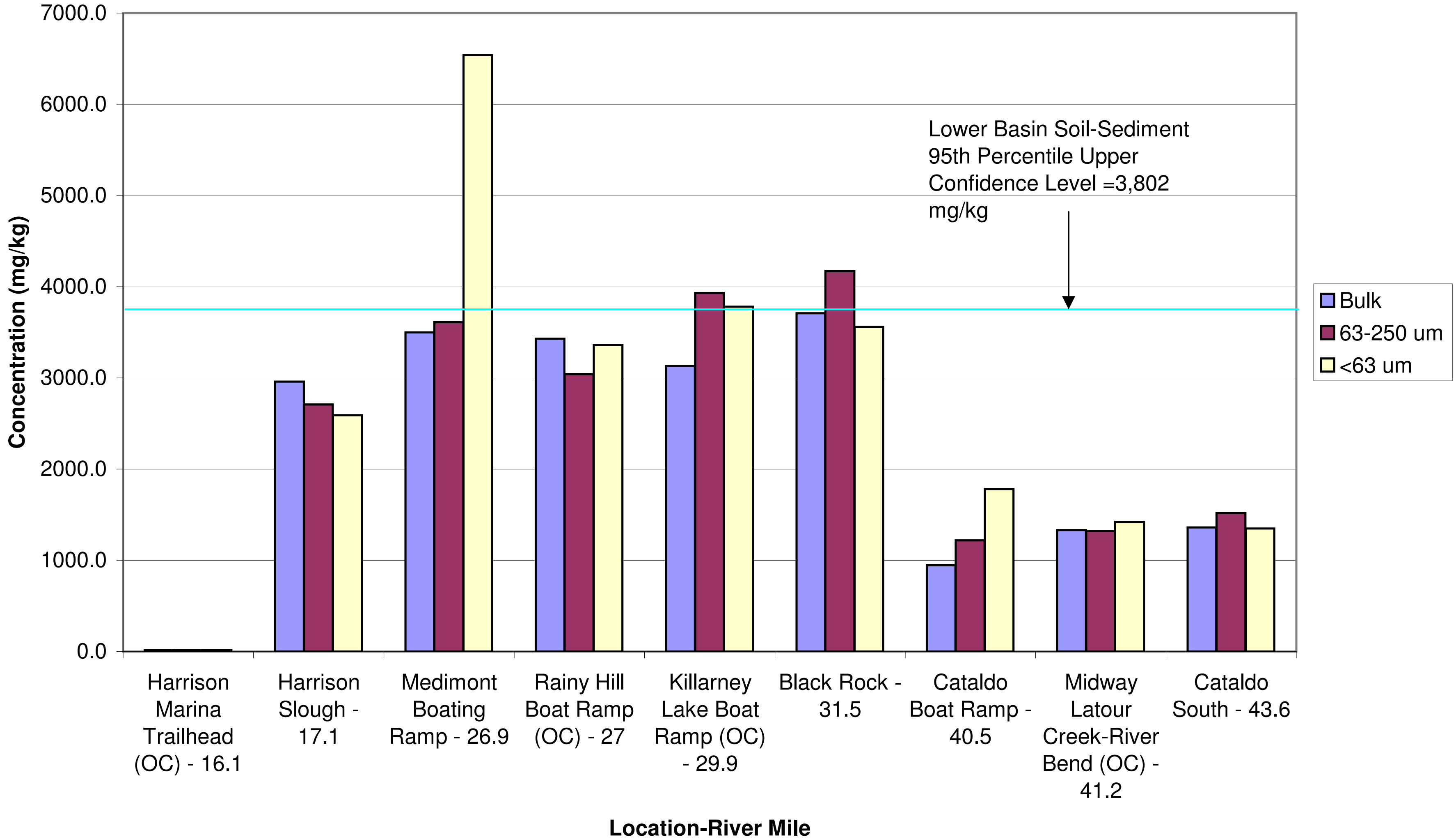


Figure 25. 2008 LBCDR Opportunistic Sediment Sampling
Mercury Concentration by Size Fraction

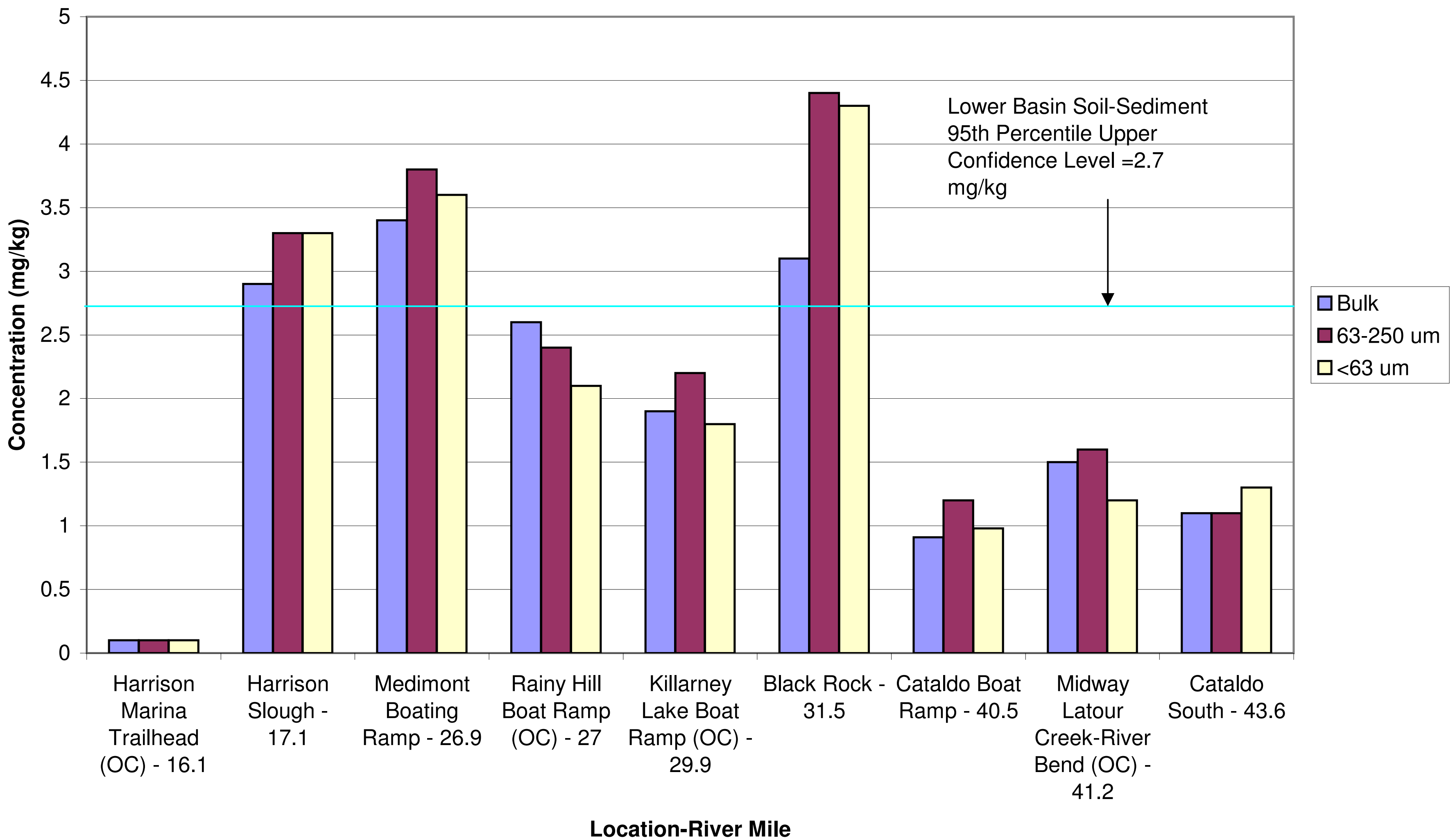


Figure 26. 2008 LBCDR Opportunistic Sediment Sampling Silver Concentration by Size Fraction

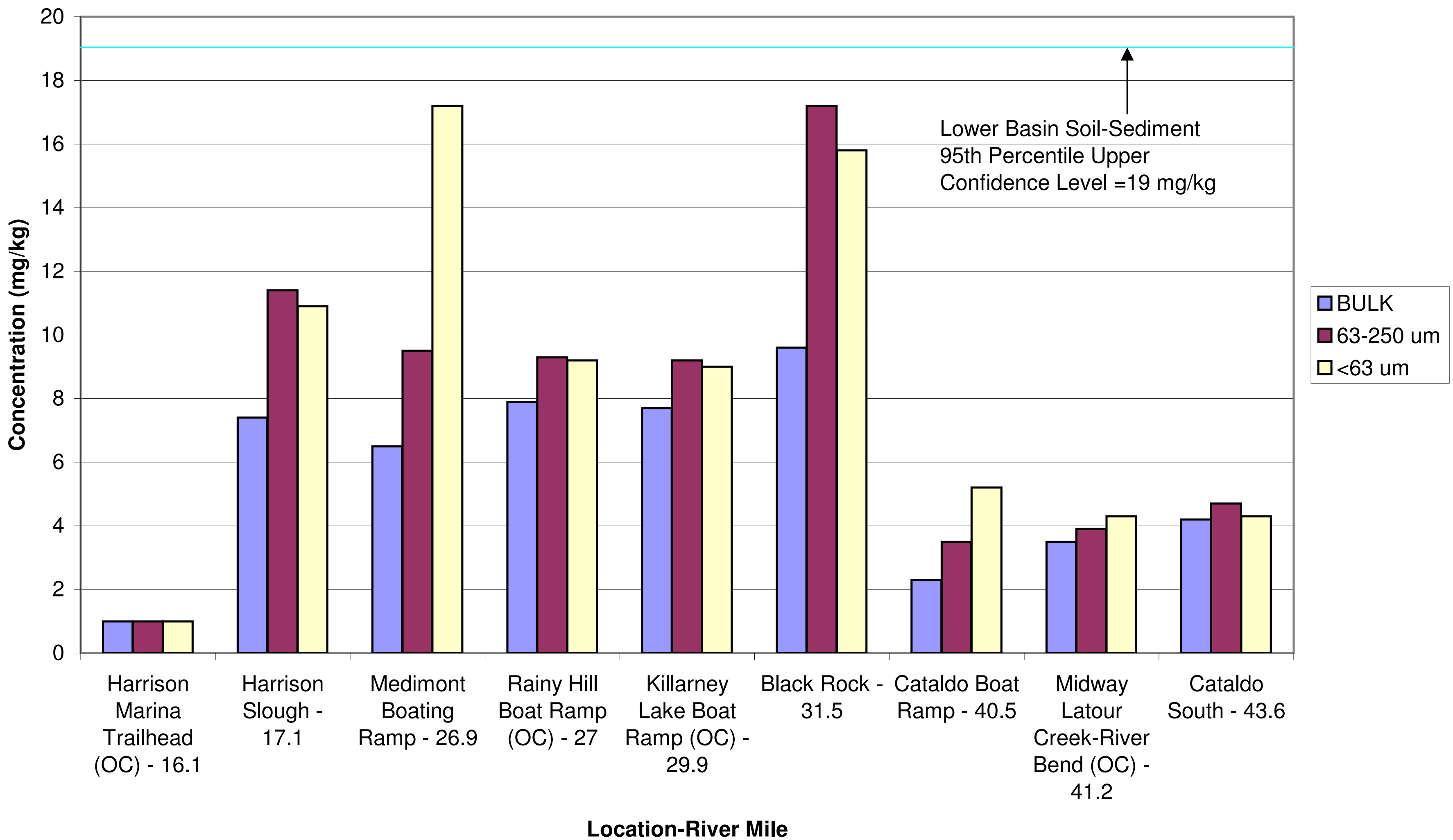
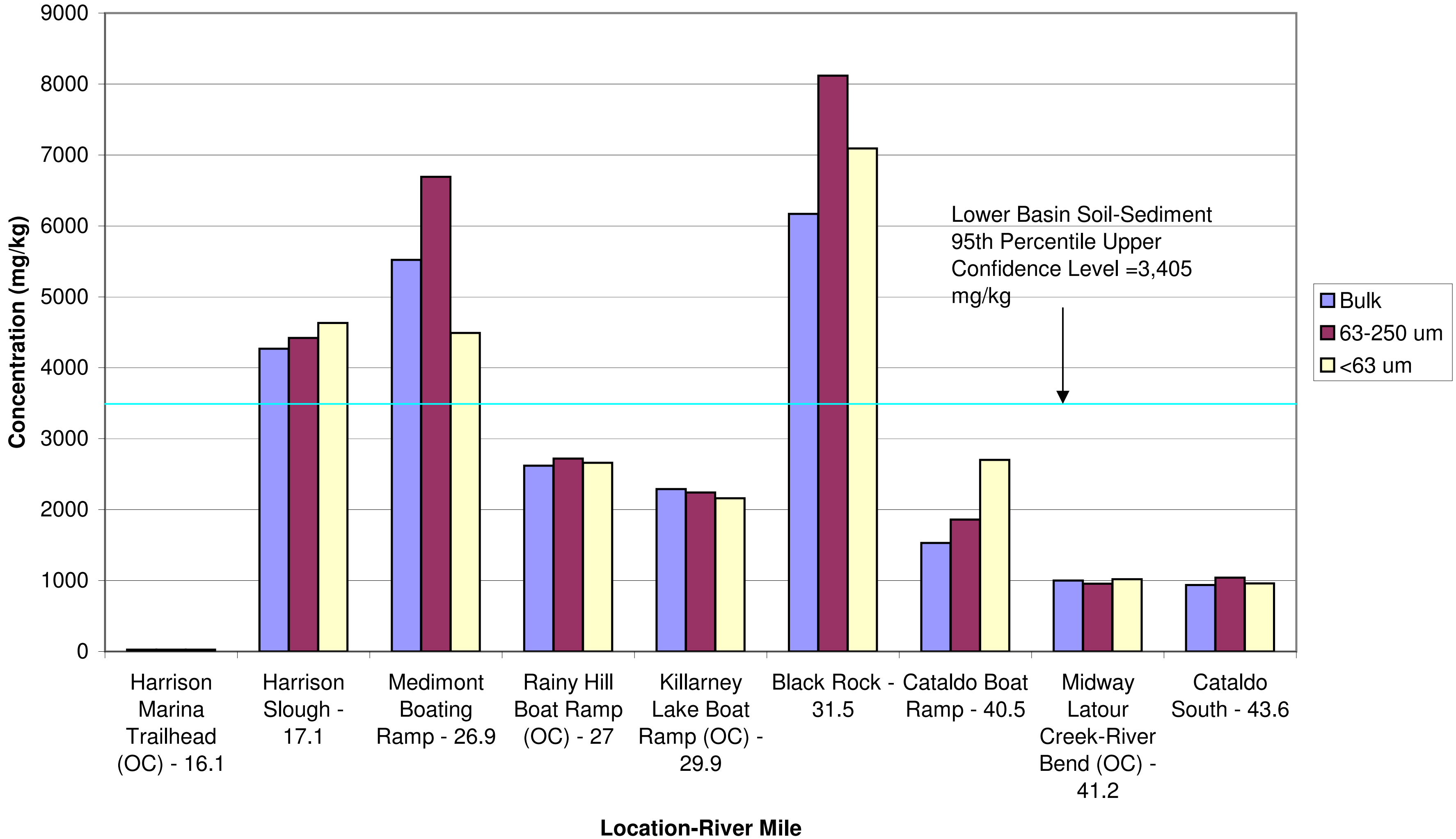


Figure 27. 2008 LBCDR Opportunistic Sediment Sampling Zinc Concentration by Fraction



Attachments

A-1—Harrison Marina Trailhead

A-2—Harrison Slough

A-3—Anderson Lake Wayside.

A-4—Springston

A-5—Thompson Lake

A-6—Upstream Cottonwood


A-7—Black Lake Breach


A-8—Medimont Boating Ramp


A-9—Rainy Hill Boat Ramp


A-10—Killarney Lake Boat Ramp


A-11—Black Rock


A-12—Midway Black Rock-Bull Run

A-13—Bull Run.

A-14—Rose Lake Boat Ramp.

A-15—Cedar Grove.

A-16—Downstream Dudley.

A-17—Dudley.

A-18—River Bend Wayside.

A-19—Cataldo Boat Ramp

A-20—Midway Latour Creek-River Bend

A-21—Cataldo South

A-22—Cataldo North

A-23— Cataldo North Rocks

A-24—Backwater Bay.

A-25—Downstream Enaville

A-26— Upland Downstream Enaville

Attachment B-Suspended Sediment Loading Analysis

Total suspended sediment transport that occurred during this spring's runoff event (May 2008) was estimated using sediment transport rating curves developed by the USGS (Berenbrock and Tranmer, 2008). A rough, order-of-magnitude approximation of the total sediment deposited (i.e., retained) within the Lower Basin of the Coeur d'Alene River can be coarsely approximated by computing the difference between the incoming sediment load and the load discharging to Lake Coeur d'Alene.

This section will describe the methods applied to develop the sediment loading and approximate the total sediment deposition and routing through the Lower Basin system during the spring 2008 runoff event and the limitations associated with this type of analysis. A more detailed discussion of sediment transport, sediment characteristics, and available data will be presented in forthcoming technical memorandums.

Approach

Berenbrock and Tranmer (USGS 2008) developed relationships between suspended sediment and river discharge using field data collected by USGS. Berenbrock and Tranmer (2008) used the same procedures as Clark and Woods (USGS 2001) to develop a revised relationship, herein referred to as sediment transport curves, at each of the three USGS gaging stations that bound the Lower Basin (Harrison at the downstream end and Enaville and Pinehurst at the upstream ends). Further details describing methods used by the USGS are included in Berenbrock and Tranmer (USGS 2008).

Input Data

The total suspended sediment load can be approximated from these sediment transport curves by applying the equations for these curves to the mean daily discharge data collected at the USGS gaging stations during the May 2008 event. Mean daily discharges recorded at the USGS gaging stations (Harrison, Enaville, and Pinehurst) are shown in Figure 1. The May 2008 runoff event was initiated by above average snow pack which led to above average flows during the annual spring snowmelt cycle. River discharge began rising markedly around 4/14/2008, and flows returned their previous level by 7/2/2008 (at Harrison) with the highest daily flows occurring between 5/18/2008 and 5/21/2008. The maximum mean daily flows recorded at each station are summarized in Table 1.

Figure 1

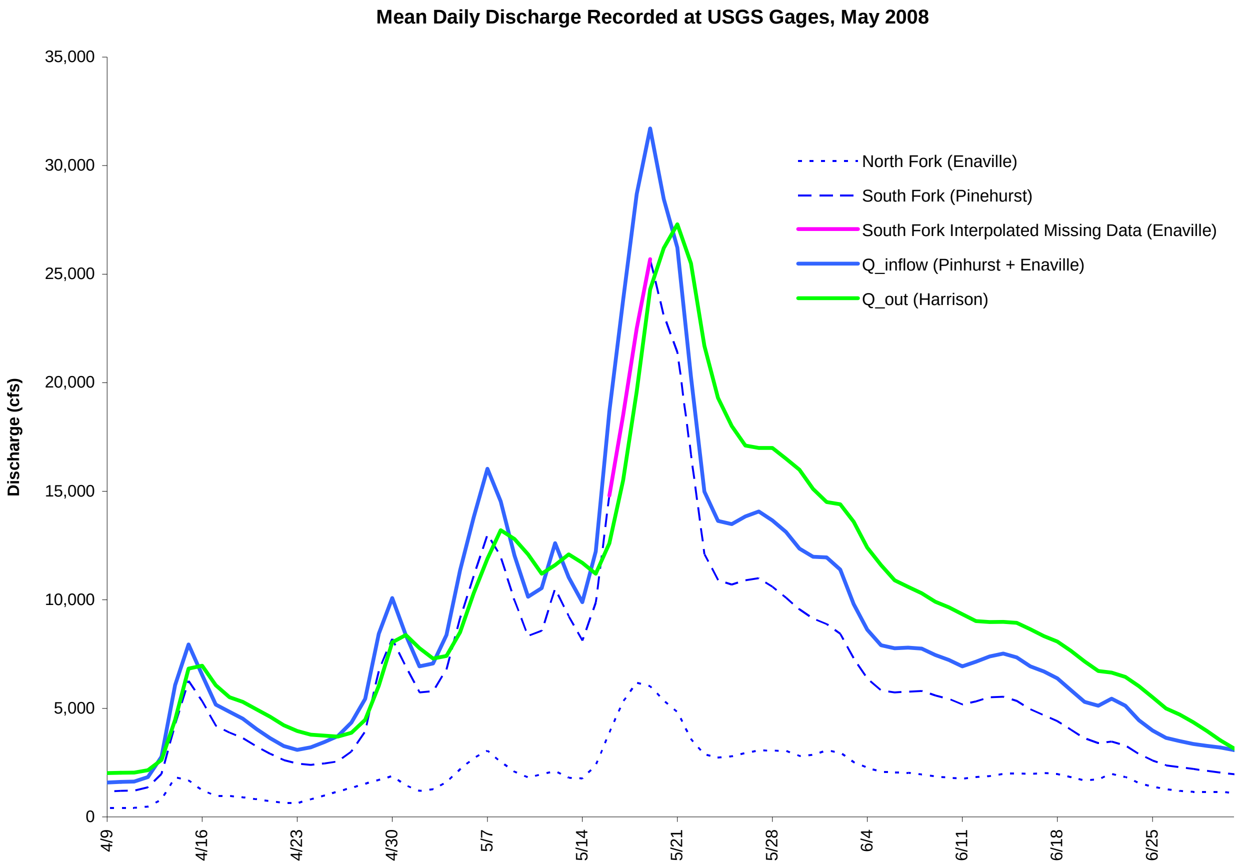


Table 1

Gage	Date of Maximum Mean Daily Discharge	Maximum Mean Daily Discharge
South Fork (Pinehurst)	5/18/2008	6,190
North Fork (Enaville)	5/19/2008	25,700
Combined N. Forth and S. Fork	5/19/2008	31,720 [1]
Lower CDA (Harrison)	5/21/2008	27,300

1 – This value does not sum to the peak from North Fork and South Fork because the respective peak flows occurred at different times.

Estimated Sediment Transport Rates in Spring 2008

The total amount of suspended sediment flowing into and out of the Lower Basin was estimated by summing the daily load at each station over the duration of the runoff event. The amount of material deposited in the Lower Basin was estimated by computing the difference between the total mass of suspended sediment entering the Lower Basin (North Fork and South Fork combined) and the mass leaving the Lower Basin at Harrison. The resulting sediment discharge computed at each of the gaging stations is shown in Figure 2, and the cumulative total mass at each station is summarized in Table 2.

Figure 2

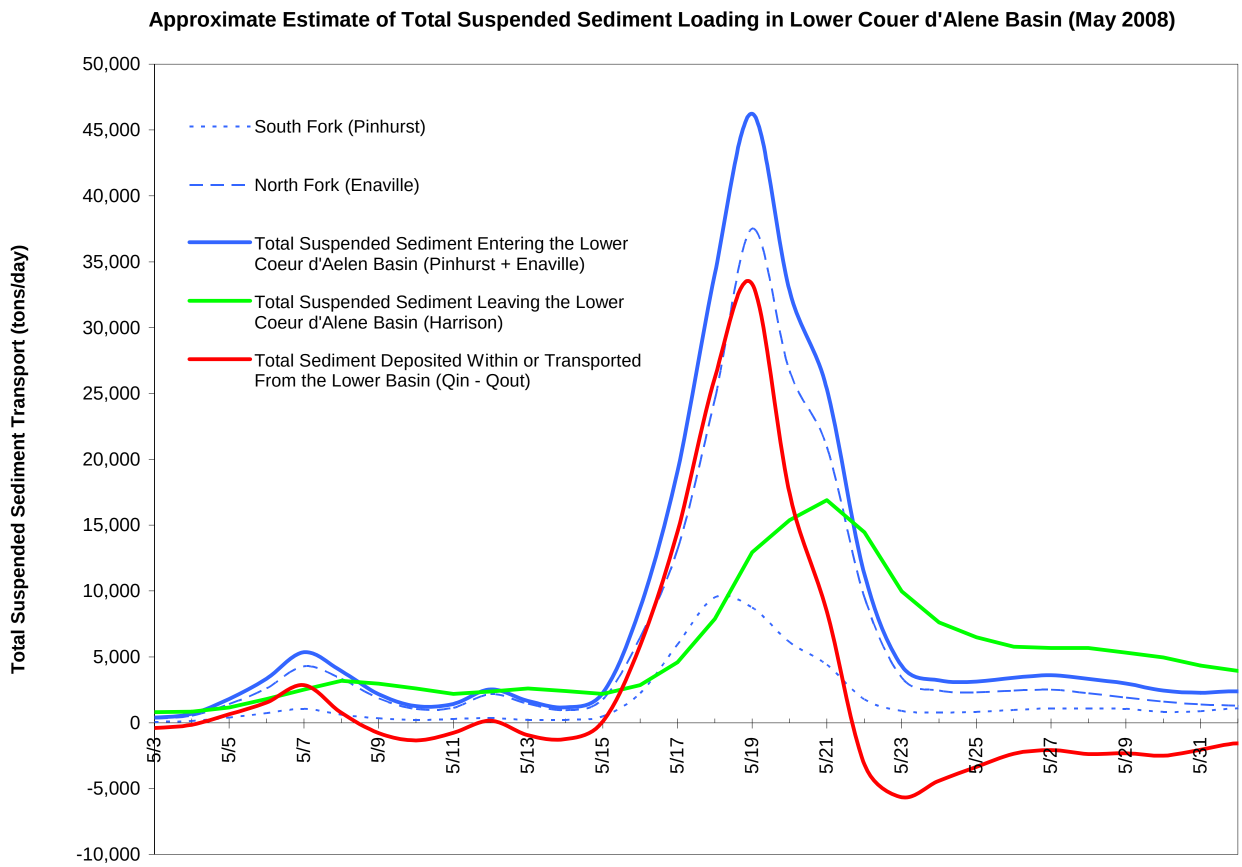


Table 2

Gage	**Total Cumulative Suspended Sediment (tons) [4/14/02 – 7/2/2008]**	**Peak Daily Load (tons/day)**
South Fork (Pinehurst)	62,000	10,000
North Fork (Enaville)	193,000	38,000
Combined N. Forth and S. Fork	255,000	48,000
Lower CDA (Harrison)	208,000	17,000
Estimated Total Deposition in the Lower Basin	48,000	-

In Figure 2, the red line is the average difference between the incoming and outgoing total suspended sediment loads on a daily basis. A positive value indicates the estimated amount of deposition in the Lower Basin, and a negative number indicates the estimated amount of sediment transported out of the Lower Basin. This analysis does not account for the timing (i.e., duration) of deposition or erosion in the Lower Basin, a process that could take several days. This means that the red line can not be used to estimate the daily mass of sedimentation or erosion, it must be applied over a specific period of time, in this case the reported values are based on the period from 4/14/08 to 7/2/2008. A hydraulic and sediment transport model would help to analyze factors such as retention time. This mass balance analysis merely represents an approximate sediment budget, an accounting of sediment mass within the Lower Basin.

Results from the sediment budget analysis indicate that 48,000 tons or 96 million pounds of suspended sediment were deposited within the Lower Basin between 4/14/2008 and 7/2/2008.

Comparison of 2008 to an "Average Year"

To provide a reference for the order of magnitude of the 2008 event relative to previous years, these same sediment transport curves were applied to the historical average daily flow based on the period of record for each of the three gages. The period of record varies widely, and therefore affects the validity of this analysis for a given gage. Seventy years of data are available for Enaville, but only 20 years are available for Pinehurst and just 3 years at Harrison. (Typically, at least 20 to 30 years of record are required for statistical confidence working with gage data.) Figures 3 through 5 compare the 2008 event to an "average year" in terms of river discharge and suspended sediment load for each of the three gages, Harrison, Pinehurst, and Enaville, respectively.

Figure 3

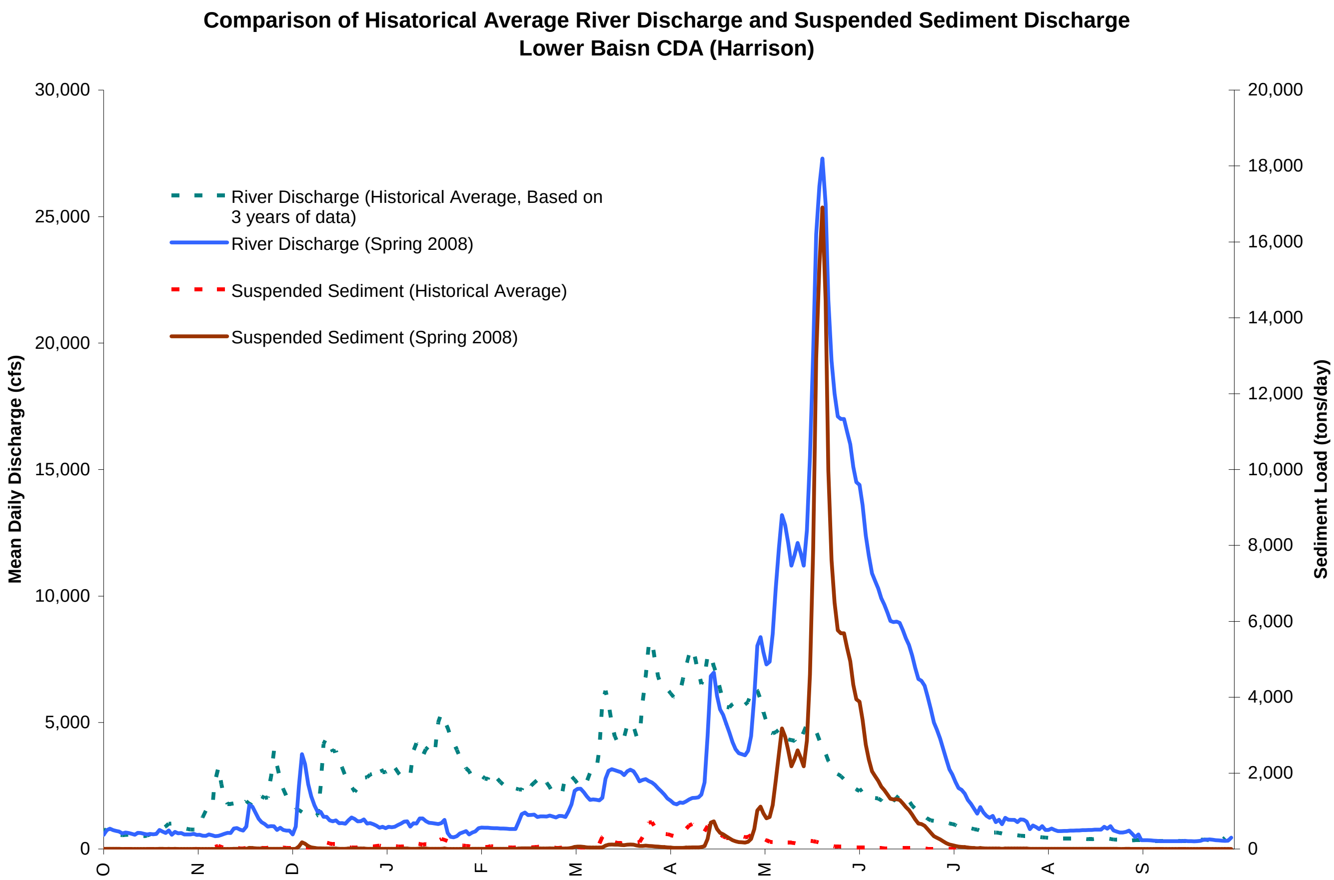


Figure 4

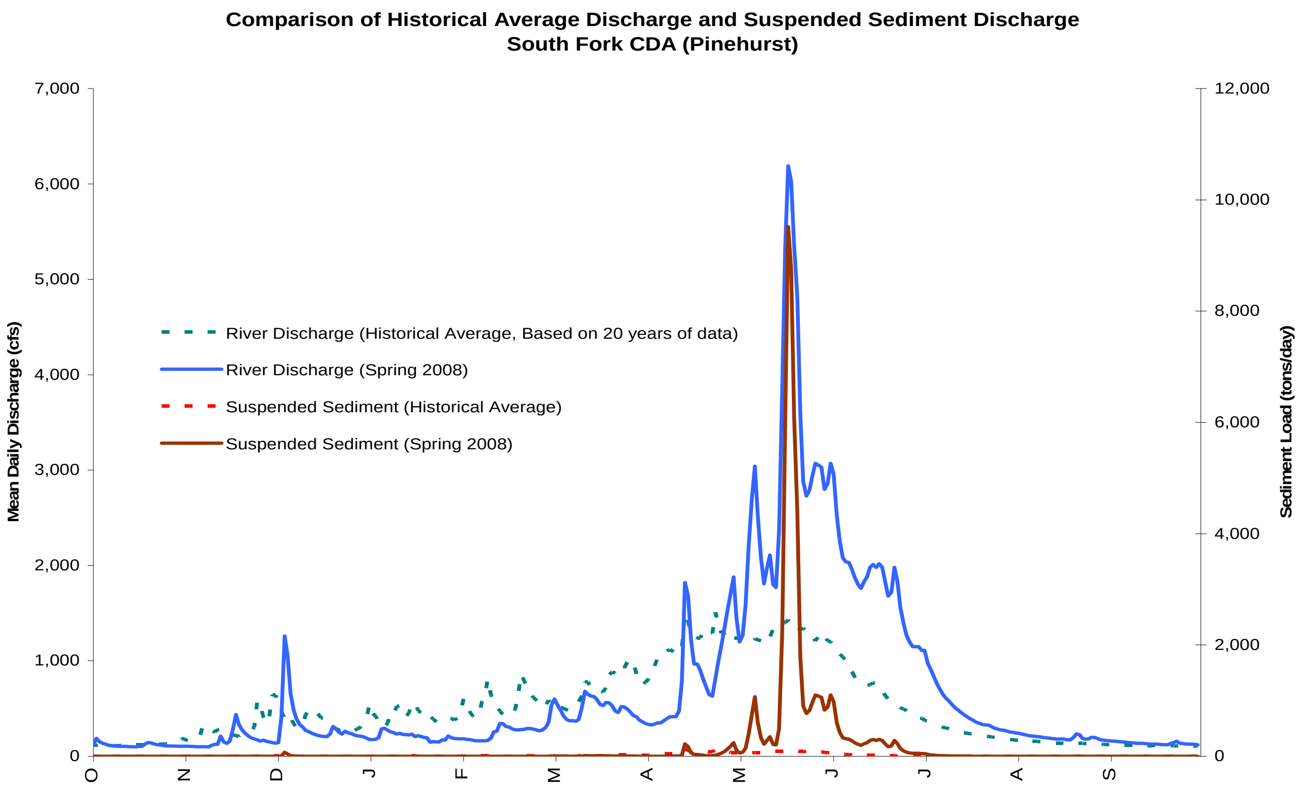
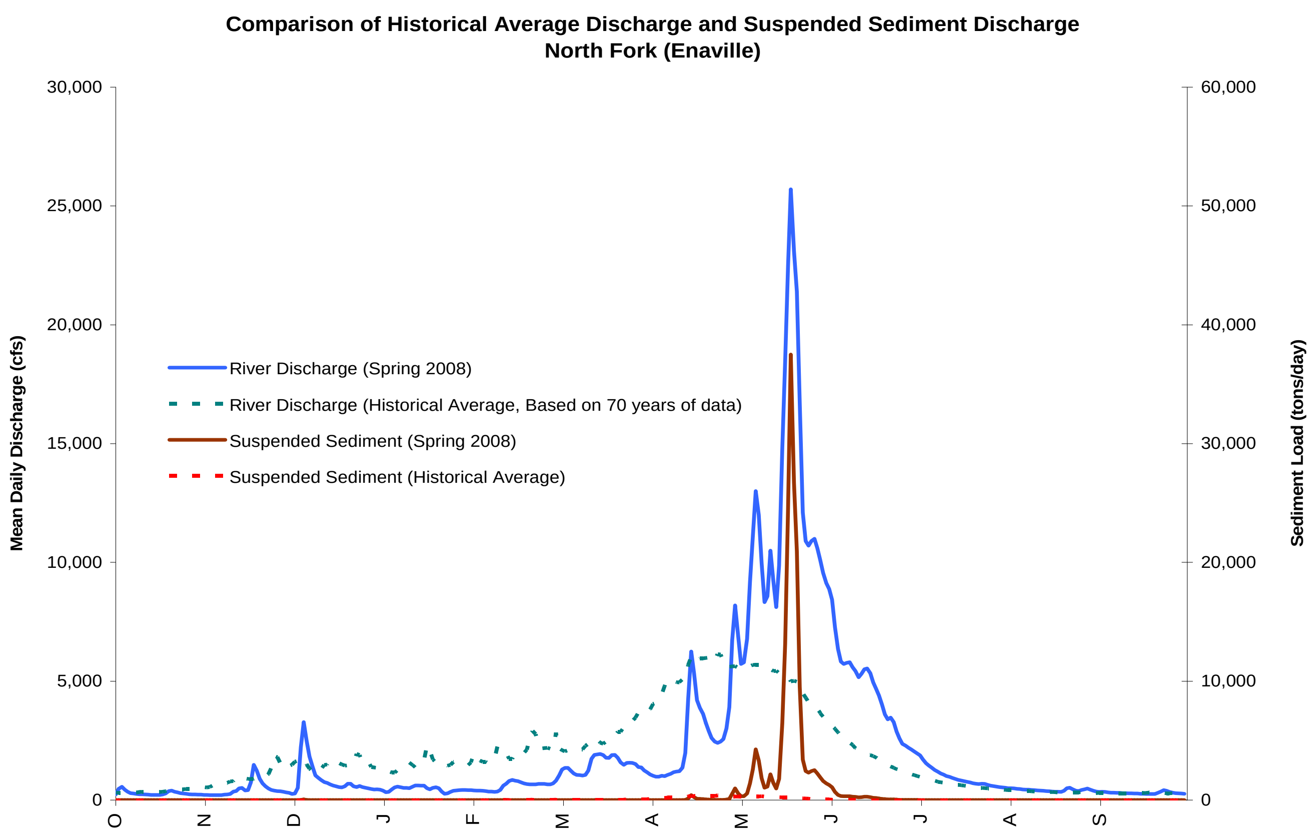


Figure 5



Summing the total sediment transport over the entire water year provides a way to compare the total volume transported in Water Year 2008 (WY 2008) to other water years at an individual gage. Based on 20 years of data from the Pinehurst gage, this comparison suggests the South Fork transported 10 times more sediment in WY 2008 compared to an average year. Based on 70 years of data at the Enaville gage, the North Fork transported 11 times more sediment in WY 2008 compared to an average year. The Coeur d'Alene River at Harrison transported four times more sediment in WY 2008 compared to the average of volume from WYs 2005 to 2007. These figures illustrate the exponential nature of sediment transport, and the volume of transport that can occur during large events.

Limitations of Approach and Implications on Findings

This analysis approach includes several important limitations summarized here. In addition to sampling and measurement errors inherent in any data collection, the primary limitations include lack of representativeness with the input data, failure to account for all possible sediment sources, and uncertainty associated with the sediment transport curves. Each of these limitations has an effect on the findings of this analysis.

First, the sediment input data to the sediment transport curves includes only suspended sediment. No bed load measurements of sediment were collected during spring 2008. Therefore, the sediment discharge calculations underestimate the total sediment routed into and out of the Lower Basin. However, the bed load fraction is much smaller than the suspended sediment contribution. The bed load fraction is typical less than 10% of the total load in this region of the country.

Second, this approach does not account for additional sediment sources in the Lower Basin downstream of the Enaville and Pinehurst gages. These sediment sources include tributary inputs (i.e. Latour Creek, Forth of July Creek, etc.) as well as sediment mobilized from the channel bed, banks, and floodplains. The effect of these sources on the final calculations of sediment deposition is difficult to estimate. Future data collection, such as repeat surveys (e.g., ground and LiDAR) at key locations to monitor and document changes, would help address this limitation.

Third, the origin of the sediment predicted to be leaving the system is unknown. The sediment could be from the North and/or South Fork, mobilized within the Lower Basin, or from tributaries with in the Lower Basin. Future data collection may help to distinguish the sources.

Fourth, uncertainty with sediment transport curves contributes to uncertainty in calculations and conclusions. For a number of reasons, at the same water discharge, the sediment transport rate is typically much greater in the rising limb of a hydrograph than in the declining limb. This situation, called hysteresis, occurs in individual events and over the course of a full runoff season, and it is one reason why scatter is observed in the measured field data for suspended sediment. The sediment transport curves are a line of best fit through the scattered data and are interpreted as an average transport rate for a given flow. However, the actual transport rate depends on available sediments (size and supply), not solely river discharge. Despite this limitation, using sediment transport rating curves to predict the movement of sediment for a given flow is standard practice.

Comparison of Rating Curves to Field Measurements

To ground-truth the sediment rating curves, a comparison was made between measured suspended sediment concentrations collected by USGS during the Spring 2008 event, to the computed values suspended sediment transport rates based on the sediment rating curves. This is a useful check, but it can only be applied over a single day in which the sample was collected (May 18 and 19). This comparison can not be extrapolated to estimate the total sediment load over the duration of the entire event.

Results from this single day of field measurements suggest that the rating curves for Enaville (North Fork) and Pinehurst (South Fork) may each be over predicting the actual sediment load, at least at extreme high flows. In contrast, at Harrison, the single day of field measurements suggests the sediment rating curve may be under predicting suspended sediment load at high flows. There is uncertainty associated with this comparison. The limitations described above apply to this comparison, especially the fact that the rate of sediment transport varies throughout a runoff event and is a function of more factors than just discharge. The results are summarized in Table 2 and shown graphically in Figures 6 through Figure 8.

As can be seen in the figures below, the measured data does not plot directly on the sediment loading curves. The reasons for this were described earlier and this is a typical phenomenon observed with measurements suspended sediment data. One of the main reasons for this is the influence of hysteresis as described above; other reasons scatter or variability include the type of sampling methods used (depth integrated sample vs grab sample) and cross channel variability (i.e. where the sample was taken: mid-channel, quarter points, etc.). While acknowledging variability, one can still make an estimate of the suspended sediment mass and compare it to the values computed from the curves which account for a more average condition. Results of this comparison show that for a single day when the measurement was taken, the incoming load appears to be overestimated and the outgoing load appears to be underestimated. However, as stated previously, these results should not be extrapolated beyond this single day. And, this approach can not be used to estimate the effect this has on the total deposition or erosion that may have occurred in the lower basin because of the effects of residence time as described in the Limitations of Approach and Implications on Findings section of this document.

Table 3

		Estimated Total Suspended Sediment		
Gage	**Date**	**Calculated from Rating Curves (tons)**	**Calculated from Field Sample Data (tons)**	**Difference [Curve - Field Data] (tons)**
Enaville (North Fork)	5/18/2008	25,000	12,000	13,000
Pinehurst (South Fork)	5/18/2008	10,000	6,000	4,000
Total Inflow (North Fork + South Fork)	5/18/2008	34,000	18,000	16,000
Harrison (Lower Basin CDA)	5/19/2009	13,000	27,000	-14,000

Figure 6

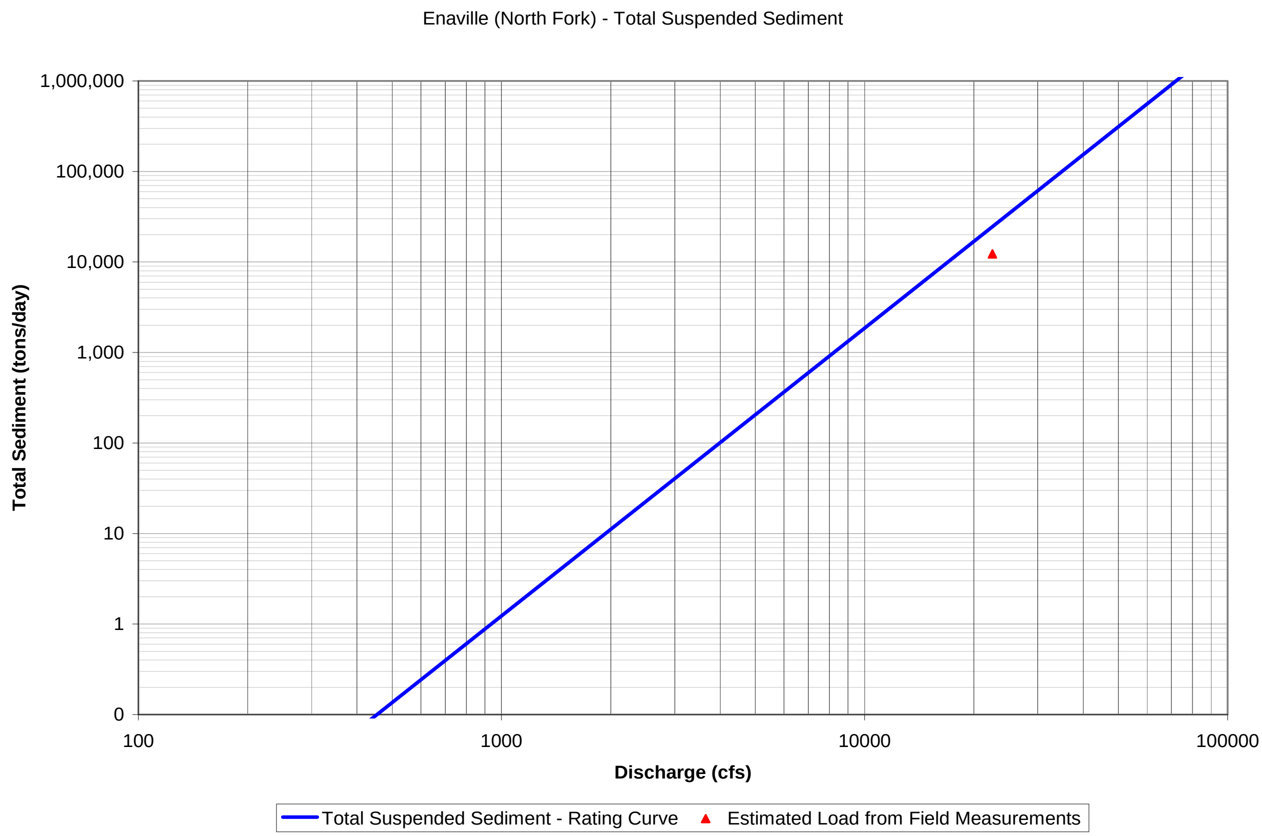


Figure 7

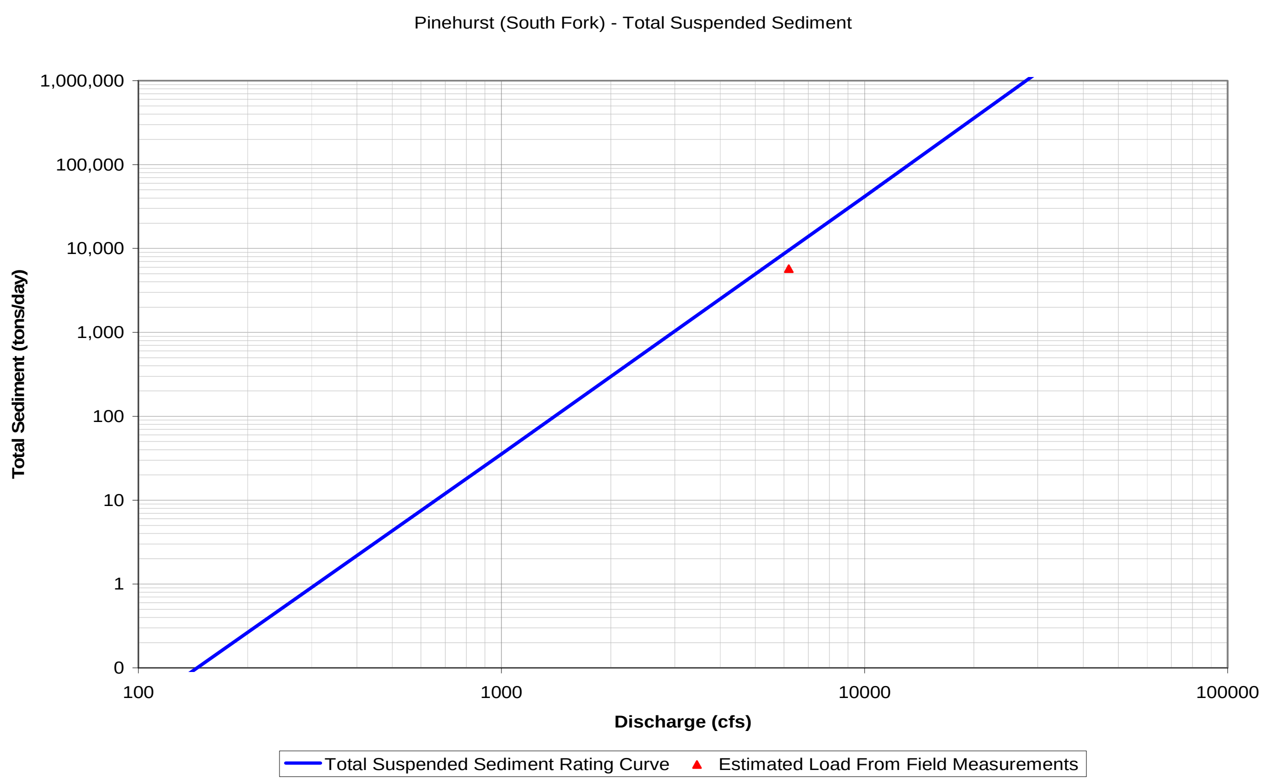


Figure 8


Harrison (Lower Basin CDA) Total Suspended Sediment
1000000
100000
10000
1000
100
10
1
0.1
Total Sediment (tons/day)
100
1000
10000
100000
Discharge (cfs)
Total Suspended Sediment Rating Curve
Estimated Load From Field Measurement